Modelling Unmanned Aerial Swarms Using Unreal Game Engine and AirSim Simulator

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Introduction

This system uses Unreal Engine AirSim Simulator to simulate UAVs in a realistic three-dimensional environment. The UAV swarm will be autonomous with a unified behavior. The mission is to be able to collect data from its environment.

Benefits:

- Safe use in dangerous environments
- Easy to use autonomously
- Perfect for time constrained missions
- Minimizes human error
- Allows user to focus on other aspects

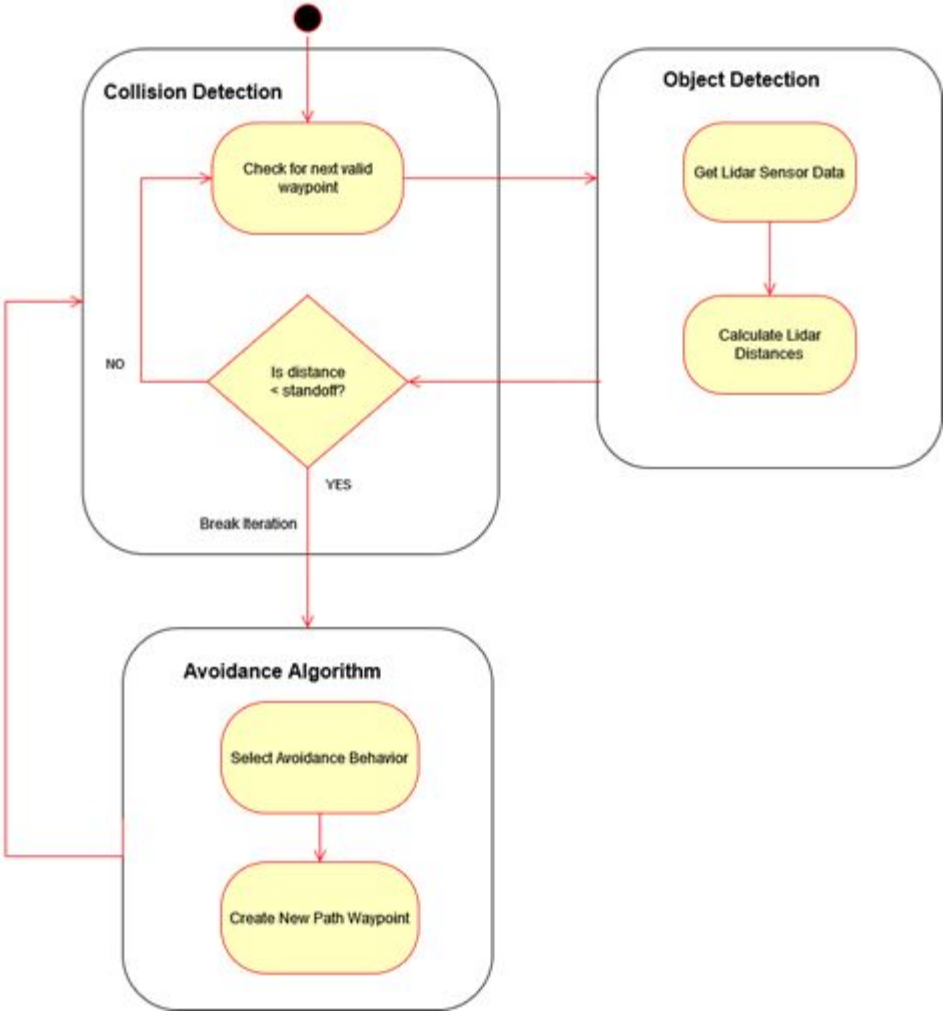
Previous Work

- Lidar implemented on individual UAV
- Objects within range detected
- Collision Detection
  - Executes continuously
  - Initiates Avoidance Module
- Swarm Pathing
  - Executes continuously
  - Mark waypoint as visited

