CONTROLLING SAFETY CRITICAL SYSTEMS

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MINDS·CDT

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MY BACKGROUND

A LEVELS

ELECTRONIC ENGINEERING

MASTER’S DEGREE

MINDS CDT

SAFETY CRITICAL SYSTEMS

- **Safety Critical System:** A system that changes over time and, if not controlled, could result in damage or cause harm to humans or animals.

- **Objective:** Establish some safety conditions which guarantee tracking of a desired path, so no collisions occur.

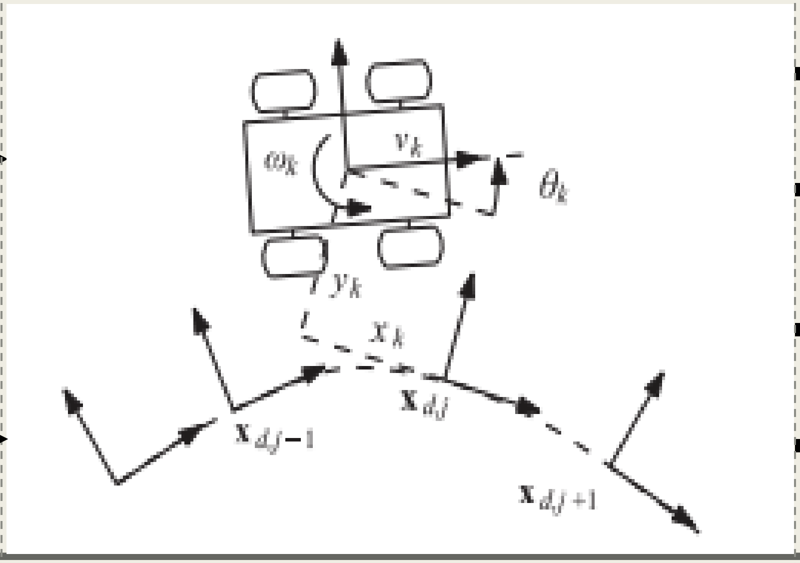
MODELLING THE PROBLEM

Input Signals

V velocity of wheels

θ angle of wheels

Model



Measurements

X position of robot on x-axis

Y position of robot on y-axis

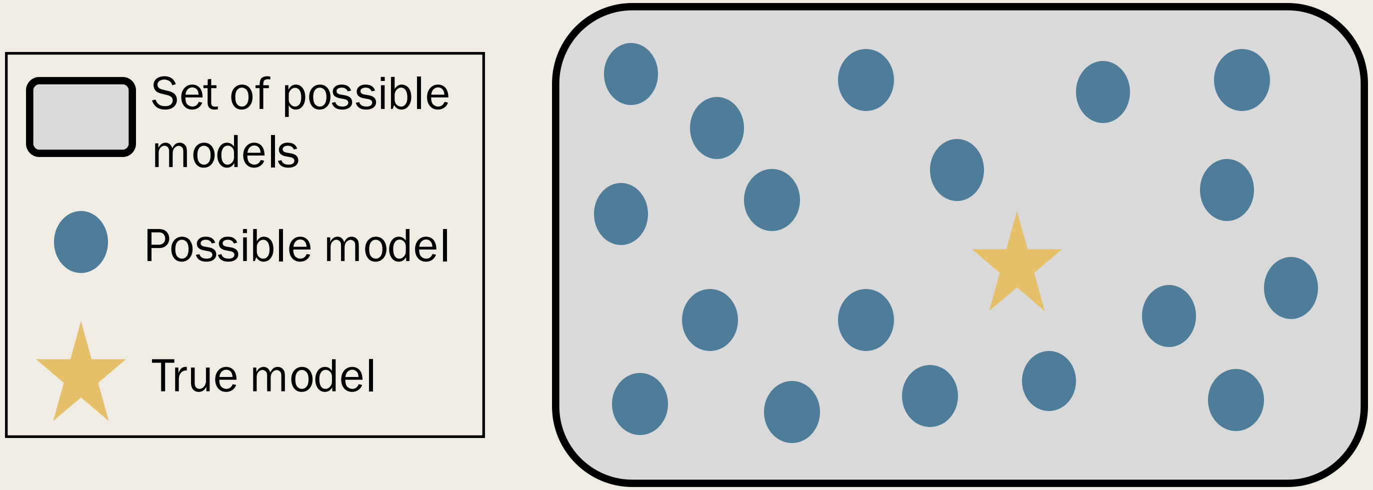
V_x velocity of robot on x-axis

V_y velocity of robot on y-axis

- **Refined Objective:** Design the velocity and angle of the wheels (input signals) so the measurements satisfy some safety conditions, and you can trust the path taken by the mobile robot (MR) will accurately track a desired path.
- **Challenge:** Typically, this relies on an accurate model of the MR which is difficult to obtain.
- **Problem:** Input signals based on an inaccurate model may cause the MR to follow an unexpected path.

