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CS480 Senior Project Proposal

PROJECT INTRODUCTION:

Currently I am a 3rd year student with a double major in Computer Science and Physics, and this project that I propose here would allow me to apply the skills and knowledge I have developed in both fields. I would like to work on a simulation program for an experiment in high energy particle physics. This experiment is currently being coordinated by a scientific collaboration at Jefferson National Laboratory in Newport News, VA. One of the members of this collaboration is Dr. Will Tireman of NMU's Physics Department, who I would be working with on this simulation program. The experiment will not be performed until after I graduate from Northern, but currently the collaboration desires a program to simulate the experiment for many reasons including measurement of background radiation in the experiment hall, optimization of the detector setup, and to provide a means of comparison to other neutron interaction simulation programs.

SOFTWARE LIBRARIES TO BE USED:

The simulation program is to be written in C++ using the Geant4 simulation toolkit, which is developed by a collaboration at CERN with the purpose of simulating the passage of particles through matter. Most of the work of this project will be creating subclasses of Geant4's abstract classes and letting the Geant4 run manager handle a lot of the construction and running of the simulation internally. We may also write some C or C++ code for the ROOT analysis framework, developed by another collaboration at CERN, when we get to the phase of the simulation development where we focus on analyzing the simulation's output.

PROJECT DETAILS:

The features that will be implemented in this simulation program fall under the three following categories: experiment hall construction, tracking routines, and analysis routines. The simulated experiment hall must be set up according to the plans agreed upon by the collaboration. Some objects that are to be included are the polarimeter detector setup, two dipole magnets, a liquid deuterium target in an aluminum can, an electron detection arm, and the shield hut for the polarimeter detectors. Tracking routines refer to code that collects data from the Geant4 libraries at the runtime of the simulation. Particles will be tracked and the quantities we are interested in will be collected and stored. Analysis routines refer to code that analyzes the output of the simulation program after it has run. This may be written into our Geant4 code or we may decide to use the ROOT analysis toolkit.

While designing and writing the simulation program, it is very important that certain parts of it be easy to modify. As the collaboration becomes aware of more finalized information regarding funding and availability of equipment, the plans for the setup of the experiment hall may change. Therefore it must be easy to add, remove, or change objects in the simulated experiment hall without affecting other objects. The tracking and analysis routines should also be easy to modify if the collaboration would like to investigate different aspects of the experiment.

Multi-threading support was added to the latest version of Geant4, version 10.00. To significantly cut down on the amount of time needed to run the simulation, and to fully utilize the Physics Department's new machine's hyper-threaded hex-core processor, the simulation program should utilize Geant4's multi-threading capabilities.

PROJECT GOALS:

- Simulated experiment hall construction – 40 Points
  - Constructed to match the collaboration's plans – 10 points
  - Easy to add, remove, or change objects in the simulated experiment hall – 20 points
  - Working graphical visualization – 10 points
- Tracking routines – 20 points
  - Relevant quantities are collected at runtime and stored – 10 points
  - Easy to add, remove, or change tracking routines to collect different data or modify the parameters of data collection (particles tracked, energy cuts, etc.) - 10 points
- Analysis routines – 30 points
  - Data output from the simulation is put into a physicist-understandable format – 15 points
  - Easy to add, remove, or change analysis routines as the collaboration becomes interested in different quantities and to accommodate changes in the tracking routines – 15 points
- Geant4's multi-threading capabilities utilized – 10 points

TOTAL: 100 points

90% - A
80% - B
70% - C
60% - D
50% and under - F