Design Considerations

- Assumptions
  - Camera Sensor is oriented in the direction of movement
  - Lidar Sensor is oriented in the direction of movement
  - There is no interference with the sensors
  - UAV will only move in forward direction
  - There are no adversarial actors
  - Only small UAV
  - No landing or water FAA Right of Way scenarios
- Dependencies
  - Microsoft AirSim Simulator
  - Unreal Engine 4
  - Visual Studio 2019
  - Utilizes Python Environment
- Design Constraints
  - Limited to Unreal Engine 4/ AirSim environments

Collision Avoidance System

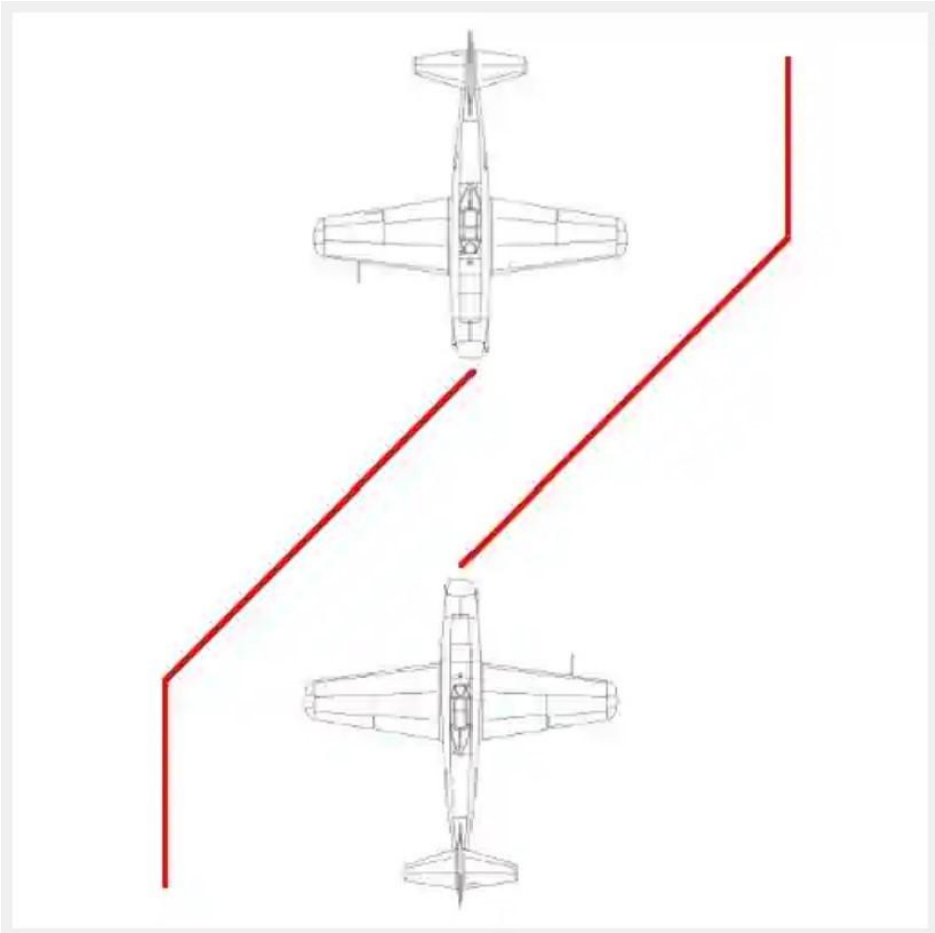


FAA Right of Way Rules

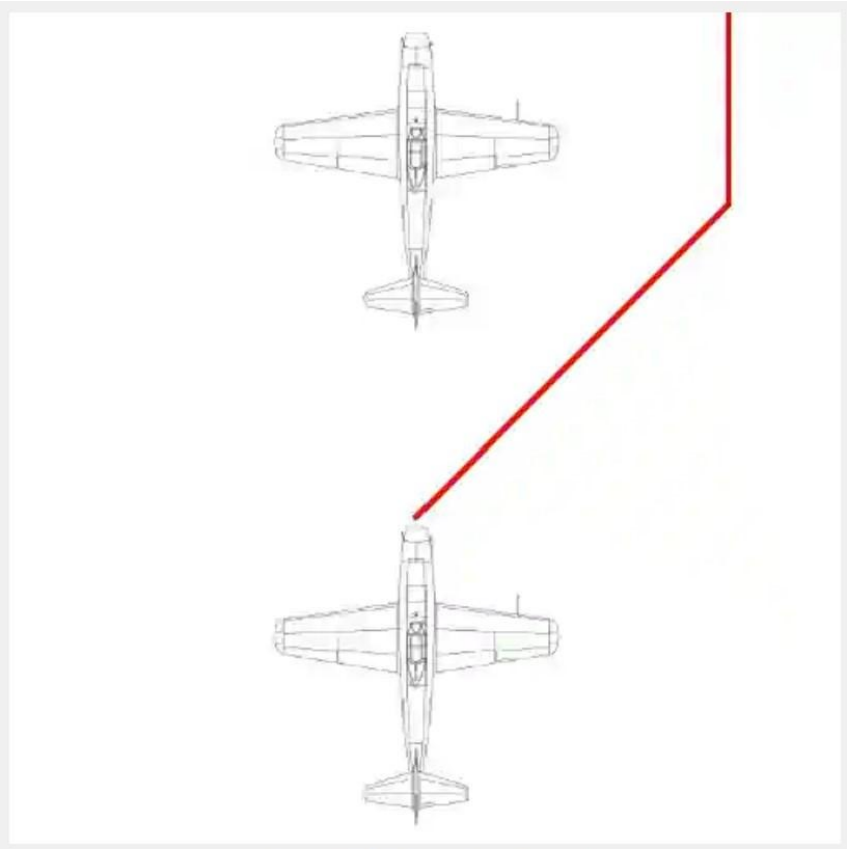
Collision Avoidance Behavior

1. Head-On Approach
2. Overtaking Approach
