THE DARK TOWER

Visual Servo Laser Pointer

Alec Duvall (color segmentation, servo, documentation)
Charlie Peterson (servo, laser, documentation)
Johannes Winarta (CAD, soldering, Arduino IDE test code)

EE 5271: Robot Vision Final Project
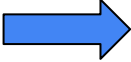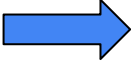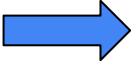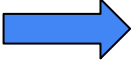
Project Motivation/Goal

Motivation: Develop a better understanding of how robot vision techniques can be used to provide real-time feedback for control of moving systems. Demonstrate the use of color segmentation in a visual servo context.

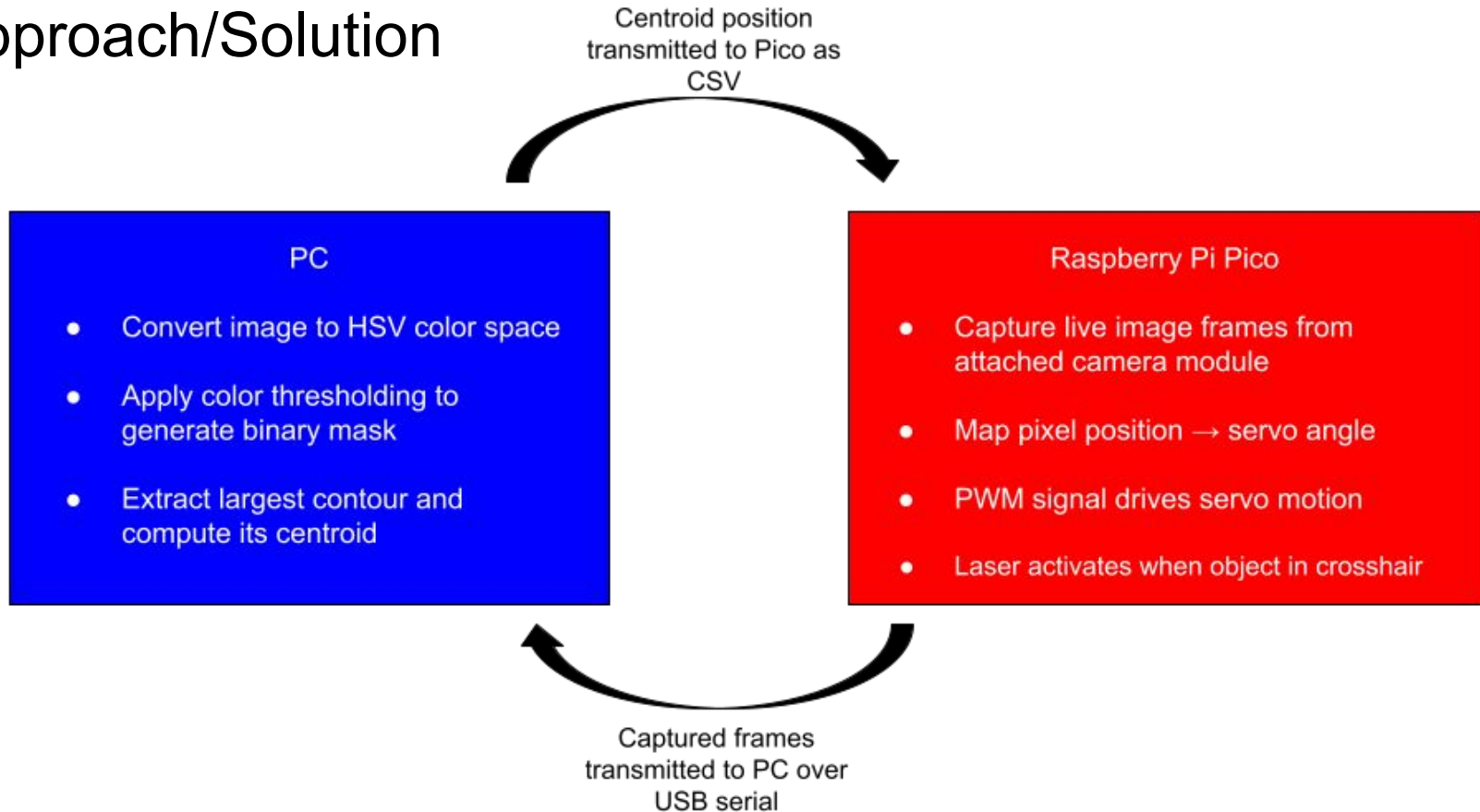Challenge: Tracking objects in real time with limited hardware

Goal:

- Detect a colored object using color segmentation
- Extract its centroid
- Send position data to microcontroller
- Move servo to track object in real time

Challenges → Solutions

- Lighting sensitivity in color detection → Switched to HSV color space and tuned thresholds

- Noise causing unstable centroid detection → Applied morphological opening and closing to remove small noise and fill gaps in the object

- Raspberry Pi Pico might not have enough memory for image processing → Communicate with laptop via USB to process frames

Various versions of python 3.13 work well.

- Newer python versions cause compatibility issues →

Approach/Solution

Centroid position transmitted to Pico as CSV

PC

- Convert image to HSV color space

- Apply color thresholding to generate binary mask

- Extract largest contour and compute its centroid

Raspberry Pi Pico

- Capture live image frames from attached camera module

- Map pixel position → servo angle

- PWM signal drives servo motion

- Laser activates when object in crosshair

Captured frames transmitted to PC over USB serial

Results/Demo

QnA

GITHUB

Future Improvements

- Add User Interface to easily pick the color range of the object
- Implement object detection and servo positioning with more advanced methods involving a neural network or reinforcement learning
- Multiple object tracking(Servo tracks closest object or switches dynamically)
- Predictive tracking
- Object presets
- Depth estimation(stereo cameras)
- Wireless communication between the Pico and PC