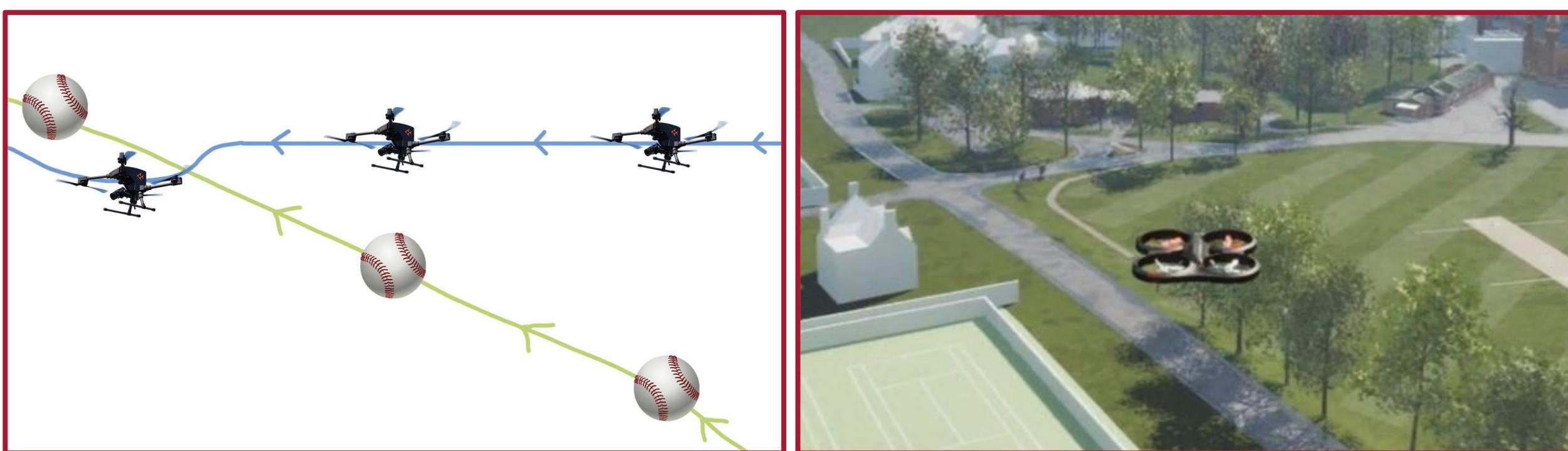


Mission Purpose

The Baseball Avoidance Multirotor, also known as BAM, is a NASA Challenge out of NASA Langley Research Center. The challenge asks researchers to program a model drone to dodge baseballs.

The BAM Project is mainly about Autonomous Collision Avoidance which is a hot topic in the Aerospace industry today. The key problems in this are perception, prediction, and planning.



