PURSUIT-EVASION TRAJECTORY GENERATION BETWEEN DRONES

M+AE

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INTRODUCTION

Aerial pursuit-evasion games pose significant challenges with applications ranging from anti-drone military operations to civilian missions like search and rescue. In these scenarios, agents must consider their adversary's potential strategies when determining their actions.

Traditionally, obtaining the optimal trajectories in real-time has not been feasible due to the mathematical complexity even if it is highly approximated. However, the recent development in deep declarative networks provides a potential way to compute high-quality pursuit-evasion trajectories in real time.

Our research aims to implement the learning-based mixed-strategy pursuit-evasion trajectory generation and to demonstrate its feasibility using a physical micro-drone testbed, specifically the Crazyflie 2.1, using the CrazySwarm 2 ROS package.

METHOD AND APPROACH

The implementation of the trajectory generation is shown in Figure 1 and explained in the steps below.

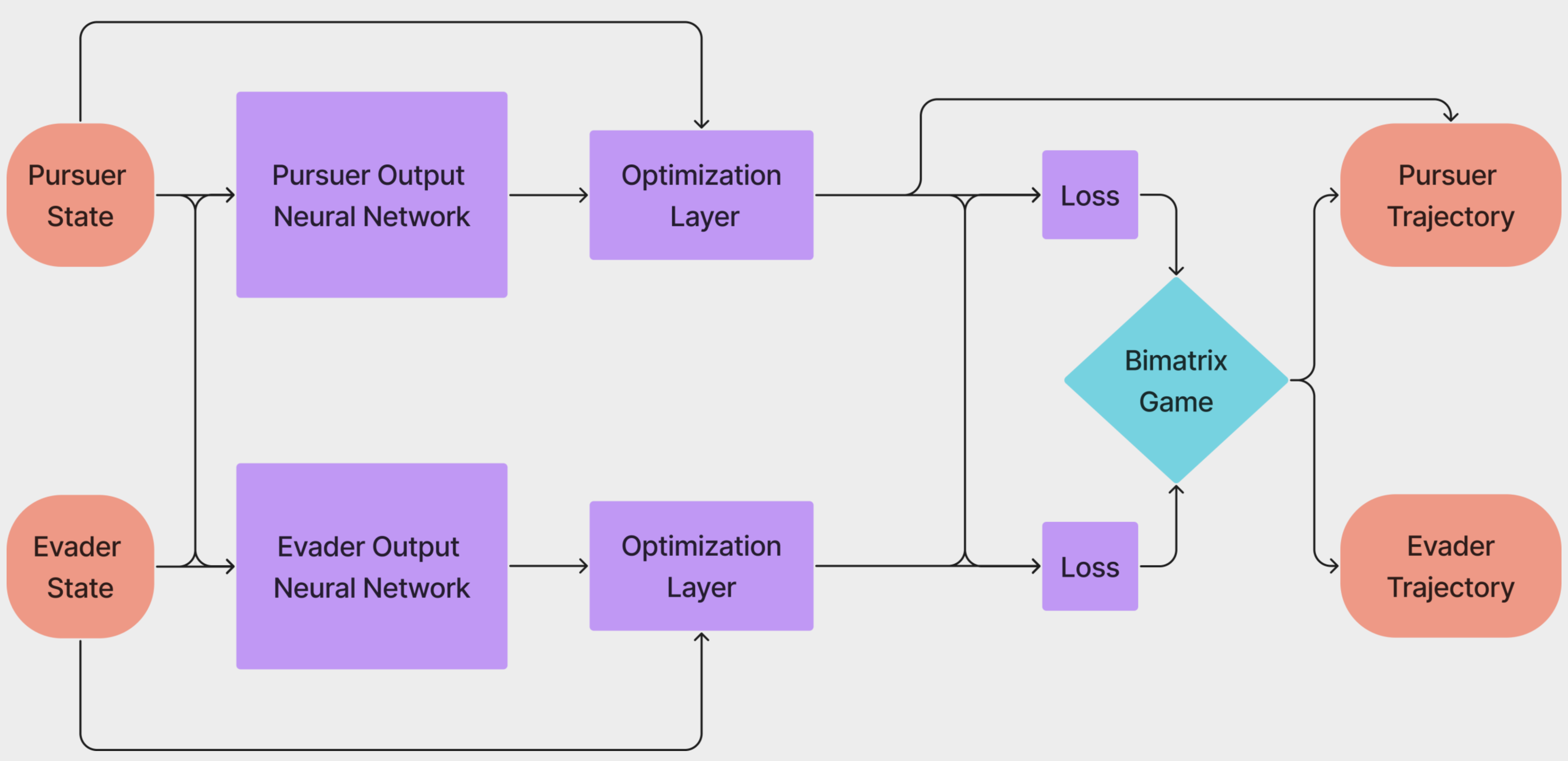

Figure 1. Overview of controller to generate pursuer and evader trajectories

Physical Test Bed:

