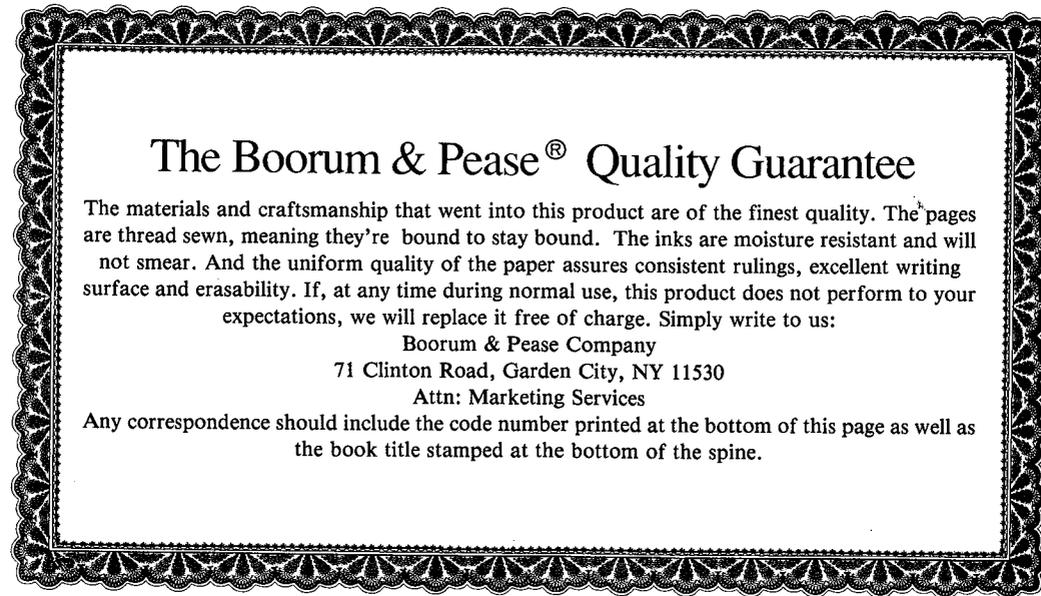


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Scientific Notebook
#120-Tectonic Research
Project

Tectonics Research Project
Paritra Ramanyan / D Ferrill SWRI
6220 Culebra Road SA TX 78238
210- 522-5254



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09-01-94

Project Title - Tectonics Research 20-5704-163
P.I.: David Ferrilli S. Young

Objective: To analyze Landsat Thematic Mapper satellite data to monitor / Identify Earth Resources: specifically gold and uranium.

Current tasks include making an interface between the user and the system (the Silicon Graphics computer named Performer) such that the user could invoke the driver for the image classifying software from the command line.

The next task would be to create appropriate displays for the input image files and processed output files. The final tasks include writing Image processing software.

Programming language: C++.

Platform: ONYX (The UNIX operating system of the Silicon Graphics (SIC)).

Paundra Ramanyan

09-01-94

09-02-94

The program to process remotely sensed Thematic Mapper Images is designed to be invoked from the command line.

The name of executable is "tm_proc" and is in directory "bin"

The command line syntax, which describes the exact manner in which tm_proc can be invoked from the command-line and be used for various image processing and analyzing operations;

is described below below:

commandline_syntax.txt

Page 1

This demonstrates examples of how the program tm_proc could be invoked from the command line to process image data and classify it in terms of specific Earth Resources

I. General Syntax

1. To Perform Band Ratioing:
The following commands should be typed in from the command line:

```
tm_proc Band_Ratio -i <inputfile1> -i <inputfile2> -o <outputfil
e>
```

2. To perform Merging:

The following commands should be typed from the command line:

```
tm_proc Merge -i <filename1> -i <filename2> -i <filename3>
              (red)          (green)          (blue)
```

To save the results specify an output filename after the inputs are specified:

```
tm_proc Merge -i <inputfile1> -i <inputfile2> -i <inputfile3>
              -o <outputfilename>
```

3. To perform classification:

The following commands should be typed in from the command line:

```
tm_proc Classify_Resources -i <inputfile> -o <classified.rgb>
                          <lower threshold> <upper threshold>
```

4. To display a saved image file on the screen:

Type the following commands from the key board:

```
tm_proc Display -i <filename to be displayed>
```

5. To perform texture analysis for identifying shape parameters:

Type the following commands from the keyboard:

```
tm_proc Circular_Texture -i <inputfile>
                          -o <outputname>
```

Note: If the outputfile is not specified from the command line then the results are displayed on the screen and then destroyed.

6. To find threshold of the classes of interest:

Type the following commands from the keyboard:

```
tm_proc Calc_Ref -i <image file name> <x_offset> <y_offset> <x_size of R
OI> <y_size of ROI>
```

7. To perform various image processing operations

- (i) To perform a pixel by pixel division of two input images:

```
tm_proc Band_Ratio -i <inputfilename1> -i <inputfilename2>
                  -o <outputfilename>
```

- (ii) To perform a threshold operation on an image:

```
tm_proc Threshing -i <inputfilename> -o <outputfilename>
```

R. Pantha

```

(iii) To perform contrast stretching on an image:
      tm_proc StretchImg -i <inputfilename> -o <outputfilename>
(iv) To perform Image inversion:
      tm_proc InvertImg -i <inputfilename> -o <outputfilename>
(v) To perform histogram equalization on an image:
      tm_proc HistEqImg -i <inputfilename> -o <outputfilename>
(vi) To perform conversion from color to grayscale:
      tm_proc Graying -i <colorimgname> -o <outputgraying name>
(vii) To perform pixel by pixel logical ANDing of 2 images:
      tm_proc Anding -i <inputfilename1> -i <inputfilename2>
                    -o <outputfilename>
(viii) To perform pixel by pixel addition of two images:
      tm_proc Adding -i <inputname1> -i <inputname2>
                    -o <outputname>
(ix) To perform correlation of 2 images in fourier domain:
      tm_proc CorrFFT -i <inputname1> -i <inputname2>
                    -o <outputfilename>
(x) To perform classification on an image
      tm_proc Classify_Resources -i <inputfilename>
                                -o <classified image name>
(xi) To make a bitmap region of interest:
      tm_proc bitmapROI -i <inputname> -o <outputname>
(xii) To make a rectangular region of interest:
      tm_proc rectROI -i <inputname> -o <outputname>
                    -x_offset <xoffset from inimage> -y_offset <yoffset from inimag>
                    -size_x <xsize of ROI> -size_y <ysize of ROI>
(xiii) To perform edge detection on an image:
      tm_proc Circular_Texture -i <inimagenam> -o <outimagenam>

```

R. P. Painter

09-03-94

The design of the software intended to process remotely sensed TM data for Earth Resources was made with three stand-alone classes and a main driver program. The driver program drives the three classes to perform various operations specified by the analyst from the commandline interface. R.P.

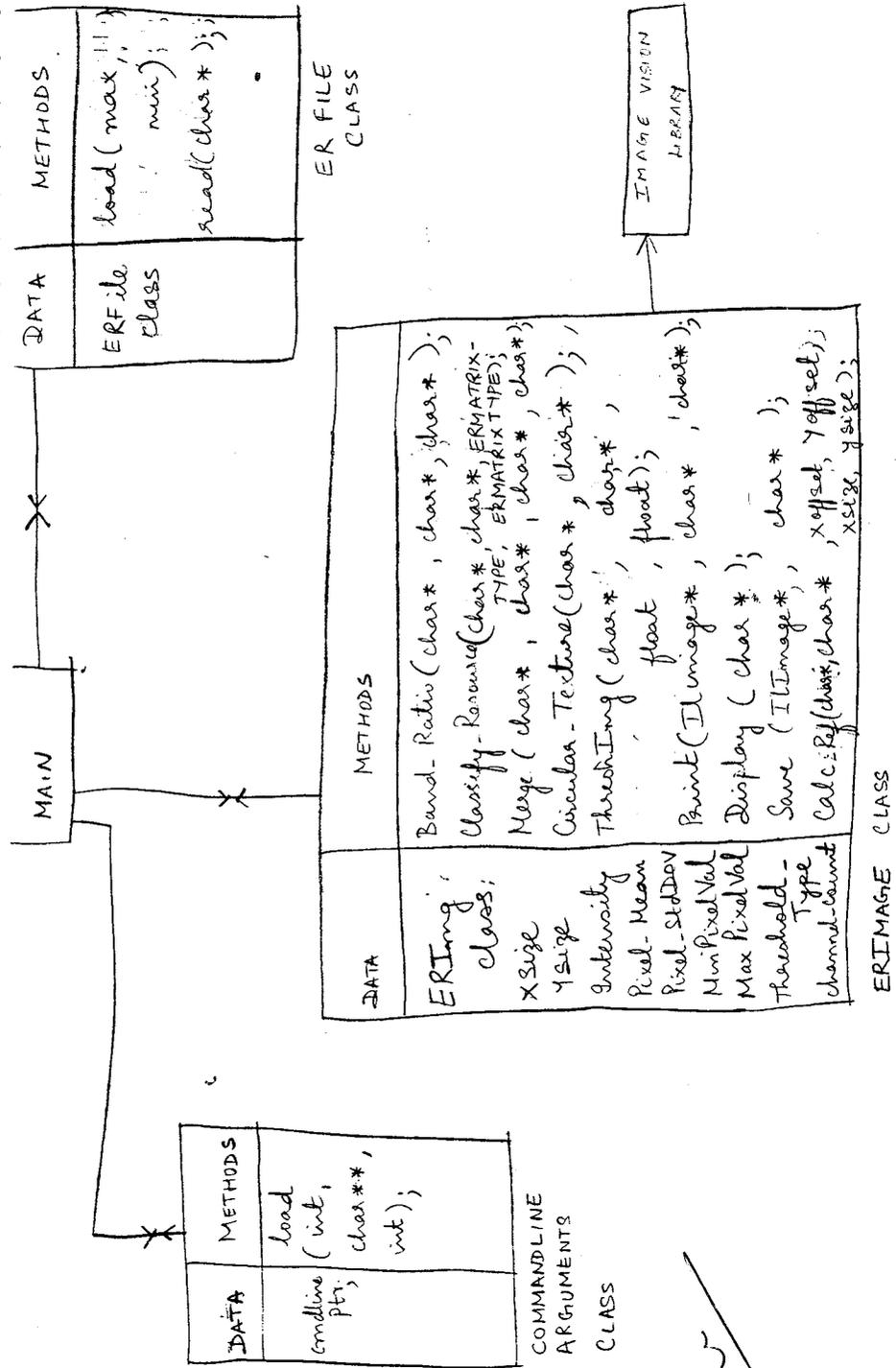
The main program: tm_proc.C++

cmdlinearg.hh/cmdlinearg.C++ → This class reads the commandline arguments and loads the commandline data structure defined in cmdlinearg.hh. This is invoked from tm_proc.C++.

ERImg
R.P.

ERImg.hh/ERImg.C++ → This class performs image processing operations and is invoked from tm_proc.C++. From R.P. tm_proc.C++ calls the appropriate Image operations as specified by the user in the commandline.

ERFile.hh/ERFile.C++ → This class stores threshold intensity values from R.P. R.P. for the various TM data bands in memory and in files.



R. Parth

09-07-94

The main driver program tm_proc.c++ is shown here:

```

tm_proc.c++
Page 1

#include <stdio.h>
#include <stdlib.h>
#include "cmdlinearg.hh"
#include "ERimg.hh"
#include "ERfile.hh"

void main(int argc, char** argv)
{ // begin main
// create commandline data object
Cmdclass CmdObj;
Cmdline_arg* cptr; // assign a pointer to data structure

// create an ERimg class object
ERimgclass ERimgObj;

// create an ERfile object
ERfileclass ERfileObj;

// assign a pointer to ERMatrix data structure type
ERMATRIX_TYPE* ERMatrix = NULL;

cptr = CmdObj.load(argc, argv, 1);

for (int i=0; i<cptr->operatorcnt; i++) { // loop to check all operators
switch(cptr->imgoperator[i]) { // begin switch

case Band_Ratio :
    if (cptr->Inputfilename[0] == NULL) {
        printf("Input file not entered\n");
        exit(0);
    }
    if (cptr->Inputfilename[1] == NULL) {
        printf("Input file not entered\n");
        exit(0);
    }
    if (cptr->Outputfilename[0] == NULL) {
        printf("Output file name not entered\n");
        exit(0);
    }
    ERimgObj.Band_Ratio(cptr->Inputfilename[0], cptr->Inputfilename[1],
        cptr->Outputfilename[0], quiet, noDisplay);

    printf("Image operator: %s\n", cptr->imgoperator[i]);
    printf("Input file 1,2: %s %s\n", cptr->Inputfilename[0],
        cptr->Inputfilename[1]);
    printf("Output file: %s\n", cptr->Outputfilename[0]);

break;

case Merge :
    if (cptr->Inputfilename[0] == NULL) {
        printf("Input file not entered\n");
        exit(0);
    }
    if (cptr->Inputfilename[1] == NULL) {

```

R. Parth

```

printf("Input file not entered\n");
exit(0);
}
if (cptr->Inputfilename[2] == NULL) {
printf("Input file not entered\n");
exit(0);
}
if (cptr->Outputfilename[0] == NULL) {
printf("Output file name not entered\n");
exit(0);
}
ERingObj.Merge(cptr->Inputfilename[0],cptr->Inputfilename[1],
cptr->Inputfilename[2],cptr->Outputfilename[0],
quiet,noDisplay);

printf("Input files 1, 2 3: %s %s %s \n",
cptr->Inputfilename[0],
cptr->Inputfilename[1],
cptr->Inputfilename[2]);

printf("The output file : %s\n",
cptr->Outputfilename[0]);

break;
case ThreshIng:
if (cptr->Inputfilename[0] == NULL) {
printf("Input file not entered\n");
exit(0);
}
if (cptr->Outputfilename[0] == NULL) {
printf("Output file name not entered\n");
exit(0);
}
ERingObj.ThreshIng(cptr->Inputfilename[0],cptr->Outputfilename[0],
cptr->threshval,verbose,noDisplay);

printf("Input file :%s\n", cptr->Inputfilename[0]);
printf("Output file: %s\n", cptr->Outputfilename[0]);
printf("The threshold value: %f\n",cptr->threshval);

break;
case StretchIng:
if (cptr->Inputfilename[0] == NULL) {
printf("Input file not entered\n");
exit(0);
}
if (cptr->Outputfilename[0] == NULL) {
printf("Output file name not entered\n");
exit(0);
}
ERingObj.StretchIng(cptr->Inputfilename[0],cptr->Outputfilename[0],
quiet,noDisplay);

break;
case InvertIng:

```

R. Panthar

```

if (cptr->Inputfilename[0] == NULL) {
printf("Input file not entered\n");
exit(0);
}
if (cptr->Outputfilename[0] == NULL) {
printf("Output file name not entered\n");
exit(0);
}
ERingObj.InvertIng(cptr->Inputfilename[0],cptr->Outputfilename[0],
"verbose,noDisplay");

break;
case HistEqIng:
if (cptr->Inputfilename[0] == NULL) {
printf("Input file not entered\n");
exit(0);
}
if (cptr->Outputfilename[0] == NULL) {
printf("Output file name not entered\n");
exit(0);
}
ERingObj.HistEqIng(cptr->Inputfilename[0],cptr->Outputfilename[0],
quiet,noDisplay);

break;
case GrayIng:
if (cptr->Inputfilename[0] == NULL) {
printf("Input file not entered\n");
exit(0);
}
if (cptr->Outputfilename[0] == NULL) {
printf("Output file name not entered\n");
exit(0);
}
ERingObj.GrayIng(cptr->Inputfilename[0],cptr->Outputfilename[0],
verbose,noDisplay);

break;
case AndIng:
if (cptr->Inputfilename[0] == NULL) {
printf("Input file 1 not entered\n");
exit(0);
}
if (cptr->Inputfilename[1] == NULL) {
printf("Input file 2 name not entered\n");
exit(0);
}
if (cptr->Outputfilename[0] == NULL) {
printf("Output file name not entered\n");
exit(0);
}

```

R. Panthar

```

ERimgObj.AndImg(cptr->Inputfilename[0],cptr->Inputfilename[1],
               cptr->Outputfilename[0],quiet,noDisplay);

break;

case Adding:

if (cptr->Inputfilename[0] == NULL) {
    printf("Input file 1 not entered\n");
    exit(0);
}

if (cptr->Inputfilename[1] == NULL) {
    printf("Input file 2 name not entered\n");
    exit(0);
}

if (cptr->Outputfilename[0] == NULL) {
    printf("Output file name not entered\n");
    exit(0);
}

ERimgObj.Adding(cptr->Inputfilename[0],cptr->Inputfilename[1],
               cptr->Outputfilename[0],quiet,noDisplay);

break;

case CorrFFT:

if (cptr->Inputfilename[0] == NULL) {
    printf("Input file 1 not entered\n");
    exit(0);
}

if (cptr->Inputfilename[1] == NULL) {
    printf("Input file 2 name not entered\n");
    exit(0);
}

if (cptr->Outputfilename[0] == NULL) {
    printf("Output file name not entered\n");
    exit(0);
}

ERimgObj.CorrFFT(cptr->Inputfilename[0],cptr->Inputfilename[1],
                 cptr->Outputfilename[0],quiet,noDisplay);

break;

case Classify_Resources:

if (cptr->Inputfilename[0] == NULL) {
    printf("Input file not entered\n");
    exit(0);
}

if (cptr->Outputfilename[0] == NULL) {
    printf("Output file name not entered\n");
    exit(0);
}

printf("Input file :%s\n", cptr->Inputfilename[0]);
printf("Output file: %s\n", cptr->Outputfilename[0]);

printf("the value of tmax : %d\n",

```

R. Partha

```

               cptr->tmax);
printf("the value of tmin : %d\n",
       cptr->tmin);
printf("the value of mflag is %d\n",
       cptr->mflag);

// check for error

if ((cptr->mflag != 1) && (cptr->tmax != 1) && (cptr->tmin != 1)) {
    printf("Insufficient parameters Entered\n");
    exit(0);
}

if (cptr->tmax == 1)
    printf("The threshold max value: %f\n",cptr->threshmax);
if (cptr->tmin == 1)
    printf("The threshold min value: %f\n",cptr->threshmin);

if (cptr->mflag == 1)
    printf("The threshold values are read from %s\n",
           cptr->Inputfilename[1]);

if ((cptr->tmax == 1) && (cptr->tmin == 1))
    [ // assign to the matrix data structure
      ERMatrix = ERFileObj.load(cptr->threshmax,
                                cptr->threshmin,
                                1);

      printf("the configured max val : %f\n",
             ERMatrix->value_max[0]);
      printf("the configured min val : %f\n",
             ERMatrix->value_min[0]);
    ]

ERimgObj.Classify_Resources(cptr->Inputfilename[0],
                            cptr->Outputfilename[0],
                            ERMatrix->value_max[0],
                            ERMatrix->value_min[0],
                            verbose,noDisplay);

break;

case bitmapROI:

if (cptr->Inputfilename[0] == NULL) {
    printf("Input file not entered\n");
    exit(0);
}

if (cptr->Outputfilename[0] == NULL) {
    printf("Output file name not entered\n");
    exit(0);
}

ERimgObj.bitmapROI(cptr->Inputfilename[0],cptr->Outputfilename[0],
                   cptr->threshval,verbose,noDisplay);

break;

case rectROI:

if (cptr->Inputfilename[0] == NULL) {
    printf("Input file not entered\n");
    exit(0);
}

```

R. Partha

tm_proc.c++

Page 6

```

    }

    if (cptr->Outputfilename[0] == NULL) {
        printf("Output file name not entered!\n");
        exit(0);
    }

    ERingObj.Calc_Ref(cptr->Inputfilename[0],cptr->Outputfilename[0],
                    cptr->x_offset,cptr->y_offset,
                    cptr->size_x,cptr->size_y,quiet);

break;

case Calc_Ref:

    if (cptr->Inputfilename[0] == NULL) {
        printf("Input file not entered!\n");
        exit(0);
    }

    if (cptr->Outputfilename[0] == NULL) {
        printf("Output file name not entered!\n");
        exit(0);
    }

    ERingObj.Calc_Ref(cptr->Inputfilename[0],cptr->Outputfilename[0],
                    cptr->x_offset,cptr->y_offset,
                    cptr->size_x,cptr->size_y,verbose);

break;

case Circular_Texture:

    if (cptr->Inputfilename[0] == NULL) {
        printf("Input file not entered!\n");
        exit(0);
    }

    if (cptr->Outputfilename[0] == NULL) {
        printf("Output file name not entered!\n");
        exit(0);
    }

    ERingObj.Circular_Texture(cptr->Inputfilename[0],cptr->Outputfilename[0],
                            quiet,noDisplay);

break;

} // end switch
} // end for
} // end main

```

R. Partha

09-08-94

The command line interface code is shown below.

cmdlinearg.hh

Page 1

```

////////////////////////////////////
// Filename: cmdlinearg.hh
// Author: Pavitra Ramanujan
// Date: 09-01-94
//
// Purpose: Defines data structure and class for
//           command line arguments
//
// $Header: $
//
// Revision History
// $Log: $
//
////////////////////////////////////

#ifndef _CMDLINEARG_HH_
#define _CMDLINEARG_HH_
// contents of cmdlinearg.h go here

// assign integer values to datafile formats

enum CmdFileType { TM,RGB,TIFF,Matrix};
enum ImgOperatorType {Band_Ratio,Classify_Resources,
                    Circular_Texture,Merge,Wt_Avg,
                    Display,Save,Calc_Ref,GrayImg,
                    HistEqIng,StretchIng,ThresholdIng,
                    InvertIng,AndIng,bitmapROI,rectROI,
                    Adding,CorrFFT};

// describe commandline data structure and class

typedef struct {
    int Inputcnt;
    int Outputcnt;
    char* Inputfilename[256];
    CmdFileType Inputfiletype[256];
    int Inputfilesymbol[256];
    float Wt[256];
    char* Outputfilename[256];
    CmdFileType Outputfiletype[256];
    int Outputfilesymbol[256];
    int Operatorcnt;
    ImgOperatorType Ingoperator[256];
    float threshval; // single threshold value ( to be used if necessary)
    float threshmax;
    float threshmin; // max & min threshold values for specifying range
    int nflag;
    int tmin; // flags for error checking
    int tmax;
    int x_offset; // parameters for region of interest
    int y_offset;
    int size_x; // size
    int size_y;
    }cmdline_arg;

class Cmdclass { // begin cmd class
public:
    Cmdclass(); // constructor
    ~Cmdclass(); // destructor
    Cmdline_arg* load(int //argc
                    char** // argv

```

R. Partha

cmdlinearg.hh

Page 2

```

        int ); //verbose

private:
    Cmdline_arg cmddata; // create a type Cmdline_arg
}; // end class

#endif

```

R. Partha

cmdlinearg.c++

Page 1

```

////////////////////////////////////
// Filename: cmdlinearg.c++
// Author: Pavitra Ramanujan
// Date: 09-07-94
// Purpose: Loads the command line data structure
//
// $Header: $
//
// Revision History
// $Log: $
////////////////////////////////////

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <assert.h>
#include "cmdlinearg.hh"

// Public Methods
Cmdclass::Cmdclass() { // begin initialization
  cmdata.Inputcnt=0;
  cmdata.Outputcnt=0;
  cmdata.Operatorcnt = 0;
  cmdata.threshval = 0;
  cmdata.threshmax = 0;
  cmdata.threshmin = 0;
  cmdata.mflag = 0;
  cmdata.tfin = 0;
  cmdata.tfinmax = 0;
  cmdata.x_offset = 0;
  cmdata.y_offset = 0;
  cmdata.size_x = 0;
  cmdata.size_y = 0;
} // constructor

Cmdline_arg* Cmdclass::load(int count, char** myarg, int verbose) {
  // data
  int i, flag=0;

  // load the image operators
  for (i=1; i<count; i++)
  { // begin for
    if ((strncasecmp(myarg[i], "Band_Ratio", 10) == 0))
    { // begin if
      cmdata.Ingoperator[cmdata.Operatorcnt] = Band_Ratio;
      cmdata.Operatorcnt++; // increment operator count
    } //endif
    else if ((strncasecmp(myarg[i], "Classify_Resources", 18) == 0))
    {
      cmdata.Ingoperator[cmdata.Operatorcnt] = Classify_Resources;
      cmdata.Operatorcnt++;
    }
    else if ((strncasecmp(myarg[i], "Circular_Texture", 16) == 0))
    {
      cmdata.Ingoperator[cmdata.Operatorcnt] = Circular_Texture;
      cmdata.Operatorcnt++;
    }
    else if ((strncasecmp(myarg[i], "Merge", 5) == 0))
    {

```

R. Parvitha

cmdlinearg.c++

Page 2

```

      cmdata.Ingoperator[cmdata.Operatorcnt] = Merge;
      cmdata.Operatorcnt++;
    }
    else if ((strncasecmp(myarg[i], "Wt_Avg", 6) == 0))
    {
      cmdata.Ingoperator[cmdata.Operatorcnt] = Wt_Avg;
      cmdata.Operatorcnt++;
      flag = 1; // set a flag
    }
    else if ((strncasecmp(myarg[i], "Display", 7) == 0))
    {
      cmdata.Ingoperator[cmdata.Operatorcnt] = Display;
      cmdata.Operatorcnt++;
    }
    else if ((strncasecmp(myarg[i], "Save", 4) == 0))
    {
      cmdata.Ingoperator[cmdata.Operatorcnt] = Save;
      cmdata.Operatorcnt++;
    }
    else if ((strncasecmp(myarg[i], "Calc_Ref", 8) == 0))
    {
      cmdata.Ingoperator[cmdata.Operatorcnt] = Calc_Ref;
      cmdata.Operatorcnt++;
    }

    else if ((strncasecmp(myarg[i], "GrayIng", 7) == 0))
    {
      cmdata.Ingoperator[cmdata.Operatorcnt] = GrayIng;
      cmdata.Operatorcnt++;
    }

    else if ((strncasecmp(myarg[i], "StretchIng", 10) == 0))
    {
      cmdata.Ingoperator[cmdata.Operatorcnt] = StretchIng;
      cmdata.Operatorcnt++;
    }

    else if ((strncasecmp(myarg[i], "HistEqIng", 9) == 0))
    {
      cmdata.Ingoperator[cmdata.Operatorcnt] = HistEqIng;
      cmdata.Operatorcnt++;
    }

    else if ((strncasecmp(myarg[i], "ThreshIng", 9) == 0))
    {
      cmdata.Ingoperator[cmdata.Operatorcnt] = ThreshIng;
      cmdata.Operatorcnt++;
    }

    else if ((strncasecmp(myarg[i], "InvertIng", 9) == 0))
    {
      cmdata.Ingoperator[cmdata.Operatorcnt] = InvertIng;
      cmdata.Operatorcnt++;
    }

    else if ((strncasecmp(myarg[i], "AndIng", 6) == 0))
    {
      cmdata.Ingoperator[cmdata.Operatorcnt] = AndIng;
      cmdata.Operatorcnt++;
    }

    else if ((strncasecmp(myarg[i], "bitmapROI", 9) == 0))

```

R. Parvitha

cmdlinearg.c++

Page 3

```

    {
        cmddata.Ingoperator[cmddata.Operatoront] = bitmapROI;
        cmddata.Operatoront++;
    }
    else if ((strncasecmp(myarg[i], "rectROI", 7) == 0))
    {
        cmddata.Ingoperator[cmddata.Operatoront] = rectROI;
        cmddata.Operatoront++;
    }
    else if ((strncasecmp(myarg[i], "AddImg", 6) == 0))
    {
        cmddata.Ingoperator[cmddata.Operatoront] = Adding;
        cmddata.Operatoront++;
    }
    else if ((strncasecmp(myarg[i], "CorrFFT", 7) == 0))
    {
        cmddata.Ingoperator[cmddata.Operatoront] = CorrFFT;
        cmddata.Operatoront++;
    }
    else if ((strncasecmp(myarg[i], "-i", 2) == 0))
    {
        // begin if
        // assign input file name
        cmddata.Inputfilename[cmddata.Inputont] =
            myarg[i+1];
        if (verbose)
            printf("the loaded inputfilename is %s\n",
                cmddata.Inputfilename[cmddata.Inputont]);

        // assign input file type
        cmddata.Inputfiletype[cmddata.Inputont] = TM;
        if (verbose)
            printf("The inputfiletype is %d\n",
                cmddata.Inputfiletype[cmddata.Inputont]);

        // Display loaded wts if image operator is Wt_Avg
        if (flag == 1)
            cmddata.Wt[cmddata.Inputont] = atof(myarg[i+2]);
        if (verbose == 1 && flag == 1)
            printf("The loaded wt is: %f\n",
                cmddata.Wt[cmddata.Inputont]);

        // increment input number
        cmddata.Inputont = cmddata.Inputont+1;
    } // end if
    else if ((strncasecmp(myarg[i], "-tfile", 7) == 0))
    {
        // Assign input file name for reading threshold values
        cmddata.Inputfilename[cmddata.Inputont] = myarg[i+1];

        // set flag to indicate that a file has been specified
        cmddata.mflag = cmddata.mflag++;
        if (verbose)
            printf("the input matrix file is %s\n",
                cmddata.Inputfilename[cmddata.Operatoront]);
    }

```

R. Pantra

cmdlinearg.c++

Page 4

```

        // Assign Matrix file type
        cmddata.Inputfiletype[cmddata.Inputont] = Matrix;
        if (verbose)
            printf("the file type is %d\n",
                cmddata.Inputfiletype[cmddata.Inputont]);

        // increment inputfile number
        cmddata.Inputont++;
    }
    else if ((strncasecmp(myarg[i], "-o", 2) == 0))
    {
        // assign output file name
        cmddata.Outputfilename[cmddata.Outputont] =
            myarg[i+1];
        if (verbose)
            printf("the loaded outputfilename is %s\n",
                cmddata.Outputfilename[cmddata.Outputont]);

        // Assign output file type
        cmddata.Outputfiletype[cmddata.Outputont] = TM;

        if (verbose)
            printf("the output filetype is %d\n",
                cmddata.Outputfiletype[cmddata.Outputont]);

        // increment output file number
        cmddata.Outputont++;
    }
    else if ((strncasecmp(myarg[i], "-singlethresh", 13) == 0))
    {
        // assign threshold value
        cmddata.threshold = atof(myarg[i+1]);
        if (verbose)
            printf("the loaded threshold value is %f\n",
                cmddata.threshold);
    }
    else if ((strncasecmp(myarg[i], "-tmax", 5) == 0))
    {
        // assign max threshold value
        cmddata.thresholdmax = atof(myarg[i+1]);
        cmddata.tfsmax++;
        if (verbose)
            printf("incremented tfsmax: %d\n",
                cmddata.tfsmax);
        if (verbose)
            printf("the loaded threshold value is %f\n",
                cmddata.thresholdmax);
    }
    else if ((strncasecmp(myarg[i], "-tmin", 5) == 0))
    {
        // assign max threshold value
        cmddata.thresholdmin = atof(myarg[i+1]);
        cmddata.tfsmin++;
        if (verbose)
            printf("incremented tfsmin: %d\n",
                cmddata.tfsmin);
        if (verbose)
            printf("the loaded threshold value is %f\n",
                cmddata.thresholdmin);
    }
}

```

R. Pantra

```

cmdlinearg.cpp                                     Page 5

else if ((strncasecmp(myarg[i],"-x_offset",9) == 0))
{ // assign offset for ROI and its size
    cmdata.x_offset = atoi(myarg[i+1]);
    if (verbose) {
        printf("The offset for x is %d\n",
               cmdata.x_offset);
    }
}

else if ((strncasecmp(myarg[i],"-y_offset",9) == 0))
{ // assign offset for ROI and its size
    cmdata.y_offset = atoi(myarg[i+1]);
    if (verbose)
        printf("The offset for y is %d\n",
               cmdata.y_offset);
}

else if ((strncasecmp(myarg[i],"-size_x",7) == 0))
{ // assign size
    cmdata.size_x = atoi(myarg[i+1]);
    if (verbose)
        printf("The x size is %d\n",
               cmdata.size_x);
}

else if ((strncasecmp(myarg[i],"-size_y",7) == 0))
{ // assign size
    cmdata.size_y = atoi(myarg[i+1]);
    if (verbose)
        printf("The y size is %d\n",
               cmdata.size_y);
}
else
{
    if (verbose)
        printf("\n\n");
}
} // end for

if (verbose)
    printf("The value of Image operator is %d\n",
           cmdata.Ingoperator(cmdata.Operatoront-1));
return cmdata;
} // end function

Cmdclass::~Cmdclass() {} // definition of destructor

```

R. Parittra

09-10-94

The principle features to help recognize mineralization.

The Feature Set and its Attributes

Classification of occurrence of gold and uranium

- Spectral information content: Band ratioing
Each element exhibits a unique color response in certain combinations of ratios.
- Spatial information content: Identification of circular signatures pertaining to altered rocks.
- Final Classification of the merged image obtained by the above two methods
Spectral thresholding: calculate the threshold value for the intensity of the pixels belonging to the class of interest.
- The regions of interest could be indicated by special color schemes:
Eg: Gold could be represented by yellow.

R. Parittra

09-15-94

The following classes were developed to perform image processing operations.

