ROI driven color selection algorithm

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Abstract

This is an algorithm developed to make sample detection in the 2025 FTC UK nationals more efficient and simple.

1 Introduction

The First Tech Challenge (FTC) is a robotics competition which requires competitors to design a robot both on the hard and software with specifications in regard to each year's theme. In the 2024 - 2025 season, my team and I have learnt that the implementation of OpenCV may be necessary to achieve awards and a high placement. Other members of the team have developed the basic OpenCV pipeline and the result was beyond our expectations; therefore we decided to implement it properly into the game.

2 Problems

Originally, we planned to calculate the localised 3D position of samples via reverse projection and camera parameters. However, we realised that this would take some amount of computational power - ultimately lowering efficiency and leading to a higher power usage. This is because reverse projection involves real-time linear algebra, nonlinear calibration corrections, and geometry reconstruction, which consumes CPU/GPU cycles.

3 The Solution: Sample Selection

The algorithm designed performs a continuous contour detection in a region of interest (ROI) on the central pixels of the vision pipeline. This is achieved by calculating and tracking the position of the centre of the largest contour using image moments and matrices.

$$x_c = \frac{M_{10}}{M_{00}}, y_c = \frac{M_{01}}{M_{00}},$$

where $M_i j$ are the spatial moments calculated from the binary mask of the detected contour.

$$M_{ij} = \sum_x \sum_y x^i y^j I(x, y)$$

Depending on the position of the contour, the robot moves relative to itself towards the sample via the computation of the error vector.

$$\vec{e} = (x_c - x_0, y_c - y_0).$$

This error vector is then normalized and multiplied by a constant to produce the appropriate degree of strafing. To ultimately collect the sample, we implemented a hybrid sensor fusion approach via a color sensor and linear slides which start extending once the contour is centered and stops extending as soon as the right color is detected.

4 Effects and images

Overall, our ROI algorithm is a significant advancement, as it allows much easier Teleop driving and could potentially be implemented to our autonomous.