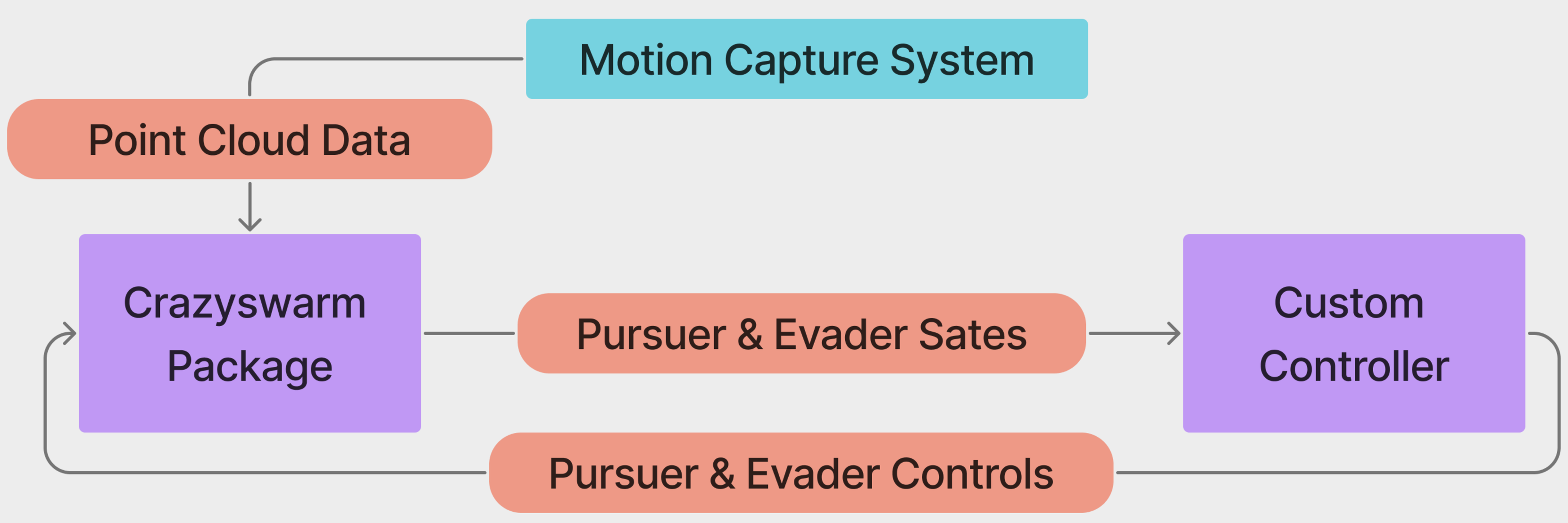

Figure 2. Overview of Physical Test Bed Setup Utilizing ROS 2 for communication between packages

