Bird Flocking

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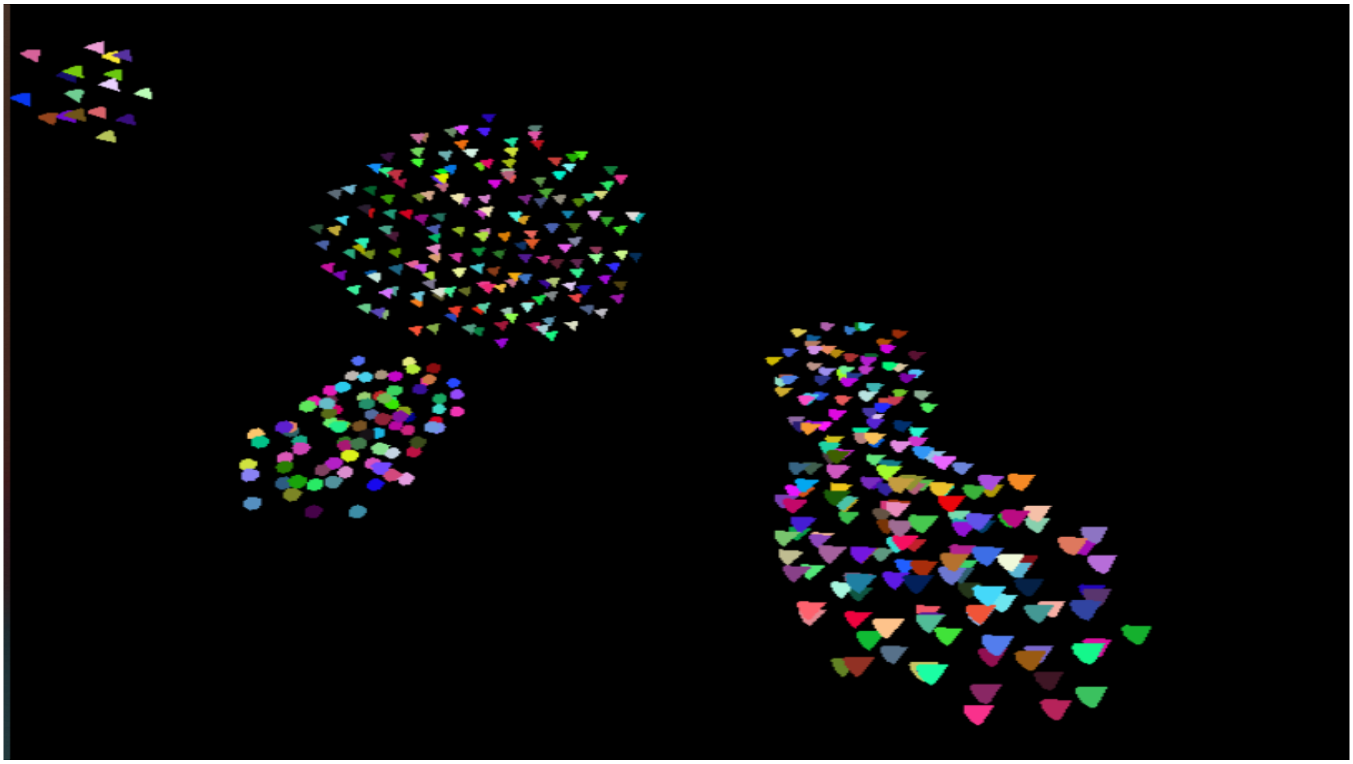

Figure 1: An interactive autonomous agents flocking simulation.

ABSTRACT

In nature birds, fishes and various land animals come together as a herd to form large groups which benefit their survival and evolution. Perceiving this fascinating yet complex behavior, Craig Reynolds in 1987, simulated the first model of this behaviour on computer. The aim of this simulation was to replicate the behavior of flocks of birds. Based on the flocking algorithm, this project visually demonstrates the logistics of collective intelligence, where it permits entities (birds) simple decision making to interact with their environment.

KEYWORDS

bird, flock, cohesion, separation, alignment, rule

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1 INTRODUCTION

The "bird flocking" or a "boids" model is an example of an 'individual-based' model. It is a class of simulation used to capture the global behavior of a large number of interacting autonomous entities. These individual-based models are being used in biology, ecology, economics, and other fields of study for various applications. This project reproduces the behavior of flocks of bird where instead of controlling the interactions of an entire flock, the boids simulation only specifies the behavior of each individual bird. With only a few simple rules, the program manages to generate a result that is complex and realistic enough to be used as a framework for computer graphics applications such as computer generated behavioral animation in motion picture films.

2 RELATED WORK

Flocks, Herds, and Schools:A Distributed Behavioral Model[2].

