Model and Simulation of Starling Murmuration.

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April 2018

1 Introduction

2 Reynolds Boid Model

A boid is representation of a bird in Flocking Simulation. A boid keeps on moving by watching his visible neighbors and deciding what direction to take next. Each neighbor inuences this direction in different conicting manners, depending on its type and distance from the simulated boid.

1. Cohesion : Steer to move toward the average position of neighbors.
2. Seperation : Steer to avoid crowding neighbors.
3. Alignment : Steer towards the average heading of neighbors.

It should be noted that each boid has a limited radius of perception. They can only 'see' other boids that are within this radius. Thus, the algorithm dictates that a given boid actually moves towards the center of mass of its ' neighbors' not the true center of mass of the flock, and only matches its velocity to the average velocity of its 'neighbors' not the actual average velocity of the flock. (Here the neighbors of a given boid refers to all other boids within its radius of perception).

2.1 Cohesion

Cohesion is the rule that keeps the ock together, without it there would not be any ocking at all. A boid will attract other boids only if they are in its raduis of perception.

2.2 Separation

With only Cohesion in consideration, there will be lot of collisions of the boids. This rule attempts to steer the boid away from possible collisions. It's important to note that the distance from which the boids start to avoid each other must be less than the distance from which the boids attract each other (due to the cohesion rule). Otherwise no ocks would be formed.

2.3 Alignment

This rule tries to make the boids mimic each others course and speed. If this rule was not used the boids would bounce around a lot and not form the beautiful ocking patterns that can be seen in real ocks.

3 Obstacles

4 Neighbourhood

The neighbourhood of a boid is the neighbourhood it perceives. The neighbourhood decides what other boids a boid should take into account when deciding the next move.
It's important that the separation rule only acts on the closest boids. If separation and cohesion would work on the same neighbourhood they would cancel each other out.
Raynolds original implementation simply dened the neighbors as the boids within a certain radius. Another possible denition of the neighbourhood is to let each boid look at the N closest boids instead.

5 Algorithm

There are 3 main parameters that are needed by each of the rules to govern the movements of boids. They are

1. location The x and y coordinates of the current position of the boid.
2. course The angle of the current course of the boid.
3. The speed of which the boid is traveling.

The course and speed could of course be represented by a equivalent velocity vector instead. But often more attributes is needed to make the simulation more convincing. Putting an upper limit on how fast the boids can move and turn is a common improvement.
For each boid we perform all the 3 rules and then update their velocity and position vectors accordingly. The psuedocode is:

```
Vector v1,v2,v3
Boid_list neig_boids
FOR b IN Boid_list
neig_boids = b.neighbours()
v1=b.cohesion()
v2=b.seperation()
v3=b.allignment()
b.update()
```

END

6 Conclusion

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References

[1] D. Adams. *The Hitchhiker's Guide to the Galaxy.* San Val, 1995.