ERImg.hh Page 1

```
// description of ERimg class:
#ifdef _ERimg_HH_
#define _ERimg_HH_
#include "ERFile.hh"
#include <il/ilImage.h>

// create enumerated data types
enum VerboseType {quiet,verbose}; // Do you want the print statements on
// or off ?

enum DisplayType {noDisplay,yesDisplay}; // Is display on or off?

typedef struct {
    float min_intensity;
    float max_intensity;
}ThresholdType;

class ERimgclass{
public:
    ERimgclass(); // constructor
    ~ERimgclass(); // destructor

    // Methods
    void Band_Ratio(const char* , // first inputfile name
                   const char* , // second inputfilename
                   const char* , // outputfilename
                   // NULL => output image is not
                   // saved
                   const int VerboseType, // print statements on
                   // or off?
                   const int DisplayType); // display or no display

    void Circular_Texture(const char* , // inimage
                          const char* , // outimage
                          const int VerboseType,
                          const int DisplayType);

    void Classify_Resources(const char* , // inimage
                            const char* , // outimage
                            float,float, // threshold info
                            const int VerboseType,
                            const int DisplayType);

    void Merge( const char* , // red
                const char* , // grn
                const char* , // blu
                const char* , // name of the outputfile
                // in which the merged image
                // is to be saved
                const int VerboseType,
                const int DisplayType);

    void GrayImg(const char* , // 3 channel input image
                 const char* , // 1 channel output image
                 const int VerboseType,
                 const int DisplayType);
```

ERImg.hh

Page 2

```
void StretchImg(const char* , // input image
                const char* , // stretched output
                const int VerboseType,
                const int DisplayType);

void HistEqImg(const char* , // input image
               const char* , // outimage
               const int VerboseType,
               const int DisplayType);

void CorrFFT(const char* , // inimage
             const char* , // inimage 2
             const char* ,
             const int VerboseType,
             const int DisplayType);

void AddImg(const char* , // inimage
            const char* , // inimage 2
            const char* ,
            const int VerboseType,
            const int DisplayType);

void ThreshImg(const char* , // input image
               const char* , // outimage
               float threshval, // threshold value
               const int VerboseType,
               const int DisplayType);

void InvertImg(const char* , // inimage
               const char* , // outimage
               const int VerboseType,
               const int DisplayType);

void AndImg(const char* , // inimage 1
            const char* , // inimage 2
            const char* , // outimage
            const int VerboseType,
            const int DisplayType);

void Calc_Ref(const char* , // outimage
              const char* , // outimage
              const int, // offset
              const int, // size
              const int, // size
              const int VerboseType);

void bitmapROI(const char* in, // inimage
               const char* out, // outimage
               float,
               const int VerboseType,
               const int DisplayType);

void rectROI(const char* in, // inimage
              const char* out, // outimage
              const int, // offset
              const int, // offset
              int, // dimension
              int, // dimension
              const int VerboseType,
              const int DisplayType);

void display(ilImage* ); // image
```

ERImg.hh

Page 3

```

void Wt_Avg(const char* , // inimage1
            const char* , // inimage 2
            const char* , // outimage
            const float,
            const int VerboseType,
            const int DisplayType);

void DisplayFile(const char* ,const int VerboseType);
void Save(const char* ,llimage *); // filename

private:
void print(llImage *,const char *,const char*);
void StatImg(const char* , // inimage
             const int VerboseType);

int xsize;
int ysize;
int zsize;
int channel_count;
int PixelCount;
double intensity; //image data attributes
double MinPixelVal;
double MaxPixelVal;
double Pixel_Mean;
double Pixel_StdDev;
ThresholdType ThresholdData;
}; // end class

#endif

```

R. Parvath

ERImg.cpp

Page 1

```

#include <stdio.h>
#include <stdlib.h>
#include "ERImg.hh"
#include <il/ilGenericImgFile.h>
#include <il/ilSize.h>
#include <il/ilPixel.h>
#include <il/ilDivimg.h>
#include <il/ilDisplay.h>
#include <gl/gl.h>
#include <gl/device.h>
#include <il/ilMergeimg.h>
#include <il/ilGraying.h>
#include <il/ilRGBimg.h>
#include <il/ilScaleimg.h>
#include <il/ilHistEqimg.h>
#include <il/ilThreshimg.h>
#include <il/ilImgstat.h>
#include <il/ilInvertimg.h>
#include <il/ilAndimg.h>
#include <il/ilRotimg.h>
#include <il/ilSubimg.h>
#include <il/ilBitMapROI.h>
#include <il/ilRectROI.h>
#include <il/ilCombineimg.h>
#include <il/ilConstimg.h>
#include <il/ilPCorring.h>
#include <il/ilAdding.h>
#include <il/ilSubtractimg.h>
#include <il/ilLaplacimg.h>
#include <il/ilBlending.h>

// public methods
ERImgclass::ERImgclass() { // begin initialization
    xsize = 0;
    ysize = 0;
    zsize = 0;
    channel_count = 0;
    MinPixelVal = 0;
    MaxPixelVal = 0;
    PixelCount = 0;
    intensity = 0;
    Pixel_Mean = 0;
    Pixel_StdDev = 0;
    ThresholdData.min_intensity = 0;
    ThresholdData.max_intensity = 0;
}

// destructor
ERImgclass::~ERImgclass() {}

void ERImgclass::Band_Ratio(const char* file1, const char* file2,
                           const char* outfile, const int VerboseType,
                           const int DisplayType) {

// Begin method
ilPileImg* infile1 = ilOpenImgFile(file1,"r");

```

R. Parvath

ERImg.cpp

Page 2

```

i1FileImg* i1file2 = i1OpenImgFile(file2,"r");

if (VerboseType == verbose) {
print(i1file1, "Input file 1,", file1);
print(i1file2, "Input file 2,", file2);
}

// perform pixelwise division of 2 input images
i1DivImg diving( i1file1, i1file2, 1);

if (VerboseType == verbose)
print(sdivImg, "Divided image file", " ");

if (DisplayType == yesDisplay)
display(sdivImg);

Save(outfile,sdivImg);
return ;
}

void ERImgclass::print(i1Image *inf, const char *ins1,
const char *ins2) {
int x;
int y;
int ind;
i1Pixel pix;
i1Size imgSize;
int verbal = 0;

// Begin
printf("\n\n%s %s\n", ins1, ins2);
inf->getSize(imgSize);
xsize = inf->getXsize();
ysize = inf->getYsize();
zsize = inf->getZsize();
printf("The xyz size is %5d %5d %5d.\n",
xsize, ysize, zsize);

channel_count = inf->getCaize();
printf("Number of channels is %d\n",channel_count);

// get pixel values
for (x=0;x<xsize;x++) {
for (y=0;y<ysize;y++) {
ind=y + x * ysize;
i1Status theStatus = inf->getPixel(x, y, pix);

switch (pix.nc()) {
case 1:
intensity = pix.getElem(0);
if (verbal)
printf("The %d pixel value at %d,%d is %02x \n",
ind, x, y,
(int)pix.getElem(0));
break;
case 3:

```

ERImg.cpp

Page 3

```

if (verbal)
printf("The %d pixel value at %d,%d is %02x %02x %02x \n",
ind, x, y,
(int)pix.getElem(0),
(int)pix.getElem(1),
(int)pix.getElem(2));
break;
default:
printf("NC is %d\n", pix.nc());
break;
}
}
return ;
} // End

void ERImgclass::display(i1Image *inf) {
// setup GL window
foreground();
i1Size size;
inf->getSize(size);
xsize=inf->getXsize(x, size.y);
long wid = w1open("Processed image: choose QUIT from menu to exit");
if (getgdesc(GD_BITS_NORM_SNG_RED) != 0) RGBmode();
gconfig();

// Create display object and add the image
i1Display disp(wid);
disp.addView(inf);

// The user should choose QUIT from menu or press <ESC> key
// display until the user quits:

qdevice(REDRAW);
qdevice(ESCKEY);

qenter(REDRAW,short(wid));
short val;

int active = 1;
while(active) {
switch(qread(&val)) {
case ESCKEY:
active = 0;
break;
case REDRAW:
disp.redraw();
break;
} // end switch
} // end while

```

ERImg.cpp

Page 4

```

    exit (0);
} // End

void ERImgclass::Merge(const char* inf1,const char* inf2,const char* inf3,
    const char* merge,const int VerboseType,
    const int DisplayType)
{
    // Begin Method

    // convert the 3 channel image to an single image
    // create new single channel images

    GrayImg(inf1,"../temp/tmp1.rgb",quiet,noDisplay);
    GrayImg(inf2,"../temp/tmp2.rgb",quiet,noDisplay);
    GrayImg(inf3,"../temp/tmp3.rgb",quiet,noDisplay);

    // stretch the resulting values

    StretchImg("../temp/tmp1.rgb", "../temp/strtmp1.rgb",quiet,noDisplay);
    StretchImg("../temp/tmp2.rgb", "../temp/strtmp2.rgb",quiet,noDisplay);
    StretchImg("../temp/tmp3.rgb", "../temp/strtmp3.rgb",quiet,noDisplay);

    // Equalize the image for better contrast

    HistEqImg("../temp/strtmp1.rgb", "../temp/tmp1.rgb",quiet,noDisplay);
    HistEqImg("../temp/strtmp2.rgb", "../temp/tmp2.rgb",quiet,noDisplay);
    HistEqImg("../temp/strtmp3.rgb", "../temp/tmp3.rgb",quiet,noDisplay);

    // construct an array of files and assign a pointer reference

    IFileImg* inp1 = ilOpenImgFile("../temp/tmp1.rgb","r");
    IFileImg* inp2 = ilOpenImgFile("../temp/tmp2.rgb","r");
    IFileImg* inp3 = ilOpenImgFile("../temp/tmp3.rgb","r");

    // make IImages
    // construct an array of pointers to IImages

    IImage* inptr1 = inp1;
    IImage* inptr2 = inp2;
    IImage* inptr3 = inp3;

    IMergeImg mergeImg(inptr1,inptr2,inptr3,inptr1->getOrder(),
        inptr1->getDataType());

    if (VerboseType == verbose){
        print(&mergeImg,"Merged image file", " ");
    }

    if (DisplayType == yesDisplay)
        display(&mergeImg);

    Save(merge,&mergeImg);

    return;
}

```

ERImg.cpp

Page 5

```

    *
void ERImgclass::Save(const char* infile,IImage* imgfile)
{
    ISize size; // create an ISize object

    // Begin Method

    // print(imgfile,"Saved Image",infile);
    imgfile->getSize(size);
    IFileImg* out = ilCreateImgFile(infile, size, imgfile->getDataType(),
        imgfile->getOrder());
    out->setCoordSpace(imgfile->getCoordSpace());
    *out << *imgfile;
    delete out;
} // end

void ERImgclass::GrayImg(const char* in,const char* out,const int VerboseType,
    const int DisplayType)
{
    // begin method

    // open input file
    IFileImg* inf = ilOpenImgFile(in,"r");

    // create a buffer to hold converted image

    IGrayImg* cnvrtImg;
    cnvrtImg = new IGrayImg(inf);

    if (VerboseType == verbose)
        print(cnvrtImg,"converted image!"," ");

    if (DisplayType == yesDisplay)
        display(cnvrtImg);

    Save(out,cnvrtImg);

    // free data buffers
    delete cnvrtImg;

    return;
}

void ERImgclass::StretchImg(const char* in,const char* out,
    const int VerboseType,
    const int DisplayType)
{
    // open the file in IL image format
    IFileImg* inf = ilOpenImgFile(in,"r");
}

```

ERImg.C++

Page 6

```

// call the stretching routine
ilScaleImg ScaleImg(inf);
if (VerboseType == verbose)
    print($ScaleImg, "Stretched Image", " ");
if (DisplayType == yesDisplay)
    display($ScaleImg);
Save(out, $ScaleImg); // save the stretched image
return;
}

void ERImgclass::HistEqImg(const char* in, const char* out,
    const int VerboseType,
    const int DisplayType)
{
    ilImgStat* imgstat = NULL;
    ilRoi* roi = NULL;

    // begin method
    ilFileImg* inf = ilOpenImgFile(in, "r");
    // call Histogram Equalization routine
    ilHistEqImg HistEqImg(inf, imgstat, roi, 0, 0);
    if (VerboseType == verbose)
        print($HistEqImg, "Equalized Image", " ");
    if (DisplayType == yesDisplay)
        display($HistEqImg);
    Save(out, $HistEqImg);

    return;
}

void ERImgclass::ThreshImg(const char* in, const char* out,
    float threshval,
    const int VerboseType,
    const int DisplayType)
{
    printf("The received threshold value : %f\n",
        threshval);
    // create an ilPixel object
    ilPixel pix;

    // create an ERImage object
    ERImgclass ERImgObj;

    // open input image
    ilFileImg* inf = ilOpenImgFile(in, "r");

```

ERImg.c++

Page 7

```

if (in == NULL) {
    printf("Couldn't open Threshold Img file!\n");
    exit (0);
}
// get the maximum and minimum pixel values for a single channel image:
inf->getMaxPixel(pix);
ERImgObj.MaxPixelVal = pix.max();
if (VerboseType == verbose) {
    printf("the max pixel val: %d\n",
        (int)pix.max());
    printf("the loaded max val: %d\n",
        (int)ERImgObj.MaxPixelVal);
}
inf->getMinPixel(pix);
ERImgObj.MinPixelVal = pix.min();
if (VerboseType == verbose) {
    printf("the max pixel val: %d\n",
        (int)pix.min());
    printf("the loaded max val: %d\n",
        (int)ERImgObj.MinPixelVal);
}

// set the maximum pixel value in a single channel image to 0:
double set_max = (double)255;
ilPixel p(ilDouble, 1, $set_max);
ilStatus firstStatus = inf->setMaxPixel(p);
inf->getMaxPixel(pix);
if (VerboseType == verbose)
    printf("the set max pixel value : %d\n",
        (int)pix.max());

double set_min = (double)0;
ilPixel q(ilDouble, 1, $set_min);
ilStatus secondStatus = inf->setMinPixel(q);
inf->getMinPixel(pix);
if (VerboseType == verbose)
    printf("the set min pixel value : %d\n",
        (int)pix.min());

// create threshold image
// set threshold pixel value to threshval:
ilPixel threshPixel(ilFloat, 1, $threshval);
ilThreshImg Thresh(inf, threshPixel);
if (VerboseType == verbose){
    print(inf, "Input file", in);
    print($Thresh, "Threshold Image", " ");
}

if (DisplayType == yesDisplay)
    display($Thresh);

```

ERImg.C++

Page 8

```

    Save(out,sThresh);
return;
}

void ERImgclass::StatImg(const char* in,const int VerboseType)
{
// define data
int xoffset = 0;
int yoffset = 0;
int autoCalcEnable = TRUE;
// open inputfile
IFileImg* infile = IOpenImgFile(in,"r");
if (in == NULL) {
    printf("Couldn't open statistics img file!\n");
    exit (0);
}
IIRoi* roi = NULL;
// begin method
// create IImgStat object
IImgStat StatImg(infile,roi,xoffset,yoffset,autoCalcEnable);
// create space for data
// get total pixel count of the input image
PixelCount = StatImg.getTotal(0);
if (VerboseType == verbose)
    printf("The total pixel count for %s is %d \n",
        in,PixelCount);
// compute the minimum and maximum values of the input image
// compute the mean and the standard deviation
MinPixelVal = StatImg.getdMin(0);
if (VerboseType == verbose)
    printf("The minimum pixel value of %s is %d \n",
        in,(int)MinPixelVal);
MaxPixelVal = StatImg.getdMax(0);
if (VerboseType == verbose)
    printf("The maximum pixel value of %s is %d \n",
        in,(int)MaxPixelVal);
Pixel_Mean = StatImg.getdMean(0);
if (VerboseType == verbose)
    printf("The mean value of %s is %d \n",
        in,(int)Pixel_Mean);
Pixel_StdDev = StatImg.getdStdDev(0);
if (VerboseType == verbose)
    printf("The std dev value of %s is %d \n",
        in,(int)Pixel_StdDev);

```

ERImg.C++

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```

return;
}

void ERImgclass::Classify_Resources(const char* in,const char* out,
float max,float min,
const int VerboseType,
const int DisplayType)
{
// begin method
if (VerboseType == verbose) {
    printf("The received max thresh val: %f\n",
        max);
    printf("The received min thresh val: %f\n",
        min);
}
max = 255-max;
if (VerboseType == verbose) {
    printf("The received max thresh val: %f\n",
        max);
}
// GrayImg(in, "../data/schannel.rgb", quiet,noDisplay);
// Stretching(in, "../data/schannel.rgb", quiet,noDisplay);
// Threshing("../data/schannel.rgb", "../data/thresh1.rgb",min,quiet,noDisplay);
// InvertImg("../data/schannel.rgb", "../data/invert.rgb", quiet,noDisplay);
// Threshing("../data/invert.rgb", "../data/thresh2.rgb",max,quiet,noDisplay);
// perform logical AND of the two thresholded images
AndImg("../data/thresh1.rgb", "../data/thresh2.rgb",out,quiet,noDisplay);
// open output file as IFile
IFileImg* outf = IOpenImgFile(out,"r");
if (DisplayType == yesDisplay)
    display(outf);
return;
}

void ERImgclass::InvertImg(const char* in,const char* out,
const int VerboseType,const int DisplayType)
{
// begin method
// open input file
IFileImg* infile = IOpenImgFile(in,"r");
// create space for inverted image
IInvertImg InvertImg(infile);
if (VerboseType == verbose) {

```

ERImg.C++

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```

    print(&invertImg, "Inverted Image", " ");
}

if (DisplayType == yesDisplay)
    display(&invertImg);

    Save(out, &invertImg);

return;
}

void ERImgclass::AndImg(const char* in1, const char* in2, const char* out,
                      const int VerboseType,
                      const int DisplayType)
{
    // open input files in
    ilFileImg* infile1 = ilOpenImgFile(in1, "r");
    ilFileImg* infile2 = ilOpenImgFile(in2, "r");

    // create space for Anded image
    ilAnding AndedImg(infile1, infile2);

    if (VerboseType == verbose) {
        print(&AndedImg, "The ANDED Image!", " ");
    }

    if (DisplayType == yesDisplay)
        display(&AndedImg);

    Save(out, &AndedImg);

return;
}

void ERImgclass::bitmapROI(const char* in, const char* out,
                          float threshVal,
                          const int VerboseType,
                          const int DisplayType)
{
    // create an ERImgclass object
    ERImgclass ERimgobj;

    // open input (foreground) image
    ilImage* inf = ilOpenImgFile(in, "r");

    // get image data attributes
    print(inf, "Foreground Image", in);

    if (VerboseType == verbose) {
        printf("The Size of the Image: %s\n", in);
        printf("Xsize: %d\n", xsize);
        printf("Ysize: %d\n", ysize);
        printf("Zsize: %d\n", zsize);
        printf("Number of channels: %d\n", channel_count);
    }
}

```

RP

ERImg.c++

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```

    int size = xsize*ysize*channel_count;
    printf("the calculated size is %d\n", size);

    if (VerboseType == verbose)
        printf("the calculated size is %d\n", size);

    // create threshold image with the values read from main
    ThreshImg(in, "../data/threshroi.rgb", threshval, quiet, noDisplay);
    // create a bit map from the thresholded image
    // ilRoi* roi = new ilBitMapRoi(&thresh);
    ilImage* read = ilOpenImgFile("../data/threshroi.rgb", "r");
    ilBitMapRoi* roi = new ilBitMapRoi(read, 1);

    // create purple background constant image
    static u_char constval[] = {128, 0, 128};
    ilConstImg bkgd(ilPixel(ilUChar, 1, constval));

    // Make sure that the coordinate space on the background matches thresh
    //bkgd.setCoordSpace(roi.getCoordSpace());

    // create combined image
    ilCombineImg *comb = new ilCombineImg(&bkgd, inf, roi);

    if (VerboseType == verbose) {
        print(inf, "Input file", in);
        print(read, "Thresholded image", " ");
        print(comb, "Region of Interest", " ");
    }

    if (DisplayType == yesDisplay)
        display(comb);

    Save(out, comb);

return;
}

void ERImgclass::rectROI(const char* in, const char* out,
                       const int Xoffset, const int Yoffset,
                       int x, int y,
                       const int VerboseType, const int DisplayType)
{
    ilConfig* config = NULL;

    ilImage* infile = ilOpenImgFile(in, "r");
    ilSubImg subimg(infile, Xoffset, Yoffset, x, y, config);

    Save(out, &subimg);
    GrayImg(out, "../data/scstat.rgb", quiet, noDisplay);
    Stating("../data/scstat.rgb", verbose);

    if (VerboseType == verbose)
        print(&subimg, "region of interest", " ");
}

```

RP

ERImg.C++

Page 12

```

    if (DisplayType == yesDisplay)
        display(&subImg);

return;
}

void ERImgclass::Calc_Ref(const char* in, const char* out,
                        const int xoffset, const int yoffset,
                        const int xsize, const int ysize,
                        const int VerboseType)

{
    ERFileclass ERFileObj;
    ERMatrixType* ERMatrix;
    IImage imgSize;
    int x=0,y=0;

    x=xsize;
    y=ysize;
    // check for size entered by user
    // get size of the input file

    IImage* inf = ilOpenImgFile(in,"r");
    inf->GetSize(imgSize);
    if (xsize > inf->getXsize())
        x = inf->getXsize();
    if (ysize > inf->getYsize())
        y = inf->getYsize();

    if (VerboseType == verbose)
        printf("The new x & y sizes are %d %d\n",
              x,y);
    rectROI(in,out,xoffset,yoffset,x,y,quiet,noDisplay);

    // assign threshold intensity ranges
    printf("The Pixel mean is %d\n", (int)Pixel_Mean);
    printf("The Pixel Std_dev is %d\n", (int)Pixel_StdDev);
    ThresholdData.min_intensity = (float)(Pixel_Mean - Pixel_StdDev);
    ThresholdData.max_intensity = (float)(Pixel_Mean + Pixel_StdDev);

    if (VerboseType == verbose) {
        printf("the minimum thresh intensity is %f\n",
              ThresholdData.min_intensity);
        printf("the maximum thresh intensity is %f\n",
              ThresholdData.max_intensity);
    }

    // assign to matrix data structure
    ERMatrix = ERFileObj.load(ThresholdData.max_intensity,
                             ThresholdData.min_intensity,1);

return;
}

void ERImgclass::CorrFFT(const char* in1,const char* in2,const char* out,
                        const int VerboseType,
                        const int DisplayType)

{
    // open input files

```

RF

ERImg.C++

Page 13

```

IImage* infile1 = ilOpenImgFile(in1,"r");
IImage* infile2 = ilOpenImgFile(in2,"r");

    ilFCrCorrImg corrImg(infile1,infile2);

    if (VerboseType == verbose)
        print(&corrImg,"cross correlated image", " ");

    if (DisplayType == yesDisplay)
        display(&corrImg);

    Save(out,&corrImg);
return;
}

void ERImgclass::Circular_Texture(const char* in, const char* out,
                                  const int VerboseType,const int DisplayType)
{
    // open input image
    IImage* infile = ilOpenImgFile(in,"r");

    // set the kernel
    void setKernel(int Kerno = 2);

    ilLaplaceImg laplaceImg(infile,0.,
                            ilPadSrc,2);

    // subtract the laplacian image from original image
    ilSubtractImg SubtractedImg(infile,&laplaceImg,0.);

    if (VerboseType == verbose)
        print(&laplaceImg,"Circular Edge Enhanced Image", " ");

    if (DisplayType == yesDisplay)
        display(&laplaceImg);

    Save(out,&SubtractedImg);

return;
}

void ERImgclass::AddImg(const char* in1,const char* in2,const char* out,
                       const int VerboseType,const int DisplayType)
{
    IImage* inf1 = ilOpenImgFile(in1,"r");
    IImage* inf2 = ilOpenImgFile(in2,"r");

    ilAddImg AddImg(inf1,inf2,0.);

    if (VerboseType == verbose)
        print(&AddImg,"Added Image", " ");

    if (DisplayType == yesDisplay)
        display(&AddImg);

    Save(out,&AddImg);
}

```

RF

```

ERImg.c++
Page 14

return;
}

void ERImgclass::Wt_Avg(const char* in1,const char* in2,const char* out,
const float Wt,
const int VerboseType,const int DisplayType)
{
// open input files
IImage* inf1 = IOpenImgFile(in1,"r");
IImage* inf2 = IOpenImgFile(in2,"r");
IBlendImg BlendImg(inf1,inf2,Wt);
if (VerboseType == verbose)
print(sBlendImg,"the Blended Image",* *);
if (DisplayType == yesDisplay)
display(sBlendImg);
Save(out,sBlendImg);

return;
}

void ERImgclass::DisplayFile(const char* in,const int VerboseType)
{
// open file to be displayed
IImage* inf = IOpenImgFile(in,"r");
if (VerboseType == verbose)
print(inf,"The Displayed file",* *);
display(inf);

return;
}

```

09-25-94

The following was developed to read text files and load memory with threshold data values.

```

ERFile.hh
Page 1

// ERfile class header
#ifndef __ERFile_HH__
#define __ERFile_HH__

// describe the matrix data structure
typedef struct {
int rows;
int cols;
float* value_max;
float* value_min;
} ERMatrixType;

class ERFileclass {
public:
ERFileclass(); // constructor
~ERFileclass(); // destructor
ERMatrixType* read(const char* ,int);
void write(const char* , // inputfile(text)
const ERMatrixType *); // data
ERMatrixType* load(float, // thresh max value
float, // thresh min val
int); // verbose

private:
ERMatrixType ERMatrixdata; // Ermatrix data type
}; // end class

#endif

```

Page 1

```

ERFile.c++
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include "ERFile.hh"

// public methods
ERFileclass::ERFileclass() { // begin initialization
    ERMATRIXdata.rows = 0;
    ERMATRIXdata.cols = 0;
} // constructor

// Destructor
ERFileclass::~ERFileclass() {}

ERMATRIXType* ERFileclass::load(float max, float min, int verbose)
{
    // data
    int i=0;

    // load the threshold values into the matrix data structure
    ERMATRIXdata.rows = 1;
    if (verbose)
        printf("the number of rows: %d\n", ERMATRIXdata.rows);
    ERMATRIXdata.cols = 2;
    if (verbose)
        printf("the number of cols: %d\n", ERMATRIXdata.cols);

    // allocate space to hold the threshold values
    int limit = ERMATRIXdata.rows*ERMATRIXdata.cols;
    ERMATRIXdata.value_max = (float *) malloc (sizeof(float)*limit);
    ERMATRIXdata.value_min = (float *) malloc (sizeof(float)*limit);

    ERMATRIXdata.value_max[0] = max;
    if (verbose)
        printf("the max value is : %f\n", ERMATRIXdata.value_max[0]);
    ERMATRIXdata.value_min[0] = min;
    if (verbose)
        printf("the min value is : %f\n", ERMATRIXdata.value_min[0]);

    return &ERMATRIXdata;
}

ERMATRIXType* ERFileclass::read(const char* in, int verbose)
{
    return &ERMATRIXdata;
}

```

RP

09-30-94

The following was done to test the cmdline arg. hh/ cmdline arg. C++.

The results are as show below:

Page 1

```

ctest.sh
../bin/tm_proc Band_Ratio -i tmband4.rgb -i tmband7.rgb -o tmout1.rgb
../bin/tm_proc Band_Ratio -i tmband6.rgb -i tmband4.rgb -o tmout2.rgb
../bin/tm_proc Band_Ratio -i tmband7.rgb -i tmband4.rgb -o tmout3.rgb
../bin/tm_proc Merge -i tmout1.rgb -i tmout2.rgb -i tmout3.rgb -o BRing.
rgb
../bin/tm_proc Display -i BRing.rgb
../bin/tm_proc Circular_Texture -i tmband7.rgb -tfile Kernel.Txt
-o circle.rgb
../bin/tm_proc Display -i circle.rgb
../bin/tm_proc Classify_Resources -i tmband7.rgb -tfile LUT.txt
-o classifieding.rgb
../bin/tm_proc Display -i classifieding.rgb
../bin/tm_proc Calc_Ref -i tmband7.rgb -i sup.rgb -o LUT.txt
../bin/tm_proc Wt_Avg -i BRing.rgb 0.5 -i circle.rgb 0.5 -i classifiedin
g.rgb 0.5 -o wteding.rgb
../bin/tm_proc Threshing -i tmband4roiBlk.rgb -o thresh.rgb -t 100.

```

RP

ctest.out

Page 1

the loaded inputfilename is tmout1.rgb
The inputfiletype is 0

the loaded inputfilename is tmout2.rgb
The inputfiletype is 0

the loaded inputfilename is tmout3.rgb
The inputfiletype is 0

the loaded outputfilename is BRing.rgb
the output filetype is 0

The value of Image operator is 3

Input File 1, tmout1.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00

Input File 2, tmout2.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00

Input File 3, tmout3.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00

Merged Image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is ff ff ff
Input files 1, 2 3: tmout1.rgb tmout2.rgb tmout3.rgb
The output file : BRing.rgb
The loaded inputfilename is BRing.rgb
The inputfiletype is 0

The value of Image operator is 5
the loaded inputfilename is tmBand7.rgb
The inputfiletype is 0

the input matrix file is Kernel.Txt
the file type is 3

The value of Image operator is 2
the loaded inputfilename is circle.rgb
The inputfiletype is 0

The value of Image operator is 5
the loaded inputfilename is tmBand7.rgb
The inputfiletype is 0

the input matrix file is LUT.txt
the file type is 3

ctest.out

Page 2

The value of Image operator is 1
the loaded inputfilename is classifiedimg.rgb
The inputfiletype is 0

The value of Image operator is 5
the loaded inputfilename is tmBand7.rgb
The inputfiletype is 0

the loaded inputfilename is sup.rgb
The inputfiletype is 0

the loaded outputfilename is LUT.txt
the output filetype is 0

The value of Image operator is 7
the loaded inputfilename is BRing.rgb
The inputfiletype is 0
The loaded wt is: 0.500000

the loaded inputfilename is circle.rgb
The inputfiletype is 0
The loaded wt is: 0.500000

the loaded inputfilename is classifiedimg.rgb
The inputfiletype is 0
The loaded wt is: 0.500000

the loaded outputfilename is wtedimg.rgb
the output filetype is 0

The value of Image operator is 4
the loaded inputfilename is tmband4roiBlk.rgb
The inputfiletype is 0

the loaded outputfilename is thresh.rgb
the output filetype is 0

the loaded threshold value is 100.000000

The value of Image operator is 11

10-02-94

The band-ratio method was tested.
The results are shown below:

```

bandtest.sh
Page 1

../bin/tm_proc Band_Ratio \
-i ../test/t1.rgb \
-i ../test/t2.rgb \
-o ../test/BR1.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t1.rgb \
-i ../test/t3.rgb \
-o ../test/BR2.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t1.rgb \
-i ../test/t4.rgb \
-o ../test/BR3.rgb

../bin/tm_proc Merge \
-i ../test/BR3.rgb \
-i ../test/BR2.rgb \
-i ../test/BR1.rgb \
-o ../test/merge.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t2.rgb \
-i ../test/t1.rgb \
-o ../test/BR1.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t2.rgb \
-i ../test/t3.rgb \
-o ../test/BR2.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t2.rgb \
-i ../test/t4.rgb \
-o ../test/BR3.rgb

../bin/tm_proc Merge \
-i ../test/BR3.rgb \
-i ../test/BR2.rgb \
-i ../test/BR1.rgb \
-o ../test/merge.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t3.rgb \
-i ../test/t1.rgb \
-o ../test/BR1.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t3.rgb \
-i ../test/t2.rgb \
-o ../test/BR2.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t3.rgb \
-i ../test/t4.rgb \
-o ../test/BR3.rgb

../bin/tm_proc Merge \
-i ../test/BR3.rgb \
-i ../test/BR2.rgb \
-i ../test/BR1.rgb

```

Handwritten initials 'JS' with a checkmark.