Mission Objectives

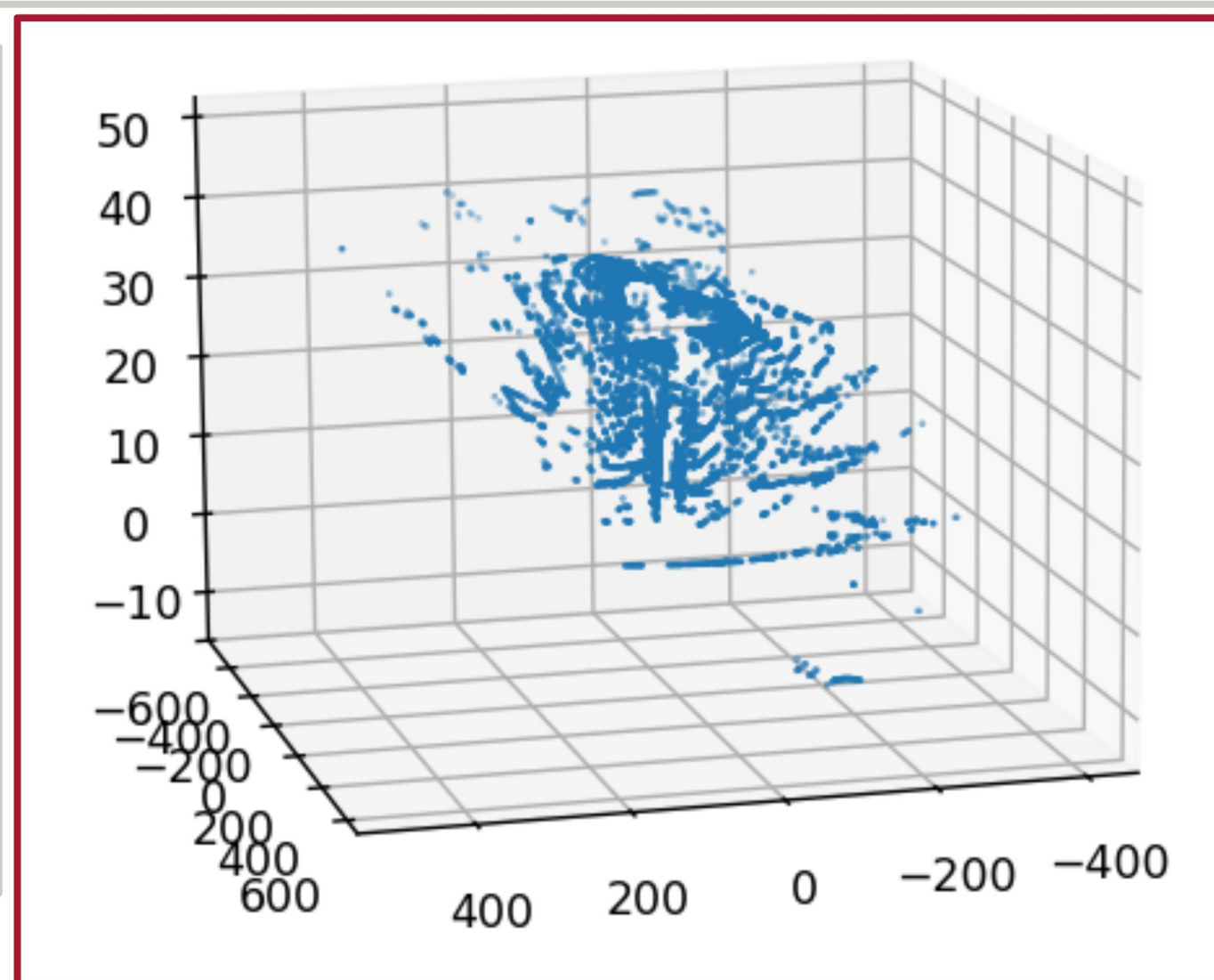
Our mission was to create a system that is able to detect the baseball, find its trajectory, figure out if there is going to be a collision with the drone, and if so, avoid collision by moving out of the way and return to its original path.

High-Fidelity Sensor Viability Testing

BAM is primarily MATLAB/Simulink based, but it also includes high-fidelity capabilities using supplemental software.

