

Masters Project Proposal
Emotion in Flocking

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Abstract

Behavioral animation is a category of computer animation that enables objects to determine their own actions [2]. This saves an animator from having to determine every detail of movement for each object in the animation. As the number of objects within an animation increases, specifying the position of each object becomes increasingly difficult. Flocking is an example of behavioral animation. Some examples of flocking can be seen in movies, such as the stampede of the antelopes in *The Lion King*, the herds of dinosaurs in *Jurassic Park*, and the massive battle scenes in *The Lord of the Rings*. In this project, I will enhance flocking to convey emotion. This will be achieved using only the movement of objects in relation to one another. There will also be a system for users to rate how well an emotion is conveyed by the flock, which will contribute to the ever changing initial state of each emotion.

1 Introduction

Behavioral animation allows an animator to program how an object or a group of objects will move without specifying each individual movement of an animation. An animator programs how an object will behave in a given situation, while the object determines when to behave in this manner. For example, if an object is moving forward and encounters an obstacle in its path, the object will turn away from the obstacle. The animator was responsible for programming the behavior when an obstacle is encountered, but the object executes the behavior only when this situation occurs. Flocking is a common use of behavioral animation.

Flocking is the coordination of animated objects so that they move together in a way that imitates the movement of a group of animals [4], such as a swarm of bees or a flock of birds. In the Computer Graphics world, objects within such groups are called *boids*. A flock consists of a group of *boids*. Each *boid* determines its own actions based on predefined steering behaviors. There are three basic steering behaviors[3]:

1. Separation - Avoid collisions with local *boids*.
2. Alignment - Move in the same direction as local *boids*.

3. Cohesion - Move towards the center of the local *boids*.

Each of these behaviors contributes to the movement of each *boi*d. To create a realistic looking flock, the right balance of contribution and interleaving between these behaviors must be found.

My project proposes to add emotion to flocking. In particular, I will develop a system that animates a swarm of bees to convey a selected emotion, such as angry or happy. The implementation will also allow users to modify the definition of each of the emotions.

2 Adding Emotion

It is difficult to create believable emotion in animation since emotion is an internal feeling. But behavior can be animated.

2.1 Behavior

According to *Webster.com*, behavior is defined to be “the response of an individual, group, or species to its environment.” It is behavior that conveys emotion to a viewer.

Three steps are necessary for a behavior to take place [1]:

1. Perception - First, the agent must perceive its environment. This means being aware of the other objects or actors that are present. External events that are happening must also be captured.
2. Emotional reaction - The agent’s emotion changes in response to its perception of the environment.
3. Physical reaction - Based on the emotion, the agent moves in a particular manner which conveys that emotion.

Such a repeating process encapsulates human reactions to events that transpire. For my project, the first two steps are irrelevant because the viewer will choose the emotion the flock is to portray. Thus, I will be focusing on the third step.

Animating a non-human object so that it behaves like a human is much easier than animating a group of objects to convey a human behavior. This is because a single object can be treated like a human body. With a flock, multiple objects must be animated in such a way that they work together to convey the appropriate message to a viewer.

2.2 Movement

Since behavior is a combination of movements, it is necessary to understand how movements can be combined to convey different emotions. Movement is a form of communication. For example, if you see two people having a conversation, even if you don't know what is being said, you can fairly accurately guess their emotions. It is usually clear if they are happy or having a fight. This expression of emotion is being conveyed through body language, which is the foundation of how we interpret movement.

The best place to see movement portraying emotion can be found on the stage. Take for example dance. Spoken words are not necessary for a dancer to convey a message to an audience. Using only the movement of their body, dancers can tell entire stories without a sound.

According to Vaughan[5], movement can be broken down into four characteristics. These characteristics are: Path, Area, Direction, and Speed.

1. Path - The path that the movement of an object follows can set a basis for emotion. For example, "while a straight line can convey formality and strength, a curved line can convey naturalness and warmth" [5]. Movement in a straight line conveys more purpose than a curved line. When we need to get something done, it is best to not wander around aimlessly.
2. Area - The amount of space the movement fills can draw attention to it. For example, if someone is trying to flag down a taxi, they will wave their entire arm, maybe even jump. This will catch a driver's attention better than a head nod or a wave of just a hand.
3. Direction - The direction of movement is also important. For example, a person running away from something suggests fright, while a person

spacing back and forth suggests worry. The direction of movement can tell a lot about what is happening, especially in conjunction with other objects in the environment helping to focus the viewer's attention.

