Design Document of a Starling Simulation

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1 Introduction

This document comprises design description and Techniques which we want to use in the Model of Simulation of starlings murmurings.Swarming/murmurings is a conspicuous behavioral trait observed in bird flocks, fish shoals, insect swarms, and mammal herds. It is thought to improve collective awareness and offer protection from predators. Many current models involve the hypothesis that information coordinating motion is exchanged among neighbors. It involves thousands of individuals form multiple flocks which are continually changing shape and density, while splitting and merging. The first and best known attempt to model flock behaviour was Reynoldss boids. Boids is short for bird-oid object In 1986 when the model was proposed the way in which collective dynamics could emerge from local rules was not well known and Reynoldss model was a huge step forward for computer animation and was taken up enthusiastically by the artificial life community.

Briefly, a boid is a little triangle in a computer simulation. Each boid has a position and a heading. Reynolds rules for each boid are to

1. Steer to avoid crowding neighbours.
2. Steer towards the average heading of neighbours.
3. Steer towards the average position of neighbours.

2 Properties of Boids

Significant property of life-like behavior is unpredictability over moderate time scales. At very short time scales the motion is quite predictable: one second from now a boid will be traveling in approximately the same direction. This property is unique to complex systems and contrasts with both chaotic behavior (which has neither short nor long term predictability) and ordered (static or periodic) behavior.

The boids model is an example of an individual-based model, a class of simulation used to capture the global behavior of a large number of interacting autonomous agents. Individual-based models are being used in biology, ecology, economics and other fields of study.

Boids are governed by three defining principles namely, alignment, cohesion and seperation.

3 Boid as an entity

The central idea behind the implementation is to define the behaviour an entity with respect to its neighbours, placing a specified number of these entities into the space and letting them interact. By this we wish to simulate the swarming. The Implementation of the model involves defining the entity "Boid" which is the primitive unit of this simulation. Having defined the boids as a class we intend to instantiate multiple instances of these. These instances interact with each other of recreate an swarming phenomenon.

- Each boid has a number of attributes like position,velocity,acceleration associated with it. These metrics help us in constraining the motion of boids according to some rules which are inspired by the Reynold's Boids.
- Each of the boid class also has physical attributes like kinetic energy momentum which are derived from the primary attributes of the object. These attributes help us in determining the accuracy with which we are able to simulate the swarming, in essence, the comparison of these parameters with the experimentally determined values gives us the measure of resemblance of our simulation to real phenomena.
- We have used colour of the to indicate the vicinity of a boid, i.e. the colour of each boid is average of the colour acquired by its neighbour.

4 Role of Multi-threading

Multi-threading has an important important role to play in this simulation. The calculation for all the parameters for a particular boid is done one by one in the main program. It keeps on updating the parameters for each boid in a loop, so the updating time increases linearly after the number of birds crosses a certain mark. This happens because of use of only one thread. This will result a slow update rate of physical attributes, whereas in real life we know that this is supposed to happen instantaneously. This is motivation behind using multiple threads to process large number of birds.

5 Interaction between Boids

Motion of each boid is affected by its neighbouring entities which lie within a specified range of radius. The radius is an important attribute of the boid. The boid class also maintains an a list of all the entities which are classified as its neighbour according to the above rule. This helps it track the physical attributes of all these boids and in turn make necessary computations about its own motion.

The three ideas that principally govern the motion of each boid are

- Separation : It involves maintaining a specified minimal from all the boids in neighbourhood.

- Alignment: It involves agreement of direction of movement of a boid with the averaged direction of movement of neighbouring boids.
- Cohesion: This ensures that the boid is in general vicinity of the boids in its neighbourhood.

5.1 Separation

Separation of a particular boid is measured as averaged vector of position of all its neighbours with respect to itself. **Pseudo Code:**

Sum=0 (vector).
for each boid=b_i do
for each neighbour boid=g_j do
Sum=Sum + gj bi;
done;
S= Sum/neighbourhood.
done;
where $b_i g_j$ is separation of these two vectors. The algorithm adds this value to position of next fram

5.2 Cohesion

Cohesion of a particular boid tends to determine the location of centre of position of neighbourhood. It also compels the boids to move towards them. Cohesion is measured as averaged vector of position of all its neighbours with respect to a common reference. **Pseudo Code:**

Sum=0 (vector).
for each boid=b_i do
for each neighbour boid=g_j do
Sum=Sum + rj;
done;
C= Sum/neighbourhood
done;
The algorithm adds this value to position of next frame, compelling it to move towards the centre o

5.3 Alignment

Head of a boid is an important indicator of direction sense. So much so that it is the averaged direction of heads of neighbouring boids compels the the boid in question to align with it. **Pseudo Code:**

Sum=0 (vector).
for each boid=b_i do
for each neighbour boid=g_j do
Sum=Sum + kj;

done;
R= Sum/neighbourhood.
done;

6 Specification

The Simulated Model requires the user to click on the screen in order to generate initiate a bird at a random point on the screen. The view angle can also be changed by rotating the coordinate system thus helping us to analyze the movement in three dimension. The physical parameters like total kinetic energy, net force and Net momentum are also displayed at the bottom of screen. These parameter values are updated instantaneously.

7 References

1. http://www.red3d.com/cwr/boids/