Alex Johnson
CS4300 - Graphics Project
Final Report

Swarm Navigation

Goal:

To develop an interactive visualization of swarm behaviour. This visualization will provide an engaging environment to demonstrate flocking behaviour. This project was inspired by Craig Reynold's work in creating algorithms to emulate the navigational behaviour of organic creatures such as birds and fish. I find the concept of organic emulation fascinating. While movement appears random, every action is determined by the surroundings. The following quote is from Craig Reynold's online writings:

> *"A significant property of life-like behavior is unpredictability over moderate time scales...It would be all but impossible to predict which direction they will be moving (say) five minutes later…. This property is unique to complex systems and contrasts with both chaotic behavior… and ordered … behavior. This fits with Langton's 1990 observation that life-like phenomena exist poised at the edge of chaos." (source)*

This project was inspired by the chaotic, yet beautiful nature of organic creatures. I wanted to create an interactive experience that used this theme as a gameplay mechanic. Contrary to most interactive experiences, the goal is not achieved by an individual, but rather collecting, and developing synergy with your swarm. I wanted to emphasize the importance of swarming behaviour by ensuring that not even the player fish is more powerful than the NPC fish. The player will notice that the player

controlled fish is limited in the speed and turn radius at which it can navigate - this was to ensure that the player fish's only advantage over its neighbors is the factor of player control.

Features:

Implement Craig Reynold's Swarm algorithms. I extended these algorithms to support the functionality necessary for the game. The swarm logic now supports multiple swarms within the same environment. These swarms navigate their environment, respecting the positions of other fish. Fish will try their best to avoid collisions within a certain proximity.

Interaction. The player can control a single blue fish. This fish is shown with a white outline. Using the arrow keys, the user can control the fish's direction and speed. Through these mechanics, the user attempts to use their position to influence and control the velocity of nearby fish. Implementing these mechanics required a number of tweaks to the initial swarming and cohesion algorithms.

Goals. Fish now have the ability to starve. In order to survive, swarms must collect food and reproduce.

Competition. Swarms compete against each other limited re-spawning resources.

Gamification. Controlling the player fish, the user now attempts to collect food, reproduce, and beat other swarms to limited resources.

Victory Conditions. As the player controlled swarm beats the other swarms to food, you can gain an advantage with population. However, due to limited resources, it's often difficult to maintain a larger population. As a result, the player must "box out" and limit other swarms access to resources. Using the influence of a larger swarm, the player can divert the paths of other fish. Doing this successfully, the player can starve and bring other colors to extinction.

Design. As seen in the process screenshots, this project went through a number of stages of UI design. After a number of user tests, I decided to set a constant color scheme. In addition, I developed a basic visual language using borders, colors, and opacity to represent swarms and their health status. Fish that are within the 'proximity of control' of the player are represented with solid colors.

Running:

This project can be found online at: http://alexjohnson.io/swarm-navigation/
Alternatively, load swarm-navigation/src/index.html from a local HTTP server.

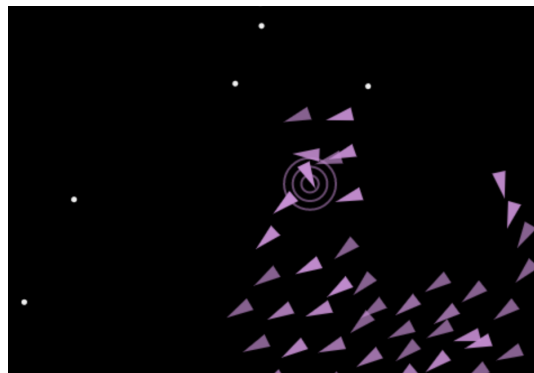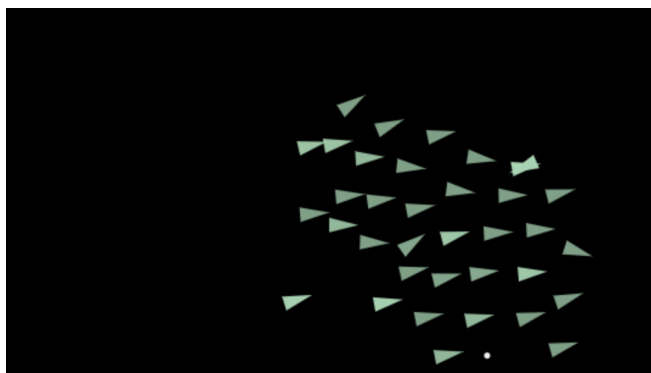# Accomplished:

Progress can been seen in the github repository:
alexjohnson505/swarm-navigation

I've uploaded a the current version of the project to my website:
http://alexjohnson.io/swarm-navigation/

Development Process:

The following screenshots show different stages of experimentation from the development process:

How to Play:

Swarms navigate their environment. When a fish collects a food, they reproduce, and their health is refreshed. If a fish goes too long without food, they will fade away and die.

You control a single fish. The Player Fish is a single, blue fish with a white outline. The other blue fish are your swarm. They will attempt to flock with you if you are close by

Hold down the LEFT & RIGHT arrow keys to control the Player Fish's direction. Hold UP & DOWN to make slight adjustments to acceleration.

I wanted the experience to instill a sense of 'companionship' with the other creatures in your swarm. I purposefully reduced the turn speed, and turn radius of the player fish. This forces the player into a movement scheme similar to his neighbors. As a result of slower turning radius, the player must collect, and rely on the fish in their swarm to make a difference in the environment.