4. Speed - The pace of movement can be used to suggest a sense of urgency. The same movement at different speeds suggests different emotions. For example, if someone places a book upon a table, they appear to be calm and relaxed. Whereas, if they slam a book onto a table, they appear to be angry or frustrated. The speed of movement can drastically change the meaning behind it.

It is the combination of these movement characteristics that creates behaviors and conveys emotion to a viewer. A small change in movement can completely change the viewer's perception.

It has been found that the more organic and complex the patterns of movement, the stronger the emotional response the movement will elicit from the viewer [5]. This is because people tend to interpret everything from their own context. People move in complex ways. Our body language combines facial expressions along with body positions and the actual movement of our limbs. In addition, as our movements are never exactly the same twice, it is difficult to program realistic movement.

3 The Project

3.1 Project Goals

The main focus of this project is to create a behavior engine. This engine will control the movement of the flock in such a way as to convey emotions.

The results of my project will be presented in two ways: First, I plan to create a website where the flocking animations can be viewed. The viewer will be able to change the emotion of the flock and respond with feedback. The viewer will choose a specific emotion and vote whether the flock accurately conveys this emotion. The website will serve as a way to display my results, as well as give me a way to quantify the otherwise subjective results.

Second, the behavior engine will be extendable beyond the website. It will be integrated, by another person, into the virtual theatre that is being created

in a class in spring 2004. More information on the *Virtual Theatre Project* can be found at <http://cs.rit.edu/~jmg/vtheatre>.

3.2 Functional Specification

All user interaction will be through a web application. This application will allow the user to view the flock, as well as interact with it.

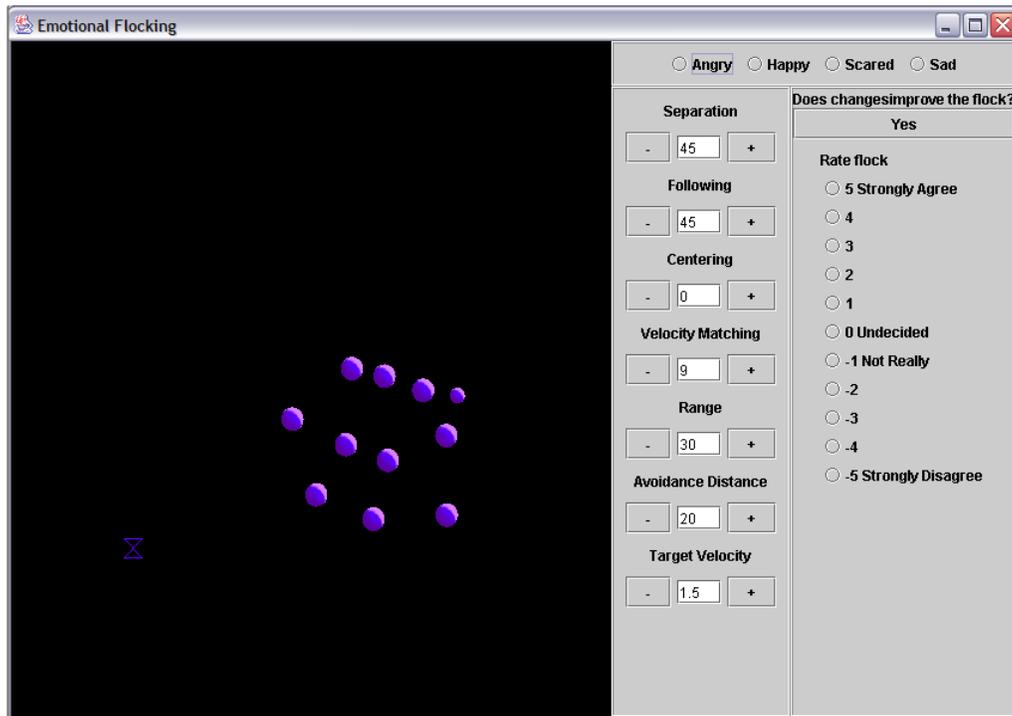


Figure 1: Potential example of final application

Figure 1 shows a preliminary layout of the web interface. It contains three sections: Variable controls, Emotion presets, and Ratings.