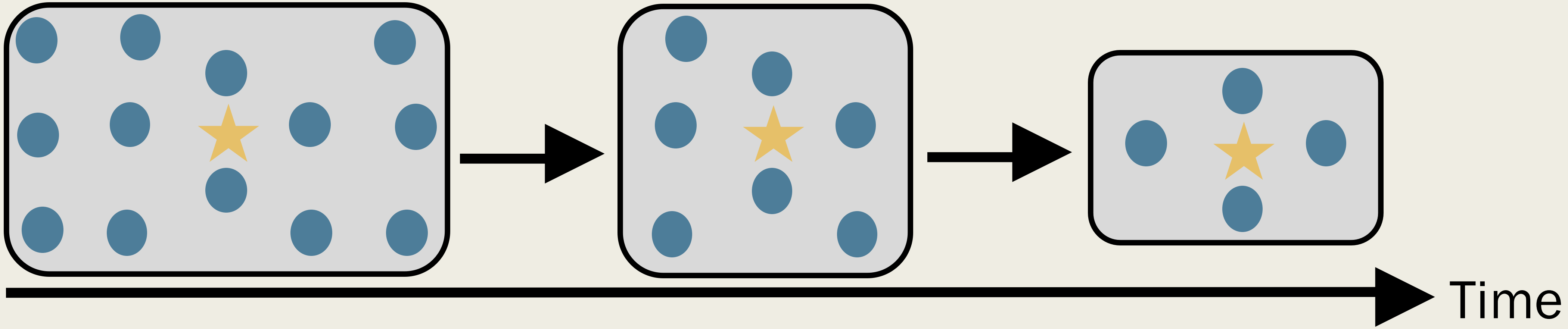
ROBUST CONTROL

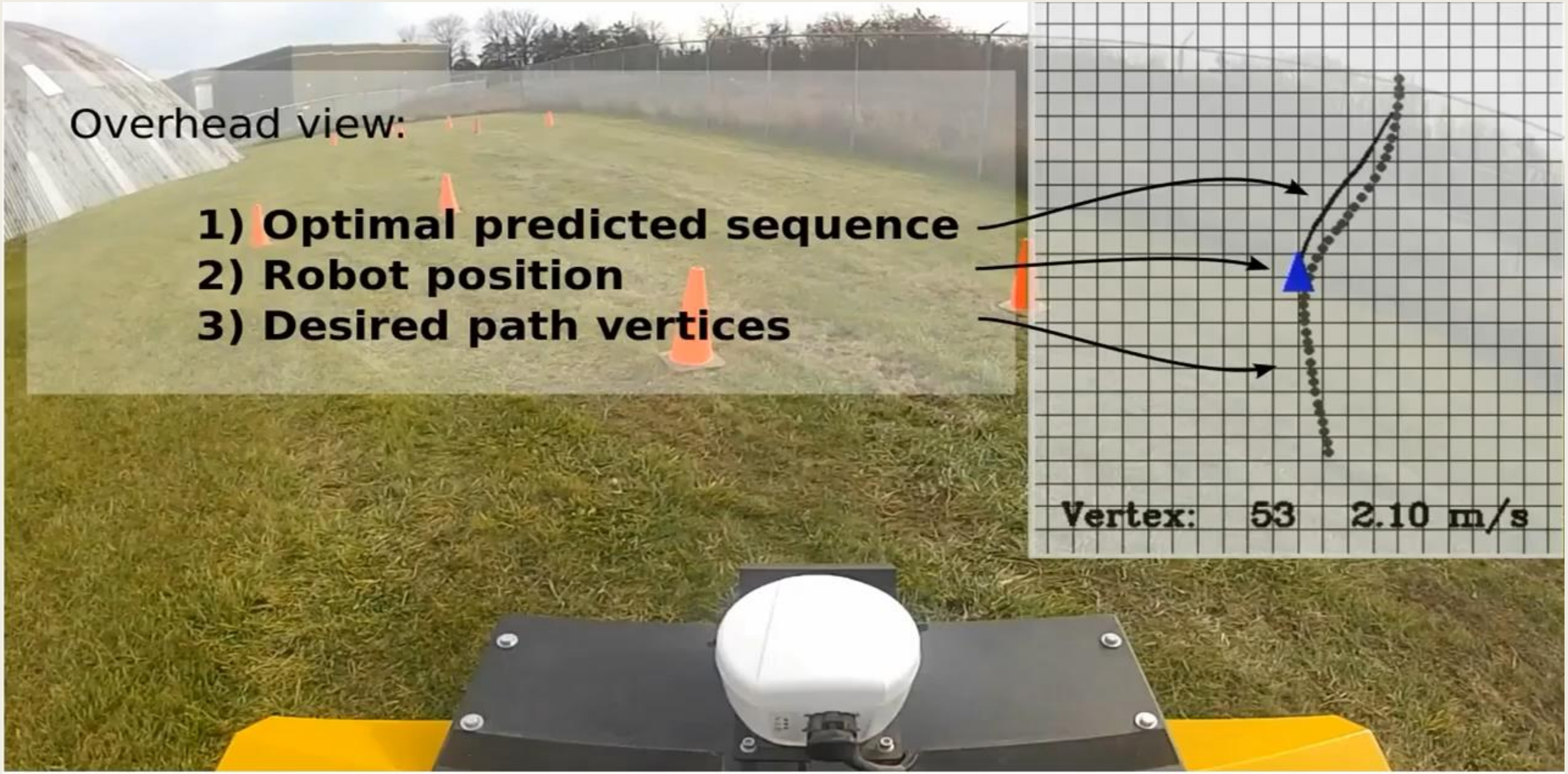
- A class of methods which assume we know a set of possible mobile robot (MR) models, and the unknown but true MR model is a member of this set.
- **Robustness:** Input signals are designed to satisfy some safety conditions which ensure reasonable tracking accuracy for all possible models of the MR in the set.
- **Weakness:** Tracking accuracy is sacrificed for robustness.
- **Problem:** How can we maintain robustness whilst improving tracking accuracy over time?