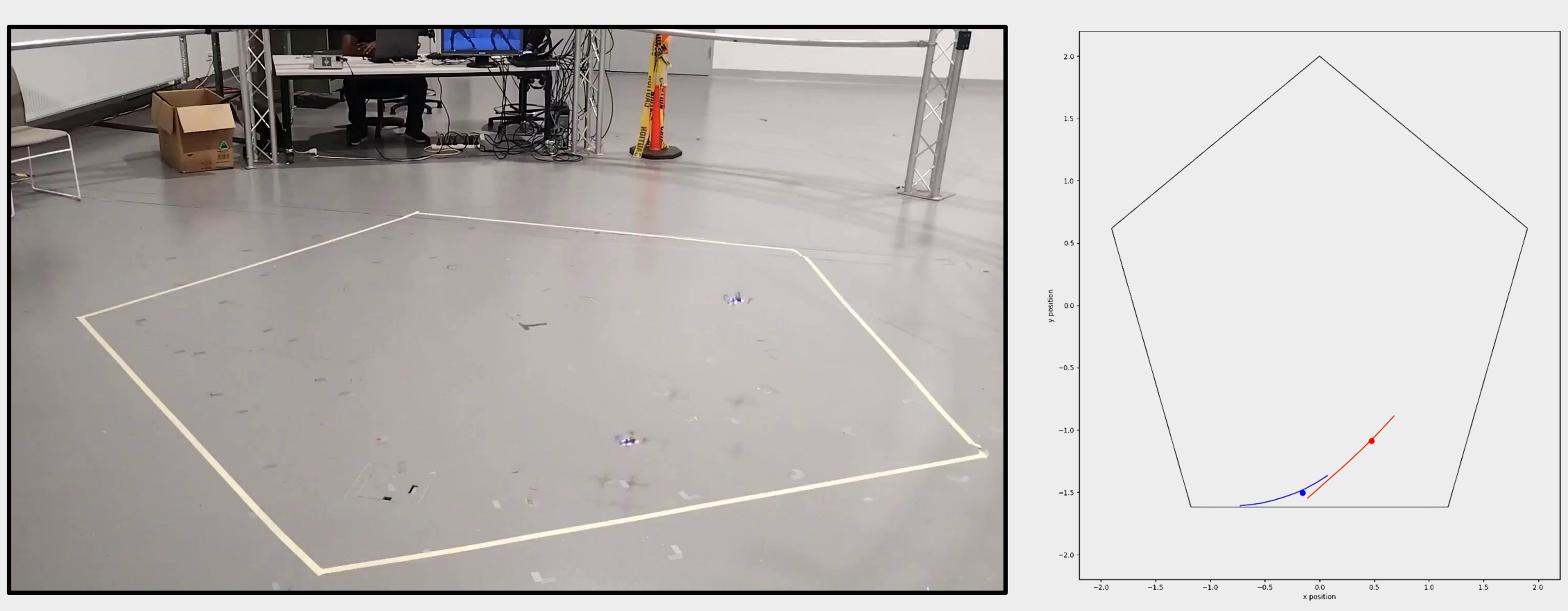

Figure 3. Physical testbed using Crazyflies and VICON Motion Capture Rig (left) with real time top-down visualization of pursuer and evader's states and trajectories (right)

RESULTS AND DISCUSSION

Note: Results below are for the environment of a 2D Regular Pentagon with a single pursuer and single evader

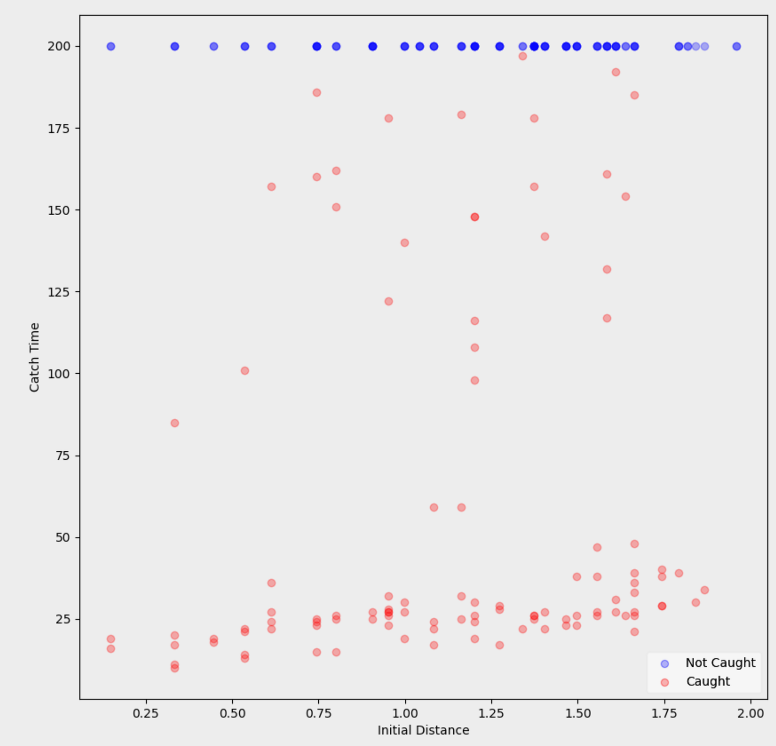

Figure 4. Relationship of initial distance between agent and time taken to get caught