3.2.1 Steering Behavior Interaction

The user will be able to control the flock based on the steering behaviors. The user will be able to change how much each steering behavior contributes

to the flock's movement. The steering behavior and variable parameters will include, but are not limited to [3]:

1. Separation - The tendency to move away from other *boids*. This corresponds to the steering behavior *Separation*.
2. Following -The tendency to follow lead *boi*d.
3. Centering - The tendency to move toward other *boids*. This corresponds to the steering behavior *Cohesion*.
4. Velocity Matching - The tendency to move in same direction as other *boids*. This corresponds to the steering behavior *Alignment*.
5. Range - Maximum distance between *boids* to neighbors
6. Avoid Distance - Distance between two *boids* for them to move away from each other
7. Target Velocity - Ideal maximum speed at which *boids* can travel
8. Noise - Vary the path so all *boids* are not heading in exactly the same direction. This makes *boids* move around each other when the lead *boi*d is not moving.

3.2.2 Emotions

The user will be able to select from a set of predefined emotions: angry, happy, sad, frightened, tired, neurotic, drunk, and confused. The weights for the various parameters will automatically change to those predefined for the selected emotion. The flock's motion will reflect the selected emotion.

3.2.3 Rating

The user will be then able to rate how well the selected emotion is conveyed. The rating system will range from -5 to 5, where -5 is *Strongly Disagree* and 5 is *Strongly Agree*.

If the user changes any of the weights, the user will be able to indicate that he/she *Agrees* that the current weights convey the emotion better than the

default weights. They will also be able to rate how well the behavior of the flock conveys the emotion with the changed weights.

The combination of these two user inputs(weights and voting) will be used to modify the default weights for a given emotion. As more users submit feedback, the weights will take this feedback into account and make the changes necessary to reflect more realistic behavior. Thus, over time, the motion will better reflect what users believe looks best.

The user will also be able to specify new emotions they feel is best represented by the movement.

3.3 Design Specification

This application will be programmed in Java using OpenGL. A weighting system will be used to create behavior through movement.

3.3.1 Behavioral Engine

The *Behavioral Engine* is the core of the system. It will be broken into two main components: the *Action Handler* and *Emotion Controller*.

The *Action Handler* is responsible for controlling the movement of each *boi*d in the flock. The *Action Handler* will be given the position of the lead *boi*d and the positions of all neighboring *boi*ds. With these positions, the next position of the current *boi*d will be calculated based on the steering behaviors separation, following, centering, and velocity matching. The weight that each behavior currently holds will determine how much each steering behavior will contribute to the *boi*d's next position. The total weight of all steering behaviors will equal 100%.

The *Emotion Controller* is responsible for applying the weights and using other variables such as the maximum speed a *boi*d may travel or the avoidance distance between two *boi*ds. Predefined emotions will have preset values that can be subsequently altered by user input. The values of these presets are derived using a PHP server interface, which is described in the next section. The PHP server interface will also process rates and values that users submit.

3.3.2 PHP Server Interface

The preset values for each emotion will be calculated using a weighted average. All ratings submitted by a user will be between -5 to 5.

All submitted ratings will be saved in a separate file for each emotion. Each file will include one line per user response that contains the rate given plus all of the steering parameters. The user input will come in two different ways:

1. The rating a user gives to the preset values for an emotion, which includes the original values supplied the first time the system is run.
2. The rating and changed values that any user submits as an improvement on the preset values.

Each value will be separated by a ":". The order of values on each line of a file will be the following:

1. rate
2. separation
3. following
4. centering
5. velocity matching
6. range
7. avoidanceDist
8. target Velocity
9. noise

To calculate the preset values of each emotion, the following algorithm will be performed on each file at the start of the program:

1. All ratings are normalized by dividing the current rate value by the total of all rating values.

2. For each steering parameter:
 - (a) For each line of user input, multiply steering parameter by normalized rating.
 - (b) Add up all the scaled steering parameter values over all the lines. This total will equal the preset value for the steering parameter.

4 Website

Implementation of the website will be done using a combination of HTML and PHP. PHP was chosen to enable the data collected from user feedback to be easily calculated into a weighted average for subsequent viewings.

5 Deliverables

The deliverables will include:

1. Project source code
2. User manual for website
3. Final report consisting of the following sections:
 - (a) Introduction
 - (b) Background
 - (c) Software Architecture
 - (d) User Documentation
 - (e) Results
 - (f) Future Work
 - (g) Conclusion

6 Tentative Schedule

May 21	Implement behavioral engine
June 4	Final Report
June 22	Project Defense

References

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