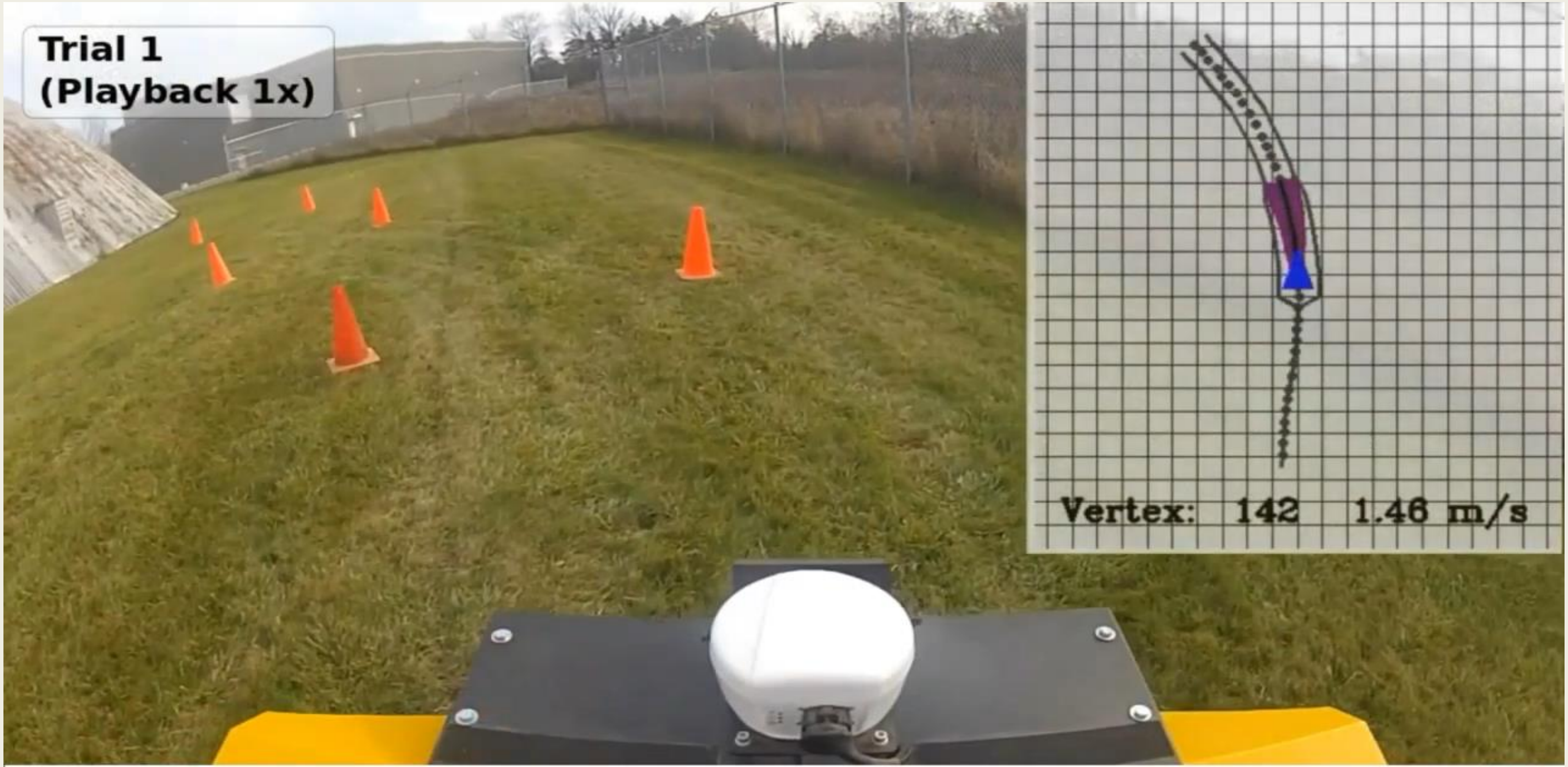
Adaptive Control

- A class of methods which can adaptively estimate the true MR model in real-time, based on the measurements from the MR.
- **Relevance**: As more measurements are recorded, the estimate of the true model becomes more accurate.
- **Solution**: Adjust the input signals according to the updated estimate of the MR.
- **Advantage**: This approach improves the accuracy of the estimated MR model, as more measurements become available. This sacrifices unnecessary robustness for tracking accuracy!





