Project Report on

“N-particle simulator”

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PROBLEM STATEMENT

- Given initial coordinates, masses and initial velocities of N particles, the program displays the motion of the N particles under gravitational force of each other.
- The program also checks whether the particle motion ‘IS-PERIODIC’.
- When the particles come closer they don’t pass or merge together, but collide.

BASIC IDEA OF SOLUTION

1. We solve this problem using ‘**Barnes-Hut**’ algorithm.
2. Functions are defined for vector addition of gravitational forces between any two particles given their initial position vectors and masses.
3. Algorithm is implemented using a tree of particles.
4. A function for net force on one particle is defined with the help of the tree.
5. New positions and velocities are calculated at intervals of 0.01. Velocities are updated according to the forces while positions are updated according to the corresponding velocities.
6. In the periodic function check, the instantaneous velocities and positions of the particles are compared with their initial state. If they are “close-enough” then a text is displayed i.e. “Motion is periodic with time period ‘T’.”
7. Graphics are designed in 2hdtp.

SAMPLE INPUT

- **Format-**

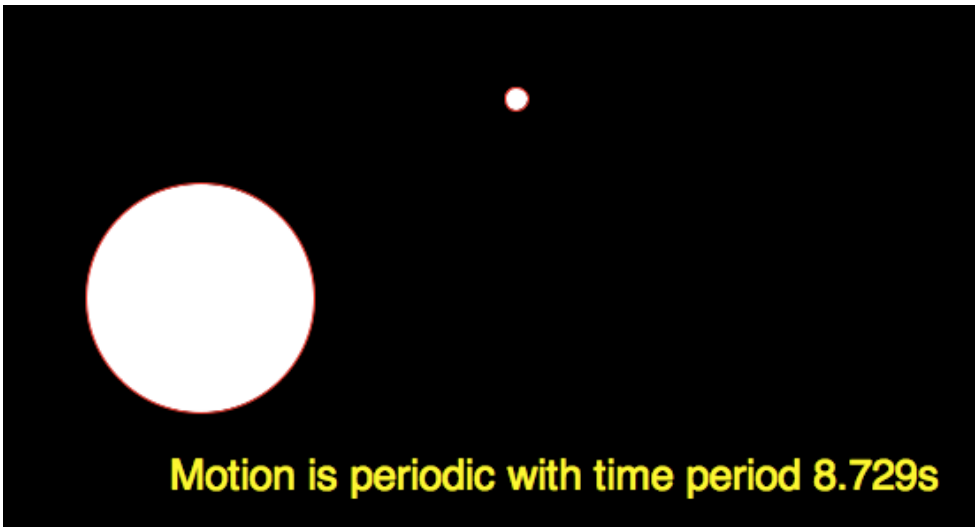
  A list of particles. ; Particle is a struct with mass, velocity and position.

- **Input-**

  (list (particle 10000 (vec 500 500) (vec 0 0)) (particle 10 (vec 700 500) (vec 0 75)))

  ; Particle moving around a massive object.

OUTPUT



CHALLENGES

- Implementing Barnes-Hut algorithm.
- Taking care of 3 particle simultaneous collision.
- Generating test cases to check whether the COLLISION and IS-PERIODIC functions are working.
- The corner cases for IS-PERIODIC function.

HIGHLIGHTS

- The code works efficiently for over 100 particles.
- If the motion is periodic it displays the time period of motion.

LIMITATIONS

- The code fails in the case of multiple collisions.