```

bandtest.sh
Page 2

-o ../test/merge.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t4.rgb \
-i ../test/t1.rgb \
-o ../test/BR1.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t4.rgb \
-i ../test/t2.rgb \
-o ../test/BR2.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t4.rgb \
-i ../test/t3.rgb \
-o ../test/BR3.rgb

../bin/tm_proc Merge \
-i ../test/BR3.rgb \
-i ../test/BR2.rgb \
-i ../test/BR1.rgb \
-o ../test/merge.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t5.rgb \
-i ../test/t1.rgb \
-o ../test/BR1.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t5.rgb \
-i ../test/t2.rgb \
-o ../test/BR2.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t5.rgb \
-i ../test/t3.rgb \
-o ../test/BR3.rgb

../bin/tm_proc Merge \
-i ../test/BR3.rgb \
-i ../test/BR2.rgb \
-i ../test/BR1.rgb \
-o ../test/merge.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t1.rgb \
-i ../test/t1.rgb \
-o ../test/BR1.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t1.rgb \
-i ../test/t5.rgb \
-o ../test/BR2.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t5.rgb \
-i ../test/t1.rgb \
-o ../test/BR3.rgb

```

Handwritten initials 'JS' with a checkmark.

bandtest.sh

Page 3

```

../bin/tm_proc Merge \
-i ../test/BR3.rgb \
-i ../test/BR2.rgb \
-i ../test/BR1.rgb \
-o ../test/merge.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t2.rgb \
-i ../test/t2.rgb \
-o ../test/BR1.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t2.rgb \
-i ../test/t5.rgb \
-o ../test/BR2.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t3.rgb \
-i ../test/t5.rgb \
-o ../test/BR3.rgb

../bin/tm_proc Merge \
-i ../test/BR3.rgb \
-i ../test/BR2.rgb \
-i ../test/BR1.rgb \
-o ../test/merge.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t3.rgb \
-i ../test/t3.rgb \
-o ../test/BR1.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t3.rgb \
-i ../test/t5.rgb \
-o ../test/BR2.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t4.rgb \
-i ../test/t4.rgb \
-o ../test/BR3.rgb

../bin/tm_proc Merge \
-i ../test/BR3.rgb \
-i ../test/BR2.rgb \
-i ../test/BR1.rgb \
-o ../test/merge.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t4.rgb \
-i ../test/t5.rgb \
-o ../test/BR1.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t5.rgb \
-i ../test/t4.rgb \
-o ../test/BR2.rgb

../bin/tm_proc Band_Ratio \
-i ../test/t5.rgb \

```

RS

bandtest.sh

Page 4

```

-i ../test/t3.rgb \
-o ../test/BR3.rgb

../bin/tm_proc Merge \
-i ../test/BR3.rgb \
-i ../test/BR2.rgb \
-i ../test/BR1.rgb \
-o ../test/merge.rgb

```

RS

btest.out

Page 1

the loaded inputfilename is ../test/t1.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/t2.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR1.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t1.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Input file 2, ../test/t2.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 01 01 01

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00
Image operator: (null)
Input file 1,2: ../test/t1.rgb ../test/t2.rgb
Output file: ../test/BR1.rgb
the loaded inputfilename is ../test/t1.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/t3.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR2.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t1.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Input file 2, ../test/t3.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 02 02 02

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00
Image operator: (null)
Input file 1,2: ../test/t1.rgb ../test/t3.rgb
Output file: ../test/BR2.rgb
the loaded inputfilename is ../test/t1.rgb
The inputfiletype is 0

btest.out

Page 2

the loaded inputfilename is ../test/t4.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR3.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t1.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Input file 2, ../test/t4.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 7f 7f 7f

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00
Image operator: (null)
Input file 1,2: ../test/t1.rgb ../test/t4.rgb
Output file: ../test/BR3.rgb
the loaded inputfilename is ../test/BR3.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/BR2.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/BR1.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/merge.rgb
the output filetype is 0

The value of Image operator is 3

Input File 1, ../test/BR3.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Input File 2, ../test/BR2.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Input File 3, ../test/BR1.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Merged Image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00
Input files 1, 2 3: ../test/BR3.rgb ../test/BR2.rgb ../test/BR1.rgb
The output file : ../test/merge.rgb

btest.out

the loaded inputfilename is ../test/t2.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/t1.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR1.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t2.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 01 01 01

Input file 2, ../test/t1.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00
Image operator: (null)
Input file 1,2: ../test/t2.rgb ../test/t1.rgb
Output file: ../test/BR1.rgb
the loaded inputfilename is ../test/t2.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/t3.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR2.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t2.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 01 01 01

Input file 2, ../test/t3.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 02 02 02

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00
Image operator: (null)
Input file 1,2: ../test/t2.rgb ../test/t3.rgb
Output file: ../test/BR2.rgb
the loaded inputfilename is ../test/t2.rgb
The inputfiletype is 0

btest.out

the loaded inputfilename is ../test/t4.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR3.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t2.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 01 01 01

Input file 2, ../test/t4.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 7f 7f 7f

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00
Image operator: (null)
Input file 1,2: ../test/t2.rgb ../test/t4.rgb
Output file: ../test/BR3.rgb
the loaded inputfilename is ../test/BR3.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/BR2.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/BR1.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/merge.rgb
the output filetype is 0

The value of Image operator is 3

Input File 1, ../test/BR3.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Input File 2, ../test/BR2.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Input File 3, ../test/BR1.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Merged Image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00
Input files 1, 2 3: ../test/BR3.rgb ../test/BR2.rgb ../test/BR1.rgb
The output file : ../test/merge.rgb

btest.out

Page 5

the loaded inputfilename is ../test/t3.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/t1.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR1.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t3.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 02 02 02

Input file 2, ../test/t1.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00
Image operator: (null)
Input file 1,2: ../test/t3.rgb ../test/t1.rgb
Output file: ../test/BR1.rgb
the loaded inputfilename is ../test/t3.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/t2.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR2.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t3.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 02 02 02

Input file 2, ../test/t2.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 01 01 01

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 02 02 02
Image operator: (null)
Input file 1,2: ../test/t3.rgb ../test/t2.rgb
Output file: ../test/BR2.rgb
the loaded inputfilename is ../test/t3.rgb
The inputfiletype is 0

RP

btest.out

Page 6

the loaded inputfilename is ../test/t4.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR3.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t3.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 02 02 02

Input file 2, ../test/t4.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 7f 7f 7f

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00
Image operator: (null)
Input file 1,2: ../test/t3.rgb ../test/t4.rgb
Output file: ../test/BR3.rgb
the loaded inputfilename is ../test/BR3.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/BR2.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/BR1.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/merge.rgb
the output filetype is 0

The value of Image operator is 3

Input File 1, ../test/BR3.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Input File 2, ../test/BR2.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 02 02 02

Input File 3, ../test/BR1.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Merged image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 02 00
Input files 1, 2 3: ../test/BR3.rgb ../test/BR2.rgb ../test/BR1.rgb
The output file: ../test/merge.rgb

RP

btest.out

Page 7

the loaded inputfilename is ../test/t4.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/t1.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR1.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t4.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 7f 7f 7f

Input file 2, ../test/t1.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00
Image operator: (null)
Input file 1,2: ../test/t4.rgb ../test/t1.rgb
Output file: ../test/BR1.rgb
the loaded inputfilename is ../test/t4.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/t2.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR2.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t4.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 7f 7f 7f

Input file 2, ../test/t2.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 01 01 01

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 7f 7f 7f
Image operator: (null)
Input file 1,2: ../test/t4.rgb ../test/t2.rgb
Output file: ../test/BR2.rgb
the loaded inputfilename is ../test/t4.rgb
The inputfiletype is 0

btest.out

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the loaded inputfilename is ../test/t3.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR3.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t4.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 7f 7f 7f

Input file 2, ../test/t3.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 02 02 02

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 3f 3f 3f
Image operator: (null)
Input file 1,2: ../test/t4.rgb ../test/t3.rgb
Output file: ../test/BR3.rgb
the loaded inputfilename is ../test/BR3.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/BR2.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/BR1.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/merge.rgb
the output filetype is 0

The value of Image operator is 3

Input File 1, ../test/BR3.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 3f 3f 3f

Input File 2, ../test/BR2.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 7f 7f 7f

Input File 3, ../test/BR1.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Merged Image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 3f 7f 00
Input files 1, 2 3: ../test/BR3.rgb ../test/BR2.rgb ../test/BR1.rgb
The output file : ../test/merge.rgb

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```

btest.out
the loaded inputfilename is ../test/t5.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/t1.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR1.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t5.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is ff ff ff

Input file 2, ../test/t1.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00
Image operator: (null)
Input file 1,2: ../test/t5.rgb ../test/t1.rgb
Output file: ../test/BR1.rgb
the loaded inputfilename is ../test/t5.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/t2.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR2.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t5.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is ff ff ff

Input file 2, ../test/t2.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 01 01 01

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is ff ff ff
Image operator: (null)
Input file 1,2: ../test/t5.rgb ../test/t2.rgb
Output file: ../test/BR2.rgb
the loaded inputfilename is ../test/t5.rgb
The inputfiletype is 0

```

RP

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```

btest.out
the loaded inputfilename is ../test/t3.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR3.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t5.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is ff ff ff

Input file 2, ../test/t3.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 02 02 02

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 7f 7f 7f
Image operator: (null)
Input file 1,2: ../test/t5.rgb ../test/t3.rgb
Output file: ../test/BR3.rgb
the loaded inputfilename is ../test/BR3.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/BR2.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/BR1.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/merge.rgb
the output filetype is 0

The value of Image operator is 3

Input File 1, ../test/BR3.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 7f 7f 7f

Input File 2, ../test/BR2.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is ff ff ff

Input File 3, ../test/BR1.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Merged Image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 7f ff 00
Input files 1, 2 3: ../test/BR3.rgb ../test/BR2.rgb ../test/BR1.rgb
The output file : ../test/merge.rgb

```

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btest.out

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the loaded inputfilename is ../test/t1.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/t1.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR1.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t1.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Input file 2, ../test/t1.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00
Image operator: (null)
Input file 1,2: ../test/t1.rgb ../test/t1.rgb
Output file: ../test/BR1.rgb
the loaded inputfilename is ../test/t1.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/t5.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR2.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t1.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Input file 2, ../test/t5.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is ff ff ff

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00
Image operator: (null)
Input file 1,2: ../test/t1.rgb ../test/t5.rgb
Output file: ../test/BR2.rgb
the loaded inputfilename is ../test/t5.rgb
The inputfiletype is 0

btest.out

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the loaded inputfilename is ../test/t1.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR3.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t5.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is ff ff ff

Input file 2, ../test/t1.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00
Image operator: (null)
Input file 1,2: ../test/t5.rgb ../test/t1.rgb
Output file: ../test/BR3.rgb
the loaded inputfilename is ../test/BR3.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/BR2.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/BR1.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/merge.rgb
the output filetype is 0

The value of Image operator is 3

Input File 1, ../test/BR3.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Input File 2, ../test/BR2.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Input File 3, ../test/BR1.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Merged Image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00
Input files 1, 2 3: ../test/BR3.rgb ../test/BR2.rgb ../test/BR1.rgb
The output file : ../test/merge.rgb

btest.out

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the loaded inputfilename is ../test/t2.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/t2.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR1.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t2.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 01 01 01

Input file 2, ../test/t2.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 01 01 01

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 01 01 01
Image operator: (null)
Input file 1,2: ../test/t2.rgb ../test/t2.rgb
Output file: ../test/BR1.rgb
the loaded inputfilename is ../test/t2.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/t5.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR2.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t2.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 01 01 01

Input file 2, ../test/t5.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is ff ff ff

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00
Image operator: (null)
Input file 1,2: ../test/t2.rgb ../test/t5.rgb
Output file: ../test/BR2.rgb
the loaded inputfilename is ../test/t3.rgb
The inputfiletype is 0

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btest.out

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the loaded inputfilename is ../test/t5.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR3.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t3.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 02 02 02

Input file 2, ../test/t5.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is ff ff ff

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00
Image operator: (null)
Input file 1,2: ../test/t3.rgb ../test/t5.rgb
Output file: ../test/BR3.rgb
the loaded inputfilename is ../test/BR3.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/BR2.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/BR1.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/merge.rgb
the output filetype is 0

The value of Image operator is 3

Input File 1, ../test/BR3.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Input File 2, ../test/BR2.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Input File 3, ../test/BR1.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 01 01 01

Merged Image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 01
Input files 1, 2 3: ../test/BR3.rgb ../test/BR2.rgb ../test/BR1.rgb
The output file : ../test/merge.rgb

RP

btest.out

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```

the loaded inputfilename is ../test/t3.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/t3.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR1.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t3.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 02 02 02

Input file 2, ../test/t3.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 02 02 02

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 01 01 01
Image operator: (null)
Input file 1,2: ../test/t3.rgb ../test/t3.rgb
Output file: ../test/BR1.rgb
the loaded inputfilename is ../test/t3.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/t5.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR2.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t3.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 02 02 02

Input file 2, ../test/t5.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is ff ff ff

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00
Image operator: (null)
Input file 1,2: ../test/t3.rgb ../test/t5.rgb
Output file: ../test/BR2.rgb
the loaded inputfilename is ../test/t4.rgb
The inputfiletype is 0

```

btest.out

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```

the loaded inputfilename is ../test/t4.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR3.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t4.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 7f 7f 7f

Input file 2, ../test/t4.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 7f 7f 7f

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 01 01 01
Image operator: (null)
Input file 1,2: ../test/t4.rgb ../test/t4.rgb
Output file: ../test/BR3.rgb
the loaded inputfilename is ../test/BR3.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/BR2.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/BR1.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/merge.rgb
the output filetype is 0

The value of Image operator is 3

Input File 1, ../test/BR3.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 01 01 01

Input File 2, ../test/BR2.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Input File 3, ../test/BR1.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 01 01 01

Merged Image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 01 00 01
Input files 1, 2 3: ../test/BR3.rgb ../test/BR2.rgb ../test/BR1.rgb
The output file : ../test/merge.rgb

```

btest.out

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the loaded inputfilename is ../test/t4.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/t5.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR1.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t4.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 7f 7f 7f

Input file 2, ../test/t5.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is ff ff ff

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00
Image operator: (null)
Input file 1,2: ../test/t4.rgb ../test/t5.rgb
Output file: ../test/BR1.rgb
the loaded inputfilename is ../test/t5.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/t4.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR2.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t5.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is ff ff ff

Input file 2, ../test/t4.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 7f 7f 7f

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 02 02 02
Image operator: (null)
Input file 1,2: ../test/t5.rgb ../test/t4.rgb
Output file: ../test/BR2.rgb
the loaded inputfilename is ../test/t5.rgb
The inputfiletype is 0

btest.out

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the loaded inputfilename is ../test/t3.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/BR3.rgb
the output filetype is 0

The value of Image operator is 0

Input file 1, ../test/t5.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is ff ff ff

Input file 2, ../test/t3.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 02 02 02

Divided image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 7f 7f 7f
Image operator: (null)
Input file 1,2: ../test/t5.rgb ../test/t3.rgb
Output file: ../test/BR3.rgb
the loaded inputfilename is ../test/BR3.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/BR2.rgb
The inputfiletype is 0

the loaded inputfilename is ../test/BR1.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/merge.rgb
the output filetype is 0

The value of Image operator is 3

Input File 1, ../test/BR3.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 7f 7f 7f

Input File 2, ../test/BR2.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 02 02 02

Input File 3, ../test/BR1.rgb
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 00 00 00

Merged Image file
The xyz size is 1 1 1.
The 0 pixel value at 0,0 is 7f 02 00
Input files 1, 2 3: ../test/BR3.rgb ../test/BR2.rgb ../test/BR1.rgb
The output file : ../test/merge.rgb

10-5-94

The following was done to test Spectral Thresholding (Classify_Resources)

- A script file was executed

The results are shown below.

```

class.test.sh                                     Page 1
./bin/tm_proc Classify_Resources -i ../test/abc.rgb -o ../test/class.rgb -tmin
22. -tmax 66.
./bin/tm_proc Classify_Resources -i ../test/abc.rgb -o ../test/class.rgb -tmi
n 10. -tmax 20.
./bin/tm_proc Classify_Resources -i ../test/abc.rgb -o ../test/class.rgb -tmi
n 15. -tmax 25.
./bin/tm_proc Classify_Resources -i ../test/abc.rgb -o ../test/class.rgb -tmi
n 30. -tmax 45.
./bin/tm_proc Classify_Resources -i ../test/abc.rgb -o ../test/class.rgb -tmi
n 15. -tmax 50.
./bin/tm_proc Classify_Resources -i ../test/abc.rgb -o ../test/class.rgb -tmin
50. -tmax 70.
./bin/tm_proc Classify_Resources -i ../test/abc.rgb -o ../test/class.rgb -tmin
60. -tmax 66.

```

RP

```

class.out                                         Page 1

the loaded outputfilename is ../test/class.rgb
the output filetype is 0

incremented tmin:1
the loaded threshold value is 22.000000

incremented tmax:1
the loaded threshold value is 66.000000

The value of Image operator is 0
the loaded inputfilename is ../test/abc.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/class.rgb
the output filetype is 0

incremented tmin:1
the loaded threshold value is 10.000000

incremented tmax:1
the loaded threshold value is 20.000000

The value of Image operator is 1
Input file: ../test/abc.rgb
Output file: ../test/class.rgb
the value of tmax : 1
the value of tmin : 1
the value of mflag is 0
The threshold max value: 20.000000
The threshold min value: 10.000000
the number of rows: 1
the number of cols: 2
the max value is : 20.000000
the min value is : 10.000000
the configured max val : 20.000000
the configured min val : 10.000000
The received max thresh val: 20.000000
The received min thresh val: 10.000000
The received max thresh val: 235.000000
The received threshold value : 10.000000
The received threshold value : 235.000000
the loaded inputfilename is ../test/abc.rgb
The inputfiletype is 0

the loaded outputfilename is ../test/class.rgb
the output filetype is 0

incremented tmin:1
the loaded threshold value is 15.000000

incremented tmax:1
the loaded threshold value is 25.000000

```

RP

class.out

Page 2

```

The value of Image operator is 1
Input file : ../test/abc.rgb
Output file: ../test/class.rgb
the value of tmax : 1
the value of tmin : 1
the value of mflag is 0
The threshold max value: 25.000000
The threshold min value: 15.000000
the number of rows: 1
the number of cols: 2
the max value is : 25.000000
the min value is : 15.000000
the configured max val : 25.000000
the configured min val : 15.000000
The received max thresh val: 25.000000
The received min thresh val: 15.000000
The received max thresh val: 230.000000
The received threshold value : 15.000000
The received threshold value : 230.000000
the loaded inputfilename is ../test/abc.rgb
The inputfiletype is 0

```

```

the loaded outputfilename is ../test/class.rgb
the output filetype is 0

```

```

incremented tmin:1
the loaded threshold value is 30.000000

```

```

incremented tmax:1
the loaded threshold value is 45.000000

```

```

The value of Image operator is 1
Input file : ../test/abc.rgb
Output file: ../test/class.rgb
the value of tmax : 1
the value of tmin : 1
the value of mflag is 0
The threshold max value: 45.000000
The threshold min value: 30.000000
the number of rows: 1
the number of cols: 2
the max value is : 45.000000
the min value is : 30.000000
the configured max val : 45.000000
the configured min val : 30.000000
The received max thresh val: 45.000000
The received min thresh val: 30.000000
The received max thresh val: 210.000000
The received threshold value : 30.000000
The received threshold value : 210.000000
the loaded inputfilename is ../test/abc.rgb
The inputfiletype is 0

```

```

the loaded outputfilename is ../test/class.rgb
the output filetype is 0

```

```

incremented tmin:1
the loaded threshold value is 15.000000

```

class.out

Page 3

```

incremented tmax:1
the loaded threshold value is 50.000000

```

```

The value of Image operator is 1
Input file : ../test/abc.rgb
Output file: ../test/class.rgb
the value of tmax : 1
the value of tmin : 1
the value of mflag is 0
The threshold max value: 50.000000
The threshold min value: 15.000000
the number of rows: 1
the number of cols: 2
the max value is : 50.000000
the min value is : 15.000000
the configured max val : 50.000000
the configured min val : 15.000000
The received max thresh val: 50.000000
The received min thresh val: 15.000000
The received max thresh val: 205.000000
The received threshold value : 15.000000
The received threshold value : 205.000000
the loaded inputfilename is ../test/abc.rgb
The inputfiletype is 0

```

```

the loaded outputfilename is ../test/class.rgb
the output filetype is 0

```

```

incremented tmin:1
the loaded threshold value is 50.000000

```

```

incremented tmax:1
the loaded threshold value is 70.000000

```

```

The value of Image operator is 1
Input file : ../test/abc.rgb
Output file: ../test/class.rgb
the value of tmax : 1
the value of tmin : 1
the value of mflag is 0
The threshold max value: 70.000000
The threshold min value: 50.000000
the number of rows: 1
the number of cols: 2
the max value is : 70.000000
the min value is : 50.000000
the configured max val : 70.000000
the configured min val : 50.000000
The received max thresh val: 70.000000
The received min thresh val: 50.000000
The received max thresh val: 185.000000
The received threshold value : 50.000000
The received threshold value : 185.000000
the loaded inputfilename is ../test/abc.rgb
The inputfiletype is 0

```

```

the loaded outputfilename is ../test/class.rgb
the output filetype is 0

```

```

class.out
Page 4

incremented tfsin:1
the loaded threshold value is 0.000000
incremented tfsax:1
the loaded threshold value is 66.000000

The value of image operator is 1
Input file: ../test/abc.rgb
Output file: ../test/class.rgb
the value of tfsax: 1
the value of tfsin: 1
the value of mflag is 0
The threshold max value: 66.000000
The threshold min value: 0.000000
the number of rows: 1
the number of cols: 2
the max value is: 66.000000
the min value is: 0.000000
the configured max val: 66.000000
the configured min val: 0.000000
The received max thresh val: 66.000000
The received min thresh val: 0.000000
The received max thresh val: 189.000000
The received threshold value: 0.000000
The received threshold value: 189.000000

```

RP

10-10-94

The following was done to ~~edpp~~ calculate reference threshold values. Tests were done to see if it worked correctly.

```

refthresh.sh
Page 1

../bin/tm_proc Calc_Ref -i ../data/tmband1.rgb -o ../data/ref1.rgb -x_offset 0 -
y_offset 0 -size_x 10 -size_y 10
../bin/tm_proc Calc_Ref -i ../data/tmband3.rgb -o ../data/ref3.rgb -x_offset 0 -
y_offset 0 -size_x 10 -size_y 10
../bin/tm_proc Calc_Ref -i ../data/tmband6.rgb -o ../data/ref6.rgb -x_offset 0 -
y_offset 0 -size_x 10 -size_y 10
../bin/tm_proc Calc_Ref -i ../data/tmband3.rgb -o ../data/ref2.rgb -x_offset 0 -
y_offset 0 -size_x 10 -size_y 10
../bin/tm_proc Calc_Ref -i ../data/tmband5.rgb -o ../data/ref5.rgb -x_offset 0 -
y_offset 0 -size_x 10 -size_y 10
../bin/tm_proc Calc_Ref -i ../data/tmband7.rgb -o ../data/ref7.rgb -x_offset 0 -
y_offset 0 -size_x 10 -size_y 10
../bin/tm_proc Calc_Ref -i ../data/tmband4.rgb -o ../data/ref4.rgb -x_offset 0 -
y_offset 0 -size_x 10 -size_y 10
#tosun ../data/ref.rgb ../data/ref.ras