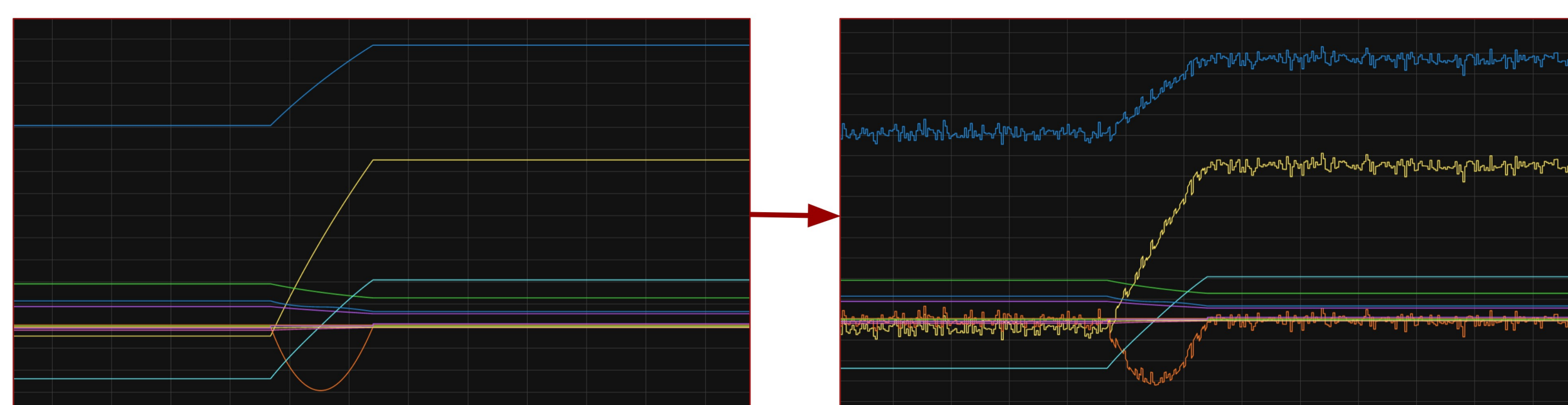
- Unreal Engine = 3D Visualization
- CodexLabsLLC Colosseum / Microsoft AirSim = Simulated Sensors
- Robot Operating System 2 (ROS2) = Middleware

- Sensors could be added via ROS2.
- We attempted using LiDAR (Light Detection and Ranging) point cloud data as the primary perception sensor, however; full implementation was outside the scope of this project.. (See image on the right)
- Computer vision and Machine Learning could have also been implemented, but time limitations hindered us.



