# Novel Rule-Based Path Planning Algorithm

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## Abstract

As drones have become increasingly more popular in recent years, drone technology has also grown in use and potential. Specifically, object detection and tracking using drones has become more prevalent over the past decade. We propose a drone with a path planning algorithm that can following moving subjects of interest. We will mainly utilize OpenCV and a YOLO model to program two main algorithms: object detection and path planning. Drones will be able to follow objects of desire while recording them and following a safe, optimal path.

## Methods

**Object Detection**: We utilized the YOLO algorithm, specifically the Yolov4-tiny model, due to its balance of speed and accuracy. If YOLO detected an object from the drone camera image and was above a certain threshold of confidence, the program drew a box around said object and labeled it.

Our interface draws bounding boxes for every object detected by YOLO on the drone camera. However, if the user selects one object than only its bounding box will show and the drone starts following the chosen object

**Path Planning**: We implemented a rule-based path planning algorithm. By deriving relative position along with other variables from different video frames, we calculated the necessary parameters for the drone to follow the object.

We also implemented a basic PID controller to account for error in drone movements. The Tello we tested had a tendency to drift or overshoot/undershoot its target. The PID controller continuously tracks these tiny errors and attempts to correct them using proportional, integral, and derivative terms

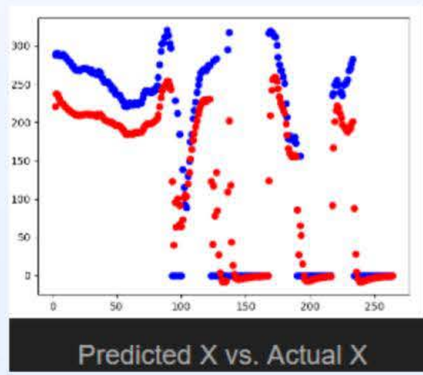
*Drone following bottle*

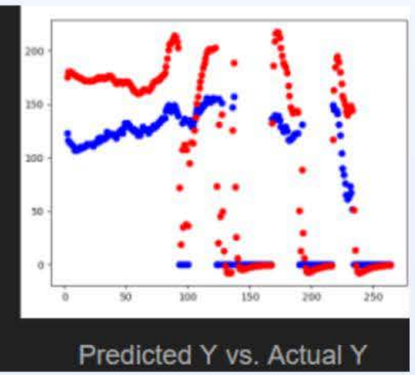

*Drone POV*

## Results

We created a UI to connect to and control the drone. The drone received commands from a laptop over a wireless network. As the drone sent what its camera was seeing as individual frames back to the computer, YOLO was then used to infer objects in the frame. The resulting bounding boxes were displayed to the laptop screen for the user to see, at which point it became possible to select one to focus on and follow.

Including the time it took for YOLO to make inferences, our live video feed of the drone cam averages about X frames per second. Over the course of the flight, we also recorded data on the object we were tracking, specifically its X and Y position on the screen. We then compared this to our predicted X and Y positions of the object using the Kalman Filter, which was assisting the drone whenever it broke LOS with the object.




## Conclusion/Future Work

We were able to create a program that allows a user to look through the camera of a drone and the objects it detects. The user is able to select objects of interest to follow, and we utilized the Kalman filter to try and predict the trajectory of said object. Some setbacks we faced were the speed of the YOLO algorithm, which we hope to improve in the future by implementing a tiny version of the model, and lack of accounting for external factors such as the surrounding environment. Moving forward the next step would be to improve path planning, perhaps by using reinforcement learning