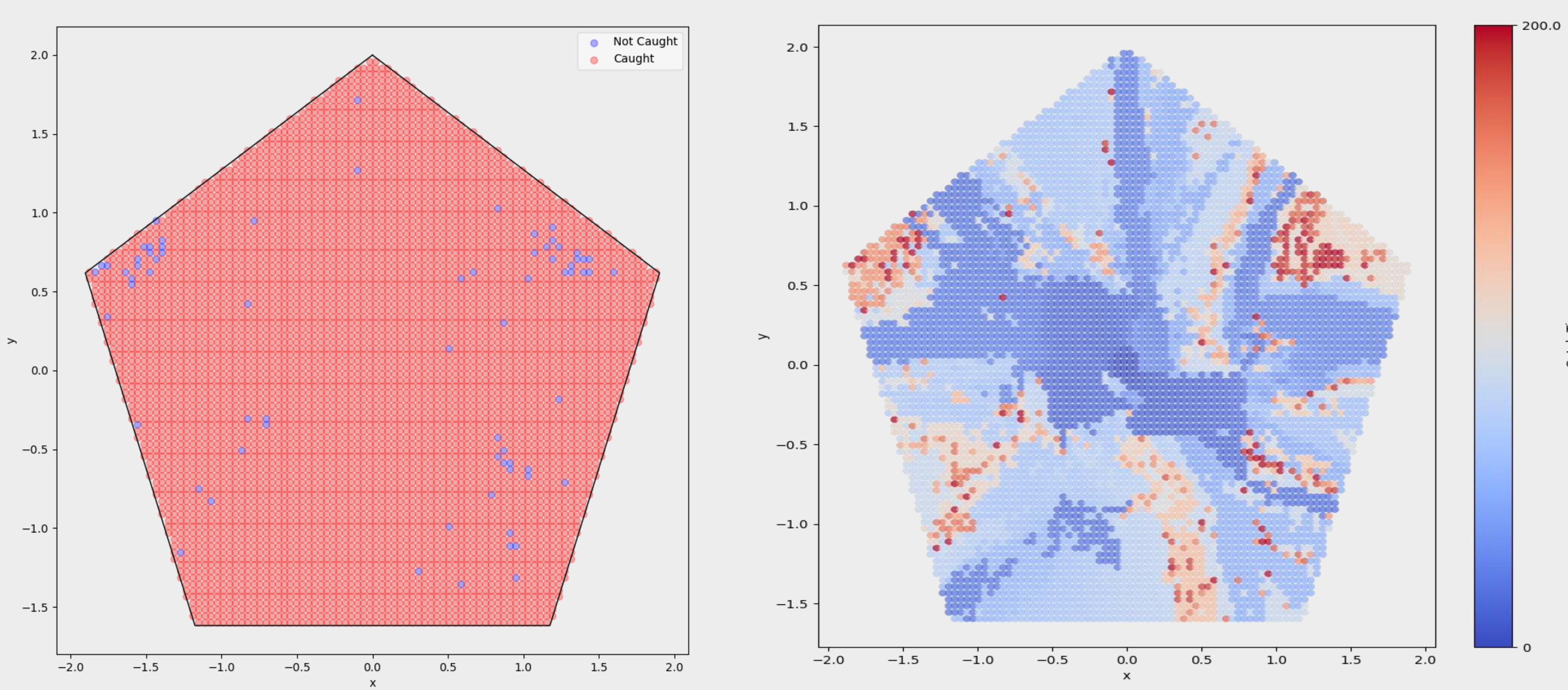

Figure 5. Scatter Plot of Time taken for Evader Caught for Fixed State of Pursuer at x= 0, y=0 from rest

The Figure above shows the relationship between the relative initial position of the agents and time taken for the evader to get caught. In particular, close to the corners are generally the most optimal initial position for the evader in this setup.

CONCLUSION AND FUTURE PLANS

In conclusion, this study successfully replicates and expands upon a method for learning mixed strategies in pursuit-evasion games with drone agents. Through the implementation using mini drones, the proposed approach demonstrates its versatility and accuracy to the mathematical predictions.

Future plans include

- Exploring different dynamic systems (e.g. Unicycle Dynamics)
- exploring three-dimensional games
- multi-agent implementation and testing.

REFERENCES

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[2] Gould, Stephen, Richard Hartley, and Dylan Campbell. "Deep declarative networks." IEEE Transactions on Pattern Analysis and Machine Intelligence 44.8 (2021): 3988-4004.

[3] Peters, L., Ferranti, L., Stachniss, C., & Laine, F. (2022). Learning Mixed Strategies in Trajectory Games. ArXiv. /abs/2205.00291

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