3 METHOD

The program consists of the following rules:

- Alignment : This rule drives each bird to align its path based on the movement of its neighbors.
- Cohesion : This rule steers each bird to move towards the center of their neighbors defined space.
- Separation : This rule allows to keep enough distance around each bird to avoid collisions in case of crowding.
- Avoid Blocks[1] : This rule allows the birds to fly through simulated environments while dodging static blocks.
- Limit Velocity : This rule limits the magnitude of the birds' velocities, this way they don't go too fast. Without such limitations, their speed will actually fluctuate and they may move very fast.
- Avoid Walls: This rule allows the flocks to stay within a certain area (e.g. to keep them on-screen).

3.1 Implementation

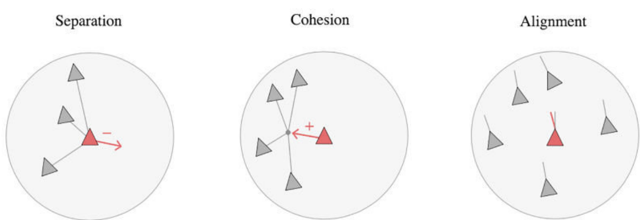

Figure 2: Three fundamental rules.

To implement this project the major part was to calculate average position and average velocity of birds within certain radius using Three.js Summarising the three important rules in pseudocode[3]:

```
PROCEDURE rule1 align ( boid b)
    Vector p
    FOR EACH BOID currentB
        IF currentB distance to b < radius THEN
            p = p + currentB.velocity
            count++
        END IF
    END

    IF count > 0 THEN
        p = p / count
    END IF

    RETURN (p - b.velocity) / 8
END PROCEDURE

PROCEDURE rule2 cohesion ( boid b)
    Vector p
    FOR EACH BOID currentB
        IF currentB distance to b < radius THEN
            p = p + currentB.position
            count++
        END IF
    END

    IF count > 0 THEN
        p = p / count
    END IF

    RETURN (p - b.position) / 100
END PROCEDURE

PROCEDURE rule3 separation ( boid b)
    Vector p, diff
    FOR EACH BOID currentB
        IF currentB distance to b < radius THEN
            diff = b.position - currentB.position
            p = p -diff
        END IF
    END

    RETURN p
END PROCEDURE
```

3.2 Milestones

3.2.1 Milestone 1. Initially it was hard to decide whether to implement the algorithm in 3D or 2D. I finally decided to work with Vector3() for better visualization.

3.2.2 Milestone 2. To implement all the physics calculation correctly and efficiently, better understanding of all the methods in Vector3() was required.

3.2.3 Milestone 3. The toughest rule to apply is separation. To understand the physics calculation and logic, followed by implementation of the code correctly was required for the algorithm to work smoothly.

3.3 Challenges

- Challenge 1: Some tricky physics calculations that had to be implemented in 3D space with limited methods in Vector3()
- Challenge 2: To incorporate all the rules together such that each bird registers and applies these rules while interacting with its immediate neighbors, within the limited ranges.

4 RESULTS

The project successfully demonstrates an interactive simulation of autonomous flocking agents in the browser using threejs. The final project demo is here.

5 CONCLUSIONS

Flocking generates complex and powerful results. It is a common technology used in screensavers, and animation. This phenomena has also been incorporated in many films to generate realistic animated crowds. Tim Burton's Batman Returns (1992) featured flocking bats, and Disney's The Lion King (1994) included a wildebeest stampede.

Flocking is applied in the field of "swarm intelligence" where lack of centralized control agent is one of the key aspects. This

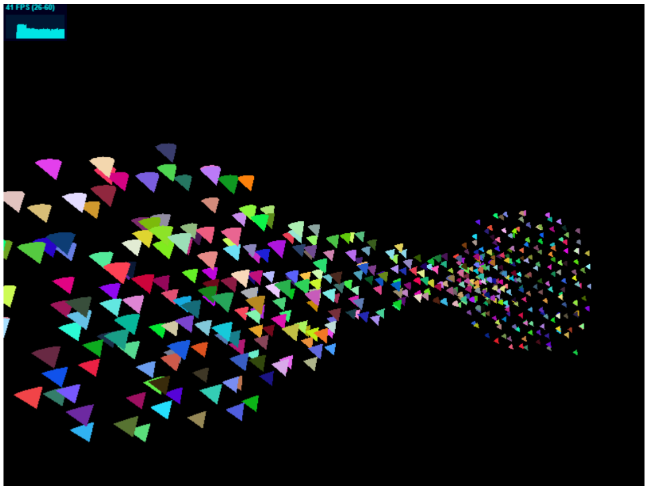

Figure 3: With Performance Panel.

allows each individual unit in the swarm to follow its own defined rules, resulting in a coordinated behavior for a group as a whole.[4]

REFERENCES

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