#../bin/tm_proc Calc_Ref -i ../data/bare.rgb -o ../data/ref.rgb -x_offset 300 -y
_offset 400 -size_x 50 -size_y 50

```

RP

ref.out

Page 1

the loaded inputfilename is ../data/tmband1.rgb
The inputfiletype is 0

the loaded outputfilename is ../data/ref1.rgb
the output filetype is 0

The offset for x is 0

The offset for y is 0

The x size is 10

The y size is 10

The value of Image operator is 7
The new x & y sizes are 4 5
The total pixel count for ../data/scstat.rgb is 0
The minimum pixel value of ../data/scstat.rgb is 147
The maximum pixel value of ../data/scstat.rgb is 157
The mean value of ../data/scstat.rgb is 151
The std dev value of ../data/scstat.rgb is 2
The Pixel mean is 151
The Pixel Std_dev is 2
the minimum thresh intensity is 149.208008
the maximum thresh intensity is 154.191986
the number of rows: 1
the number of cols: 2
the max value is : 154.191986
the min value is : 149.208008
the loaded inputfilename is ../data/tmband3.rgb
The inputfiletype is 0

the loaded outputfilename is ../data/ref3.rgb
the output filetype is 0

The offset for x is 0

The offset for y is 0

The x size is 10

The y size is 10

The value of Image operator is 7
The new x & y sizes are 4 5
The total pixel count for ../data/scstat.rgb is 0
The minimum pixel value of ../data/scstat.rgb is 95
The maximum pixel value of ../data/scstat.rgb is 118
The mean value of ../data/scstat.rgb is 107
The std dev value of ../data/scstat.rgb is 6
The Pixel mean is 107
The Pixel Std_dev is 6
the minimum thresh intensity is 101.412323
the maximum thresh intensity is 114.387680

ref.out

Page 2

the number of rows: 1
the number of cols: 2
the max value is : 114.387680
the min value is : 101.412323
the loaded inputfilename is ../data/tmband6.rgb
The inputfiletype is 0

the loaded outputfilename is ../data/ref6.rgb
the output filetype is 0

The offset for x is 0

The offset for y is 0

The x size is 10

The y size is 10

The value of Image operator is 7
The new x & y sizes are 4 5
The total pixel count for ../data/scstat.rgb is 0
The minimum pixel value of ../data/scstat.rgb is 189
The maximum pixel value of ../data/scstat.rgb is 193
The mean value of ../data/scstat.rgb is 191
The std dev value of ../data/scstat.rgb is 1
The Pixel mean is 191
The Pixel Std_dev is 1
the minimum thresh intensity is 189.654312
the maximum thresh intensity is 192.545685
the number of rows: 1
the number of cols: 2
the max value is : 192.545685
the min value is : 189.654312
the loaded inputfilename is ../data/tmband2.rgb
The inputfiletype is 0

the loaded outputfilename is ../data/ref2.rgb
the output filetype is 0

The offset for x is 0

The offset for y is 0

The x size is 10

The y size is 10

The value of Image operator is 7
The new x & y sizes are 4 5
The total pixel count for ../data/scstat.rgb is 0
The minimum pixel value of ../data/scstat.rgb is 71
The maximum pixel value of ../data/scstat.rgb is 79
The mean value of ../data/scstat.rgb is 75
The std dev value of ../data/scstat.rgb is 2

ref.out

Page 3

The Pixel mean is 75
 The Pixel Std_dev is 2
 the minimum thresh intensity is 73.323586
 the maximum thresh intensity is 78.176414
 the number of rows: 1
 the number of cols: 2
 the max value is : 78.176414
 the min value is : 73.323586
 the loaded inputfilename is ../data/tmband5.rgb
 The inputfiletype is 0

the loaded outputfilename is ../data/ref5.rgb
 the output filetype is 0

The offset for x is 0

The offset for y is 0

The x size is 10

The y size is 10

The value of Image operator is 7
 The new x & y sizes are 4 5
 The total pixel count for ../data/scstat.rgb is 0
 The minimum pixel value of ../data/scstat.rgb is 135
 The maximum pixel value of ../data/scstat.rgb is 158
 The mean value of ../data/scstat.rgb is 147
 The std dev value of ../data/scstat.rgb is 6
 The Pixel mean is 147
 The Pixel Std_dev is 6
 the minimum thresh intensity is 140.682312
 the maximum thresh intensity is 153.417694
 the number of rows: 1
 the number of cols: 2
 the max value is : 153.417694
 the min value is : 140.682312
 the loaded inputfilename is ../data/tmband7.rgb
 The inputfiletype is 0

the loaded outputfilename is ../data/ref7.rgb
 the output filetype is 0

The offset for x is 0

The offset for y is 0

The x size is 10

The y size is 10

The value of Image operator is 7
 The new x & y sizes are 4 5
 The total pixel count for ../data/scstat.rgb is 0

ref.out

Page 4

The minimum pixel value of ../data/scstat.rgb is 67
 The maximum pixel value of ../data/scstat.rgb is 90
 The mean value of ../data/scstat.rgb is 82
 The std dev value of ../data/scstat.rgb is 6
 The Pixel mean is 82
 The Pixel Std_dev is 6
 the minimum thresh intensity is 75.810455
 the maximum thresh intensity is 89.189545
 the number of rows: 1
 the number of cols: 2
 the max value is : 89.189545
 the min value is : 75.810455
 the loaded inputfilename is ../data/tmband4.rgb
 The inputfiletype is 0

the loaded outputfilename is ../data/ref4.rgb
 the output filetype is 0

The offset for x is 0

The offset for y is 0

The x size is 10

The y size is 10

The value of Image operator is 7
 The new x & y sizes are 4 5
 The total pixel count for ../data/scstat.rgb is 0
 The minimum pixel value of ../data/scstat.rgb is 73
 The maximum pixel value of ../data/scstat.rgb is 93
 The mean value of ../data/scstat.rgb is 85
 The std dev value of ../data/scstat.rgb is 5
 The Pixel mean is 85
 The Pixel Std_dev is 5
 the minimum thresh intensity is 79.374634
 the maximum thresh intensity is 91.225372
 the number of rows: 1
 the number of cols: 2
 the max value is : 91.225372
 the min value is : 79.374634

10-25-94

The executable was invoked using script files and information extracted out of TM data by

"band Ratio", "Classify Resources".

The data was converted to BW image by utility UTM Tm To Rgb.

Then this base image was processed upon by ERTmg.hh/ERTmg.ch.

The results are in US71/Praman/
tm-project/Pass1Data.

12/20/95

AS OF THIS DATE, I AM CLOSING OUT PAUITRA'S SCIENTIFIC NOTEBOOK.

TWO AUXILIARY ATTACHMENTS ARE INCLUDED WITH THIS NOTEBOOK.

ATTACHMENT 1. 8mm BRU Backup of PAUITRA'S FILES.
A LIST OF FILES ON THE TAPE ARE

ATTACHMENT 2. REPORT ENTITLED "REGISTRATION AND CLASSIFICATION OF TERRAIN USING IMAGE PROCESSING TECHNIQUES ON LANDSAT TM IMAGERY" BY PAUITRA RAMANITAN. THIS REPORT REPRESENTS THE RESULTS OF A SPECIAL PROJECT SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL OF ST. MARY'S UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR PAUITRA'S MASTER OF SCIENCE DEGREE IN ENGINEERING (AT ST. MARY'S UNIVERSITY).

Neil H. Hild

-rw-r--r--	1	praman	sgiu	597	Apr	20	14:52	./login
-rw-r--r--	1	praman	sgiu	1627	Dec	8	14:38	./cshrc
-rw-r--r--	1	praman	sgiu	722	Apr	20	14:52	./profile
drwxr-xr-x	3	praman	sgiu	0	Apr	20	14:58	./workspace
-rw-r--r--	1	praman	sgiu	5	Nov	23	1993	./workspace/
-rw-rw-rw-	1	praman	sgiu	5	Nov	23	1993	./workspace/.tmLockysiris.0.0
-rw-rw-rw-	1	praman	sgiu	20	Nov	23	1993	./workspace/.wsLockysiris.0.0
-rw-r--r--	1	praman	sgiu	38	Nov	23	1993	./workspace/ctrTimeFile
-rw-rw-rw-	1	praman	sgiu	808	Nov	23	1993	./workspace/currentTransferDevice
-rw-r--r--	1	praman	sgiu	306	Nov	23	1993	./workspace/database
drwxr-xr-x	2	praman	sgiu	0	Apr	20	14:58	./workspace/localTransferLinks
-rw-rw-rw-	1	praman	sgiu	46	Nov	23	1993	./workspace/saveFiles
-rw-rw-rw-	1	praman	sgiu	10	Nov	23	1993	./workspace/timeFile
drwxr-xr-x	8	praman	sgiu	0	Sep	19	15:12	./home
drwxr-xr-x	7	praman	sgiu	0	Sep	26	16:17	./home/tm_project
-rw-r--r--	1	praman	sgiu	4422	Jun	29	13:44	./home/tm_project/grid.gif
-rw-r--r--	1	praman	sgiu	19253	Jun	29	13:40	./home/tm_project/grid.rgb
-rwxr-xr-x	1	praman	sgiu	38416	Jan	13	14:29	./home/tm_project/add
-rwxr-xr-x	1	praman	sgiu	38096	Jan	13	14:29	./home/tm_project/assemble
-rw-r--r--	1	praman	sgiu	93901	Jun	29	13:49	./home/tm_project/tmband4.gif
-rw-r--r--	1	praman	sgiu	93832	Jun	29	13:58	./home/tm_project/tmband7.gif
-rw-rw-rw-	1	praman	sgiu	878	Jul	6	12:01	./home/tm_project/multidimArrays.c
drwxr-xr-x	12	praman	sgiu	0	Dec	3	09:59	./home/tm_project/tm
drwxr-xr-x	2	praman	sgiu	0	Dec	10	13:31	./home/tm_project/tm/src
-rwxr-xr-x	1	praman	sgiu	773	Sep	28	17:04	./home/tm_project/tm/src/makefile
-rw-r--r--	1	praman	sgiu	5433	Nov	7	13:11	./home/tm_project/tm/src/refbullfrog.out
-rw-rw-rw-	1	praman	sgiu	1554	Oct	21	15:38	./home/tm_project/tm/src/ym_92_1.txt
-rw-r--r--	1	praman	sgiu	8232	Nov	17	11:19	./home/tm_project/tm/src/cmdlinearg.o
-rw-r--r--	1	praman	sgiu	37040	Nov	17	11:19	./home/tm_project/tm/src/ERImg.o
-rw-r--r--	1	praman	sgiu	981	Dec	10	13:17	./home/tm_project/tm/src/ERFile.hh
-rwxr-xr-x	1	praman	sgiu	496864	Sep	16	16:43	./home/tm_project/tm/src/tmToRgb
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-rw-r--r--	1	praman	sgiu	3320	Nov	17	11:19	./home/tm_project/tm/src/ERFile.o
-rw-r--r--	1	praman	sgiu	2184	Sep	23	17:19	./home/tm_project/tm/src/ctest.out
-rw-rw-rw-	1	praman	sgiu	1929	Nov	17	11:18	./home/tm_project/tm/src/cmdlinearg.hh
-rwxr-xr-x	1	praman	sgiu	902	Sep	28	14:24	./home/tm_project/tm/src/ctest.sh
-rw-r--r--	1	praman	sgiu	1569	Dec	10	13:56	./home/tm_project/tm/src/ERFile.c++
-rwxr-xr-x	1	praman	sgiu	121	Nov	1	16:59	./home/tm_project/tm/src/class.sh
-rw-r--r--	1	praman	sgiu	19079	Dec	10	13:15	./home/tm_project/tm/src/ERImg.c++
-rwxr-xr-x	1	praman	sgiu	187	Oct	26	15:35	./home/tm_project/tm/src/bittest.sh
-r--r--r--	1	praman	sgiu	9963	Jul	1	15:43	./home/tm_project/tm/src/tmToRgb.c
-rwxr-xr-x	1	praman	sgiu	286	Nov	1	17:18	./home/tm_project/tm/src/recordthresh.txt
-rwxr-xr-x	1	praman	sgiu	509	Oct	10	15:11	./home/tm_project/tm/src/roi.sh
-rw-r--r--	1	praman	sgiu	8732	Nov	17	11:19	./home/tm_project/tm/src/cmdlinearg.c++
-rw-r--r--	1	praman	sgiu	5419	Nov	7	16:26	./home/tm_project/tm/src/2std.out
-rw-r--r--	1	praman	sgiu	2959	Oct	15	21:57	./home/tm_project/tm/src/prob.txt
-rw-r--r--	1	praman	sgiu	5465	Nov	17	11:32	./home/tm_project/tm/src/class.out
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-rw-r--r--	1	praman	sgiu	14628	Nov	17	11:29	./home/tm_project/tm/src/tm_proc.o
-rwxr-xr-x	1	praman	sgiu	110	Nov	4	15:58	./home/tm_project/tm/src/hyd.sh
-rw-r--r--	1	praman	sgiu	10552	Dec	10	12:03	./home/tm_project/tm/src/tm_proc.c++
-rwxr-xr-x	1	praman	sgiu	77	Nov	17	11:21	./home/tm_project/tm/src/circle.sh
-rwxr-xr-x	1	praman	sgiu	4451	Sep	22	16:24	./home/tm_project/tm/src/bandtest.sh
-rwxr-xr-x	1	praman	sgiu	3450	Nov	17	13:17	./home/tm_project/tm/src/run.sh
-rwxr-xr-x	1	praman	sgiu	813	Oct	26	16:40	./home/tm_project/tm/src/runTmToRgb
-rwxr-xr-x	1	praman	sgiu	60	Nov	1	14:15	./home/tm_project/tm/src/runUTM
-rwxr-xr-x	1	praman	sgiu	443	Nov	10	12:16	./home/tm_project/tm/src/uranium.sh
-rwxr-xr-x	1	praman	sgiu	1771	Nov	1	14:16	./home/tm_project/tm/src/runTmToRgb
-rwxr-xr-x	1	praman	sgiu	670	Oct	6	16:37	./home/tm_project/tm/src/blasstest.sh
-rw-r--r--	1	praman	sgiu	683	Oct	21	18:17	./home/tm_project/tm/src/Makefile.basic
-rw-r--r--	1	praman	sgiu	748	Oct	21	18:17	./home/tm_project/tm/src/Makefile
-rwxr-xr-x	1	praman	sgiu	956	Nov	7	14:54	./home/tm_project/tm/src/refthresh.sh
-rwxr-xr-x	1	praman	sgiu	123	Nov	1	18:08	./home/tm_project/tm/src/blendclass.sh
-rwxr-xr-x	1	praman	sgiu	66	Oct	26	13:59	./home/tm_project/tm/src/blendedges.sh
-rwxr-xr-x	1	praman	sgiu	95	Nov	15	14:32	./home/tm_project/tm/src/composite.sh
-rwxr-xr-x	1	praman	sgiu	485	Nov	17	13:06	./home/tm_project/tm/src/sun.sh
-rw-r--r--	1	praman	sgiu	24876	Sep	22	16:25	./home/tm_project/tm/src/btest.out
-rwxr-xr-x	1	praman	sgiu	447	Nov	4	13:55	./home/tm_project/tm/src/gold.sh
-rwxr-xr-x	1	praman	sgiu	1824	Nov	17	13:07	./home/tm_project/tm/src/goldclass.sh
-rw-r--r--	1	praman	sgiu	5421	Nov	10	16:17	./home/tm_project/tm/src/ref.out
-rwxr-xr-x	1	praman	sgiu	1480	Nov	7	16:41	./home/tm_project/tm/src/std.sh
drwxr-xr-x	2	praman	sgiu	0	Nov	18	12:47	./home/tm_project/tm/bin
-rwxr-xr-x	1	praman	sgiu	65444	Nov	18	12:47	./home/tm_project/tm/bin/tm_proc
drwxr-xr-x	4	praman	sgiu	0	Dec	7	13:15	./home/tm_project/tm/data
-rw-r--r--	1	praman	sgiu	249	Nov	18	13:00	./home/tm_project/tm/data/README
-rw-r--r--	1	praman	sgiu	889290	Nov	19	10:40	./home/tm_project/tm/data/bareI.rgb
-rw-r--r--	1	praman	sgiu	3243968	Nov	19	11:17	./home/tm_project/tm/data/bareI.rgb
-rw-r--r--	1	praman	sgiu	1799494	Nov	19	13:06	./home/tm_project/tm/data/yuccamtI.rgb
-rw-r--r--	1	praman	sgiu	217441	Dec	7	13:04	./home/tm_project/tm/data/calicoI.rgb.sav.bak
-rw-r--r--	1	praman	sgiu	354974	Dec	7	13:14	./home/tm_project/tm/data/calicoI.rgb
-rw-r--r--	1	praman	sgiu	3243792	Nov	19	11:39	./home/tm_project/tm/data/testI.rgb
-rw-r--r--	1	praman	sgiu	164382	Dec	3	11:56	./home/tm_project/tm/data/bareII.rgb
-rw-r--r--	1	praman	sgiu	256619	Nov	19	12:30	./home/tm_project/tm/data/calicoII.rgb
-rw-r--r--	1	praman	sgiu	1776599	Nov	19	13:19	./home/tm_project/tm/data/yuccamtII.rgb
-rw-r--r--	1	praman	sgiu	533809	Nov	19	12:07	./home/tm_project/tm/data/calicoI.rgb
-rw-r--r--	1	praman	sgiu	1737469	Nov	19	13:30	./home/tm_project/tm/data/yuccamtII.rgb
-rw-r--r--	1	praman	sgiu	1210512	Dec	7	13:15	./home/tm_project/tm/data/testI.rgb

[Handwritten signature]

drwxr-xr-x	2	praman	sgiu	0	Dec	3	09:45	./home/tm_project/tm/data/rgbimage
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-rw-r--r--	1	praman	sgiu	635840	Nov	19	10:00	./home/tm_project/tm/data/bareII.rgb
-rw-r--r--	1	praman	sgiu	635840	Nov	19	10:00	./home/tm_project/tm/data/calicoI.rgb
-rw-r--r--	1	praman	sgiu	635840	Nov	19	10:00	./home/tm_project/tm/data/calicoI.rgb
drwxr-xr-x	2	praman	sgiu	0	Dec	3	09:46	./home/tm_project/tm/data/calicoII.rgb
-rwxr-xr-x	1	praman	sgiu	35	Dec	3	09:52	./home/tm_project/tm/data/rasterimage
-rw-r--r--	1	praman	sgiu	164382	Dec	7	13:04	./home/tm_project/tm/data/calicoI.rgb.bak
-rw-r--r--	1	praman	sgiu	2624	Dec	3	11:34	./home/tm_project/tm/data/bareI.rgb.sav
-rw-r--r--	1	praman	sgiu	217441	Dec	3	11:19	./home/tm_project/tm/data/calicoI.rgb.sav
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-rw-r--r--	1	praman	sgiu	635840	Dec	3	12:00	./home/tm_project/tm/data/yuccaII.rgb
-rw-r--r--	1	praman	sgiu	635840	Dec	3	12:00	./home/tm_project/tm/data/yuccaII.rgb
-rwxr-xr-x	2	praman	sgiu	285825	Dec	3	12:06	./home/tm_project/tm/data/bareI.rgb.sav
drwxr-xr-x	2	praman	sgiu	0	Dec	10	13:54	./home/tm_project/tm/archive
-rw-r--r--	1	praman	sgiu	8732	Nov	15	14:23	./home/tm_project/tm/archive/cmdlinearg.c++
-rw-r--r--	1	praman	sgiu	2082	Dec	10	13:54	./home/tm_project/tm/archive/copyERF.c++
-rw-r--r--	1	praman	sgiu	1165	Sep	1	17:10	./home/tm_project/tm/archive/cmdlinearg.h
-rw-r--r--	1	praman	sgiu	2382155	Oct	18	18:36	./home/tm_project/tm/archive/mergeI.rgb
-rw-r--r--	1	praman	sgiu	18695	Nov	15	16:24	./home/tm_project/tm/archive/ERImg.c++
-rw-r--r--	1	praman	sgiu	4339	Nov	15	14:22	./home/tm_project/tm/archive/ERImg.hh
-rw-r--r--	1	praman	sgiu	37040	Nov	17	11:18	./home/tm_project/tm/archive/ERImg.o
-rwxr-xr-x	1	praman	sgiu	773	Oct	20	16:34	./home/tm_project/tm/archive/makefile
-rw-r--r--	1	praman	sgiu	8232	Nov	17	11:18	./home/tm_project/tm/archive/cmdlinearg.o
-rw-r--r--	1	praman	sgiu	3320	Nov	17	11:18	./home/tm_project/tm/archive/ERFile.o
-rw-r--r--	1	praman	sgiu	10205	Nov	15	14:25	./home/tm_project/tm/archive/tm_proc.c++
-rw-r--r--	1	praman	sgiu	1124	Sep	21	16:21	./home/tm_project/tm/archive/tmtest.c++
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-rw-r--r--	1	praman	sgiu	1187	Oct	26	16:43	./home/tm_project/tm/archive/refI.rgb
drwxr-xr-x	2	praman	sgiu	0	Nov	7	16:19	./home/tm_project/tm/README
-rw-r--r--	1	praman	sgiu	3698	Sep	9	17:20	./home/tm_project/tm/README/fastimgdataclassifi
-rw-r--r--	1	praman	sgiu	3366	Nov	11	14:38	./home/tm_project/tm/README/commandline_syntax
-rw-r--r--	1	praman	sgiu	2182	Sep	28	12:25	./home/tm_project/tm/README/expclass.txt
-rw-r--r--	1	praman	sgiu	230	Sep	29	16:17	./home/tm_project/tm/README/classmethod.txt
-rw-r--r--	1	praman	sgiu	1303	Nov	7	16:22	./home/tm_project/tm/README/aim.txt
drwxr-xr-x	2	praman	sgiu	0	Oct	4	14:22	./home/tm_project/tm/test
-rw-r--r--	1	praman	sgiu	545	Sep	21	16:46	./home/tm_project/tm/test/t1.rgb
-rw-r--r--	1	praman	sgiu	545	Sep	21	16:47	./home/tm_project/tm/test/t2.rgb
-rw-r--r--	1	praman	sgiu	545	Sep	21	16:47	./home/tm_project/tm/test/t3.rgb
-rw-r--r--	1	praman	sgiu	545	Sep	21	16:47	./home/tm_project/tm/test/t4.rgb
-rw-r--r--	1	praman	sgiu	545	Sep	21	16:48	./home/tm_project/tm/test/t5.rgb
-rw-r--r--	1	praman	sgiu	545	Oct	3	14:38	./home/tm_project/tm/test/a.rgb
-rw-r--r--	1	praman	sgiu	545	Oct	3	15:48	./home/tm_project/tm/test/b.rgb
-rw-r--r--	1	praman	sgiu	545	Oct	3	15:49	./home/tm_project/tm/test/c.rgb
-rw-r--r--	1	praman	sgiu	623	Oct	3	15:50	./home/tm_project/tm/test/abc.rgb
-rw-r--r--	1	praman	sgiu	574	Sep	22	12:31	./home/tm_project/tm/test/stat.out
-rw-r--r--	1	praman	sgiu	14818	Oct	3	15:52	./home/tm_project/tm/test/class.out
-rw-r--r--	1	praman	sgiu	539	Nov	17	11:32	./home/tm_project/tm/test/class.rgb
-rw-r--r--	1	praman	sgiu	113	Oct	3	15:53	./home/tm_project/tm/test/abc.st
-rw-r--r--	1	praman	sgiu	539	Oct	3	17:21	./home/tm_project/tm/test/thresh.rgb
drwxr-xr-x	2	praman	sgiu	0	Nov	17	13:22	./home/tm_project/tm/temp
drwxr-xr-x	3	praman	sgiu	0	Dec	5	14:02	./home/tm_project/tm/images
-rw-r--r--	1	praman	sgiu	939658	Nov	14	16:07	./home/tm_project/tm/images/barefinal.cps.Z
-rw-r--r--	1	praman	sgiu	1007665	Nov	14	15:55	./home

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-rw-r--r--	1	praman	sgiuser	2052081	Nov	15	16:47	./home/tm_project/tm/images/bareI.rgb.z
drwxr-xr-x	3	praman	sgiuser	0	Dec	8	15:47	./home/tm_project/tm/passldata
-rw-r--r--	1	praman	sgiuser	0	Nov	15	14:38	./home/tm_project/tm/passldata/bare.ps
-rw-r--r--	1	praman	sgiuser	3006515	Nov	17	13:15	./home/tm_project/tm/passldata/bareclass.rgb
-rw-r--r--	1	praman	sgiuser	3006515	Nov	17	13:16	./home/tm_project/tm/passldata/barehyd.rgb
-rw-r--r--	1	praman	sgiuser	2094532	Nov	14	15:53	./home/tm_project/tm/passldata/bareinter.cps.ba
-rw-r--r--	1	praman	sgiuser	3007036	Nov	17	13:59	./home/tm_project/tm/passldata/baremtn.ras
-rw-r--r--	1	praman	sgiuser	3006515	Nov	17	13:14	./home/tm_project/tm/passldata/baremtnI.rgb
-rw-r--r--	1	praman	sgiuser	3007036	Nov	17	13:59	./home/tm_project/tm/passldata/baremtnI.ras
-rw-r--r--	1	praman	sgiuser	2973483	Nov	17	13:15	./home/tm_project/tm/passldata/baremtnII.rgb
-rw-r--r--	1	praman	sgiuser	3007036	Nov	17	13:59	./home/tm_project/tm/passldata/baremtnII.ras
-rw-r--r--	1	praman	sgiuser	4008516	Nov	17	13:32	./home/tm_project/tm/passldata/baremtnIII.rgb
-rw-r--r--	1	praman	sgiuser	2033272	Nov	10	12:49	./home/tm_project/tm/passldata/calicooclass.ps
-rw-r--r--	1	praman	sgiuser	3006515	Nov	17	12:47	./home/tm_project/tm/passldata/calicooclassI.rgb
-rw-r--r--	1	praman	sgiuser	3007036	Nov	17	13:59	./home/tm_project/tm/passldata/calicooclassI.ras
-rw-r--r--	1	praman	sgiuser	3006515	Nov	17	12:47	./home/tm_project/tm/passldata/calicooclassII.rgb
-rw-r--r--	1	praman	sgiuser	3007036	Nov	17	13:59	./home/tm_project/tm/passldata/calicooclassII.ras
-rw-r--r--	1	praman	sgiuser	2999496	Nov	17	12:47	./home/tm_project/tm/passldata/calicooclassIII.rgb
-rw-r--r--	1	praman	sgiuser	3007036	Nov	17	13:59	./home/tm_project/tm/passldata/calicooclassIII.ras
-rw-r--r--	1	praman	sgiuser	4008516	Nov	17	13:30	./home/tm_project/tm/passldata/calicooclassIIII.rgb
-rw-r--r--	1	praman	sgiuser	3006515	Nov	17	12:56	./home/tm_project/tm/passldata/calicooclassIIII.ras
drwxr-xr-x	2	praman	sgiuser	0	Dec	8	18:45	./home/tm_project/tm/passldata/calicochyd.rgb
-rw-r--r--	1	praman	sgiuser	36	Dec	8	17:45	./home/tm_project/tm/passldata/report
-rw-r--r--	1	praman	sgiuser	994780	Dec	8	18:38	./home/tm_project/tm/passldata/report/size.sh
-rw-r--r--	1	praman	sgiuser	609565	Dec	8	16:48	./home/tm_project/tm/passldata/report/bareI.sc
-rw-r--r--	1	praman	sgiuser	742532	Dec	8	15:13	./home/tm_project/tm/passldata/report/bare.sc
-rw-r--r--	1	praman	sgiuser	447089	Dec	8	18:25	./home/tm_project/tm/passldata/report/test.ras
-rw-r--r--	1	praman	sgiuser	609565	Dec	8	18:37	./home/tm_project/tm/passldata/report/test.rgb
-rw-r--r--	1	praman	sgiuser	994716	Dec	8	18:45	./home/tm_project/tm/passldata/report/bare.sc.b
-rw-r--r--	1	praman	sgiuser	995180	Dec	8	18:38	./home/tm_project/tm/passldata/report/calicoI.sc
-rw-r--r--	1	praman	sgiuser	1520699	Dec	8	17:38	./home/tm_project/tm/passldata/report/bareII.cp
-rw-r--r--	1	praman	sgiuser	1520514	Dec	8	16:49	./home/tm_project/tm/passldata/report/bareII.cps
-rw-r--r--	1	praman	sgiuser	1520815	Dec	8	17:21	./home/tm_project/tm/passldata/report/bareI.cps
-rw-r--r--	1	praman	sgiuser	994780	Dec	8	17:21	./home/tm_project/tm/passldata/report/bareI.sc
-rw-r--r--	1	praman	sgiuser	995180	Dec	8	17:37	./home/tm_project/tm/passldata/report/bareII.sc
-rw-r--r--	1	praman	sgiuser	1520050	Dec	8	16:45	./home/tm_project/tm/passldata/report/calicoI.sc
-rw-r--r--	1	praman	sgiuser	609559	Dec	8	16:44	./home/tm_project/tm/passldata/report/calicoI.cp
-rw-r--r--	1	praman	sgiuser	994716	Dec	8	18:46	./home/tm_project/tm/passldata/report/calicoI.s
-rw-r--r--	1	praman	sgiuser	1520935	Dec	8	18:45	./home/tm_project/tm/passldata/report/calicoI.c
-rw-r--r--	1	praman	sgiuser	1521110	Dec	8	17:36	./home/tm_project/tm/passldata/report/calicoII.c
-rw-r--r--	1	praman	sgiuser	995432	Dec	8	17:36	./home/tm_project/tm/passldata/report/calicoII.s
-rw-r--r--	1	praman	sgiuser	1519650	Dec	8	18:12	./home/tm_project/tm/passldata/report/calicoII.cps
-rw-r--r--	1	praman	sgiuser	458381	Dec	8	18:11	./home/tm_project/tm/passldata/report/yucca.cps
-rw-r--r--	1	praman	sgiuser	458381	Dec	8	18:47	./home/tm_project/tm/passldata/report/yucca.sc
-rw-r--r--	1	praman	sgiuser	451197	Dec	8	18:36	./home/tm_project/tm/passldata/report/yuccaII.s
-rw-r--r--	1	praman	sgiuser	992792	Dec	8	18:13	./home/tm_project/tm/passldata/report/yuccaI.sc
-rw-r--r--	1	praman	sgiuser	992792	Dec	8	18:13	./home/tm_project/tm/passldata/report/yuccaI.sc
-rw-r--r--	1	praman	sgiuser	994548	Dec	8	18:47	./home/tm_project/tm/passldata/report/yuccaI.sc
-rw-r--r--	1	praman	sgiuser	994548	Dec	8	18:40	./home/tm_project/tm/passldata/report/yuccaI.sc
-rw-r--r--	1	praman	sgiuser	1520325	Dec	8	18:41	./home/tm_project/tm/passldata/report/yuccaII.cp
-rw-r--r--	1	praman	sgiuser	451197	Dec	8	18:47	./home/tm_project/tm/passldata/report/yuccaII.s
-rw-r--r--	1	praman	sgiuser	1520435	Dec	8	18:36	./home/tm_project/tm/passldata/report/yuccaII.c
-rw-r--r--	1	praman	sgiuser	609559	Dec	8	18:46	./home/tm_project/tm/passldata/report/calico.sc
-rw-r--r--	1	praman	sgiuser	995432	Dec	8	18:46	./home/tm_project/tm/passldata/report/calicoII.c
-rw-r--r--	1	praman	sgiuser	2222732	Nov	17	13:21	./home/tm_project/tm/passldata/yuccaclass.rgb
-rw-r--r--	1	praman	sgiuser	2222732	Nov	17	13:22	./home/tm_project/tm/passldata/yuccahyd.rgb
-rw-r--r--	1	praman	sgiuser	2222992	Nov	17	13:59	./home/tm_project/tm/passldata/yuccamt.n.ras
-rw-r--r--	1	praman	sgiuser	2222732	Nov	17	13:21	./home/tm_project/tm/passldata/yuccamt.n.ras
-rw-r--r--	1	praman	sgiuser	2222992	Nov	17	13:59	./home/tm_project/tm/passldata/yuccamtI.rgb
-rw-r--r--	1	praman	sgiuser	2149797	Nov	17	13:21	./home/tm_project/tm/passldata/yuccamtII.ras
-rw-r--r--	1	praman	sgiuser	2222992	Nov	17	13:59	./home/tm_project/tm/passldata/yuccamtII.ras
-rw-r--r--	1	praman	sgiuser	2963472	Nov	17	13:27	./home/tm_project/tm/passldata/yuccamtIII.rgb
-rw-r--r--	1	praman	sgiuser	249	Nov	18	13:00	./home/tm_project/tm/passldata/README
-rw-r--r--	1	praman	sgiuser	3008407	Dec	8	14:50	./home/tm_project/tm/passldata/baremtn.sc
-rw-r--r--	1	praman	sgiuser	1803456	Nov	19	15:24	./home/tm_project/tm/passldata/baretetII.rgb
-rw-r--r--	1	praman	sgiuser	2397442	Nov	19	15:36	./home/tm_project/tm/passldata/baretetI.rgb
-rw-r--r--	1	praman	sgiuser	2401480	Nov	19	15:43	./home/tm_project/tm/passldata/calicotestI.rgb
-rw-r--r--	1	praman	sgiuser	1772582	Nov	19	15:54	./home/tm_project/tm/passldata/calicotestII.rgb
-rw-r--r--	1	praman	sgiuser	2098163	Dec	8	18:24	./home/tm_project/tm/passldata/img.rgb
drwxr-xr-x	2	praman	sgiuser	0	Dec	7	13:21	./home/tm_project/tm/reportimages
-rw-r--r--	1	praman	sgiuser	1856153	Dec	7	13:13	./home/tm_project/tm/reportimages/bareI.cps
-rw-r--r--	1	praman	sgiuser	1854632	Dec	3	13:19	./home/tm_project/tm/reportimages/bare.cps
-rw-r--r--	1	praman	sgiuser	218333	Dec	3	13:28	./home/tm_project/tm/reportimages/calicoI.rgb.ba
-rw-r--r--	1	praman	sgiuser	367024	Dec	3	13:18	./home/tm_project/tm/reportimages/calicoI.rgb
-rw-r--r--	1	praman	sgiuser	1215104	Dec	7	13:13	./home/tm_project/tm/reportimages/bareI.rgb
-rw-r--r--	1	praman	sgiuser	1855588	Dec	3	13:25	./home/tm_project/tm/reportimages/bareII.cps
-rw-r--r--	1	praman	sgiuser	261416	Dec	3	13:25	./home/tm_project/tm/reportimages/bareII.cps
-rw-r--r--	1	praman	sgiuser	1854432	Dec	3	13:27	./home/tm_project/tm/reportimages/bareII.rgb
-rw-r--r--	1	praman	sgiuser	218333	Dec	3	13:23	./home/tm_project/tm/reportimages/calicoI.cps
-rw-r--r--	1	praman	sgiuser	261416	Dec	3	13:30	./home/tm_project/tm/reportimages/calicoI.rgb
-rw-r--r--	1	praman	sgiuser	1855328	Dec	7	13:06	./home/tm_project/tm/reportimages/bareII.rgb.ba
-rw-r--r--	1	praman	sgiuser	1214640	Dec	7	13:00	./home/tm_project/tm/reportimages/calicoI.cps
-rw-r--r--	1	praman	sgiuser	203157	Dec	7	12:47	./home/tm_project/tm/reportimages/calicoI.rgb
-rw-r--r--	1	praman	sgiuser	1855479	Dec	3	13:29	./home/tm_project/tm/reportimages/calicoII.cps
-rw-r--r--	1	praman	sgiuser	164350	Dec	3	12:36	./home/tm_project/tm/reportimages/calicoIIsave.
-rw-r--r--	1	praman	sgiuser	1853787	Dec	3	13:31	./home/tm_project/tm/reportimages/yucca.cps
-rw-r--r--	1	praman	sgiuser	286081	Dec	3	13:31	./home/tm_project/tm/reportimages/yucca.rgb
-rw-r--r--	1	praman	sgiuser	164350	Dec	3	12:25	./home/tm_project/tm/reportimages/calicoII.rgb

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-rw-r--r--	1	praman	sgiuser	286081	Dec	3	13:30	./home/tm_project/tm/reportimages/yucca.rgb.bak