3. Converging Approach

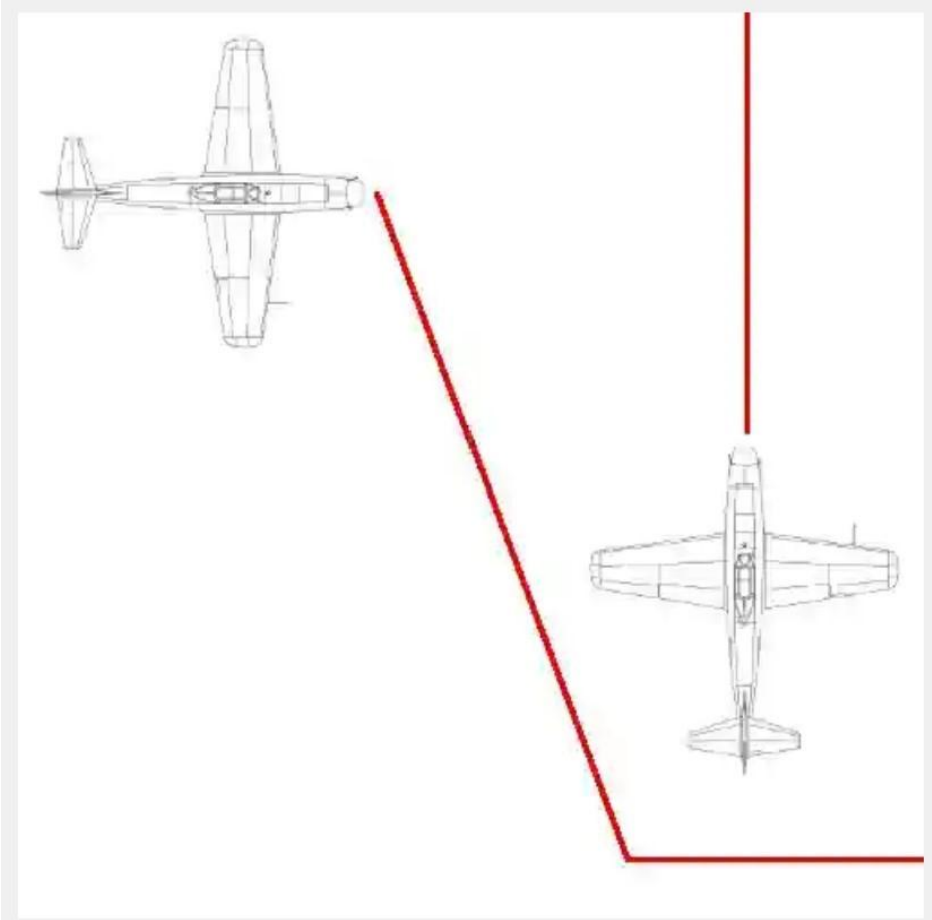
Head-On Approach



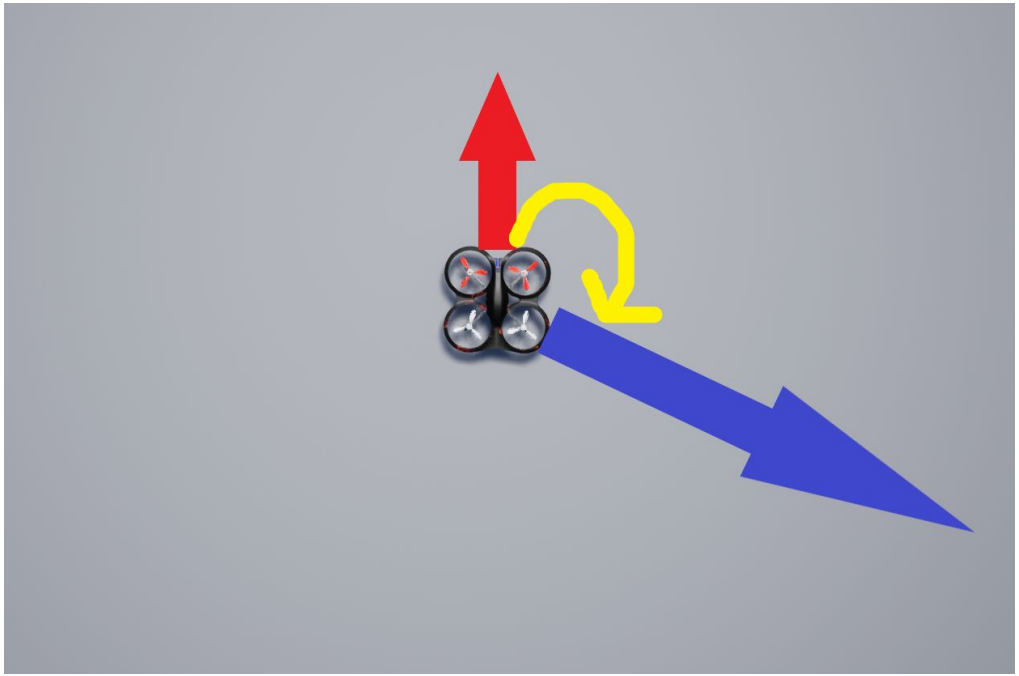
Overtaking Approach



Converging Approach

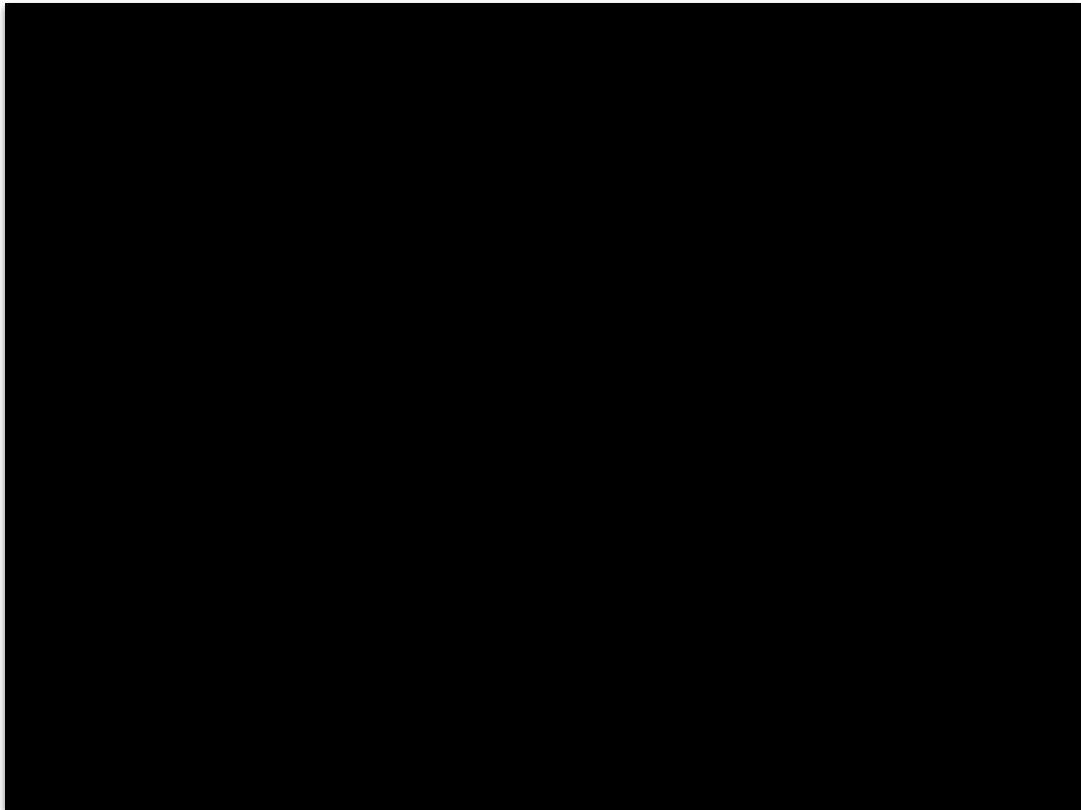


UAV Movement & Heading

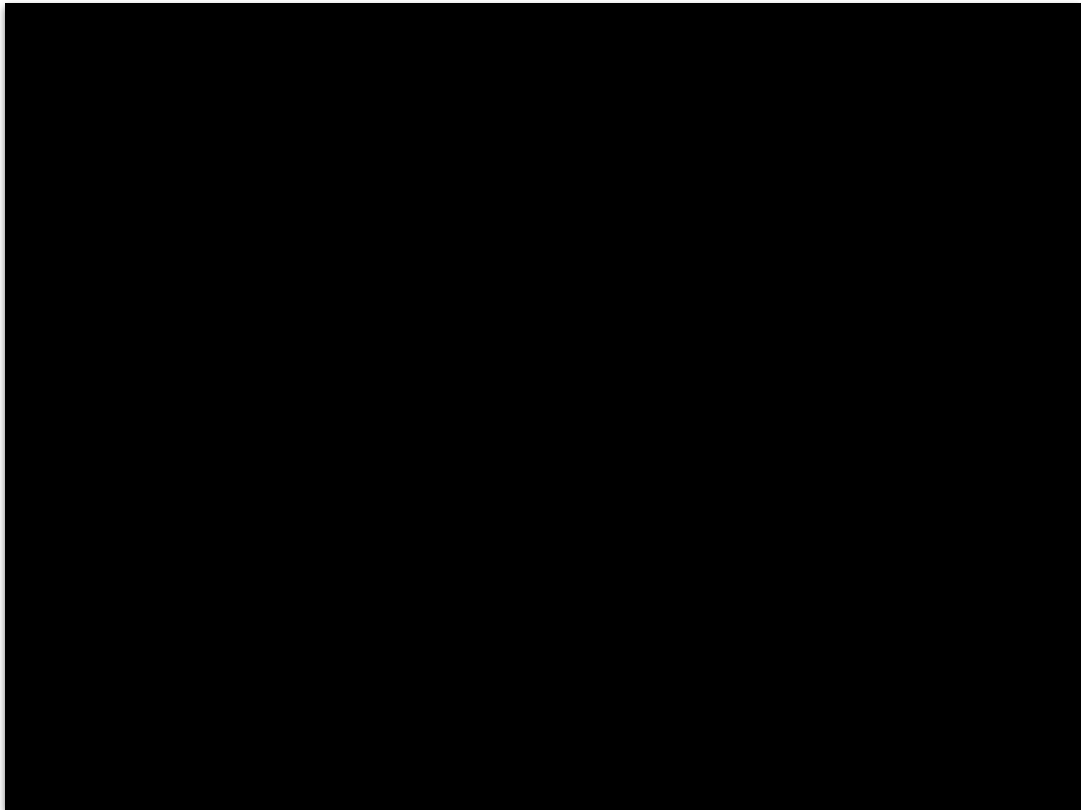


Demonstrations

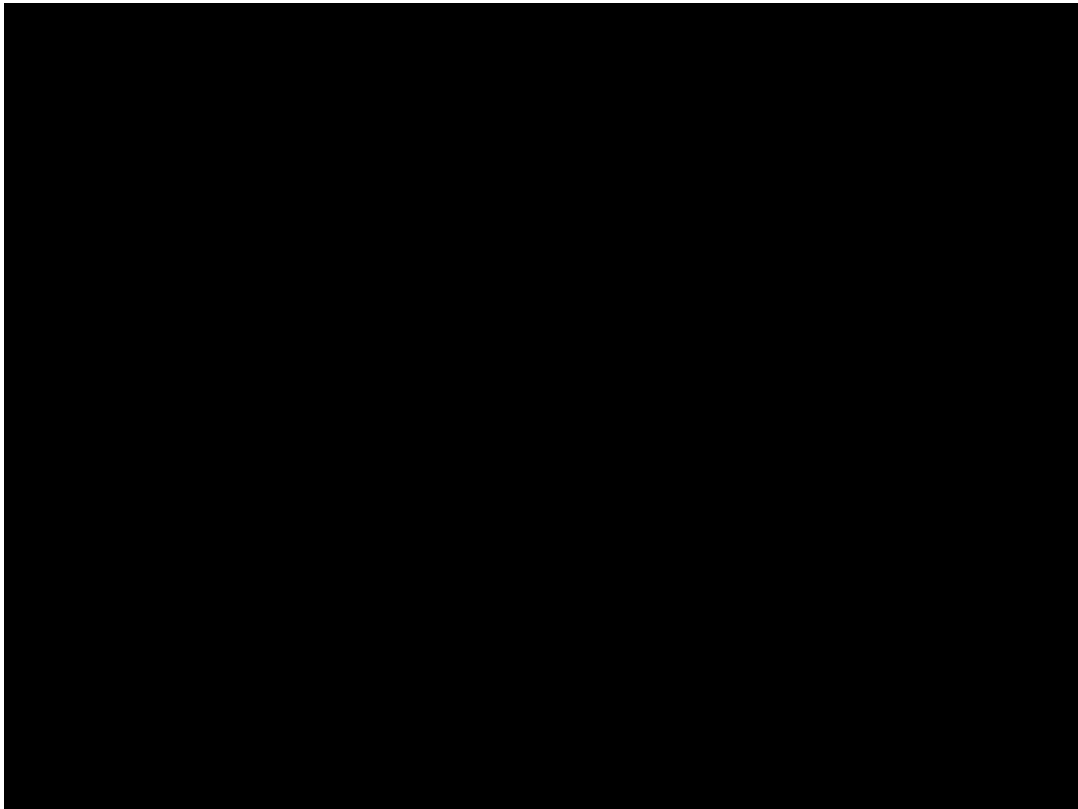
Turn Towards Waypoint



