Two-Dimensional Neutron Transport Equation Solver with Acceleration

Information

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Objective

Solution of the two-dimensional neutron transport equation using the discrete ordinates method in x-y geometry:

$$\left[\mu_n \frac{\partial}{\partial x} + \eta_n \frac{\partial}{\partial y} + \sigma(x,y)\right]\psi(\vec{r},\hat{\mathbf{\Omega}}) = q(\vec{r},\hat{\mathbf{\Omega}}).$$

where

$$q(\vec{r},\mu_n,\eta_n) = \sum_{l=0}^{L}\sum_{m=0}^{l}(2-\delta_{m0})Y_{lm}^{e}(\hat{\mathbf{\Omega}})\sigma_l(\vec{r})\phi_l^m(\vec{r}) + s(\vec{r},\hat{\mathbf{\Omega}})$$

Objective of the project is to write a two-dimensional neutron transport equation solver. Solver will use the discrete ordinates method to calculate neutron angular flux in the system and will be written to incorporate arbitrary boundary conditions in order to meet project problem specifications. Solver will assume constant material properties in the domain to simplify implementation. The problem domain will be represented by a 2D Cartesian mesh. Various solution methods will be implemented including the traditional transport sweep, diffusion synthetic-acceleration (DSA), and another method to be determined based on a literature review and ease of implementation. If time permits, criticality eigenvalue search to be implemented and extension to multigroup neutron transport equation.

Code Details

Coding language: C++ (backup is MATLAB)

Schedule

- Week 1 (3/28/2016 - 4/1/2016)
  - Initialization of Github repo for version control of code (Due date: 4/1/2016).
    - Github repo link: `https://github.com/marort91/2DNeutronTransportDiscreteOrdinatesCode`
  - Begin work on MATLAB one-dimensional discrete ordinates code for testing and pedagogical purposes.
  - Document writeup on 1D discrete ordinates method with finite differencing.
  - **Deliverable:** Project abstract (Due date: 4/1/2016).
- Week 2 (4/4/2016 - 4/8/2016)
  - 1D discrete ordinates writeup completed (Due date: 4/8/2016).
  - 1D MATLAB discrete ordinate code complete (Due date: 4/8/2016).
  - Begin work and research on two-dimensional discrete ordinates quadrature.

- Week 3 (4/11/2016 - 4/15/2016)
  - Begin writeup on 2D discrete ordinates solution method (detail algorithm for final report).
  - Angular and spatial discretization complete (Due date: 4/15/2016).
  - **Deliverable:** Interim report (Due date: 4/15/2016).
- Week 3 (4/18/2016 - 4/22/2016)
  - Implement transport sweep algorithm (Due date: 4/22/2016).
  - Test different boundary conditions (vacuum, reflective, white(?), periodic(?))
  - Begin work on DSA (Due date: 4/29/2016).
  - Begin work on third acceleration method (Due date: 4/29/2016).
- Week 4 (4/25/2016 - 4/29/2016)
  - Complete work on acceleration methods
  - Compare effects of preconditioning on solution of neutron transport equation. Begin work on MATH221 poster presentation.
- Week 5 (5/2/2016 - 5/6/2016)
  - Begin work on final report and presentation (Due date: 5/10/2016).
  - Time permitting: implement criticality eigenvalue calculation for multiplying system.
  - Time permitting: extension to multigroup neutron transport equation solver.
- Week 6 (5/9/2016 - 5/10/2016)
  - **Deliverable:** Final report (Due date: 5/10/2016).
  - **Deliverable:** Final presentation (Due date: 5/10/2016).