Ostafew, Schoellig, Barfoot, **“Robust constrained learning-based NMPC enabling reliable mobile robot path tracking,”** *IJRR*, 2016



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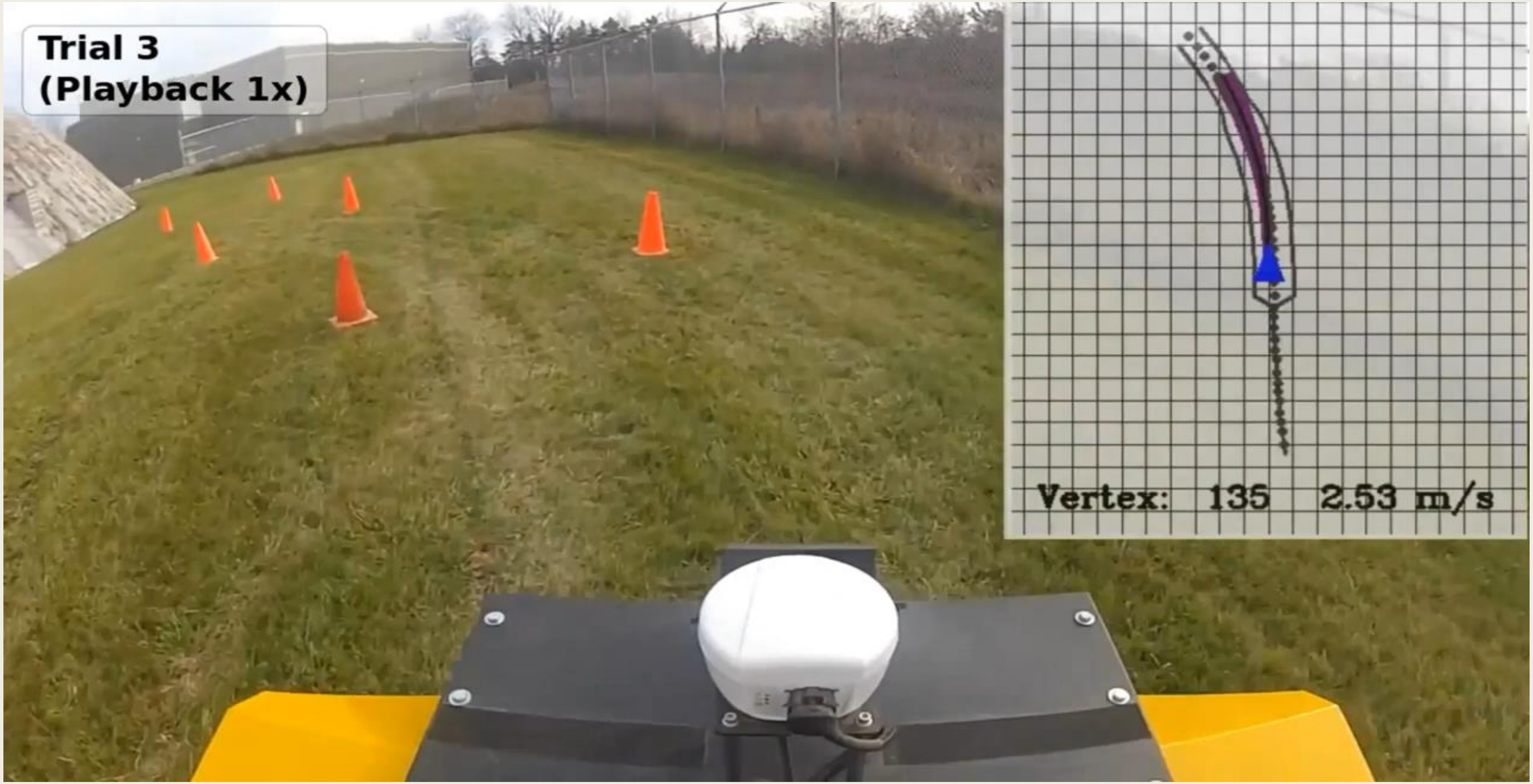

Trial 3
(Playback 1x)
Vertex: 135 2.53 m/s