Multibody Systems

2/29/2008

Opening Discussion

- Do you have any questions about the quiz?
- What did we talk about last class?
- Do you have any questions about the assignment?

Gravity

- Last time we started working on a function to do a system of mutually attracting massive bodies.
- Let's finish that up and see if we can finish this N-body integrator.

Real Gravity Simulations

- Real simulations of gravitational systems would never be done this way. The lack of energy conservation is a serious problem for long term integrations.
- Small systems have to go a long time normally so a symplectic integrator would be used.
- Large systems would have problems with the $O(n^2)$ nature of what we have written. Tree codes can improve this to $O(n \log n)$. Multipole methods can run in $O(n)$ time. The coefficients and complexity go up with each of these.

Other N-body/Multibody Systems

- Other common N-body type systems include collisional systems, molecular dynamics, granular flows, etc.
- Collisions can be handled through either hard or soft sphere means. Hard sphere doesn't work with an integrator, but soft sphere does, assuming the integrator is advanced enough.
- Boundary conditions can also complicate things. These are reasons why a large system likely wouldn't be integrated with something like ode45.

Writing a Leapfrog Method

- The simplest type of symplectic integrator is a first order method called the leapfrog method. Let's go ahead and work on a T+V leapfrog method.
- This method looks almost like Euler's method. We just have to be careful to separate some things. To see what we need to do we should discuss a little Hamiltonian dynamics as well.
- This is worth discussing because MD simulations also typically need to be symplectic.

Reminders

- Assignment #5 is due Monday.