-rw-r--r--	1	praman	sgiuser	318433	Dec	7	13:08	./home/tm_project/tm/reportimages/bareI.rgb.bak
-rw-r--r--	1	praman	sgiuser	367024	Dec	3	13:30	./home/tm_project/tm/reportimages/bareI.rgb.bak
-rw-r--r--	1	praman	sgiuser	203157	Dec	3	12:35	./home/tm_project/tm/reportimages/calicoIsave.r
-rw-r--r--	1	praman	sgiuser	164350	Dec	3	13:29	./home/tm_project/tm/reportimages/calicoII.rgb
-rw-r--r--	1	praman	sgiuser	238297	Dec	7	13:16	./home/tm_project/tm/reportimages/yuccaI.rgb.ba
-rw-r--r--	1	praman	sgiuser	1214440	Dec	7	13:21	./home/tm_project/tm/reportimages/yuccaI.rgb
-rw-r--r--	1	praman	sgiuser	1854937	Dec	7	13:22	./home/tm_project/tm/reportimages/yuccaI.cps
-rw-r--r--	1	praman	sgiuser	1854819	Dec	3	13:04	./home/tm_project/tm/reportimages/yuccaII.cps
-rw-r--r--	1	praman	sgiuser	164350	Dec	3	13:29	./home/tm_project/tm/reportimages/calicoII.rgb
-rw-r--r--	1	praman	sgiuser	164350	Dec	3	12:46	./home/tm_project/tm/reportimages/calicoIIsave.
-rw-r--r--	1	praman	sgiuser	1213848	Dec	3	13:01	./home/tm_project/tm/reportimages/calicoIIsave.
-rw-r--r--	1	praman	sgiuser	1214612	Dec	3	13:03	./home/tm_project/tm/reportimages/yuccaII.rgb
-rw-r--r--	1	praman	sgiuser	1214612	Dec	3	13:32	./home/tm_project/tm/reportimages/yuccaII.rgb.b
-rw-r--r--	1	praman	sgiuser	121	Dec	3	14:01	./home/tm_project/tm/reportimages/README
-rw-r--r--	1	praman	sgiuser	203157	Dec	7	13:05	./home/tm_project/tm/reportimages/calicoI.rgb.b
-rw-r--r--	1	praman	sgiuser	303796	Jan	13	14:29	./home/tm_project/extract_sgi_bin.Z
-rw-r--r--	0	Jun	28	10:48	./home/tm_project/dumpster			
-rw-r--r--	0	Nov	23	1993	./home/tm_project/dumpster/.dumpster			
-rw-r--r--	301419	Jan	13	14:29	./home/tm_project/mytops.Z			
-rw-r--r--	7073	Dec	20	1993	./home/tm_project/extract_sgi_bin.c			
-rw-r--r--	960255	Jan	13	14:29	./home/tm_project/tmBandInv.rgb.Z			
-rw-r--r--	967631	Jan	13	14:34	./home/tm_project/tmBand7inv.rgb.Z			
-rw-r--r--	13004	May	3	12:03	./home/tm_project/hello			
-rw-r--r--	56	Jan	27	15:57	./home/tm_project/hello.c			
-rw-r--r--	445880	Jan	13	14:29	./home/tm_project/hist			
-rw-r--r--	0	Jul	11	14:43	./home/tm_project/tm_dip			
-rw-r--r--	0	Jul	8	16:08	./home/tm_project/tm_dip/archive			
-rw-r--r--	924	Jul	2	09:19	./home/tm_project/tm_dip/archive/cpymd.h			
-rw-r--r--	4736	Jun	28	11:45	./home/tm_project/tm_dip/archive/copy.c			
-rw-r--r--	0	Jul	21	08:41	./home/tm_project/tm_dip/bin			
-rw-r--r--	18688	Jul	21	08:42	./home/tm_project/tm_dip/bin/tm			
-rw-r--r--	103108	Jul	21	08:42	./home/tm_project/tm_dip/bin/ilcview			
-rw-r--r--	0	Jun	28	11:44	./home/tm_project/tm_dip/datafiles			
-rw-r--r--	1995	Jul	11	14:42	./home/tm_project/tm_dip/archives			
-rw-r--r--	0	Jul	21	08:39	./home/tm_project/tm_dip/src			
-rw-r--r--	1989	Jul	21	08:41	./home/tm_project/tm_dip/src/tm.c			
-rw-r--r--	880	Jul	8	15:59	./home/tm_project/tm_dip/src/cmdlinearg.h			
-rw-r--r--	9552	Jul	21	08:41	./home/tm_project/tm_dip/src/cmdlinearg.o			
-rw-r--r--	3364	Jul	21	08:42	./home/tm_project/tm_dip/src/cmd.o			
-rw-r--r--	10907	Jul	21	08:41	./home/tm_project/tm_dip/src/cmdlinearg.c			
-rw-r--r--	667	Jul	21	08:42	./home/tm_project/tm_dip/src/makefile			
-rw-r--r--	5932	Jul	21	08:42	./home/tm_project/tm_dip/src/ilcview.o			
-rw-r--r--	21248	Jul	1	15:42	./home/tm_project/tm_dip/src/multiview			
-rw-r--r--	2843	Jul	21	08:41	./home/tm_project/tm_dip/src/ilcview.c			
-rw-r--r--	0	Sep	26	16:17	./home/tm_project/image			
-rw-r--r--	750	Aug	2	1993	./home/tm_project/image/MakefileRef			
-rw-r--r--	24855	Aug	2	1993	./home/tm_project/image/README			
-rw-r--r--	7297	Aug	2	1993	./home/tm_project/image/greyscale.c			
-rw-r--r--	13092	Aug	2	1993	./home/tm_project/image/greyscale.o			
-rw-r--r--	6433	Aug	5	1993	./home/tm_project/image/grid2rgb.c			
-rw-r--r--	5536	Aug	5	1993	./home/tm_project/image/grid2rgb.o			
-rw-r--r--	3016	Aug	3	1993	./home/tm_project/image/grid_rgb.c			
-rw-r--r--	56536	Aug	3	1993	./home/tm_project/image/flip			
-rw-r--r--	291	Aug	2	1993	./home/tm_project/image/makefile			
-rw-r--r--	1331	Aug	2	1993	./home/tm_project/image/noblack.c			
-rw-r--r--	112412	Aug	2	1993	./home/tm_project/image/rampgx.rgb			
-rw-r--r--	6512	Aug	2	1993	./home/tm_project/image/rampgy.rgb			
-rw-r--r--	2072	Aug	2	1993	./home/tm_project/image/rampx.rgb			
-rw-r--r--	842	Aug	2	1993	./home/tm_project/image/rampy.rgb			
-rw-r--r--	15	Aug	4	1993	./home/tm_project/image/x.dat			
-rw-r--r--	73440	Aug	2	1993	./home/tm_project/image/xgreyscale			
-rw-r--r--	62476	Aug	5	1993	./home/tm_project/image/xgrid2rgb			
-rw								

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-rwxr-xr-x	1	praman	sgiuuser	14476	Aug	5	22:08	./home/tm_project/prac/a.out
-rwxr-xr-x	1	praman	sgiuuser	14628	Aug	5	22:41	./home/tm_project/prac/input
-rwxr-xr-x	1	praman	sgiuuser	214	Jan	13	14:29	./home/tm_project/runAssemble
-rwxr-xr-x	1	praman	sgiuuser	958	Jan	13	14:32	./home/tm_project/runTmTest
drwxrwxrwx	2	praman	sgiuuser	0	Jun	28	11:39	./home/fract
-rwxr-xr-x	1	praman	sgiuuser	53172	Aug	20	1993	./home/fract/Brown
-rwxr-xr-x	1	praman	sgiuuser	928	Aug	20	1993	./home/fract/Brown.c
-rwxr-xr-x	1	praman	sgiuuser	1408	Aug	20	1993	./home/fract/Brown.o
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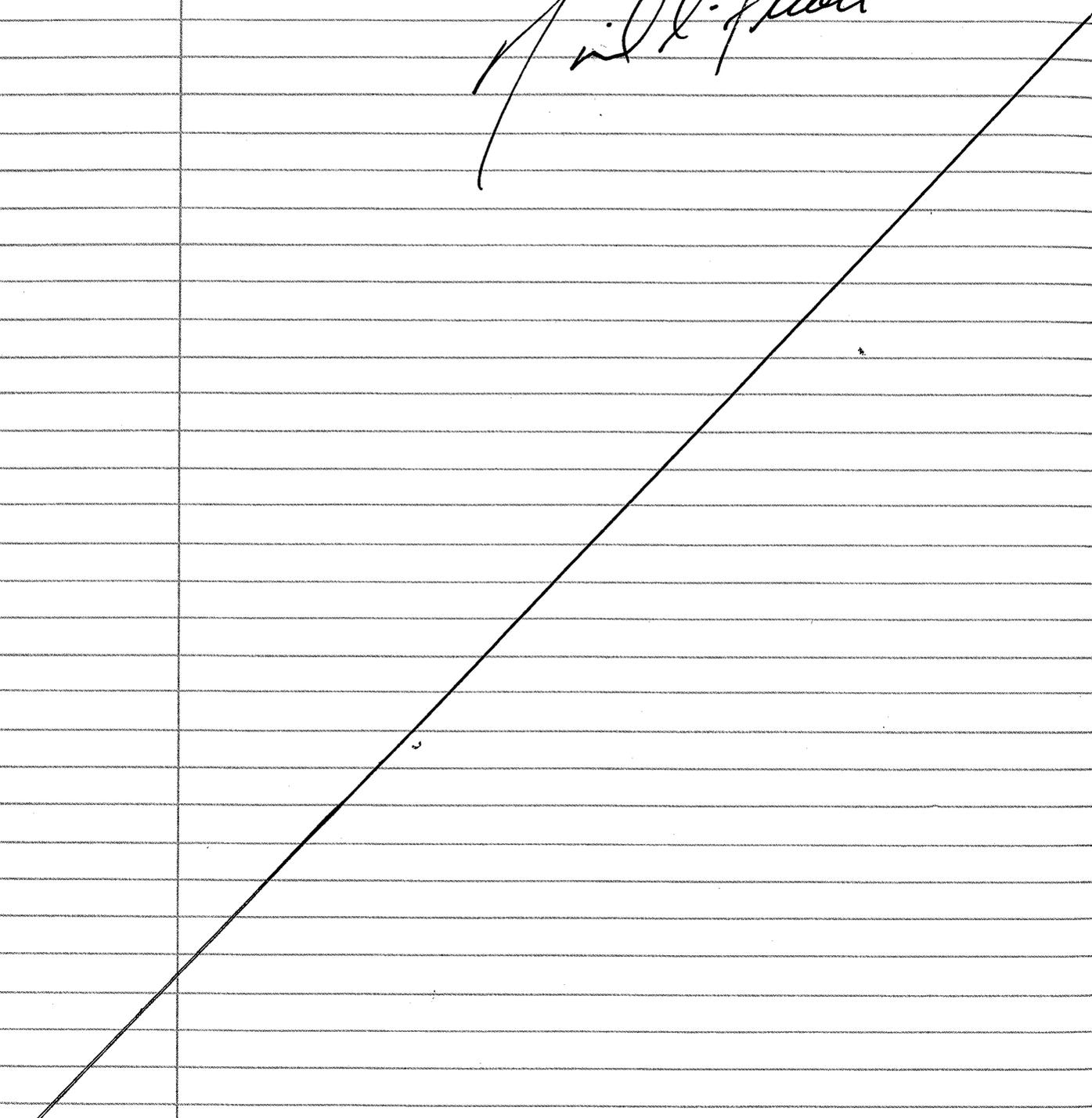
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END OF NOTEBOOK.

H. L. McKague



I have reviewed scientific notebook 120 and find it in compliance with QAP-001. There is sufficient information regarding procedure used for conducting the research and acquiring and analyzing the data so that another qualified scientist could repeat the activity or activities recorded in this scientific notebook. This notebook and accompanying files are to be archived and the notebook closed.

H. Lawrence McKague
GLGP Element Manager
Reviewed 07/03/03

H. L. McKague

THIS IS BASED ON
REVIEW OF ATTACHMENT
2

ADDITIONAL INFORMATION FOR SCIENTIFIC NOTEBOOK #: 120

Document Date:	09/01/1994
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Application Used: (including version number)	
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File Types: (.exe, .bat, .zip, etc.)	Various
Remarks: (computer runs, etc.)	Media contains: Full backup of TM code

The 8 mm tape is Attachment 1

Attachment 2
of Scientific Notebook # 120 1/18

**St Mary's University.
Engineering Department**

**REGISTRATION AND CLASSIFICATION OF TERRAIN
USING IMAGE PROCESSING TECHNIQUES ON
LANDSAT TM IMAGERY**

**A special project submitted to the faculty of the
Graduate School of St. Mary's University in
partial fulfillment of the requirement for the
degree of Master of Science**

BY: Pavitra Ramanijan

Advisor: Dr. Bahman Rezaie

December 11, 1994

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*Dedicated to the faculty of the Engineering School at St. Mary's University,
San Antonio, Texas*

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1 INTRODUCTION

Given remotely sensed images of a particular terrain, the purpose of this project is to create a classified map using digital image processing principles for showing areas of possible mineralization for that terrain as well as to come up with a general scheme for classifying image data pertaining to analogous regions of similar geological characteristics. The digital data used in this project is obtained from Landsat Thematic Mapper scanner which is mounted aboard the remote sensing satellite L5. A classified map showing areas of mineralization or terrain features and formations associated with possible underlying mineralization permits the determination of probable position and extent of the mineralized zones in the region under analysis. Normally remotely sensed data is used to recognize higher than average ground concentration of minerals. The capability to detect and monitor ground concentration of minerals is intended to be used for conducting site analysis of the terrain for evaluating its suitability for processing of radioactive wastes.

There are two steps in classifying the image data. The first step is to use digital image processing techniques to process and enhance the data and the second step is to determine/identify signatures pertaining to features of interest, on the basis of which the entire data is classified. This involves some image interpretation.

Landsat TM image may be considered to be comprising of tiny, equal areas called picture elements or *pixels*. The position of each pixel is determined on an X-Y coordinate system, the origin of which is the upper left corner of the image. The height of the images used in this case is 8440 pixels and the width is 9010 pixels. Each pixel on the Landsat TM data represents 25m x 25m on the ground and has a corresponding numerical value known as digital number which represents the intensity of electromagnetic energy for the ground resolution cell (25m x 25m) represented by that pixel. Each digital number is 8-bits wide, which means that 256 different intensity levels can be distinguished for a particular range of wavelength of the electromagnetic spectrum.

For each pixel in the Landsat TM image, the spectral brightness is recorded for seven different wavelength bands. A pixel is then characterized by its spectral signature, which is determined by relative reflectance in the different wavelength bands. Then multispectral classification is applied to the image data to classify the image. Multispectral classification is an information extraction procedure that analyzes spectral signature of the pixels and then assigns pixels to categories based on similar signatures.

Remote Sensing denotes collecting and interpreting information about an object without being in physical contact with it. The conventional platforms for remote sensing have been aircrafts and satellites. The technique employed in remote sensing is to use electromagnetic energy as the means to detect, obtain and measure characteristics about the object of interest. Since the Earth's atmosphere absorbs energy in the Gamma-ray, X-ray and most of the ultra violet region, these regions are not used for remote sensing. The wavelength regions with high atmospheric transmission, called *atmospheric windows* are used to obtain remote sensing images. The major

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remote sensing regions are further subdivided into *Bands* such as blue, green and red of the visible region.

Remotely sensed images are very useful for analyzing terrain features because they bring out two kinds of features. They bring out both previously identified features as well as features that were not known to have existed on that terrain. Remotely sensed images are analyzed for features by looking for specific signatures that are unique to each feature on the terrain corresponding to the image. The signature of an object could be identified by the corresponding spectral signature or texture on the image. The following paragraph briefly describes common terms used to analyze and identify information contained in the remotely sensed image.

Signature is the expression of an object on an image by which the object can be recognized. The characteristics of the object that determine its interaction with the electromagnetic energy that impinges on it, can be used as a signature. As a general example, the spectral signature of an object is its brightness measured at a specific wavelength range of energy. For example carbonate minerals have a distinct blue signature corresponding to reflectance in TM Band 7. (See below)

Texture is the frequency of change and arrangement of tones in the image. An Interpretation key is a single characteristic or a combination of characteristics that determines how an object could be identified on an image. For example, size, shape, tone and color could be interpretation keys or features.

1.1 EVOLUTION OF LANDSAT AND THEMATIC MAPPER SATELLITE SYSTEMS

Landsat is an unmanned system that was known as ERTS (Earth Resources Technology satellite) prior to 1974. Initially it was operated by the National Aeronautical Space Administration but in 1985, control of the entire system was transferred to the EOSAT company. The system operates in the international public domain.

The Thematic Mapper (TM) was deployed on Landsat 4 and 5 and was a major improvement over the previous missions. The TM is a cross-track scanner with an oscillating scan mirror and array of detectors and has the following characteristics which represents its improvements over the Landsat Multispectral Scanner (Landsat 1, 2, & 3):

- TM has a spatial resolution of 25m.
- TM has seven spectral bands and has extended spectral range in the visible and reflected infrared regions.

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- The addition of blue spectral data (TM-band 1) enables production of normal color composites.
- TM has a thermal infrared band.

It is important to know the spectral wavelength ranges for all the TM bands because this determines how TM bands can be used to extract and highlight information of interest. A number of examples could be cited to make this point clear. As a first example, a study of spectral reflectance curve showed that the maximum reflectance of vegetation occurred in TM band 4 (reflected infrared) and the reflectance of vegetation was considerably lower in TM band 2(green). On preparing a ratio image 4/2, which is an image as a result of dividing the digital numbers in band 4 by digital numbers in band 2, it was seen that the brightest signatures on the ratio image corresponded with cultivated fields and heavily vegetated areas. This was then used as a signature to identify vegetation in all subsequent image analysis. A second example would be to cite the knowledge of the spectral properties of thematic mapper bands in choosing bands for color compositing. For displaying topographic features such as volcanic tuffs, vegetated areas as well as highly mineralized zones, an ideal choice for color composite would be 1, 4, and 7 in red, green, and blue. TM band 1 distinguishes soil from vegetation; TM band 4 highlights vegetation and biomass content of the terrain and TM band 7 is sensitive to mineral ions and hence highlights mineralized areas. Such an image could then be used by the analyst for visual identification of features on the terrain.

1.2 THE THEMATIC MAPPER SPECTRAL BANDS¹

TM band 1:

Wavelength: 0.45 to 0.52 microns.

Characteristics: Blue-Green. Maximum penetration of water which is useful for mapping of shallow water. Also useful for distinguishing soil from vegetation.

TM band 2:

Wavelength: 0.52 to 0.60 microns.

Characteristics: Green. Matches green reflectance peak of vegetation, which is useful for measuring plant vigor.

TM band 3:

¹Remote Sensing: Principles and Interpretation. Floyd. F. Sabins. Second Edition. W.H. Freeman Company, New York, 1987.

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Wavelength: 0.63 to 0.69 microns.

Characteristics: Matches a chlorophyll absorption band that is important for discriminating different vegetation types.

TM band 4:

Wavelength: 0.76 to 0.90 microns.

Characteristics: Reflected infrared. Useful for determining biomass content and for mapping shorelines.

TM band 5:

Wavelength: 1.55 to 1.75 microns.

Characteristics: Reflected infrared. Indicates moisture content of soil and vegetation. Penetrates thin clouds and provides good contrast between vegetation types.

TM band 6:

Wavelength: 10.40 to 12.50 microns.

Characteristics: Thermal infrared. Night time images are useful for thermal mapping and estimating soil moisture.

TM band 7:

Wavelength: 2.08 to 2.35 microns.

Characteristics: Reflected infrared. Coincides with absorption band caused by hydroxyl ions in mineral.

The application of digital image processing to extract information from images involves procedures that enhance and extract features of interest in a manner that is easily recognizable.

The first step, therefore, would be to determine what information needs to be extracted and what are the feature or features on the terrain that would be associated with that information.

The need, in this case, is to identify mineralized zones. Minerals do not occur naturally in nature. They exist as elements in their natural state and normally they occur in a form mixed with other elements such as limestone, carbonates, and alunite and the elements also get mixed with local rocks such as granite, sandstone and shale. As a result of mixture with elements, such rocks exhibit some anomalous spectral and spatial characteristics. The clue to identify minerals would be to search for elements like limestone and carbonates which occur mixed with

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elements of interest like gold, uranium and silver and also to search for altered rocks which show characteristics different from normal rocks.

The following section examines methods which have been employed before to identify earth resources, particularly minerals. The section following the immediate section describes image processing techniques employed in this project to extract information pertaining to mineralization.

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2 PREVIOUS WORK APPLYING IMAGE PROCESSING TO RESOURCE EXPLORATION

2.1 REMOTE SENSING APPLIED FOR RESOURCE EXPLORATION : PUBLISHED METHODS

Remote Sensing methods have proved to be of great importance for both reconnaissance and detailed exploration. Remote sensing methods have been widely employed in various parts of the state of Nevada for identifying various ore deposits as well as identifying geologic structures associated with surface mineralization. The data set that has been used for this project also comes from Nevada and contains some regions of known mineralization and other regions of unknown resource types. Notable Prospecting methods have been done in GoldField Nevada. Eyeballing the Landsat TM image in selective band combinations or a single band has been successful in identifying regional lineaments along which groups of mining districts occur as well as in mapping local fracture patterns that may control individual ore deposits.²

Many ore minerals are formed by deposition of the ores on rocks by hot aqueous fluids which are known as hydrothermal solutions. During formation of the ore minerals, the fluids also react chemically with the host rock by which process, the original composition of the rock gets affected considerably. The altered rocks are called as hydrothermally altered rocks, named so, after their nature of formation. These rocks contain distinctive secondary minerals which have taken the place of the original rock constituents. The importance of these rocks lie in the fact that are reliable signatures for identifying surface minerals through the digital processing of TM images and often provide lead to underlying ore deposits. Not all alteration zones are associated with ore bodies and also not all ore deposits are marked by alteration zones; but these provide reliable indications to possible ore deposits in most cases. In Goldfield, Nevada, digital processing of TM images have led to prospecting of considerable gold and silver deposits using alteration zones as an indicator.

Spectrometers are devices that record electromagnetic energy reflected from materials as a function of wavelength. Measurements are usually done first in the laboratory using unweathered samples. But since remote sensing instruments usually scan over terrain types containing rocks with varying degrees of weathering, moisture content and vegetation-cover, portable spectrometers have been developed to record, in the field, the actual terrain surfaces that are imaged by the remote sensing instruments. The spectral reflectance curves obtained by such a method provides a comparison for identifying spectra of unknown materials. They also provide a means to determine threshold intensity value for minerals while performing a search on a terrain of unknown resource types.

²Remote Sensing: Principles and Interpretation. floyd. F. Sabins Jr. Second Edition. pp. 280-290. W.H. Freeman Company, New York, 1987.

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This kind of information is useful for performing a search for minerals in terrains where there is no known knowledge of the terrain characteristics. Normally, the spectral reflectance values obtained from the spectrometers are calibrated with the values of spectral reflectance of minerals measured in the Laboratory and such values are automatically defined as classes. Then classification of the image proceeds based on these classes and the results are then analyzed for narrowing errors. This has been a popular method for performing classification for features of interest.

Another popular method has been the technique of band-ratioing. In goldfield, Nevada and elsewhere, hydrothermally altered rocks have been valuable indicators of underlying ore deposits. In places where the gold mineral was separated from the host rock, the tailings pond have also provided useful standards of reference. The spectra of altered and unaltered rocks at goldfield has provided a means of distinguishing altered and unaltered rocks.³ Absorption caused by alunite and clay minerals results in low reflectance in at 2.2 micro meters, which corresponds to TM band 7. Altered rocks have high reflectance at 1.6 micro meters which corresponds to TM band 5. A ratio 5/7 image has bright signatures for altered rocks because lower reflectance values of band 7 are in the denominator, which results in higher values for the ratio. The unaltered rocks have nearly equal reflectance values and thus a ratio of 5/7 produces dim signatures for unaltered rocks.

The spectra of weathered iron minerals have weak reflectance in the blue region (TM band 1) and strong reflectance in the red region (TM band 3). The ratio 3/1 has high values for iron stained areas. Another way of using ratio images has been to combine the ratio images 5/7, 3/1 and 3/5 in red, green and blue respectively. Altered rocks have been known to have a combination of orange and yellow signatures. Such a ratio image displays both iron staining and clay minerals. A disadvantage of this method is that both patterns often overlap each other and it becomes practically impossible to distinguish between the two types.

Another well tested and proven method is multispectral classification. There are two approaches to multispectral classification:

Supervised Classification: A small training site is defined on the image which is representative of the category of interest or class. Spectral values for each pixel in the training site is used to define the decision boundary for that class. After the cluster in the training site has been defined the spectral range is applied for the whole data set and the pixels that fall in that particular category is picked up. All the pixels that are classified as belonging to a class is represented by special schemes. For example color scheme in which pixels describing vegetation could be assigned green color, pixels describing water could be assigned blue color etc.

³Remote Sensing: Principles and Interpretation. Floyd F. Sabins. pp. 288-290. Second Edition. W.H. Freeman Company, New York, 1987.

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Unsupervised Classification: Using values of spectral reflectance obtained from field data and samples, range of threshold values for different classes can be automatically defined. This threshold is then applied over the image resulting in unsupervised classification of the image. This can then be processed by the analyst, who by using geologic maps and field analysis can interactively modify the boundaries of the class or classes of interest.

To determine the threshold ranges automatically, spectral reflectance curves measured in the laboratory for different minerals could be used. Or when such information is unavailable, threshold ranges measured in different sites may be used.

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3 DESCRIPTION OF THE IMAGE PROCESSING/INTERPRETATION SCHEMES

Before proceeding to analyze the images, a set of tasks was identified. An interactive computer program was required to be developed in order to analyze and interpret Landsat TM data. To develop the program, it was necessary to develop a design for the program development. The design for the program would then involve choice of digital image processing techniques that would enhance and extract the features on the remotely sensed image which would make the interpretation easy for the analyst. The choice of image processing techniques depended upon the nature of the data set and the type of terrain features that would decisively identify potential mineral zones.

3.1 THE NATURE OF THE DATA SET

The data set has not been calibrated for gain and offset errors of the scanner. The information pertaining to gain, offset and atmospheric scattering parameters are also missing from the header of the data set and this information could not be obtained from EOSAT. The description of the data-header is provided in Appendix A. Also, the raw data for different bands have been processed and the exact nature of the processing done is unknown. The reasonable assumption in this case could be that some bands have been the result of mosaicing and patching several images taken at different times of the day or year.

The limitations imposed by the data set itself makes multispectral unsupervised classification (using the values obtained from field data samples and the values of spectral reflectance measured in the laboratory) impossible. In this case, threshold ranges calculated for a different region (Bare Mountain) were used automatically to define threshold range in the other regions. Thus unsupervised classification was performed on the remaining regions.