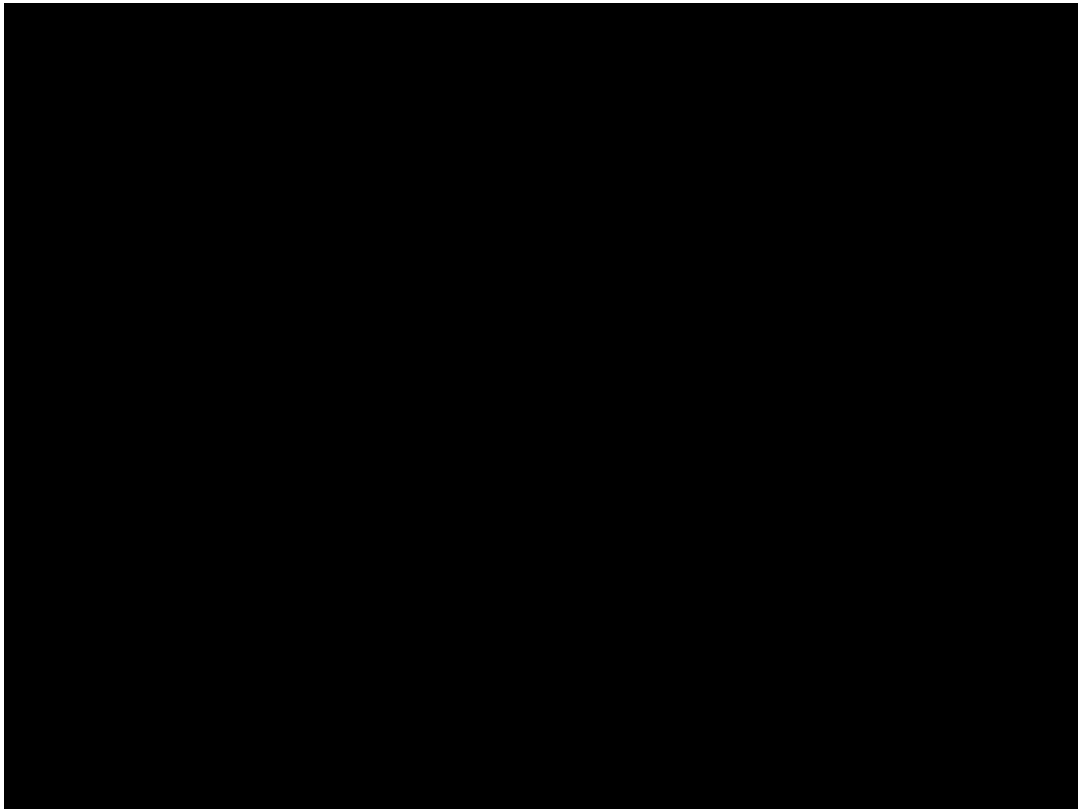
Right Turn Avoid



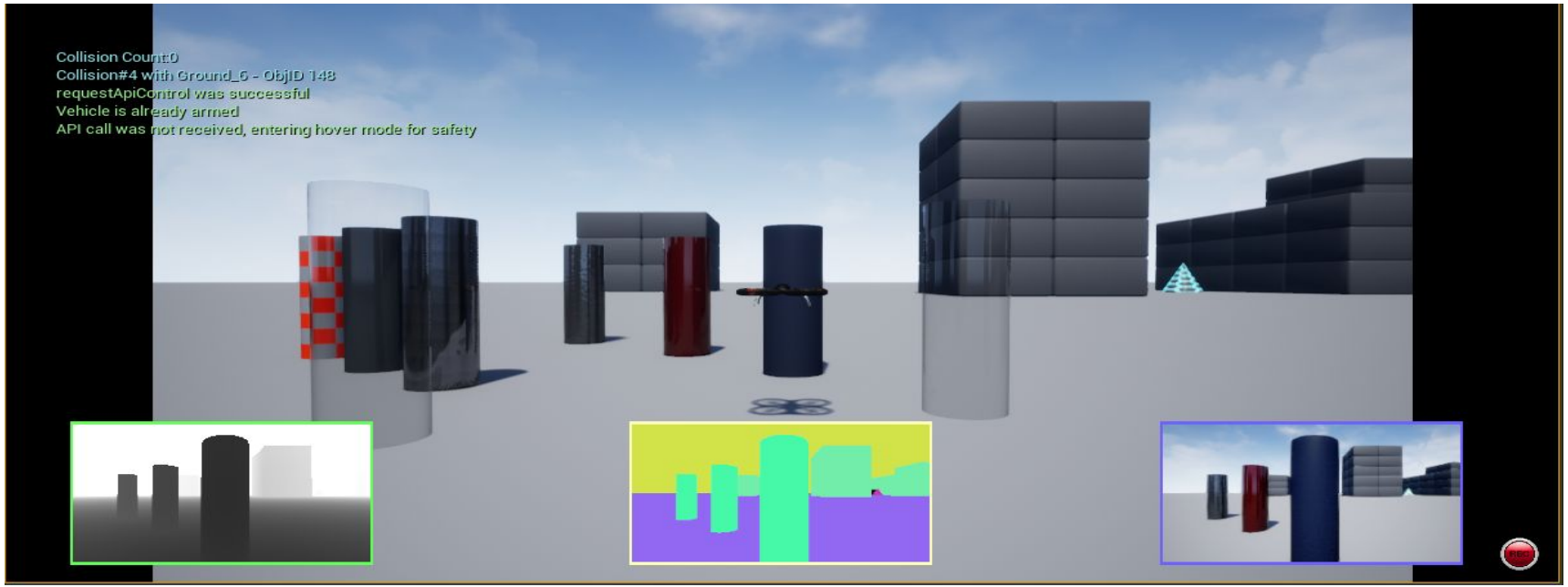
Overtaking



Converging



Camera Sensor



Lessons Learned

- Multiple drones actors may need multiple “clients” to handle their behavior
- The increase of sensors greatly affects performance
- Limited options with additional sensor

Sprint Timeline

Sprint 1 Promised

- Implement Lidar Sensor
- Object Detection
- Collision Detection
  - Executes continuously
  - Initiates Avoidance Module
- Swarm Pathing
  - Executes continuously
  - Moves swarm to next unvisited waypoint
  - Mark waypoints as visited

Sprint 1 Completed

- Lidar implemented on individual UAV
- Objects within range detected
- Collision Detection
  - Executes continuously
  - Initiates Avoidance Module
- Swarm Pathing
  - Executes continuously
  - Mark waypoint as visited

Sprint 2 Promised

- Fix AirSim msg_pack bug
- Fix UAV avoidance movement response
- Implement iteration & comparison of distance array
- Implement right turn avoid maneuver
- Implement right-of-way rules

Sprint 2 Completed

- Fixed AirSim msg_pack bug
- Fixed UAV avoidance movement response
- Included vector calculation
- Implemented iteration & comparison of distance array
- Implemented right turn avoid maneuver
- Implemented right-of-way rules

Sprint 3 Goals

- Increase size of swarm
  - Implement collision avoidance on each UAV
- Run multitude of simulation scenarios
- Use scenario data for statistical analysis

Thank You

Any Questions ?