Home Assignment 1

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1 Description of the model

Every particle is a bird-like (or bird-oid, or boid) object that is capable of flying and experiences the following behavioural urges:

- Collision Avoidance - avoid running into nearby boids or designated obstacles.
- Flock Centering - try to move towards the center of the flock.
- Velocity Matching - try to move at the same velocity as neighbouring boids.

Each of these is expressed as an acceleration term; the weighted sum of all terms is the final acceleration of the boid at that timestep.

2 Implementation details

In my implementation, the boids are an extension of the particle system that was given to us as part of the example code. Therefore, each boid is a spherical particle, with mass, radius, position, velocity and acceleration. In addition, a boid is also characterized by two virtual boundaries - a *neighbouring radius*, which is how large it appears to other boids for the purpose of collision avoidance, and an *obstacle radius*, which is how large a designated obstacle appears to the boid.

In addition, a boid experiences the collision avoidance and flock centering urges.

2.1 Flock Centering

The flock centering term calculates the mean position of all the boids, then adds an acceleration term to each boid that is in the direction that takes the boid to this mean position.

2.2 Collision Avoidance

Collisions can be of two types - collision with neighbouring boids, or with designated obstacles. These two are treated differently to model the notion that it is more important to avoid an imminent collision with a mountain than it is to avoid ruffling the neighbouring boids' feathers.

Figure 1 illustrates how I test to see if a collision is imminent.

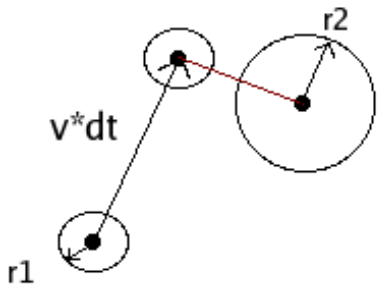

Figure 1: How to test for collision

The position vectors of the two particles are p_1 and p_2 and their respective radii are r_1 and r_2. The velocity of particle 1 is v and the timestep value is dt. A collision will occur if

$$mag(p_2 - (p1 + v * dt)) < (r_1 + r_2).$$

3 Discussion

The concept of using the distributed boids system to simulate large herds is elegant. The most time-consuming (and tiresome)aspect of this implementation, however, is the amount of tuning required by the various parameters. In my implementation, the tunable parameters were the two virtual boundaries, the weights given to each behavioral urge, and the trajectory of the center of the flock (an attempt to produce meaningful motion). And most of my time was spent tweaking them, and re-tweaking them for different flock sizes.

Another observation that I found interesting was the way in which the velocities built up (for lack of a damping term) and the oscillations that occurred when the flock centering urge interacted with collision avoidance urge (as a result of a sharp sphere of influence for each boid, instead of an exponential fall-off).