It looked as though the most likely results would come from supervised classification using a region of known mineral deposit and the determination of the types of formations associated with such mineralization. And then using these threshold ranges, unsupervised classification could be performed in other regions of similar or dissimilar characteristics. The second method that was decided to be attempted was Band-Ratioing. After getting the band-ratioed and enhanced image, an attempt was made to identify signatures pertaining to mineralized alterations using geology maps.

3.2 THE ALGORITHM

The identification of potential mineral zones on the terrain involves the determination of all the features and properties the terrain that decisively identifies it. Two kinds of features could be used to identify potential mineral zones:

- (1) **Spectral Information Content:** Each element on the terrain has a distinct spectral response in different TM Bands. When using band ratios, each element shows a unique color response in certain combinations of band ratios. Using Digital image processing techniques like band ratioing, color compositing and spectral thresholding, the image spectral features can be enhanced and extracted.
- (2) **Spatial Information Content:** Elements can be recognized by the way they alter the rocks with which they interact in volcanic regions, gold and other elements react with granite and the altered granite exhibits a circular or oblong shape as compared to unaltered granite. This could be used a clue to underlying ore deposits. Using Digital image processing techniques like edge extraction and color compositing, the spatial features can be delineated.

It would depend solely on the nature of the data set and the user's wishes to use all or some of the features to identify potential mineral zones. Separate image processing techniques have been used to extract the above mentioned features. These techniques are mutually and chronologically independent. It is left to the user's discretion to choose the schemes necessary to extract the features that identify mineral zones or even other earth resources.

Since the characteristics of the terrain under analysis exhibited different constituent rock types and topographic features in different parts, four general schemes were chosen to identify region of interest. This was to minimize classification errors, which would be a lot more if just one scheme was implemented to classify a region for features of interest. Also, implementing several schemes seemed to make the algorithm/code reusable for different situations. The four schemes chosen were:

Spectral information content:

- Band Ratio
- Multispectral classification by spectral thresholding

Spatial information content:

- Color compositing
- Circular texture analyses

The analysis involved was to choose the schemes that suited in nature of the terrain and facilitated the extraction of information regarding mineralization. The reasons why each scheme was chosen or not chosen implement this particular information extraction procedure and how each scheme was implemented is discussed in detail in the forth coming section. The results of all the schemes were then combined to study the extent of correlation between the results

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predicted by each different scheme. The flow chart describing all the schemes is included in the Appendix C.

3.2.1 Band Ratio

Ratio images are images that are obtained as a result of dividing the digital number in one band by the corresponding digital number in another band, stretching the resulting value and plotting the new value as an image.⁴ This scheme is typically used in satellite imagery, for terrain classification and identification of rocks. In a Ratio image, the black and white extremes of the gray scale represents pixels with the greatest difference in reflectivity between the two spectral bands. The darkest signatures correspond to areas where the denominator of the ratio is greater than the numerator. Ratio images minimize differences in illumination, thus suppressing the expression of the topological features. Ratio images emphasize differences in shapes of spectral reflectance curves between the 2 bands of the ratio. In a ratio image, the digital number of one band is divided by the digital number of another band. So essentially a ratio image tells about the relative reflectance of the two bands. This saves a lot of preprocessing that needs to be done on the raw data. Thus, using band ratio saves a lot of preprocessing because in effect, while performing ratios, gain and offset errors of the scanner as well as atmospheric scattering errors are nullified.

Preprocessing cannot be done on the data set used in this project because information regarding gain and offset parameters are missing from the data set. This makes band ratioing a very important method to give a reliable interpretation of the images. Three ratios are taken and assigned to red, green, and blue respectively. What was needed here was to enhance the appearance of hydrothermally altered rocks and clays as well as to enhance the appearance of iron staining materials. Therefore, 5/7, 3/1, and 5/4 were assigned to red, green, and blue respectively. Altered rocks have high reflectance in TM 5 but low reflectance in TM 7. Therefore, ratio image 5/7 would have bright signatures corresponding to altered rocks because ratio intensities in a 5/7 image for altered rocks would have the ratio value greater than 1 while, for unaltered rocks the ratio value would be less than or nearly equal to 1. Iron staining material have strong reflectance in TM band 3 and weak reflectance in TM band 1. Therefore, bright signatures in TM 3/1 would correspond to iron minerals. The ratio 5/4 was chosen to suppress vegetation. Contrast stretching and histogram equalization was then done on the color ratio composite image to enhance the visual acuity the image.

3.2.2 Color Compositing

This is a general method in which three bands are assigned to red, green and blue and the composited image is examined for possible signatures. Three band ratioed images may also be chosen for color compositing. The choice of bands or band ratios depend on the feature that needs to be extracted. The addition of TM band 1 enables the production of normal color

⁴The Image Processing Handbook. John C. Russ. CRC Press. Boca Ration, Florida. 1992.

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composites. The advantage of color compositing of three different bands is that the topographic features get expressed distinctly.

Color composite of bands 1, 4, and 7 was done to provide a good visual of the region. These bands were chosen because TM band 1 distinguishes soil from vegetation and TM band 4 highlights biomass content of the terrain and TM band 7 is sensitive to hydroxyl ions in different minerals. Color composite of 1, 4, and 7 did give better visual acuity than other composites.

3.2.3 Spectral Thresholding

This basically involves dividing the image into regions that hopefully correspond to structural units in the scene or distinguish objects of interest. Selecting features within a scene is important for most kinds of measurements or scene understanding. Thresholding is a process by which a range of brightness values is defined to describe the object of interest and then assigning pixels that belong to this range as the foreground image and the rest belonging to background.⁵ Such an image is usually displayed as a binary or a two-level image.

Spectral thresholding constitutes one of the basic and most important operations in image analysis. Suppose that a gray level histogram corresponds to an image $f(x,y)$, composed of light objects on a dark background, in such a way that the object and the background have gray levels grouped in two distinct modes.⁶ One way to select the objects in the background would be to find the threshold T that separates these two modes. Then, any point (x,y) for which $f(x,y) > T$ is called an object point. The same basic approach classifies a point (x,y) as belonging to one object class if $T1 < f(x,y) < T2$, to the other object class if $f(x,y) > T2$, and to the background if $f(x,y) \leq T1$. This type of multilevel thresholding is generally less reliable than its single level counterpart.

In this case simple global thresholding is used, where the image histogram is partitioned using a threshold range. Segmentation is then accomplished by scanning the image pixel by pixel and the labeling an object as a class of interest if it falls within the threshold range.

Since reflectance values of different minerals obtained from field data samples were unavailable, supervised classification was attempted, first on known mining regions in Bare Mountain (Figure 1a). One of the training sites chosen was Flourspar mines, where gold is actively being mined. The principle structural cause for gold formation in Flourspar mine is faulting. The result of sampling done in this region indicated that most mineralization was associated with carbonates. So, it was decided to restrict the search to carbonates and limestone with which gold was known to be actively associated. The other training site was the dike near

⁵The Image Processing Handbook. John C. Russ. CRC Press. Boca Raton, Florida. 1992.

⁶Digital Image Processing. Rafael C. Gonzalez and Richard E. Woods. pp. 433-436. Addison Wesley Publishing Company. 1992.

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the active mining region. This was chosen because it was known to be full of minerals due to close proximity to the actual mines. The following are the threshold ranges for each of the TM Band found on the training site on Bare Mountain. The minimum and maximum values were found as pixel mean \pm pixel standard deviation.

Thematic Mapper Band No.	Gray Scale Threshold Intensity	
	Minimum	Maximum
1	149	154
2	189	193
3	95	118
4	79	91
5	140	153
6	189	192
7	75	89

The threshold values using pixel mean \pm $\frac{1}{2}$ pixel standard deviation was calculated and spectral thresholding was done with those values. But some known regions of gold did not show up. The threshold values were calculated for pixel mean \pm 2. Pixel standard deviation. But the thresholded image did not significantly differ from the thresholded image using values calculated using pixel mean \pm pixel standard deviation. So, finally pixel mean \pm standard deviation was used to calculate maximum and minimum threshold intensity values. These threshold intensity values were then used to automatically define the threshold ranges for performing unsupervised classification in the other regions.

3.2.4 Identification of Circular Structures Pertaining to Altered Rocks

To identify shapes of structures of interest, a basic edge detection method is used. An edge is boundary between two regions with relatively distinct gray level properties.⁷ The basic idea underlying most edge detection techniques is the application of a gradient operator.

A Laplacian high pass filter is employed to the original image so as to delineate circular shapes associated with hydrothermally altered rocks. The following kernel is employed:

⁷Digital Image Processing. Rafael C. Gonzalez and Richard E. Woods. pp. 416–418. Addison Wesley Publishing Company, 1992.

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-1	-1	-1
-1	+8	-1
-1	-1	-1

The terrain under analysis showed no circular shapes associated with alteration of local rocks. This method will be more useful in heavily volcanic regions. So this scheme was not implemented to extract mineralized zones in the terrain under analysis.

3.3 SOFTWARE DEVELOPMENT

3.3.1 Some Library Considerations

Since the system to be used for the computer code development was the Silicon Graphics, it was decided to use ImageVision Library tools for the coding of the digital image Processing techniques and hence, the programming language for the entire code was decided to be C++. The Image Version Library™ is an objected-oriented, extensible toolkit designed for developers of image processing applications. Typical image processing programs access existing image data, manipulate it, and display and save the processed results. The IL provides a robust framework within which developers can easily create such programs to run on all Silicon Graphics workstations.⁸

The object-oriented nature of C++ programming language provides a simplified programming model based on abstracted of what images are and how they're manipulated. This model relieves developers of many tedious programming details and allows them to conceptually design creative programming solutions. Also, because the IL is written in C++, developers can easily extend it, for example, to incorporate their own image processing algorithms or to include support for their own image file formats.

3.3.2 Code Development

The general design of this particular code is that the analyst or the user would invoke the program from the commandline using specified syntax. The syntax is framed such that it would be easy to include other options at some other point of time without having to change the whole structure of the code. The filenames, image operators, text file names (holding threshold information etc) are specified by flags before them. For Example: Input filenames are preceded by -i option; the output filenames are specified by -o option; the image operators are preceded by the name of the executable code etc. The commandline syntax is included in the Appendix B. There are three stand-alone classes with the main program (tm-proc.c++) acting as the driver for all the three classes. The first class is cmdlinearg.hh and cmdlinearg.c++ which extracts

⁸Silicon Graphics Computer Systems. 1993. Image Vision Library Programming Guide. Document Number 007-1387-030.

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the commandline arguments and loads the data structure. The main driver program then calls the appropriate image processing or text-reading/loading routines from `ERImg.hh/ERImg.c++` and `ERFile.hh/ERFile.c++` respectively. The display of the images is set such that it can be either saved as a file or it can be pulled up on the screen. When screen-display is used, the result image is not saved. The display comes up on graphics library windows. The second of the classes is `ERImg.hh/ERImg.c++` which performs image processing, display and save operations. The third of the classes is `ERFile.hh/ERFile.c++` which loads calculated threshold data or the threshold values specified by the user from the commandline in the appropriate matrix data structure.

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4 RESULTS

Three different methods were chosen to predict mineralized zones in each of the region under analysis. For Bare mountain region, a color composite of 1,4 and 7 [Figure 1(a)] was done first. The known gold mining regions showed up as bright gray or white. Then spectral thresholding was done and the binary thresholded image was superimposed on the 1,4 and 7 composite to show the topography (Figure 1(b)). On comparing with geology maps, it was found to be reasonably accurate. The bright white tones in Figure 1(b) come from spectral thresholding and indicate potential gold mineralization.

Then a color ratio composite of 5/7, 3/1, and 5/4 was created Figure 1(c). The red tones are prominent because ratio 5/7 is nearly equal to 1.5 and is dominant over the other ratios. The dark bluish green in Figure 1(c) indicates probable limestone alteration. The light green spots indicate alteration related to iron minerals.

Bands 1, 4, and 7 color compositing, unsupervised multispectral classification using values calculated for Bare mountain and color ratio compositing of 5/7, 3/1, and 5.4 was done on the southwestern portion [Figures 2(a), (b), and (c)] and southern portion [Figures 3(a), (b), and (c)] of the Nevada test sites. The threshold values calculated for Bare mountain was used to define threshold ranges for the other two ranges, although the three regions differ from each other significantly in the respect of topology and terrain characteristics.

Spectral thresholding accurately predicted potential mineral zones rich in gold for the other two regions (South and Southwestern Nevada Test sites), [Figure 2(b) and 3(b)]. Many promising potential prospecting targets showed up in Figure 2(b) for the Southwestern Nevada test site, corresponding to bright-grayish white. The southern portion Figure 3(b) showed very little evidence of potential gold. This was also in line with what was expected for that region.

On examining the color ratio composites for all the three regions, it is evident that Bare mountain shows predominant limestone alteration [Figure 1(c)] and Southwestern portion of the Nevada test site shows predominant iron alteration. [Figure 2(c) Southern portion of the Nevada test site shows no alteration [Figure 3(c)]. In all the three figures, alteration is not evident near all the potential and existing gold deposit. This could be either from faulty analyses or the incomplete nature of the data set, or it could just be the ground truth. It could also be that alteration in rocks did not occur in a significant manner as to be picked up by the TM scanner for all the mineralized zones.

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5 CONCLUSIONS

The data used comprised of South and Southwestern portions of the Nevada Test Site and also the Bare mountain region. The Bare mountain region was the only region of known gold mineralization. The threshold training of the algorithm was solely based on data from this area. Threshold intensity values were calculated using known gold mineralization in Bare mountain. Then based on these values, supervised classification was performed on entire Bare mountain region. The same threshold values were used for unsupervised classification in the other regions, although they differed in their characteristics. They differed in their constituent rock types as well as elements comprising the rocks. The nature of the nature of the rock formation in all the three regions was also completely different. The results of spectral thresholding was accurate in all the regions. This was concluded because the probable extent of mineralization in all the regions was known to the geologist involved in this project.

The images analyzed are really the first pass results. However, multispectral supervised and unsupervised classification proved to be the most robust methods in all the three regions. The results of color compositing would have to be substantiated by more field sampling. After field sampling is done, the first pass results could be interactively modified by the user/analyst to reduce classification errors.

A more important task would be to recover the gain and offset parameters from EOSAT and perform extensive calibration of the TM data set. It would be interesting to apply the three image processing schemes to the calibrated TM data set and compare those results with the first pass results obtained in this project.

Color Composite Image Bare Mountain, Nye County, Nevada

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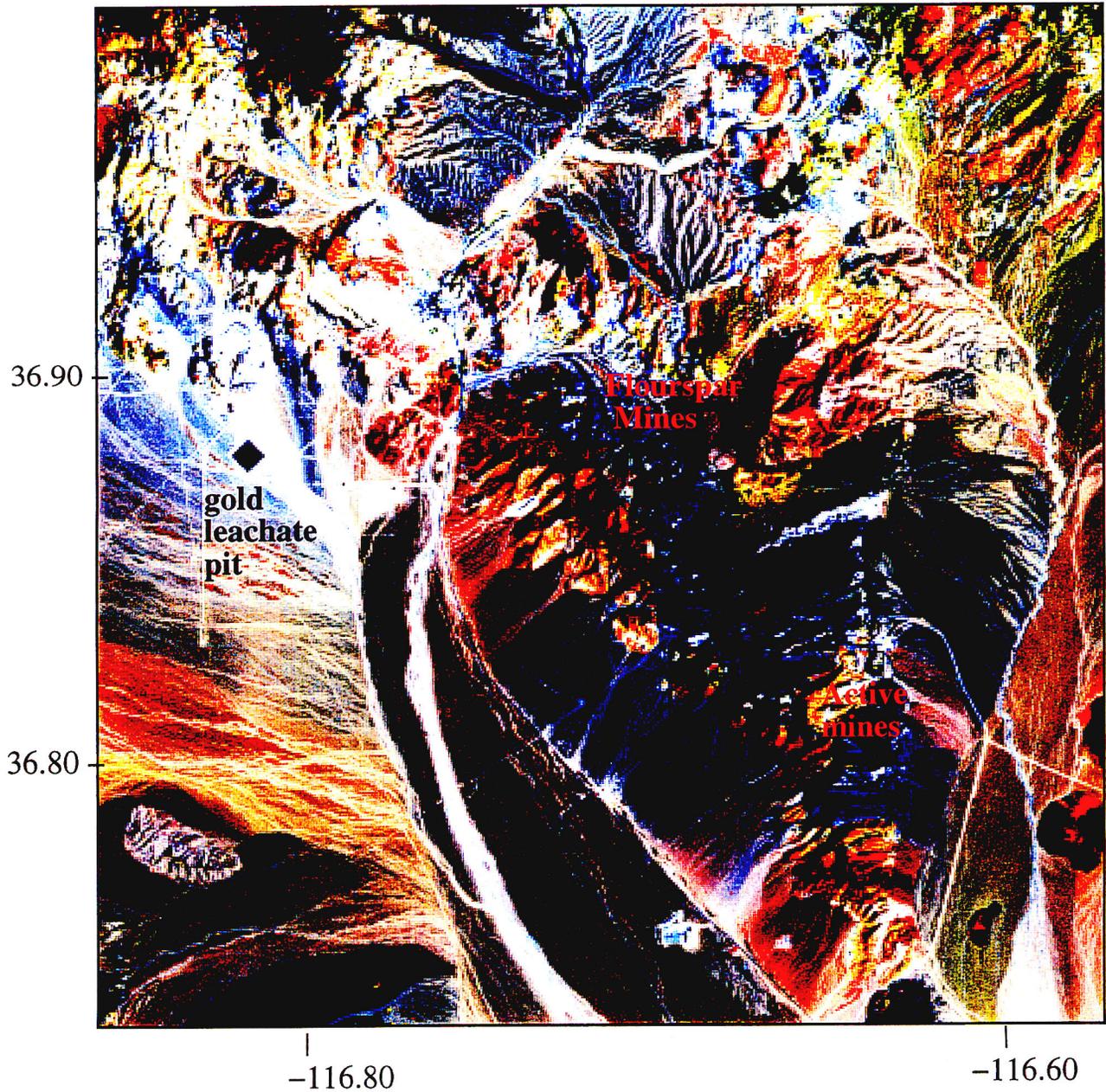


Fig 1 (a) Landsat thematic mapper bands 1, 4 and 7 assigned to red, green and blue respectively. contrast stretching and histogram equalization has been performed on the image.
Image is the result of custom code developed to analyze Landsat TM data.
Map Projection is in universal transverse mercator.

Spectrally Thresholded Image combined with Color composite of 1, 4 and 7. Bare Mountain, Nye County, Nevada

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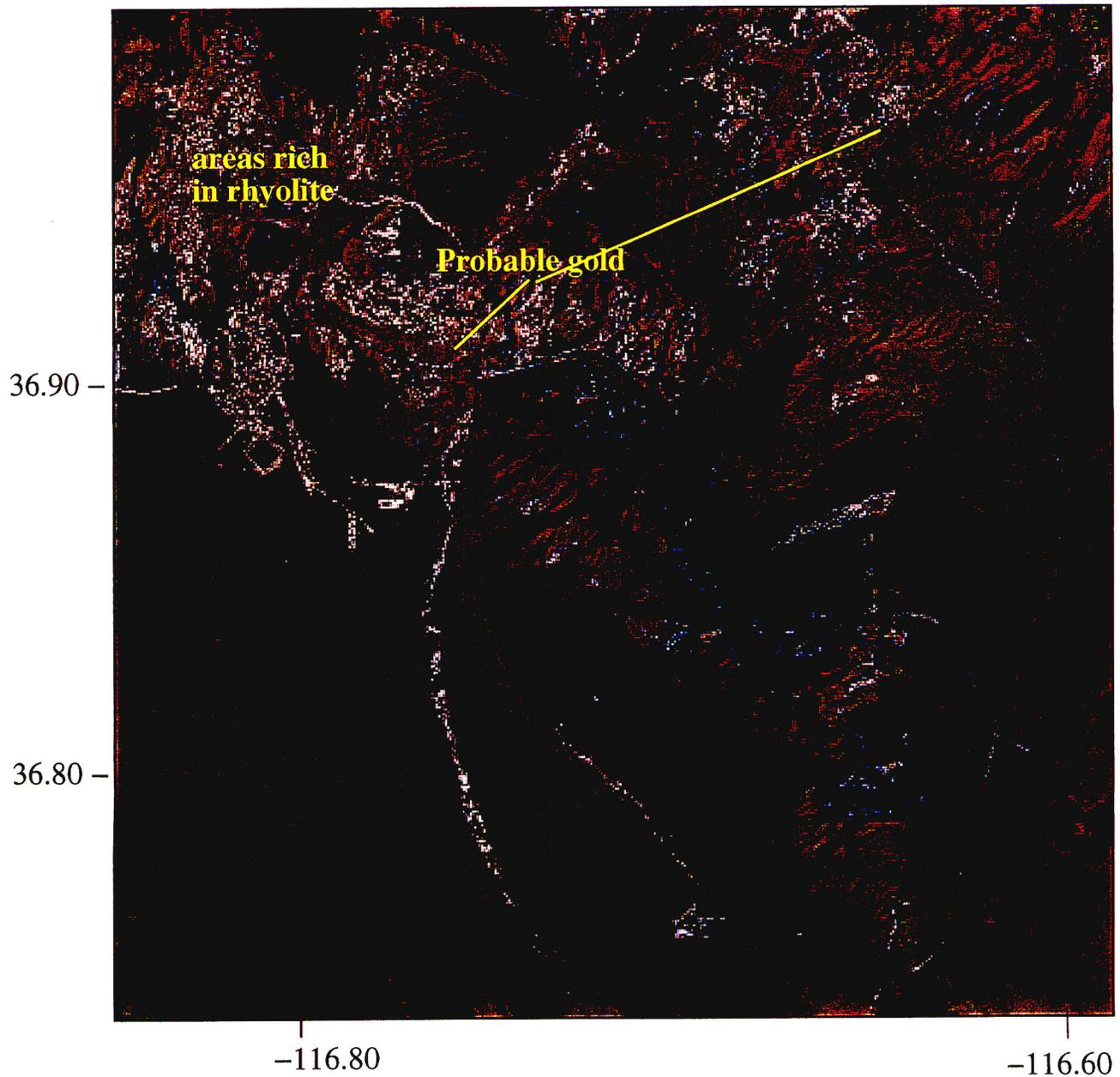


Fig 1 (b) Multispectral supervised classification done on all seven TM bands and the resulting binary image combined with color composite of 1, 4 and 7 (fig 1(a)). Image is the result of custom code developed to analyze Landsat TM data. Map projection is in universal transverse mercator.

Color ratio Composite combined with binary thresholded image Bare Mountain, Nye county, Nevada

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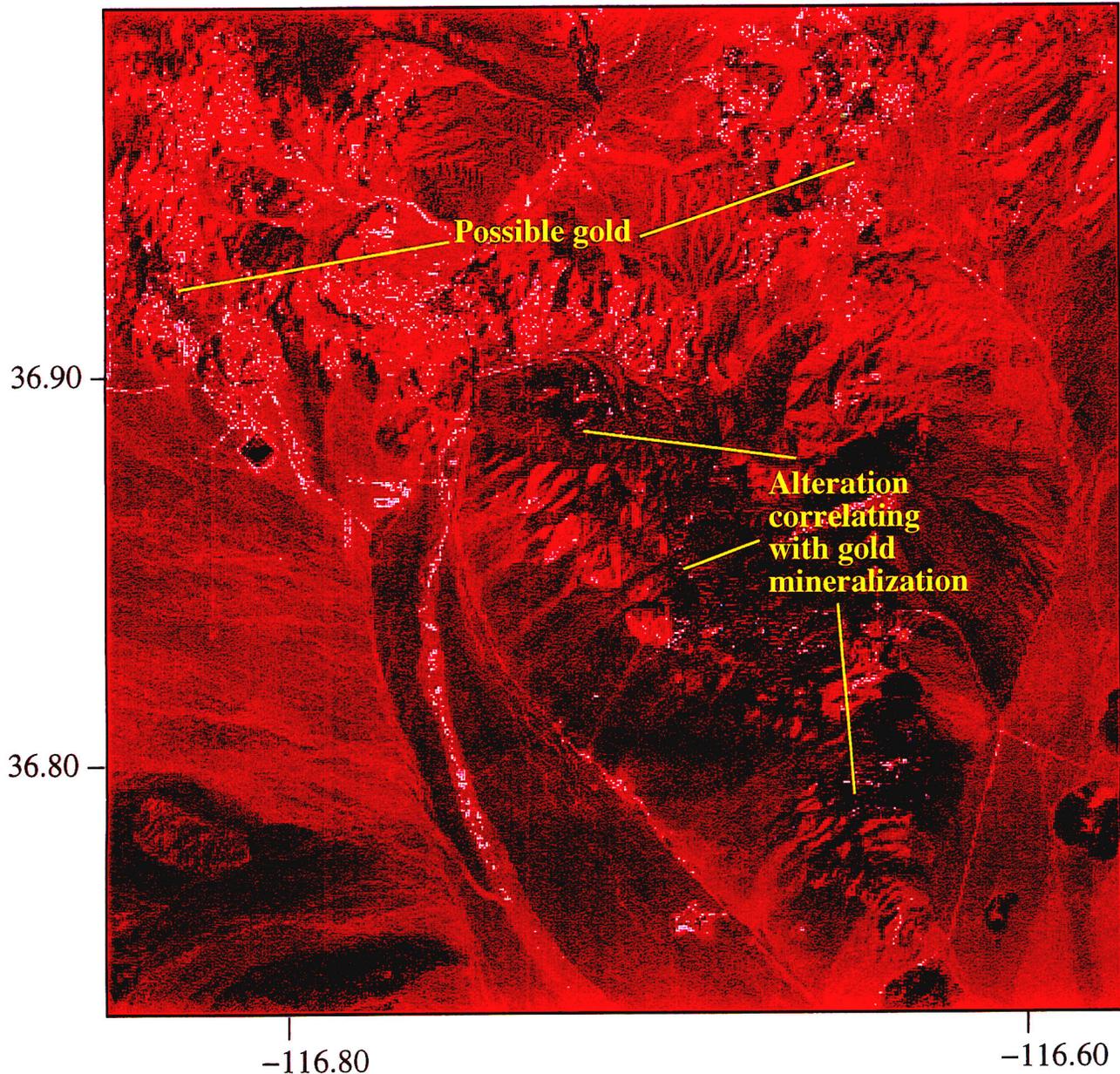


Fig 1 (c) Color Ratio Composites of band ratios 5/7, 3/1 and 5/4 assigned to red, green and blue respectively and combined with binary thresholded image and superimposed on color composite of 1, 4 and 7. This image is the result of custom code developed to analyze Landsat TM data. Map projection is in universal transverse mercator.

Color Composited Image Calico Hills Region, Nye County, Nevada

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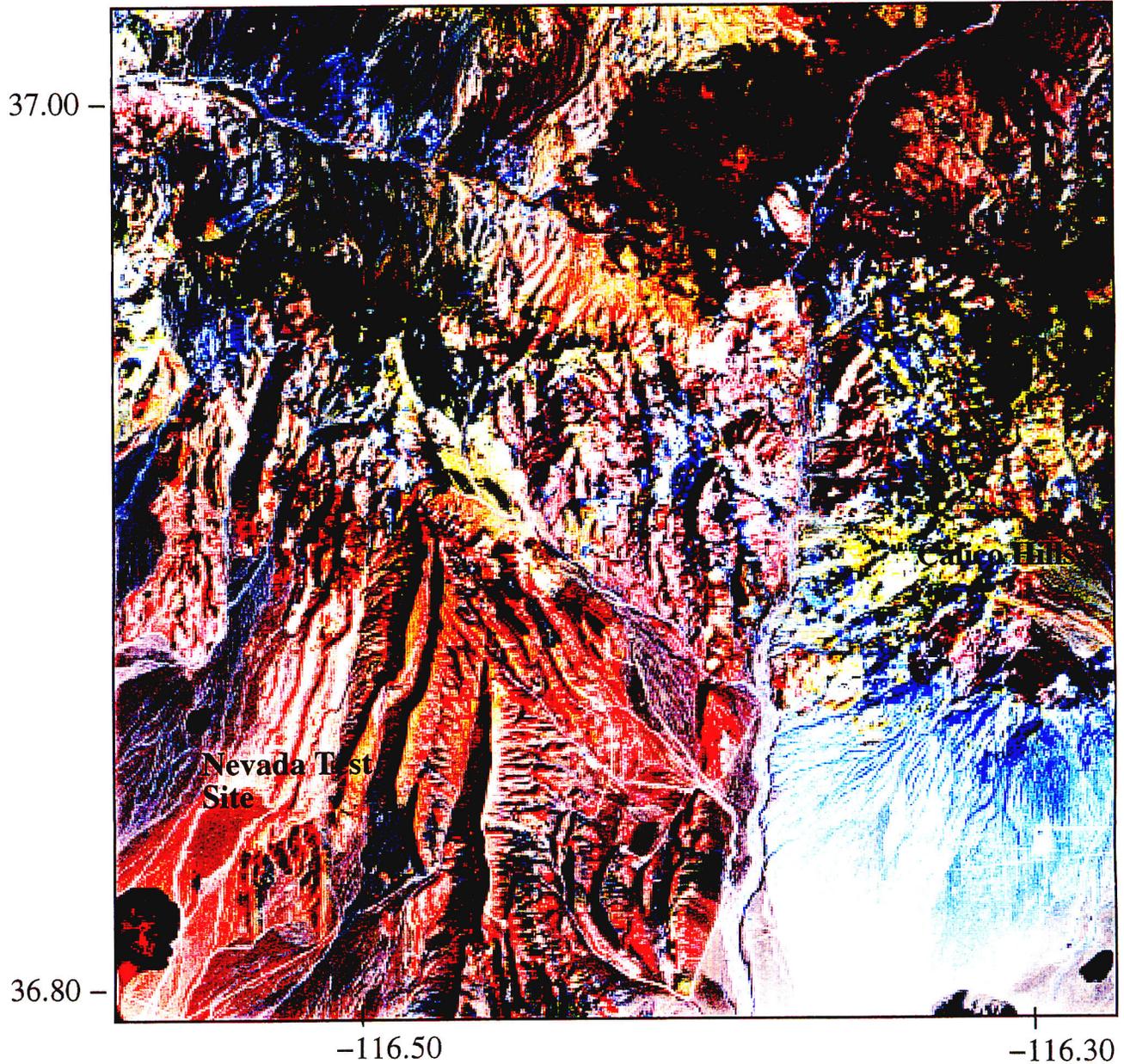


Fig 2 (a) Landsat Thematic mapper bands 1, 4 and 7 assigned to red, green and blue respectively. Contrast stretching and histogram equalization has been performed on the image. The image is the result of custom code developed to analyze Landsat TM data. Map projection is in universal transverse mercator.

Spectrally Thresholded Image combined with Color Composite of 1, 4 and 7. Calico Hills, Nye county, Nevada

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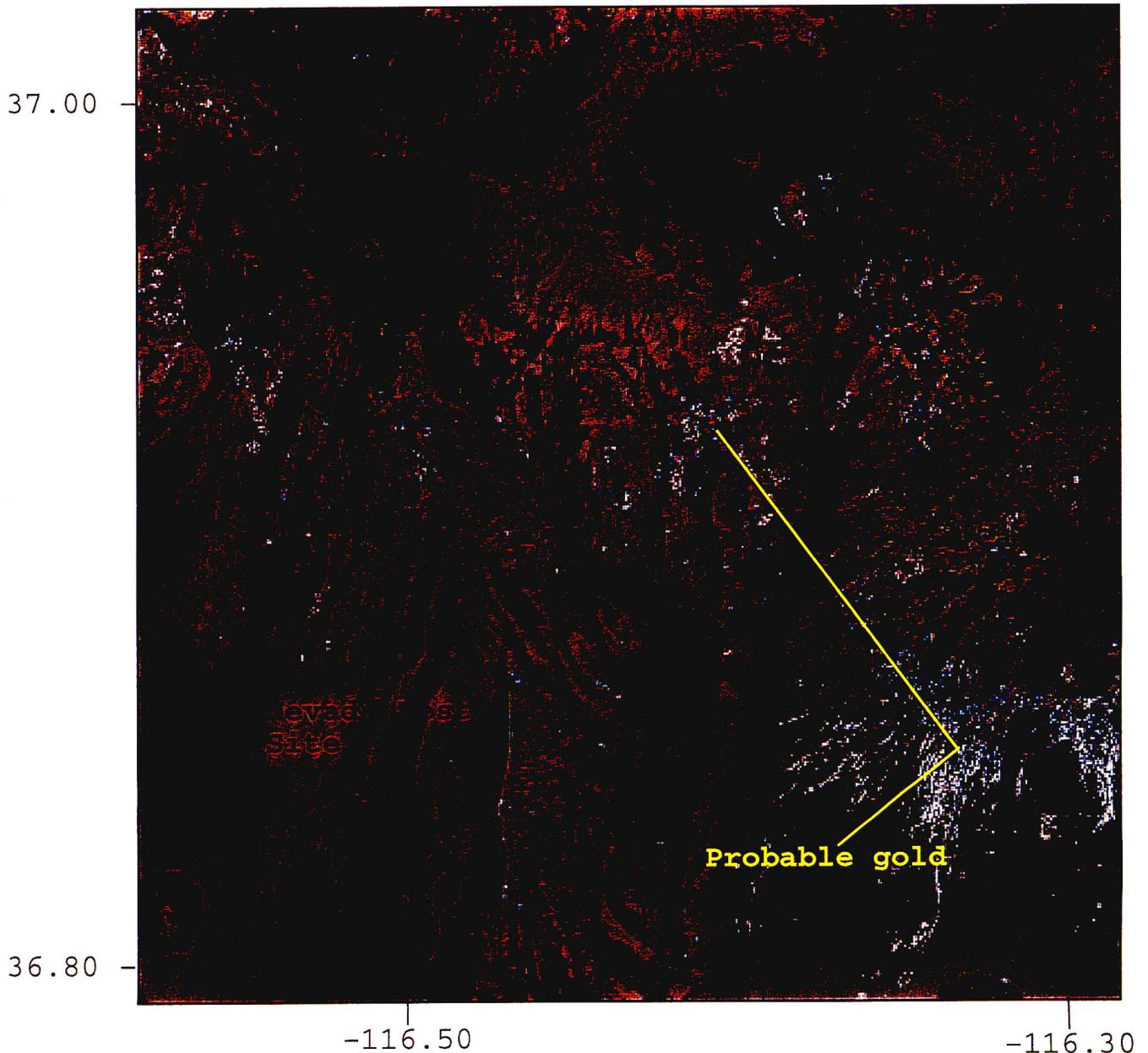


Fig 2 (b) Multispectral unsupervised classification done on all seven TM bands and the resulting binary thresholded image combined with color composite of 1, 4 and 7 (fig 2 (a)). Image is the result of custom code developed to analyze Landsat TM data. Map projection is in universal transverse mercator.

Color Ratio Composite combined binary thresholded image Calico Hills, Nye County, Nevada

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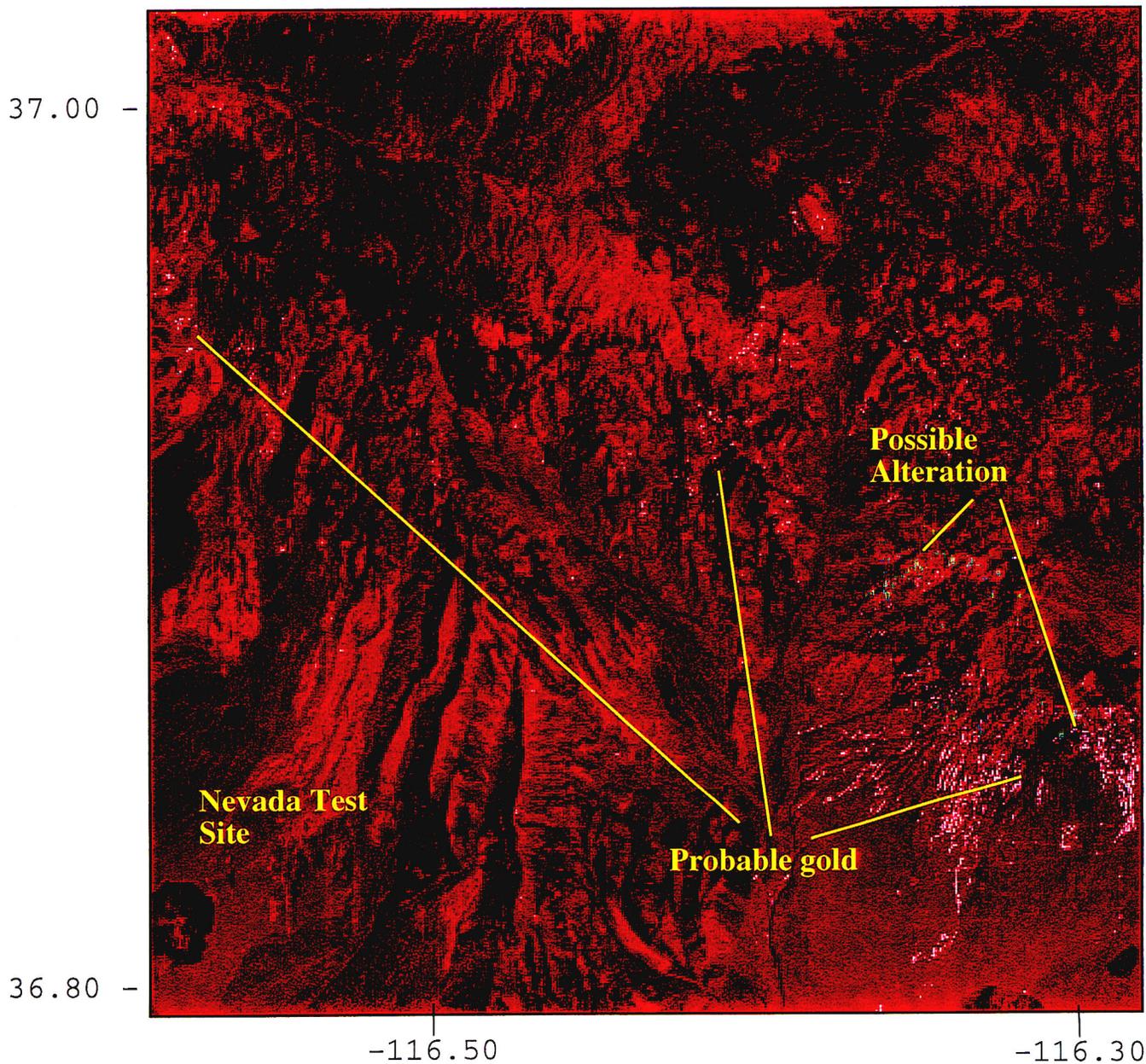


Fig 2 (c) Color ratio composites of band ratios 5/7, 3/1 and 5/4 assigned to red, green and blue respectively and combined with binary thresholded image and the superimposed on color composite of 1, 4 and 7. Image is the result of custom code to analyze Landsat TM data. Map projection is in universal transverse mercator.

Color Composite Image

South Yucca Mountain, Nye county, Nevada

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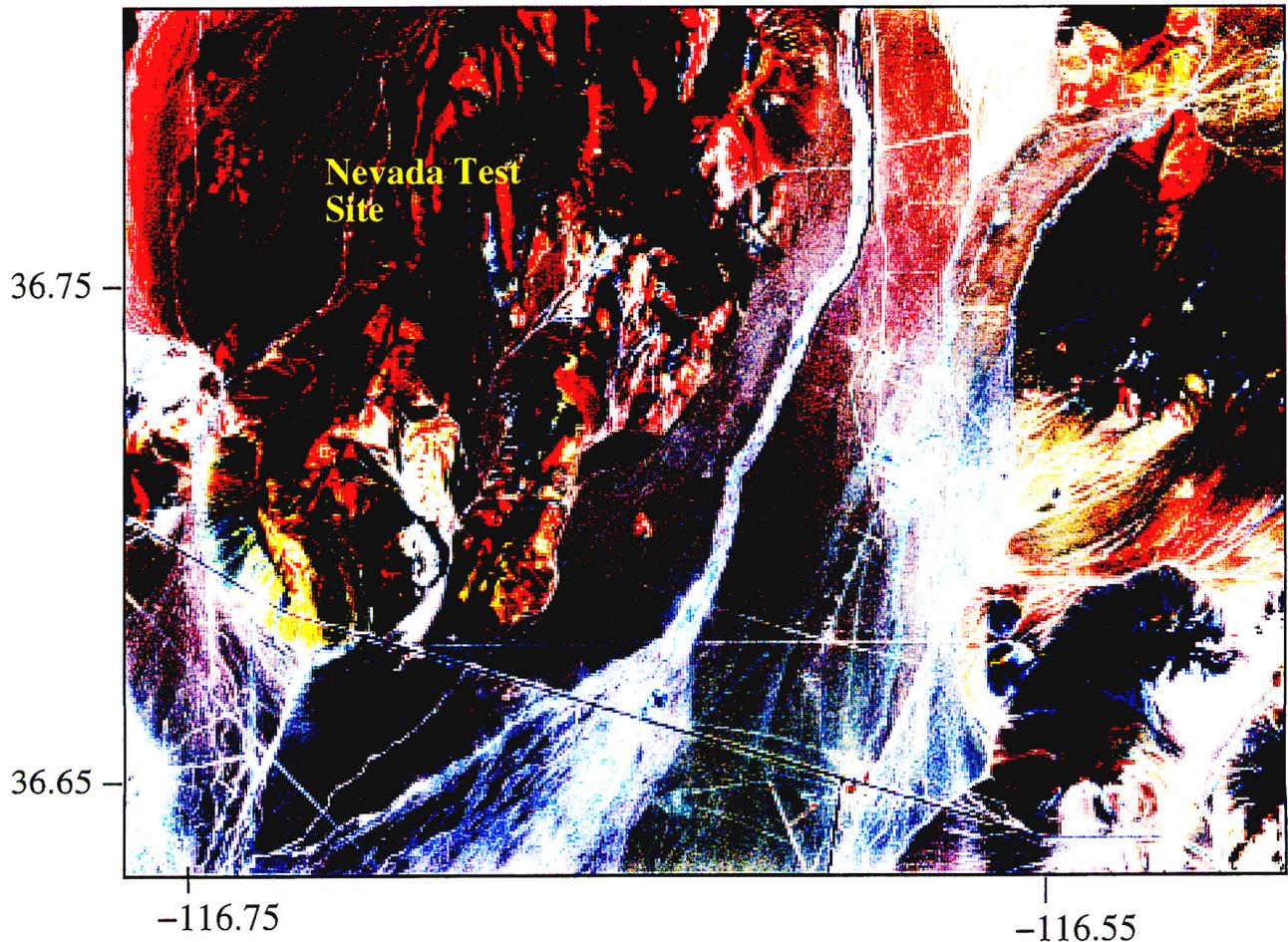


Fig 3 (a) Landsat thematic mapper bands 1, 4 and 7 assigned to red, green and blue respectively. Contrast stretching and histogram equalization has been performed on the image. Image is a result of custom code developed to analyze Land sat TM data.
Map projection is universal transverse mercator.

Spectrally Thresholded Image combined with color composite of 1, 4 and 7 29/78 South Yucca Mountain, Nye County, Nevada

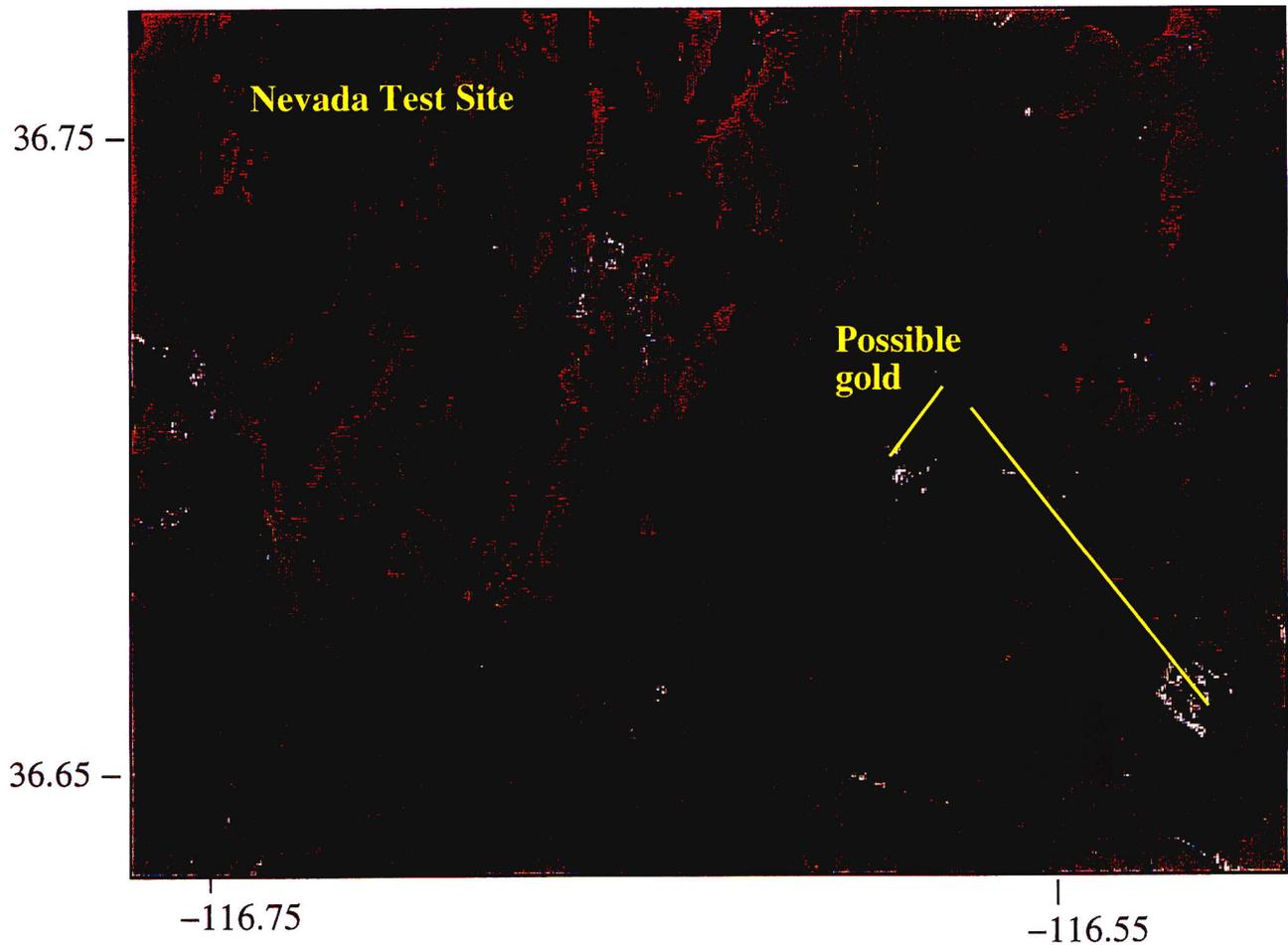


Fig 3 (b) Multispectral unsupervised classification done on all seven TM bands and the resulting binary image is combined with color composite of 1, 4 and 7 (fig 3 (a)). Image is the result of custom code developed to analyze Landsat TM data.
Map projection is in universal transverse mercator.

Color Ratio Composite Combined with binary thresholded image South Yucca Mountain, Nye County, Nevada

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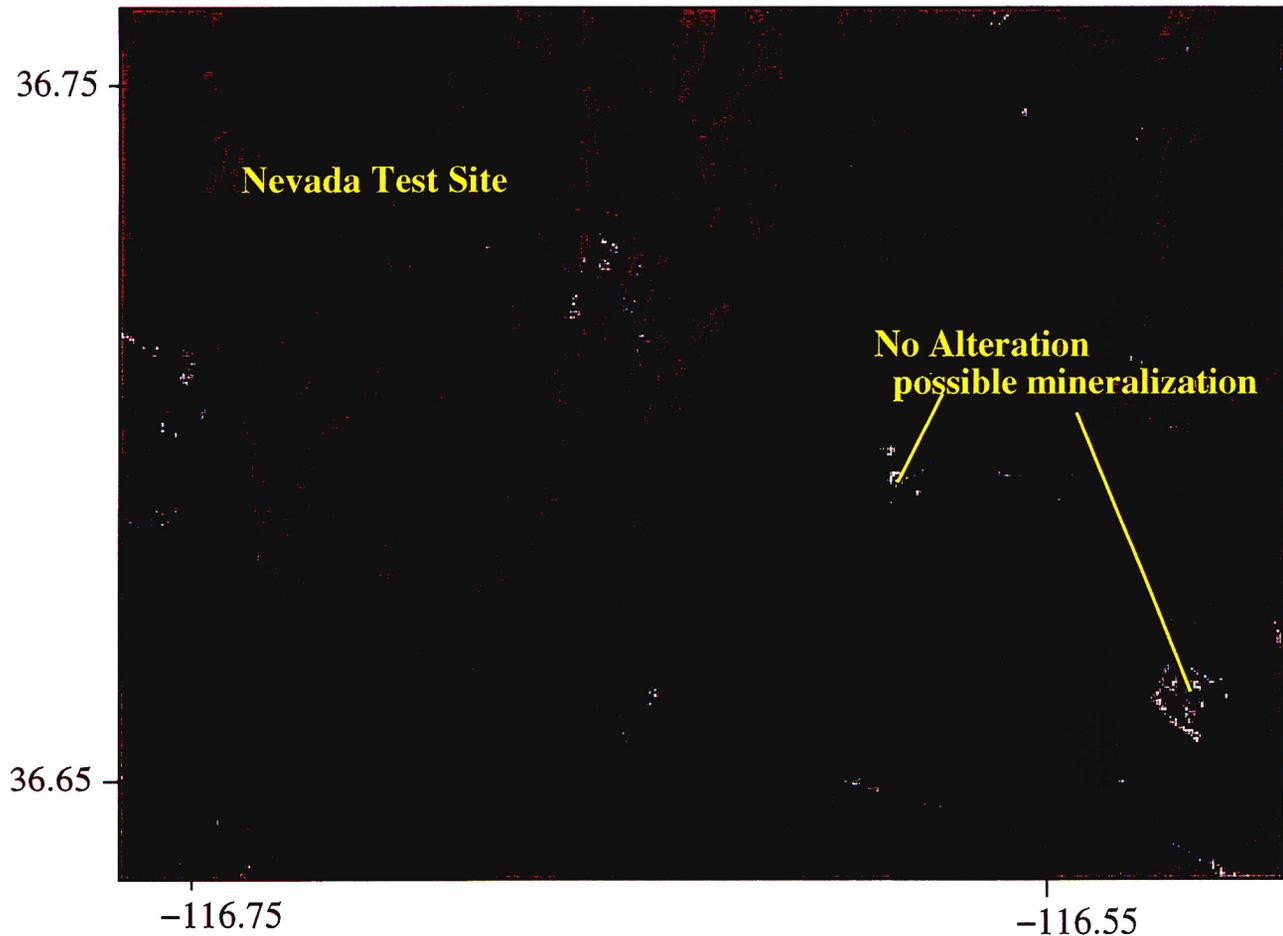


Fig 3 (c) Color Ratio composites of band ratios 5/7, 3/1 and 5/4 assigned to red, green and blue respectively and combined with binary thresholded image and superimposed on color composite of 1, 4 and 7. Image is the result of custom code developed to analyze Landsat TM data. Map projection is in universal transverse mercator.

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6 BIBLIOGRAPHY

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ym_92_1.txt

SCENE ID =5225817413
 WRS =040/034
 ACQUISITION DATE =19900507
 SATELLITE =L5
 INSTRUMENT =TM
 PRODUCT TYPE =FULL SCENE
 TYPE OF GEODETIC PROCESSING =AUTO C.P.P.
 RESAMPLING =CC TRUE
 SECOND SCENE ID =5225817415
 SECOND SCENE SATELLITE =L5
 SECOND SCENE ACQUISITION DATE =19900507
 SECOND SCENE TYPE OF GEODETIC PROCESSING =AUTO C.P.P.
 SECOND SCENE RESAMPLING =CC
 ORIENTATION = 0.00
 PROJECTION =UTM
 USGS PROJECTION # = 9
 USGS MAP ZONE = 11
 USGS PROJECTION PARAMETERS =
 0.6378206500000000D+07 0.6356584000000000D+07
 0.9996000000000000D+00 0.0000000000000000D+00
 -0.1170000000000000D+09 0.0000000000000000D+00
 0.5000000000000000D+06 0.0000000000000000D+00
 0.0000000000000000D+00 0.0000000000000000D+00
 0.0000000000000000D+00 0.0000000000000000D+00
 0.0000000000000000D+00 0.0000000000000000D+00
 0.0000000000000000D+00
 EARTH ELLIPSOID = CLARKE_1866
 SEMI-MAJOR AXIS =6378206.500
 SEMI-MINOR AXIS =6356584.000
 PIXEL SIZE =25.00
 PIXELS PER LINE =9010
 LINES PER IMAGE =8440
 UL 1172643.1924W 374259.4212N 460750.000 4174250.000
 UR 1145325.9852W 374154.5005N 685975.000 4174250.000
 LR 1145631.0860W 354752.0370N 685975.000 3963275.000
 LL 1172604.0827W 354852.6416N 460750.000 3963275.000
 BANDS PRESENT =12
 BLOCKING FACTOR = 3
 RECORD LENGTH =27030
 SUN ELEVATION =57
 SUN AZIMUTH =117
 SCENE CENTER = 572325.911 4069193.263

APPENDIX A
TM DATA HEADER

APPENDIX B
COMMANDLINE SYNTAX

This demonstrates examples of how the program tm_proc could be invoked from the command line to process image data and classify it in terms of specific Earth Resources

I. General Syntax

1. To Perform Band Ratioing:

The following commands should be typed in from the command line:

```
tm_proc Band_Ratio -i <inputfile1> -i <inputfile2> -o <outputfile>
e>
```

2. To perform Merging:

The following commands should be typed from the command line:

```
tm_proc Merge -i <filename1> -i <filename2> -i <filename3>
              (red)           (green)           (blue)
```

To save the results specify an output filename after the inputs are specified:

```
tm_proc Merge -i <inputfile1> -i <inputfile2> -i <inputfile3>
              -o <outputfilename>
```

3. To perform classification:

The following commands should be typed in from the command line:

```
tm_proc Classify_Resources -i <inputfile> -o <classified.rgb>
                          <lower threshold> <upper threshold>
```

4. To display a saved image file on the screen:

Type the following commands from the key board:

```
tm_proc Display -i <filename to be displayed>
```

5. To perform texture analysis for identifying shape parameters:

Type the following commands from the keyboard:

```
tm_proc Circular_Texture -i <inputfile>
                        -o <outputname>
```

Note: If the outfile is not specified from the command line then the results are displayed on the screen and then destroyed.

6. To find threshold of the classes of interest:

Type the following commands from the keyboard:

```
tm_proc Calc_Ref -i <image file name> <x_offset> <y_offset> <x_size of ROI> <y_size of ROI>
```

7. To perform various image processing operations

(i) To perform a pixel bt pixel division of two input images:

```
tm_proc Band_Ratio -i <inputfilename1> -i <inputfilename2>
                  -o <outputfilename>
```

(ii) To perform a threshold operation on an image:

```
tm_proc ThreshImg -i <inputfilename> -o <outputfilename>
```

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(iii) To perform contrast stretching on an image:

```
tm_proc StretchImg -i <inputfilename> -o <outputfilename>
```

(iv) To perform Image inversion:

```
tm_proc InvertImg -i <inputfilename> -o <outputfilename>
```

(v) To perform histogram equalization on an image:

```
tm_proc HistEqImg -i <inputfilename> -o <outputfilename>
```

(vi) To perform conversion from color to grayscale:

```
tm_proc GrayImg -i <colorimgname> -o <outputgrayimg name>
```

(vii) To perform pixel by pixel logical ANDing of 2 images:

```
tm_proc AndImg -i <inputfilename1> -i <inputfilename2>
               -o <outputfilename>
```

(viii) To perform pixel by pixel addition of two images:

```
tm_proc AddImg -i <inputname1> -i <inputname2>
               -o <outputname>
```

(ix) To perform correlation of 2 images in fourier domain:

```
tm_proc CorrFFT -i <inputname1> -i <inputname2>
                -o <ouputfilename>
```

(x) To perform classification on an image

```
tm_proc Classify_Resources -i <inputfilename>
                           -o <classified image name>
```

(xi) To make a bitmap region of interest:

```
tm_proc bitmapROI -i <inputname> -o <outputname>
```

(xii) To make a rectangular region of interest:

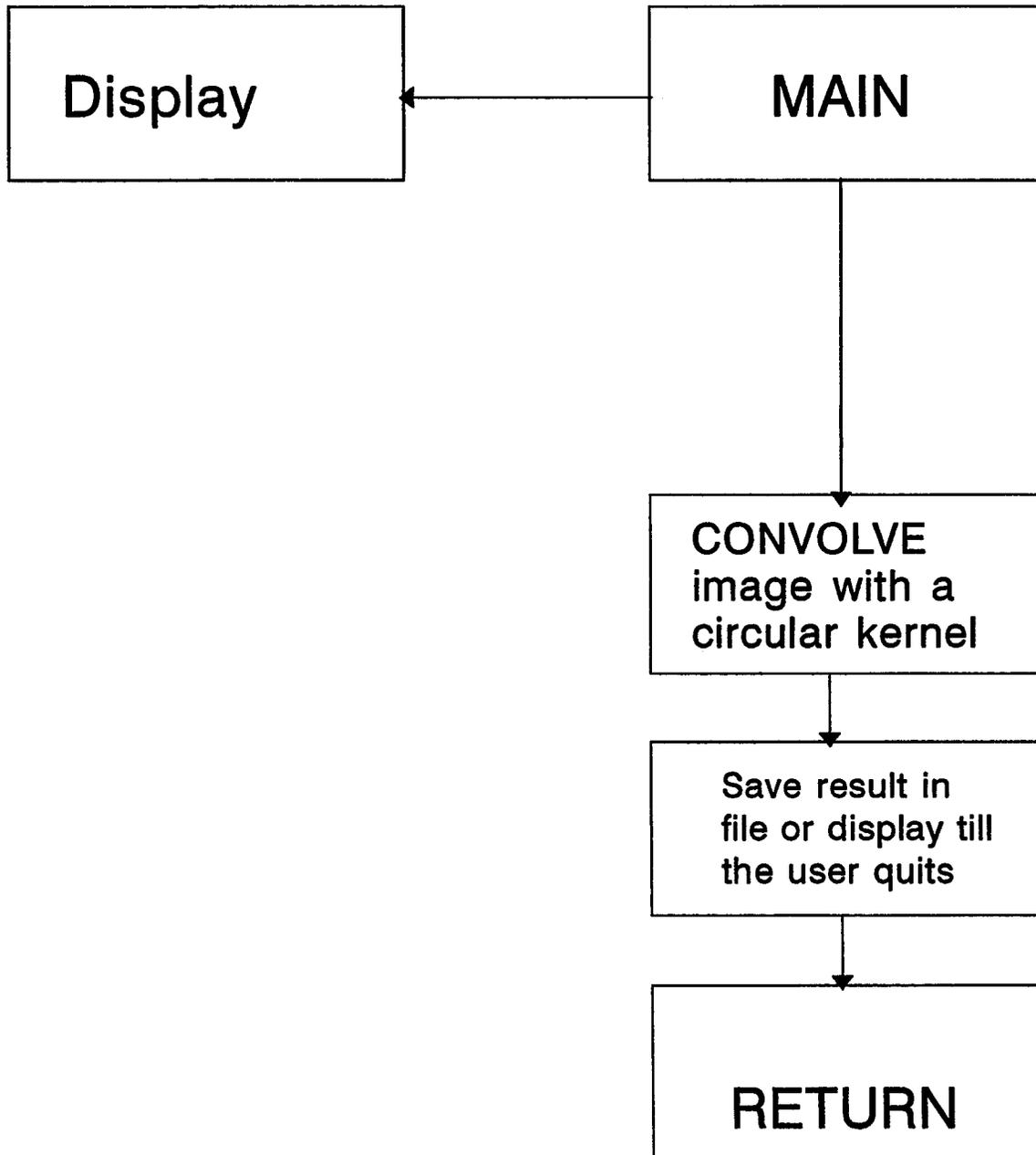
```
tm_proc rectROI -i <inputname> -o <outputname>
               -x_offset <xoffset from inimage> -y_offset <yoffset from inimag
e>
               -size_x <xsize of ROI> -size_y <ysize of ROI>
```

(xiii) To perform edge detection on an image:

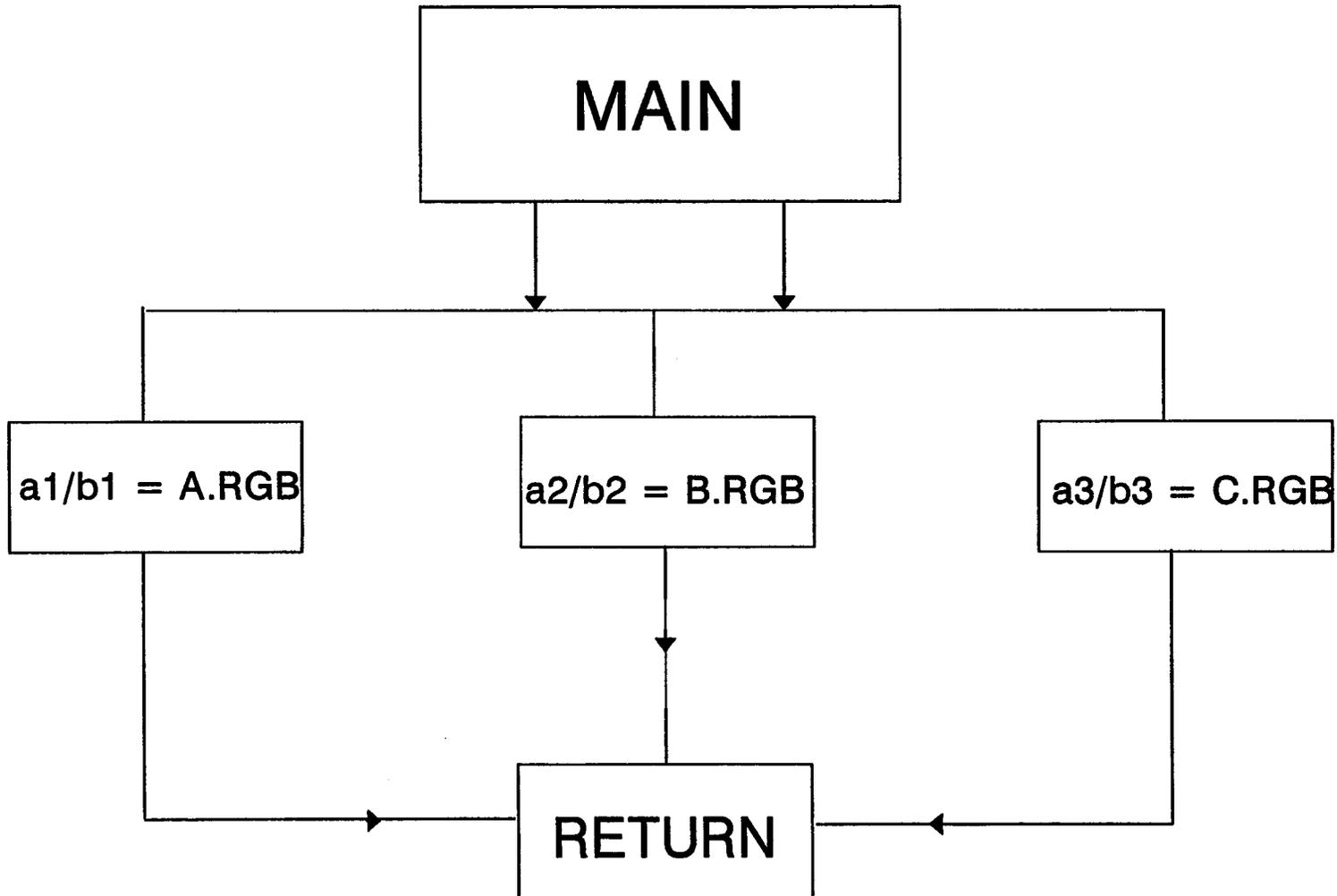
```
tm_proc Circular_Texture -i <inimagename> -o <outimagename>
```

APPENDIX C
FLOW CHARTS

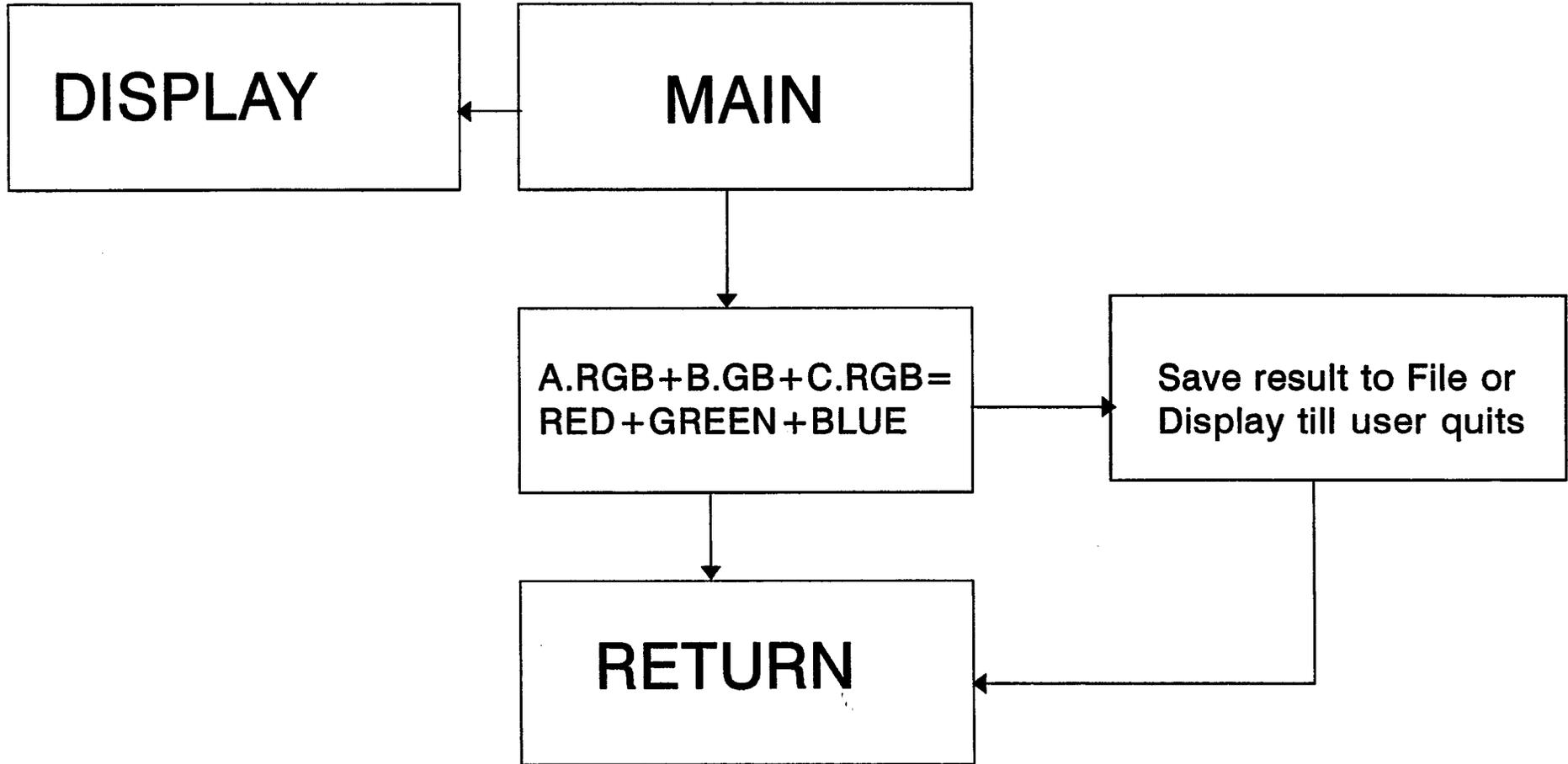
• CIRCULAR TEXTURE •



BAND RATIO

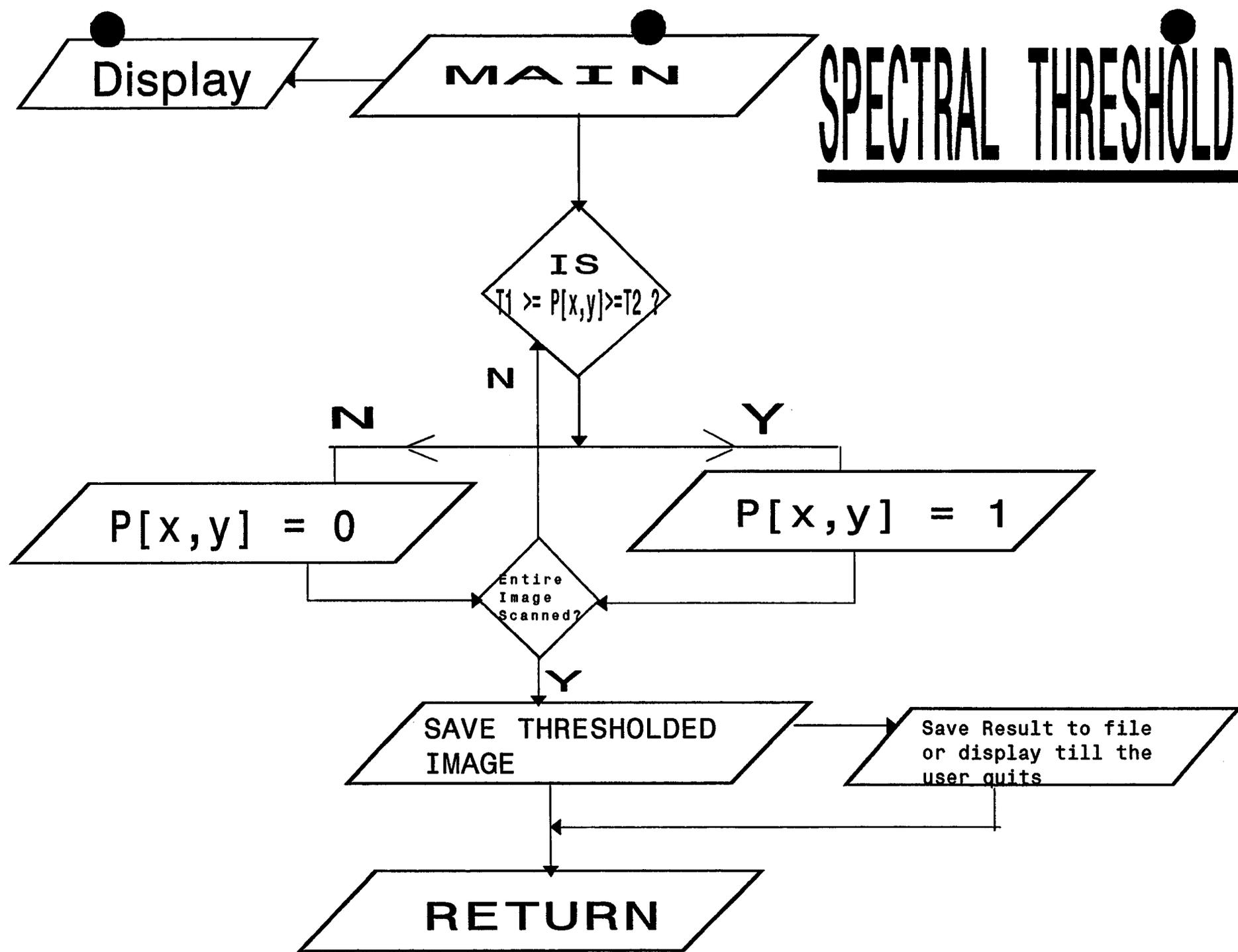


COLOR COMPOSITING



H2/
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SPECTRAL THRESHOLDING



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APPENDIX D
CODE LISTINGS

tm_proc.c++

```

////////////////////////////////////
// Filename : tm_proc.c++
// Author : Pavitra Ramanujan
// Date : 09-04-94
//
//Purpose: Driver program for the entire code for analyzing
// Landsat TM data.
//
//
// $Header : $
//
// Revision History
// $Log: $
//
////////////////////////////////////

#include <stdio.h>
#include <stdlib.h>
#include "cmdlinearg.hh"
#include "ERImg.hh"
#include "ERFile.hh"

void main(int argc,char** argv)
{ // begin main
// create commandline data object

    Cmdclass CmdObj;
    Cmdline_arg* cptr; // assign a pointer to data structure

    // create an ERImgclass object
    ERImgclass ERImgObj;

    // create an ERFileObject

    ERFileclass ERFileObj;

    // assign a pointer to ERMatrix data structure type

    ERMatrixType* ERMatrix = NULL;

    cptr = CmdObj.load(argc,argv,1);

    for (int i=0;i<cptr->Operatorcnt;i++) { // loop to check all operators
        switch(cptr->Imgoperator[i]) { // begin switch

            case Band_Ratio :

                if (cptr->Inputfilename[0] == NULL) {
                    printf("Input file not entered!\n");
                    exit(0);
                }

                if (cptr->Inputfilename[1] == NULL) {
                    printf("Input file not entered!\n");
                    exit(0);
                }

                if (cptr->Outputfilename[0] == NULL) {
                    printf("Output file name not entered!\n");
                    exit(0);
                }

                ERImgObj.Band_Ratio(cptr->Inputfilename[0],cptr->Inputfilename[1],
                    cptr->Outputfilename[0],quiet,noDisplay);

```

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```
printf("Image operator: %s\n", cptr->Imgoperator[i]);
printf("Input file 1,2: %s %s\n",cptr->Inputfilename[0],
      cptr->Inputfilename[1]);
printf("Output file: %s\n",cptr->Outputfilename[0]);

break;

case Merge :

if (cptr->Inputfilename[0] == NULL) {
    printf("Input file not entered!\n");
    exit(0);
}

if (cptr->Inputfilename[1] == NULL) {
    printf("Input file not entered!\n");
    exit(0);
}

if (cptr->Inputfilename[2] == NULL) {
    printf("Input file not entered!\n");
    exit(0);
}

if (cptr->Outputfilename[0] == NULL) {
    printf("Output file name not entered!\n");
    exit(0);
}

ERImgObj.Merge(cptr->Inputfilename[0],cptr->Inputfilename[1],
               cptr->Inputfilename[2],cptr->Outputfilename[0],
               quiet,noDisplay);

printf("Input files 1, 2 3: %s %s %s \n",
      cptr->Inputfilename[0],
      cptr->Inputfilename[1],
      cptr->Inputfilename[2]);

printf("The output file : %s\n",
      cptr->Outputfilename[0]);

break;

case ThreshImg:

if (cptr->Inputfilename[0] == NULL) {
    printf("Input file not entered!\n");
    exit(0);
}

if (cptr->Outputfilename[0] == NULL) {
    printf("Output file name not entered!\n");
    exit(0);
}

ERImgObj.ThreshImg(cptr->Inputfilename[0],cptr->Outputfilename[0],
                   cptr->threshval,verbose,noDisplay);

printf("Input file :%s\n", cptr->Inputfilename[0]);
printf("Output file: %s\n", cptr->Outputfilename[0]);
printf("The threshold value: %f\n",cptr->threshval);

break;

case StretchImg:
```

```
    if (cptr->Inputfilename[0] == NULL) {
        printf("Input file not entered!\n");
        exit(0);
    }

    if (cptr->Outputfilename[0] == NULL) {
        printf("Output file name not entered!\n");
        exit(0);
    }

    ERImgObj.StretchImg(cptr->Inputfilename[0], cptr->Outputfilename[0],
                        quiet, noDisplay);

break;

case InvertImg:

    if (cptr->Inputfilename[0] == NULL) {
        printf("Input file not entered!\n");
        exit(0);
    }

    if (cptr->Outputfilename[0] == NULL) {
        printf("Output file name not entered!\n");
        exit(0);
    }

    ERImgObj.InvertImg(cptr->Inputfilename[0], cptr->Outputfilename[0],
                       verbose, noDisplay);

break;

case HistEqImg:

    if (cptr->Inputfilename[0] == NULL) {
        printf("Input file not entered!\n");
        exit(0);
    }

    if (cptr->Outputfilename[0] == NULL) {
        printf("Output file name not entered!\n");
        exit(0);
    }

    ERImgObj.HistEqImg(cptr->Inputfilename[0], cptr->Outputfilename[0],
                       quiet, noDisplay);

break;

case GrayImg:

    if (cptr->Inputfilename[0] == NULL) {
        printf("Input file not entered!\n");
        exit(0);
    }

    if (cptr->Outputfilename[0] == NULL) {
        printf("Output file name not entered!\n");
        exit(0);
    }

    ERImgObj.GrayImg(cptr->Inputfilename[0], cptr->Outputfilename[0],
                     verbose, noDisplay);

break;
```

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```
case AndImg:
    if (cptr->Inputfilename[0] == NULL) {
        printf("Input file 1 not entered!\n");
        exit(0);
    }
    if (cptr->Inputfilename[1] == NULL) {
        printf("Input file 2 name not entered!\n");
        exit(0);
    }
    if (cptr->Outputfilename[0] == NULL) {
        printf("Output file name not entered!\n");
        exit(0);
    }
    ERImgObj.AndImg(cptr->Inputfilename[0], cptr->Inputfilename[1],
                   cptr->Outputfilename[0], quiet, noDisplay);

break;

case Wt_Avg:
    if (cptr->Inputfilename[0] == NULL) {
        printf("Input file 1 not entered!\n");
        exit(0);
    }
    if (cptr->Inputfilename[1] == NULL) {
        printf("Input file 2 name not entered!\n");
        exit(0);
    }
    if (cptr->Outputfilename[0] == NULL) {
        printf("Output file name not entered!\n");
        exit(0);
    }
    ERImgObj.Wt_Avg(cptr->Inputfilename[0], cptr->Inputfilename[1],
                   cptr->Outputfilename[0], cptr->Wt[0], quiet, noDisplay);

break;

case AddImg:
    if (cptr->Inputfilename[0] == NULL) {
        printf("Input file 1 not entered!\n");
        exit(0);
    }
    if (cptr->Inputfilename[1] == NULL) {
        printf("Input file 2 name not entered!\n");
        exit(0);
    }
    if (cptr->Outputfilename[0] == NULL) {
        printf("Output file name not entered!\n");
        exit(0);
    }
    ERImgObj.AddImg(cptr->Inputfilename[0], cptr->Inputfilename[1],
                   cptr->Outputfilename[0], quiet, noDisplay);

break;

case CorrFFT:
```

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```
if (cptr->Inputfilename[0] == NULL) {
    printf("Input file 1 not entered!\n");
    exit(0);
}

if (cptr->Inputfilename[1] == NULL) {
    printf("Input file 2 name not entered!\n");
    exit(0);
}

if (cptr->Outputfilename[0] == NULL) {
    printf("Output file name not entered!\n");
    exit(0);
}

ERImgObj.CorrFFT(cptr->Inputfilename[0],cptr->Inputfilename[1],
                cptr->Outputfilename[0],quiet,noDisplay);

break;

case Classify_Resources:

    if (cptr->Inputfilename[0] == NULL) {
        printf("Input file not entered!\n");
        exit(0);
    }

    if (cptr->Outputfilename[0] == NULL) {
        printf("Output file name not entered!\n");
        exit(0);
    }

    printf("Input file :%s\n", cptr->Inputfilename[0]);
    printf("Output file: %s\n", cptr->Outputfilename[0]);

    printf("the value of tfmax : %d\n",
           cptr->tfmax);
    printf("the value of tfmin : %d\n",
           cptr->tfmin);
    printf("the value of mflag is %d\n",
           cptr->mflag);

// check for error

if ((cptr->mflag !=1) && (cptr->tfmax != 1) && (cptr->tfmin != 1)) {
    printf("Insufficient parameters Entered!\n");
    exit (0);
}

if (cptr->tfmax == 1)
    printf("The threshold max value: %f\n",cptr->threshmax);
if (cptr->tfmin == 1)
    printf("The threshold min value: %f\n",cptr->threshmin);

if (cptr->mflag == 1)
    printf("The threshold values are read from %s\n",
           cptr->Inputfilename[1]);
if ((cptr->tfmax == 1) && (cptr->tfmin == 1))
    { // assign to the matrix data structure
        ERMatrix = ERFileObj.load(cptr->threshmax,
                                   cptr->threshmin,
                                   1);
        printf("the configured max val : %f\n",
```

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```
                ERMatrix->value_max[0]);
    printf("the configured min val : %f\n",
           ERMatrix->value_min[0]);
}

    ERImgObj.Classify_Resources(cpctr->Inputfilename[0],
                               cpctr->Outputfilename[0],
                               ERMatrix->value_max[0],
                               ERMatrix->value_min[0],
                               verbose,noDisplay);

break;

case bitmapROI:

    if (cpctr->Inputfilename[0] == NULL) {
        printf("Input file not entered!\n");
        exit(0);
    }

    if (cpctr->Outputfilename[0] == NULL) {
        printf("Output file name not entered!\n");
        exit(0);
    }

    ERImgObj.bitmapROI(cpctr->Inputfilename[0],cpctr->Outputfilename[0],
                       cpctr->threshval,verbose,noDisplay);

break;

case rectROI:

    if (cpctr->Inputfilename[0] == NULL) {
        printf("Input file not entered!\n");
        exit(0);
    }

    if (cpctr->Outputfilename[0] == NULL) {
        printf("Output file name not entered!\n");
        exit(0);
    }

    ERImgObj.Calc_Ref(cpctr->Inputfilename[0],cpctr->Outputfilename[0],
                      cpctr->x_offset,cpctr->y_offset,
                      cpctr->size_x,cpctr->size_y,quiet);

break;

case Calc_Ref:

    if (cpctr->Inputfilename[0] == NULL) {
        printf("Input file not entered!\n");
        exit(0);
    }

    if (cpctr->Outputfilename[0] == NULL) {
        printf("Output file name not entered!\n");
        exit(0);
    }

    ERImgObj.Calc_Ref(cpctr->Inputfilename[0],cpctr->Outputfilename[0],
```

```
        cptr->x_offset, cptr->y_offset,
        cptr->size_x, cptr->size_y, verbose);

    break;

    case Circular_Texture:

        if (cptr->Inputfilename[0] == NULL) {
            printf("Input file not entered!\n");
            exit(0);
        }

        if (cptr->Outputfilename[0] == NULL) {
            printf("Output file name not entered!\n");
            exit(0);
        }

        ERImgObj.Circular_Texture(cptr->Inputfilename[0], cptr->Outputfilename[0],
            quiet, noDisplay);

        break;

    case DisplayFile:

        if (cptr->Inputfilename[0] == NULL) {
            printf("Display filename not entered!\n");
            exit(0);
        }

        ERImgObj.DisplayFile(cptr->Inputfilename[0], quiet);

        break;

} // end switch
} // end for
} // end main
```

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```

////////////////////////////////////
// Filename: cmdlinearg.hh
// Author:   Pavitra Ramanujan
// Date:    09-01-94
//
// Purpose: Defines data structure and class for
//           command line arguments
//
//
// $Header:  $
//
// Revision History
// $Log:    $
//
////////////////////////////////////

#ifndef __CMDLINEARG_HH__
#define __CMDLINEARG_HH__
    // contents of cmdlinearg.h go here

// assign integer values to datafile formats

enum CmdFileType { TM,RGB,TIFF,Matrix};
enum ImgOperatorType {Band_Ratio,Classify_Resources,
    Circular_Texture,Merge,Wt_Avg,
    DisplayFile,Calc_Ref,GrayImg,
    HistEqImg,StretchImg,ThreshImg,
    InvertImg,AndImg,bitmapROI,rectROI,
    AddImg,CorrFFT};

// describe commandline data structure and class

typedef struct {
    int Inputcnt;
    int Outputcnt;
    char* Inputfilename[256];
    CmdFileType Inputfiletype[256];
    int Inputfilesymbol[256];
    float Wt[256];
    char* Outputfilename[256];
    CmdFileType Outputfiletype[256];
    int Outputfilesymbol[256];
    int Operatorcnt;
    ImgOperatorType Imgoperator[256];
    float threshval; // single threshold value ( to be used if necessary)
    float threshmax;
    float threshmin; // max & min threshold values for specifying range
    int mflag;
    int tfmin; // flags for error checking
    int tfmax;
    int x_offset; // parameters for region of interest
    int y_offset;
    int size_x; // size
    int size_y;
}Cmdline_arg;

class Cmdclass { // begin comd class

public:

    Cmdclass(); // constructor
    ~Cmdclass(); // destructor
    Cmdline_arg* load(int , //argc
        char** , // argv

```

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```
int ); //verbose

private:
  Cmdline_arg cmdata; // create a type Cmdline_arg
}; // end class

#endif
```

```

////////////////////////////////////
// Filename: cmdlinearg.c++
// Author: Pavitra Ramanujan
// Date: 09-07-94
//
// Purpose: Loads the command line data structure
//
//
// $Header: $
//
// Revision History
// $Log: $
//
////////////////////////////////////

```

```

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <assert.h>
#include "cmdlinearg.hh"

```

```

// Public Methods

```

```

Cmdclass::Cmdclass() { // begin initialization
    cmddata.Inputcnt=0;
    cmddata.Outputcnt=0;
    cmddata.Operatorcnt = 0;
    cmddata.threshval = 0;
    cmddata.threshmax = 0;
    cmddata.threshmin = 0;
    cmddata.mflag = 0;
    cmddata.tfmin = 0;
    cmddata.tfmax = 0;
    cmddata.x_offset = 0;
    cmddata.y_offset = 0;
    cmddata.size_x = 0;
    cmddata.size_y = 0;
} // constructor

```

```

Cmdline_arg* Cmdclass::load(int count,char** myarg,int verbose) {

```

```

// data

```

```

int i,flag=0;

```

```

// load the image operators
for (i=1;i<count;i++)
{ // begin for
    if ((strncasecmp(myarg[i],"Band_Ratio",10) == 0))
    { // begin if
        cmddata.Imgoperator[cmddata.Operatorcnt] = Band_Ratio;
        cmddata.Operatorcnt++; // increment operator count
    } //endif
    else if ((strncasecmp(myarg[i],"Classify_Resources",18) == 0))
    {
        cmddata.Imgoperator[cmddata.Operatorcnt] = Classify_Resources;
        cmddata.Operatorcnt++;
    }
    else if ((strncasecmp(myarg[i],"Circular_Texture",16) == 0))
    {
        cmddata.Imgoperator[cmddata.Operatorcnt] = Circular_Texture;
        cmddata.Operatorcnt++;
    }
    else if ((strncasecmp(myarg[i],"Merge",5) == 0))
    {

```