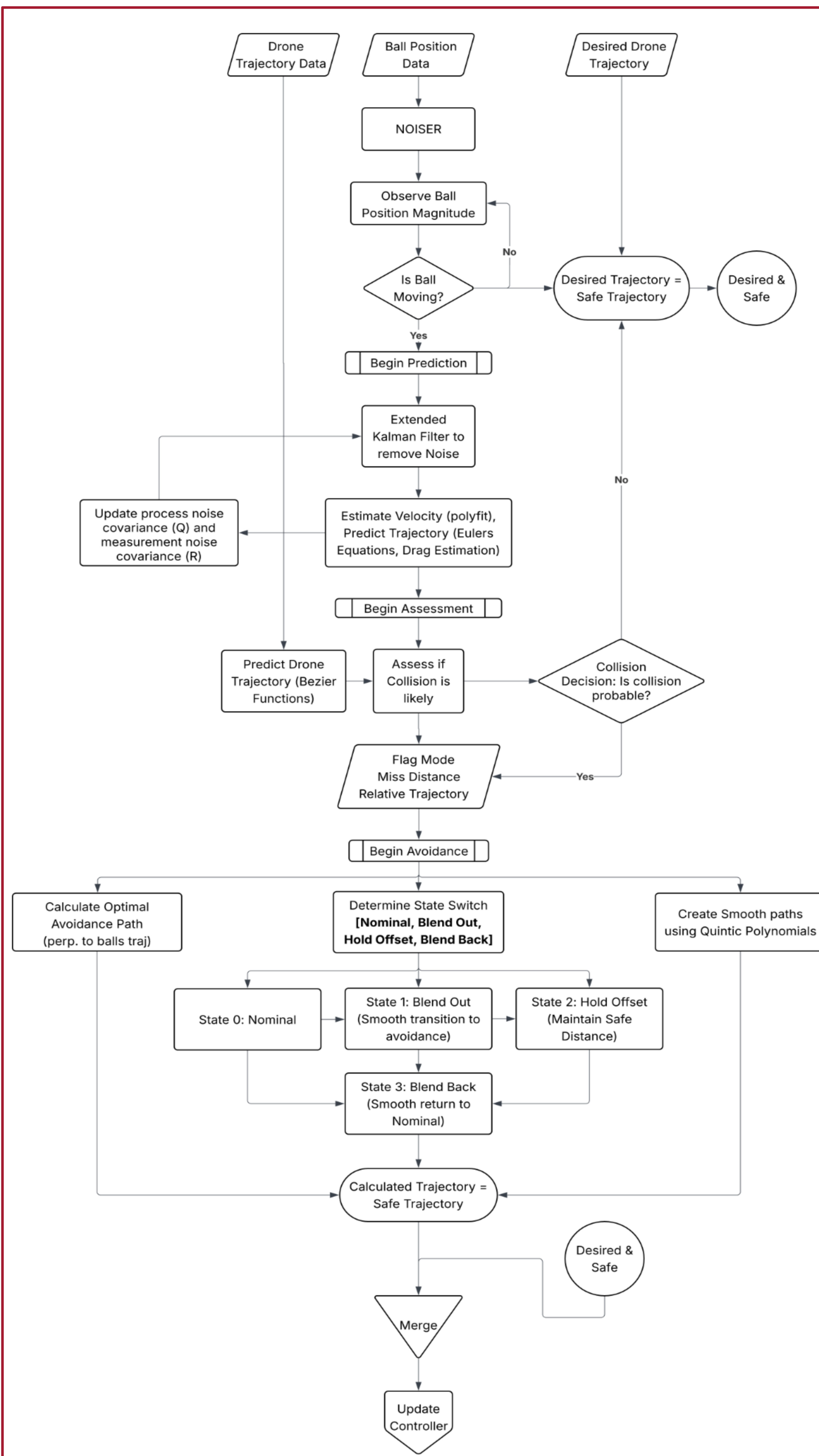
Perception

Testing showed high fidelity AirSim LiDAR point cloud was viable, but outside project scope. For repeatability, switched to adjustable pure-state noise for verification. Fed by the baseball's current position data with added white band noise, results are fed into a Kalman Filter. 100% ball detection, replicable and consistent across all testing configurations.



