"Risk assessment and risk management of nuclear technology through large-scale simulation and modeling"

Student Training: Marcus L., Junior, Computer Engineering; Benyam K. – Junior, Computer Engineering; Abraham E., Junior, Computer Engineering; Anas A. Junior, Computer Engineering, Naveen A ., Graduate, Com puter Engineering. **Research Assignment/Accomplishments:** The students received training regarding the mesh generation using the Pointwise/Gridgen and ICEMCFD s oftware and Ensight sc ientific visualization tool. They have generated g eometry and surface mesh, and volume mesh of part of Indianapolis downtown area using the most recently available geo-referenced buildings geometry.

Research Progress

We started to expand the downtown Indinapolis area from the smaller version that we originally had to most recently available 3D model, comprising about 2400 buildings and covering about 11 sq.km of the downtown area. The model geometry was provided by Indianapolis Mapping and Geographic Infrastructure System (IMAGIS). Currently, we completed to creating CFD mesh for 1x1 miles area (2.56 sq.km), central part of the downtown with the powerplant, coal-fuel based, and all major high-rise buildings, 300-811 ft tall, included. The mesh for this central downtown case consists of 43 million cells. Currently, the CFD simulation for this case is running to obtain velocity and temperature fields in our in-house clusters using 56 cores. Our incompressible hybrid flow solver was used to simulate advection problem, not dispersion of the pollutants at this time, however, we will add particulate dispersion model into our existing CFD solver to trace fate of clouds of the particles. We are in process of changing our mesh generation tool from Gridgen/Pointwise to ICEMCFD. The complete mesh model will be generated using the new tool, which will speed up the mesh generation process. We also have Marion county, where the city of Indianapolis located, DEM model that we are working on to incorpoprate into the meshing process, though resolution is low. This will give us better topographical changes off the downtown area.

Using our hybrid flow solver, we have successf ully conducted three dimensional numerical simulations for gaseous flows in rectangular and circular microchannels which are representative of much more sophisticated netw ork of micro flow devices such as micro alveolar passages i n human respiratory tracts, and also m icro porous materials. After validating our solver with extensive experimental data, gaseous flows have been thoroughly studied in the continuum and also in the rarefied regim es for these simple microchannels. Friction coefficients are found to be reduced with rarefaction in the slip f low regime for both rectangular and circular microchannels. Reduction in friction coefficients was found to be more pronounced for rectangular microchannels with sm aller aspect ratios. It was found that un like friction coef ficients heat transfer can in principle increase or decrease w ith rarefaction depending on specular to diffuse reflection of gas molecules from the wall surface. However, for most of the practical engineering applications, it was observed that rarefaction reduces the heat transfer significantly.

Manuscripts Submitted or Published

Title: "Mesh Refinement Study of Flow and Particle Deposition in Human Lung Airway Models"
Authors: B. Soni, N. Arra, S. Aliabadi, W. H. Luke and D.K. Walters
Journal: AIAA CFD conference, Honolulu, Hawaii, 27-30 Jun 2011. AIAA Paper Number: 1023976.
Status: Published

Title: "Finite Element Method in Overland Flow Modeling for an Integrated Multi-Scale Forecasting Scheme"
Authors: Shahrouz Aliabadi, Muhammad Akbar
Journal: The International Journal of Hydrology
Status: Submitted and Accepted for Publication

Title: "Surface Conformed Linear Mesh And Data Subdivision Technique For Large-Scale Flow Simulation and Visualization in Variable Intensity Computational Environment (VICE)"
Authors: Erdal Yilmaz and Shahrouz Aliabadi
Journal: Computers and Fluids
Status: Accepted for Publication