```
        cmddata.Imgoperator[cmddata.Operatorcnt] = Merge;
        cmddata.Operatorcnt++;
    }
    else if ((strncasecmp(myarg[i], "Wt_Avg", 6) == 0))
    {
        cmddata.Imgoperator[cmddata.Operatorcnt] = Wt_Avg;
        cmddata.Operatorcnt++;
        flag = 1;    // set a flag
    }
    else if ((strncasecmp(myarg[i], "DisplayFile", 11) == 0))
    {
        cmddata.Imgoperator[cmddata.Operatorcnt] = DisplayFile;
        cmddata.Operatorcnt++;
    }
    else if ((strncasecmp(myarg[i], "Calc_Ref", 8) == 0))
    {
        cmddata.Imgoperator[cmddata.Operatorcnt] = Calc_Ref;
        cmddata.Operatorcnt++;
    }

    else if ((strncasecmp(myarg[i], "GrayImg", 7) == 0))
    {
        cmddata.Imgoperator[cmddata.Operatorcnt] = GrayImg;
        cmddata.Operatorcnt++;
    }

    else if ((strncasecmp(myarg[i], "StretchImg", 10) == 0))
    {
        cmddata.Imgoperator[cmddata.Operatorcnt] = StretchImg;
        cmddata.Operatorcnt++;
    }

    else if ((strncasecmp(myarg[i], "HistEqImg", 9) == 0))
    {
        cmddata.Imgoperator[cmddata.Operatorcnt] = HistEqImg;
        cmddata.Operatorcnt++;
    }

    else if ((strncasecmp(myarg[i], "ThreshImg", 9) == 0))
    {
        cmddata.Imgoperator[cmddata.Operatorcnt] = ThreshImg;
        cmddata.Operatorcnt++;
    }

    else if ((strncasecmp(myarg[i], "InvertImg", 9) == 0))
    {
        cmddata.Imgoperator[cmddata.Operatorcnt] = InvertImg;
        cmddata.Operatorcnt++;
    }

    else if ((strncasecmp(myarg[i], "AndImg", 6) == 0))
    {
        cmddata.Imgoperator[cmddata.Operatorcnt] = AndImg;
        cmddata.Operatorcnt++;
    }

    else if ((strncasecmp(myarg[i], "bitmapROI", 9) == 0))
    {
        cmddata.Imgoperator[cmddata.Operatorcnt] = bitmapROI;
        cmddata.Operatorcnt++;
    }
}
```

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```
else if ((strncasecmp(myarg[i], "rectROI", 7) == 0))
{
    cmdata.Imgoperator[cmdata.Operatorcnt] = rectROI;
    cmdata.Operatorcnt++;
}

else if ((strncasecmp(myarg[i], "AddImg", 6) == 0))
{
    cmdata.Imgoperator[cmdata.Operatorcnt] = AddImg;
    cmdata.Operatorcnt++;
}

else if ((strncasecmp(myarg[i], "CorrFFT", 7) == 0))
{
    cmdata.Imgoperator[cmdata.Operatorcnt] = CorrFFT;
    cmdata.Operatorcnt++;
}

else if ((strncasecmp(myarg[i], "-i", 2) == 0))
{ // begin if
    // assign input file name

    cmdata.Inputfilename[cmdata.Inputcnt] =
        myarg[i+1];

    if (verbose)
        printf("the loaded inputfilename is %s\n",
            cmdata.Inputfilename[cmdata.Inputcnt]);

    // assign input file type

    cmdata.Inputfiletype[cmdata.Inputcnt] = TM;
    if (verbose)
        printf("The inputfiletype is %d\n",
            cmdata.Inputfiletype[cmdata.Inputcnt]);

    // Display loaded wts if image operator is Wt_Avg
    if (flag == 1)
        cmdata.Wt[cmdata.Inputcnt] = atof(myarg[i+2]);
        if (cmdata.Wt[0] != NULL)
            flag = 0; // remove flag

    if (verbose == 1 && flag == 1)
        printf("The loaded wt is: %f\n",
            cmdata.Wt[cmdata.Inputcnt]);

    // increment input number

    cmdata.Inputcnt = cmdata.Inputcnt+1;
} // end if

else if ((strncasecmp(myarg[i], "-tfile", 7) == 0))
{
    // Assign input file name for reading threshold values

    cmdata.Inputfilename[cmdata.Inputcnt] = myarg[i+1];

    // set flag to indicate that a file has been specified
    cmdata.mflag = cmdata.mflag++ ;
    if (verbose)
        printf("the input matrix file is %s\n",
            cmdata.Inputfilename[cmdata.Operatorcnt]);
}
```

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```
// Assign Matrix file type

    cmdata.Inputfiletype[cmdata.Inputcnt] = Matrix;
    if (verbose)
        printf("the file type is %d\n",
            cmdata.Inputfiletype[cmdata.Inputcnt]);

// increment inputfile number

    cmdata.Inputcnt++;
}
else if ((strncasecmp(myarg[i], "-o", 2) == 0))
{
    // assign output file name

    cmdata.Outputfilename[cmdata.Outputcnt] =
        myarg[i+1];
    if (verbose)
        printf("the loaded outputfilename is %s\n",
            cmdata.Outputfilename[cmdata.Outputcnt]);

// Assign output file type

    cmdata.Outputfiletype[cmdata.Outputcnt] = TM;

    if (verbose)
        printf("the output filetype is %d\n",
            cmdata.Outputfiletype[cmdata.Outputcnt]);

// increment output file number

    cmdata.Outputcnt++;
}
else if ((strncasecmp(myarg[i], "-singlethresh", 13) == 0))
{ // assign threshold value
    cmdata.threshval = atof(myarg[i+1]);
    if (verbose)
        printf("the loaded threshold value is %f\n",
            cmdata.threshval);
}

else if ((strncasecmp(myarg[i], "-tmax", 5) == 0))
{ // assign max threshold value
    cmdata.threshmax = atof(myarg[i+1]);
    cmdata.tfmax++;
    if (verbose)
        printf("incremented tfmax: %d\n",
            cmdata.tfmax);
    if (verbose)
        printf("the loaded threshold value is %f\n",
            cmdata.threshmax);
}

else if ((strncasecmp(myarg[i], "-tmin", 5) == 0))
{ // assign max threshold value
    cmdata.threshmin = atof(myarg[i+1]);
    cmdata.tfmin++;
    if (verbose)
        printf("incremented tfmin: %d\n",
            cmdata.tfmin);
    if (verbose)
        printf("the loaded threshold value is %f\n",
            cmdata.threshmin);
}
}
```

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```
else if ((strncasecmp(myarg[i], "-x_offset", 9) == 0))
    { // assign offset for ROI and its size

        cmddata.x_offset = atoi(myarg[i+1]);
        if (verbose) {
            printf("The offset for x is %d\n",
                cmddata.x_offset);
        }
    }

else if ((strncasecmp(myarg[i], "-y_offset", 9) == 0))
    { // assign offset for ROI and its size

        cmddata.y_offset = atoi(myarg[i+1]);
        if (verbose)
            printf("The offset for y is %d\n",
                cmddata.y_offset);
    }

else if ((strncasecmp(myarg[i], "-size_x", 7) == 0))
    { // assign size

        cmddata.size_x = atoi(myarg[i+1]);
        if (verbose)
            printf("The x size is %d\n",
                cmddata.size_x);
    }

else if ((strncasecmp(myarg[i], "-size_y", 7) == 0))
    { // assign size

        cmddata.size_y = atoi(myarg[i+1]);
        if (verbose)
            printf("The y size is %d\n",
                cmddata.size_y);
    }
    else
        {
            if (verbose)
                printf("\n\n");
        }
    } // end for

    if (verbose)
        printf("The value of Image operator is %d\n",
            cmddata.Imgoperator[cmddata.Operatorcnt-1]);
    return &cmddata;
} // end function

Cmdclass::~Cmdclass() { } // definition of destructor
```

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```

////////////////////////////////////
// Author : Pavitra Ramanujan
// Date : 09 - 20 - 94
//
// Purpose : Performs image processing operations on digital images
//            using ImageVision Library Programming tools.
//
// $ Header : $
//
// Revision History
// $ Log : $
//
////////////////////////////////////

// description of ERImg class:

#ifndef __ERImg_HH__
#define __ERImg_HH__
#include "ERFile.hh"
#include <il/ilImage.h>

// create enumerated data types

enum VerboseType {quiet,verbose}; // Do you want the print statements on
// or off ?

enum DisplayType {noDisplay,yesDisplay}; // Is display on or off?

typedef struct {
    float min_intensity;
    float max_intensity;
}ThresholdType;

class ERImgclass{
public:
    ERImgclass(); // constructor
    ~ERImgclass(); // destructor

    // Methods

    void Band_Ratio(const char* , // first inputfile name
                   const char* , // second inputfilename
                   const char* , // outputfilename
                   // NULL => output image is not
                   // saved
                   const int VerboseType, // print statements on
                   // or off!
                   const int DisplayType); // display or no display

    void Circular_Texture(const char* , // inimage
                         const char* , // outimage
                         const int VerboseType,
                         const int DisplayType);

    void Classify_Resources(const char* , // inimage
                           const char* , // outimage
                           float,float, // threshold info
                           const int VerboseType,
                           const int DisplayType);

```

```
void Merge( const char *,      // red
            const char *,      // grn
            const char *,      // blu
            const char *,      // name of the outputfile
                               // in which the merged image
                               // is to be saved
            const int VerboseType,
            const int DisplayType);

void GrayImg(const char* ,    // 3 channel input image
             const char* ,    // 1 channel output image
             const int VerboseType,
             const int DisplayType);

void StretchImg(const char* , // input image
               const char* , // stretched ouput
               const int VerboseType,
               const int DisplayType);

void HistEqImg(const char* , // input image
               const char* , // outimage
               const int VerboseType,
               const int DisplayType);

void CorrFFT(const char* ,    // inimage
             const char* ,    // inimage 2
             const char* ,
             const int VerboseType,
             const int DisplayType);

void AddImg(const char* ,      // inimage
            const char* ,      // inimage 2
            const char* ,
            const int VerboseType,
            const int DisplayType);

void ThreshImg(const char* , // input image
               const char* , // outimage
               float threshval, // threshold value
               const int VerboseType,
               const int DisplayType);

void InvertImg(const char* , // inimage
               const char* , // outimage
               const int VerboseType,
               const int DisplayType);

void AndImg(const char* , // inimage 1
            const char* , // inimage 2
            const char* , // outimage
            const int VerboseType,
            const int DisplayType);

void Calc_Ref(const char* , // outimage
              const char* , // outimage
              const int,    // offset
              const int,
              const int,    // size
              const int VerboseType);

void bitmapROI(const char* in, // inimage
               const char* out, // outimage
               float,
```

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```
        const int VerboseType,
        const int DisplayType);

void rectROI(const char* in, // inimage
             const char* out, // outimage
             const int, // offset
             const int,
             int,
             int, // dimension
             const int VerboseType,
             const int DisplayType);

void display(ilImage* ); // image

void Wt_Avg(const char* , // inimage1
            const char* , // nimage 2
            const char* , // outimage
            const float,
            const int VerboseType,
            const int DisplayType);

void DisplayFile(const char* ,const int VerboseType);

void Save(const char* ,ilImage *); // filename

private:
void print(ilImage *,const char *,const char*);
void StatImg(const char* , // inimage
             const int VerboseType);

int xsize;
int ysize;
int zsize;
int channel_count;
int PixelCount;
double intensity; //image data attributes
double MinPixelVal;
double MaxPixelVal;
double Pixel_Mean;
double Pixel_StdDev;
ThresholdType ThresholdData;
}; // end class

#endif
```

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```
////////////////////////////////////
// Author : Pavitra Ramanujan
// Date : 09 - 15 - 94
//
// Purpose : Performs Image processing operations on digital images
//            using ImageVision Library programming tools
//
// $ Header : $
//
// Revision History
// $ Log : $
//
////////////////////////////////////
```

```
#include <stdio.h>
#include <stdlib.h>
#include "ERImg.hh"
#include <il/ilGenericImgFile.h>
#include <il/ilSize.h>
#include <il/ilPixel.h>
#include <il/ilDivImg.h>
#include <il/ilDisplay.h>
#include <gl/gl.h>
#include <gl/device.h>
#include <il/ilMergeImg.h>
#include <il/ilGrayImg.h>
#include <il/ilRGBImg.h>
#include <il/ilScaleImg.h>
#include <il/ilHistEqImg.h>
#include <il/ilThreshImg.h>
#include <il/ilImgStat.h>
#include <il/ilInvertImg.h>
#include <il/ilAndImg.h>
#include <il/ilRoiImg.h>
#include <il/ilSubImg.h>
#include <il/ilBitMapRoi.h>
#include <il/ilRectRoi.h>
#include <il/ilCombineImg.h>
#include <il/ilConstImg.h>
#include <il/ilFCrCorrImg.h>
#include <il/ilAddImg.h>
#include <il/ilSubtractImg.h>
#include <il/ilLaplaceImg.h>
#include <il/ilBlendImg.h>
```

```
// public methods
```

```
ERImgclass::ERImgclass() { // begin initialization
    xsize = 0;
    ysize = 0;
    zsize = 0;
    channel_count = 0;
    MinPixelVal = 0;
    MaxPixelVal = 0;
    PixelCount = 0;
    intensity = 0;
    Pixel_Mean = 0;
    Pixel_StdDev = 0;
    ThresholdData.min_intensity = 0;
    ThresholdData.max_intensity = 0;
}
```

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```
// destructor
ERImgclass::~ERImgclass() { }

void ERImgclass::Band_Ratio(const char* file1, const char* file2,
                           const char* outfile, const int VerboseType,
                           const int DisplayType) {

    // Begin method

    ilFileImg* infile1 = ilOpenImgFile(file1, "r");
    ilFileImg* infile2 = ilOpenImgFile(file2, "r");

    if (VerboseType == verbose) {
        print(infile1, "Input file 1,", file1);
        print(infile2, "Input file 2,", file2);
    }

    // perform pixelwise division of 2 input images
    ilDivImg divImg( infile1, infile2, 1);

    if (VerboseType == verbose)
        print(&divImg, "Divided image file", " ");

    if (DisplayType == yesDisplay)
        display(&divImg);

    Save(outfile, &divImg);
    return ;
}

void ERImgclass::print(ilImage *inf, const char *ins1,
                      const char *ins2) {

    int          x;
    int          y;
    int          ind;
    ilPixel      pix;
    ilSize       imgSize;
    int verbal = 0;

    // Begin
    printf("\n\n%s %s\n", ins1, ins2);
    inf->getSize(imgSize);
    xsize = inf->getXsize();
    ysize = inf->getYsize();
    zsize = inf->getZsize();
    printf("The xyz size is %5d %5d %5d.\n",
           xsize, ysize, zsize);

    channel_count = inf->getCsize();
    printf("Number of channels is %d\n", channel_count);

    // get pixel values

    for (x=0; x<xsize; x++) {
        for (y=0; y<ysize; y++) {

            ind = y + x * ysize;

            ilStatus theStatus = inf->getPixel(x, y, pix);
```

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```
switch (pix.nc()) {
    case 1:
        intensity = pix.getElem(0);
        if (verbal)
            printf("The %d pixel value at %d,%d is %02x \n",
                ind, x, y,
                (int)pix.getElem(0));
        break;
    case 3:
        if (verbal)
            printf("The %d pixel value at %d,%d is %02x %02x %02x \n",
                ind, x, y,
                (int)pix.getElem(0),
                (int)pix.getElem(1),
                (int)pix.getElem(2));
        break;
    default:
        printf("NC is %d\n", pix.nc());
        break;
}
}
return ;
} // End

void ERImgclass::display(ilImage *inf) {
    // setup GL window
    foreground();
    ilSize size;
    inf->getSize(size);
    prefsize(size.x, size.y);
    long wid = winopen("processed image: choose QUIT from menu to exit");
    if (getgdesc(GD_BITS_NORM_SNG_RED) != 0) RGBmode();
    gconfig();

    // Create display object and add the image
    ilDisplay disp(wid);
    disp.addView(inf);

    // The user should choose QUIT from menu or press <ESC> key
    // display until the user quits!

    qdevice(REDRAW);
    qdevice(ESCKEY);

    qenter(REDRAW, short(wid));
    short val;

    int active = 1;
    while(active) {
        switch(qread(&val)) {
```

```
        case ESCKEY:
            active = 0;
            break;

        case REDRAW:
            disp.redraw();
            break;

    } // end switch
} // end while

exit (0);
} // End

void ERImgclass::Merge(const char* inf1,const char* inf2,const char* inf3,
                       const char* merge,const int VerboseType,
                       const int DisplayType)
{

// Begin Method

// convert the 3 channel image to an single Image
// create new single channel images

    GrayImg(inf1,"../temp/tmp1.rgb",quiet,noDisplay);
    GrayImg(inf2,"../temp/tmp2.rgb",quiet,noDisplay);
    GrayImg(inf3,"../temp/tmp3.rgb",quiet,noDisplay);

// stretch the resulting values

    StretchImg("../temp/tmp1.rgb","../temp/strtmp1.rgb",quiet,noDisplay);
    StretchImg("../temp/tmp2.rgb","../temp/strtmp2.rgb",quiet,noDisplay);
    StretchImg("../temp/tmp3.rgb","../temp/strtmp3.rgb",quiet,noDisplay);

// Equalize the image for better contrast

    HistEqImg("../temp/strtmp1.rgb","../temp/tmp1.rgb",quiet,noDisplay);
    HistEqImg("../temp/strtmp2.rgb","../temp/tmp2.rgb",quiet,noDisplay);
    HistEqImg("../temp/strtmp3.rgb","../temp/tmp3.rgb",quiet,noDisplay);

// construct an array of files and assign a pointer reference

    ilFileImg* inp1 = ilOpenImgFile("../temp/tmp1.rgb","r");
    ilFileImg* inp2 = ilOpenImgFile("../temp/tmp2.rgb","r");
    ilFileImg* inp3 = ilOpenImgFile("../temp/tmp3.rgb","r");

// make ilImages
// construct an array of pointers to ilImages

    ilImage*  inptrl = inp1;
    ilImage*  inp2r  = inp2;
    ilImage*  inp3r  = inp3;
```

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```
        ilMergeImg mergeImg(inptrl, inptr2, inptr3, inptrl->getOrder(),
                               inptrl->getDataType());

        if (VerboseType == verbose){
            print(&mergeImg, "Merged Image file", " ");
        }

        if (DisplayType == yesDisplay)
            display(&mergeImg);

        Save(merge, &mergeImg);

    return;
}

void ERImgclass::Save(const char* infile, ilImage* imgfile)
{
    ilSize    size;    // create an ilSize object

    // Begin Method

    //    print(imgfile, "Saved Image", infile);
    imgfile->getSize(size);
    ilFileImg* out = ilCreateImgFile(infile, size, imgfile->getDataType(),
                                       imgfile->getOrder());
    out->setCoordSpace(imgfile->getCoordSpace());
    *out << *imgfile;
    delete out;
} // end

void ERImgclass::GrayImg(const char* in, const char* out, const int VerboseType,
                        const int DisplayType)
{
    // begin method

    // open input file

    ilFileImg* inf = ilOpenImgFile(in, "r");

    // create a buffer to hold converted image

    ilGrayImg* cnvrtdImg;
    cnvrtdImg = new ilGrayImg(inf);

    if (VerboseType == verbose)
        print(cnvrtdImg, "converted Image!", " ");

    if (DisplayType == yesDisplay)
        display(cnvrtdImg);

    Save(out, cnvrtdImg);

    // free data buffers
    delete cnvrtdImg;
}
```

```
    return;
}

void ERImgclass::StretchImg(const char* in,const char* out,
                           const int VerboseType,
                           const int DisplayType)
{
// open the file in IL image format
    ilFileImg* inf = ilOpenImgFile(in,"r");

// call the stretching routine
    ilScaleImg ScaleImg(inf);

    if (VerboseType == verbose)
        print(&ScaleImg,"Stretched Image"," ");

    if (DisplayType == yesDisplay)
        display(&ScaleImg);

    Save(out,&ScaleImg); // save the stretched image
return;
}

void ERImgclass::HistEqImg(const char* in,const char* out,
                           const int VerboseType,
                           const int DisplayType)
{

    ilImgStat* imgstat = NULL;
    ilRoi* roi = NULL;

// begin method
    ilFileImg* inf = ilOpenImgFile(in,"r");

// call Histogram Equalization routine
    ilHistEqImg HistEqImg(inf,imgstat,roi,0,0);

    if (VerboseType == verbose)
        print(&HistEqImg,"Equalized Image"," ");

    if (DisplayType == yesDisplay)
        display(&HistEqImg);

    Save(out,&HistEqImg);

return;
}

void ERImgclass::ThreshImg(const char* in,const char* out,
                           float threshval,
                           const int VerboseType,
                           const int DisplayType)
```

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```
{
    printf("The received threshold value : %f\n",
           threshval);
// create an ilPixel object
    ilPixel pix;
// create an ERImage object
    ERImgclass ERImgObj;
// open input image
    ilFileImg* inf = ilOpenImgFile(in,"r");
    if (in == NULL) {
        printf("Couldn't open Threshold Img file!\n");
        exit (0);
    }
// get the maximum and minimum pixel values for a single channel image:
    inf->getMaxPixel(pix);
    ERImgObj.MaxPixelVal = pix.max();
    if (VerboseType == verbose) {
        printf("the max pixel val:%d\n",
               (int)pix.max());
        printf("the loaded max val: %d\n",
               (int)ERImgObj.MaxPixelVal);
    }
    inf->getMinPixel(pix);
    ERImgObj.MinPixelVal = pix.min();
    if (VerboseType == verbose) {
        printf("the max pixel val:%d\n",
               (int)pix.min());
        printf("the loaded max val: %d\n",
               (int)ERImgObj.MinPixelVal);
    }
}
// set the maximum pixel value in a single channel image to 0:
    double set_max =(double)255.;
    ilPixel p(ilDouble,1,&set_max);
    ilStatus firstStatus = inf->setMaxPixel(p);
    inf->getMaxPixel(pix);
    if (VerboseType == verbose)
        printf("the set max pixel value :%d\n",
               (int)pix.max());

    double set_min = (double)0;
    ilPixel q(ilDouble,1,&set_min);
    ilStatus secondStatus = inf->setMinPixel(q);
    inf->getMinPixel(pix);
    if (VerboseType == verbose)
        printf("the set min pixel value :%d\n",
               (int)pix.min());
```

```
// create threshold image
// set threshold pixel value to threshval:

    ilPixel threshPixel(ilFloat,1,&threshval);

    ilThreshImg Thresh(inf,threshPixel);

    if (VerboseType == verbose){
    print(inf,"Input file",in);
    print(&Thresh,"Threshold Image", " ");
    }

    if (DisplayType == yesDisplay)
    display(&Thresh);

    Save(out,&Thresh);

return;
}

void ERImgclass::StatImg(const char* in,const int VerboseType)
{

// define data

int xoffset = 0;
int yoffset = 0;
int autoCalcEnable = TRUE;

// open inputfile

    ilFileImg* infile = ilOpenImgFile(in,"r");
    if (in == NULL) {
        printf("Couldn't open statistics Img file!\n");
        exit (0);
    }

    ilRoi* roi = NULL;

// begin method

// create ilImagStat object

    ilImgStat StatImg(infile,roi,xoffset,yoffset,autoCalcEnable);

// create space for data

// get total pixel count of the input image

    PixelCount = StatImg.getTotal(0);
    if (VerboseType == verbose)
        printf("The total pixel count for %s is %d \n",
            in,PixelCount);

// compute the minimum and maximum values of the input image
// compute the mean and the standard deviation

    MinPixelVal = StatImg.getDMin(0);
    if (VerboseType == verbose)
        printf("The minimum pixel value of %s is %d \n",
            in,(int)MinPixelVal);
```

```
MaxPixelVal = StatImg.getDMax(0);
    if (VerboseType == verbose)
        printf("The maximum pixel value of %s is %d \n",
                in, (int)MaxPixelVal);

    Pixel_Mean = StatImg.getDMean(0);
    if (VerboseType == verbose)
        printf("The mean value of %s is %d \n",
                in, (int)Pixel_Mean);

    Pixel_StdDev = StatImg.getDStDev(0);
    if (VerboseType == verbose)
        printf("The std dev value of %s is %d \n",
                in, (int)Pixel_StdDev);

return;
}

void ERImgclass::Classify_Resources(const char* in, const char* out,
                                    float max, float min,
                                    const int VerboseType,
                                    const int DisplayType)
{
// begin method

    if (VerboseType == verbose) {
        printf("The received max thresh val: %f\n",
                max);

        printf("The received min thresh val: %f\n",
                min);
    }

    max = 255-max;
    if (VerboseType == verbose) {
        printf("The received max thresh val: %f\n",
                max);
    }

//    GrayImg(in, "../data/schannel.rgb", quiet, noDisplay);
//    StretchImg(in, "../data/schannel.rgb", quiet, noDisplay);
//    ThreshImg("../data/schannel.rgb", "../data/thresh1.rgb", min, quiet, noDisplay);
//    InvertImg("../data/schannel.rgb", "../data/invert.rgb", quiet, noDisplay);
//    ThreshImg("../data/invert.rgb", "../data/thresh2.rgb", max, quiet, noDisplay);
};

// perform logical AND of the two thresholded images

    AndImg("../data/thresh1.rgb", "../data/thresh2.rgb", out, quiet, noDisplay);

// open output file as ilFile

    ilFileImg* outf = ilOpenImgFile(out, "r");

    if (DisplayType == yesDisplay)
        display(outf);

return;
}
```

```
void ERImgclass::InvertImg(const char* in,const char* out,
                          const int VerboseType,const int DisplayType)
{
    // begin method
    // open input file
        ilFileImg* infile = ilOpenImgFile(in,"r");
    // create space for inverted image
        ilInvertImg InvertImg(infile);
        if (VerboseType == verbose) {
            print(&InvertImg,"Inverted Image"," ");
        }
        if (DisplayType == yesDisplay)
            display(&InvertImg);

        Save(out,&InvertImg);

return;
}
```

```
void ERImgclass::AndImg(const char* in1,const char* in2,const char* out,
                       const int VerboseType,
                       const int DisplayType)
{
    // open input files in
        ilFileImg* infile1 = ilOpenImgFile(in1,"r");
        ilFileImg* infile2 = ilOpenImgFile(in2,"r");
    // create space for Anded image
        ilAndImg AndedImg(infile1,infile2);
        if(VerboseType == verbose) {
            print(&AndedImg,"The ANDED Image!"," ");
        }
        if (DisplayType == yesDisplay)
            display(&AndedImg);

        Save(out,&AndedImg);

return;
}
```

```
void ERImgclass::bitmapROI(const char* in,const char* out,
                           float threshval,
                           const int VerboseType,
                           const int DisplayType)
{
    // create an ERImgclass object
    ERImgclass ERImgobj;
```

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```
// open input(foreground) image
    ilImage* inf = ilOpenImgFile(in,"r");

// get image data attributes

    print(inf,"Foreground Image",in);

    if (VerboseType == verbose) {
        printf("The Size of the Image: %s\n",in);
        printf("Xsize: %d\n",xsize);
        printf("Ysize: %d\n",ysize);
        printf("Zsize: %d\n",zsize);
        printf("NUmber of channels: %d\n",channel_count);
    }

    int size = xsize*ysize*channel_count;

printf("the calculated size is %d\n",size);

    if (VerboseType == verbose)
        printf("the calculated size is %d\n",size);

// create threshold image with the values read from main

    ThreshImg(in,"../data/threshroi.rgb",threshval,quiet,noDisplay);
// create a bit map from the thresholded image

//    ilRoi* roi = new ilBitMapRoi(&thresh);

    ilImage* read = ilOpenImgFile("../data/threshroi.rgb","r");
    ilBitMapRoi* roi = new ilBitMapRoi(read,1);

// create purple background constant image

    static u_char constval[] = {128,0,128};
    ilConstImg bkgd(ilPixel(ilUChar,1,constval));

// Make sure that the coordinate space on the background matches thresh

    //bkgd.setCoordSpace(roi.getCoordSpace());

// create combined image

    ilCombineImg *comb = new ilCombineImg(&bkgd,inf,roi);

    if (VerboseType == verbose) {
        print(inf,"Input file",in);
        print(read,"Thresholded image"," ");
        print(comb,"Region of interest"," ");
    }

    if (DisplayType == yesDisplay)
        display(comb);

    Save(out,comb);

return;

}

void ERImgclass::rectROI(const char* in,const char* out,
    const int xoffset,const int yoffset,
```

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```
        int x, int y,
            const int VerboseType, const int DisplayType)
{
    ilConfig* config = NULL;

    ilImage* infile = ilOpenImgFile(in, "r");
    ilSubImg subImg(infile, xoffset, yoffset, x, y, config);

    Save(out, &subImg);
    GrayImg(out, "../data/scstat.rgb", quiet, noDisplay);
    StatImg("../data/scstat.rgb", verbose);

    if (VerboseType == verbose)
        print(&subImg, "region of interest", " ");

    if (DisplayType == yesDisplay)
        display(&subImg);

return;
}

void ERImgclass::Calc_Ref(const char* in, const char* out,
                        const int xoffset, const int yoffset,
                        const int xsize, const int ysize,
                        const int VerboseType)
{
    ERFileclass ERFileObj;
    ERMatrixType* ERMatrix;
    ilSize imgSize;
    int x=0, y=0;

    x=xsize;
    y=ysize;
    // check for size entered by user
    // get size of the input file

    ilImage* inf = ilOpenImgFile(in, "r");
    inf->getSize(imgSize);
    if (xsize > inf->getXsize())
        x = inf->getXsize();
    if (ysize > inf->getYsize())
        y = inf->getYsize();

    if (VerboseType == verbose)
        printf("The new x & y sizes are %d %d\n",
              x, y);
    rectROI(in, out, xoffset, yoffset, x, y, quiet, noDisplay);

// assign threshold intensity ranges

    printf("The Pixel mean is %d\n", (int)Pixel_Mean);
    printf("The Pixel Std_dev is %d\n", (int)Pixel_StdDev);

    ThresholdData.min_intensity = (float)(Pixel_Mean - Pixel_StdDev);
    ThresholdData.max_intensity = (float)(Pixel_Mean + Pixel_StdDev);

    if (VerboseType == verbose) {
        printf("the minimum thresh intensity is %f\n",
              ThresholdData.min_intensity);
        printf("the maximum thresh intensity is %f\n",
              ThresholdData.max_intensity);
    }

// assign to matrix data structure
```

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```
        ERMatrix = ERFileObj.load(ThresholdData.max_intensity,
                                   ThresholdData.min_intensity,1);

return;
}

void ERImgclass::CorrFFT(const char* in1,const char* in2,const char* out,
                        const int VerboseType,
                        const int DisplayType)
{
// open input files

ilImage* infile1 = ilOpenImgFile(in1,"r");
ilImage* infile2 = ilOpenImgFile(in2,"r");

    ilFCrCorrImg corrImg(infile1,infile2);

    if (VerboseType == verbose)
        print(&corrImg,"cross correlated image"," ");

    if (DisplayType == yesDisplay)
        display(&corrImg);

    Save(out,&corrImg);
return;
}

void ERImgclass::Circular_Texture(const char* in, const char* out,
                                   const int VerboseType,const int DisplayType)
{
// open input image

    ilImage* infile = ilOpenImgFile(in,"r");

// set the kernel

    void setKernel(int Kerno = 2);

    ilLaplaceImg laplaceImg(infile,0.,
                            ilPadSrc,2);

// subtract the laplacian image from original image

    ilSubtractImg SubtractedImg(infile,&laplaceImg,0.);

    if (VerboseType == verbose)
        print(&laplaceImg,"Circular Edge Enhanced Image"," ");

    if (DisplayType == yesDisplay)
        display(&laplaceImg);

    Save(out,&SubtractedImg);

return;
}

void ERImgclass::AddImg(const char* in1,const char* in2,const char* out,
                       const int VerboseType,const int DisplayType)
```

```
{
    ilImage* inf1 = ilOpenImgFile(in1,"r");
    ilImage* inf2 = ilOpenImgFile(in2,"r");

    ilAddImg AddImg(inf1,inf2,0.);

    if (VerboseType == verbose)
        print(&AddImg,"Added Image", " ");

    if (DisplayType == yesDisplay)
        display(&AddImg);

    Save(out,&AddImg);

return;
}

void ERImgclass::Wt_Avg(const char* in1,const char* in2,const char* out,
                       const float Wt,
                       const int VerboseType,const int DisplayType)
{
// open input files

    ilImage* inf1 = ilOpenImgFile(in1,"r");
    ilImage* inf2 = ilOpenImgFile(in2,"r");

    ilBlendImg BlendImg(inf1,inf2,Wt);

    if (VerboseType == verbose)
        print(&BlendImg,"the Blended Image", " ");

    if (DisplayType == yesDisplay)
        display(&BlendImg);

    Save(out,&BlendImg);

return;
}

void ERImgclass::DisplayFile(const char* in,const int VerboseType)
{
// open file to be displayed

    ilImage* inf = ilOpenImgFile(in,"r");

    if (VerboseType == verbose)
        print(inf,"The Displayed file", " ");

    display(inf);

return;
}
```

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```
////////////////////////////////////
//
// Author : Pavitra Ramanujan
// Date : 10 - 05 - 94
//
// Purpose : loads memory with matrix data of threhsold values
//
// $ Header : $
//
// Revision History
// $ Log : $
//
////////////////////////////////////

// ERfile class header
#ifndef __ERFile_HH__
#define __ERFile_HH__

// describe the matrix data structure

typedef struct {
    int rows;
    int cols;
    float* value_max;
    float* value_min;
} ERMatrixType;

class ERFileclass {
public:
    ERFileclass(); // constructor
    ~ERFileclass(); // destructor
    ERMatrixType* read(const char* ,int);
    void write(const char* , // inputfile(text)
               const ERMatrixType *); // data
    ERMatrixType* load(float, // thresh max value
                       float, // thresh min val
                       int); // verbose

private:
    ERMatrixType ERMatrixdata; // Ermatrix data type
}; // end class

#endif
```

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```
////////////////////////////////////
// Author : Pavitra Ramanujan
// Date : 10 - 10- 94
//
// purpose : Loads threshold matrix data values
//
// $ Header : $
//
// Revision History
// S Log : $
//
////////////////////////////////////

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include "ERFile.hh"

// public methods

ERFileclass::ERFileclass() { // begin initialization
    ERMatrixdata.rows = 0;
    ERMatrixdata.cols = 0;
} // constructor

// Destructor
ERFileclass::~ERFileclass() { }

ERMatrixType* ERFileclass::load(float max,float min,int verbose)
{
// data
int i=0;

// load the threshold values into the matrix data structure

    ERMatrixdata.rows = 1;
    if (verbose)
        printf("the number of rows: %d\n",
                ERMatrixdata.rows);
    ERMatrixdata.cols = 2;
    if (verbose)
        printf("the number of cols: %d\n",
                ERMatrixdata.cols);

// allocate space to hold the threshold values

int limit = ERMatrixdata.rows*ERMatrixdata.cols;

    ERMatrixdata.value_max = (float *) malloc (sizeof(float)*limit );
    ERMatrixdata.value_min = (float *) malloc (sizeof(float)*limit );

    ERMatrixdata.value_max[0] = max;
    if (verbose)
        printf("the max value is : %f\n",
                ERMatrixdata.value_max[0]);
    ERMatrixdata.value_min[0] = min;
    if (verbose)
        printf("the min value is : %f\n",
                ERMatrixdata.value_min[0]);

return &ERMatrixdata;
}

ERMatrixType* ERFileclass::read(const char* in,int verbose)
```

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```
{  
return &ERMatrixdata;  
}
```