Our End-to-End Avoidance System

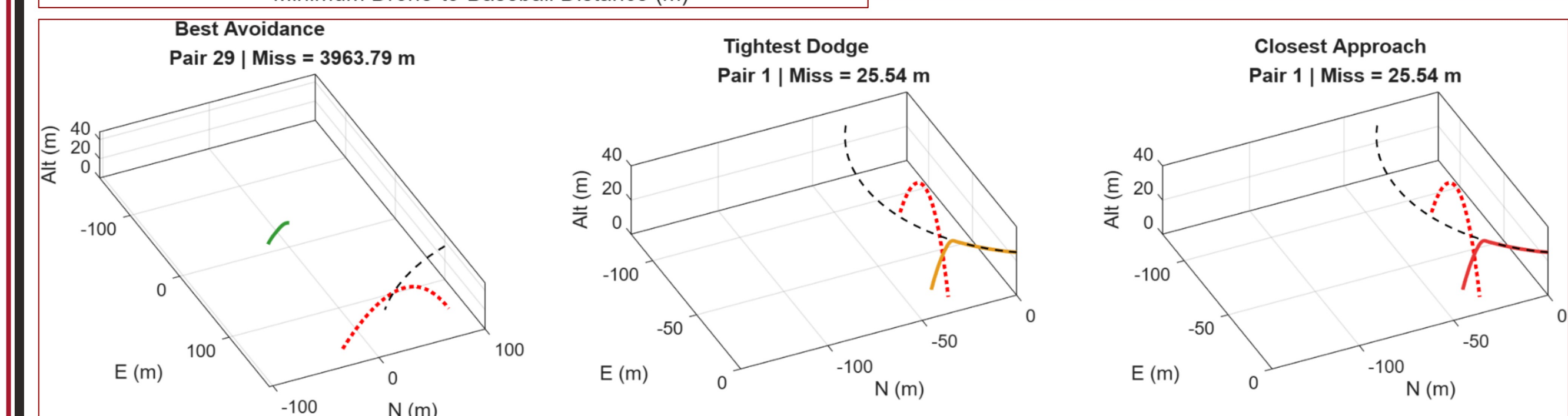
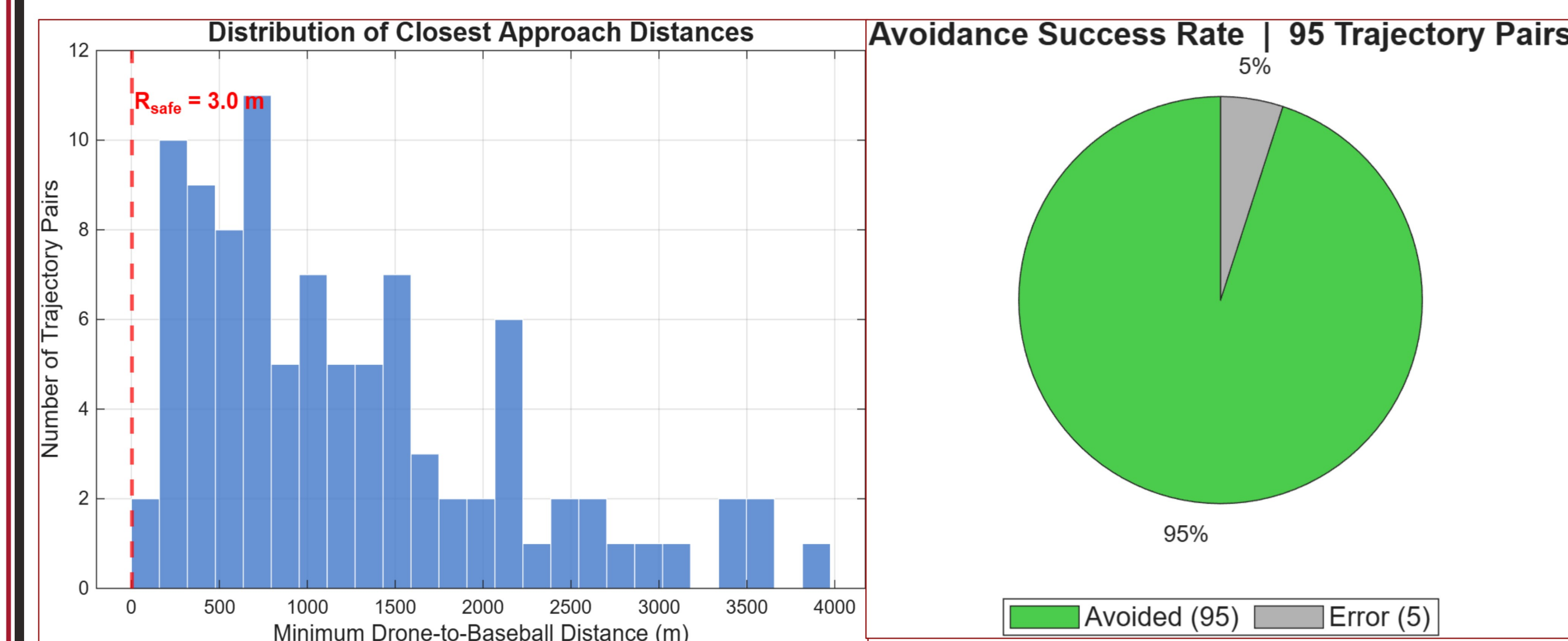
Our contribution to the NASA Challenge is the following system that sits, in the Simulink, between the trajectory positions and the controller.



Project Results

The system successfully avoided the baseball in most cases, but struggled to autonomously return to its original trajectory.

The following plots show the drone is technically successful at dodging the baseball, though they also show evidence of hyper sensitivity and failure to return to desired trajectory.



Typical Case:

- The drone successfully detects the baseball through noise.
- Successfully avoids the baseball.
- Unable to maintain stability, loses control and crashes.

Mission Summary

- Shows signs of potential success if continued.
- What to do next
 - Issues of hyper sensitivity and not returning to desired trajectory.
 - Afterwards, bring back the LiDAR sensor via Colosseum/AirSim.
 - Implement computer vision and Machine Learning to the LiDAR data.

Acknowledgements

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