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ECE 153B: Project Proposal

Overview

We propose to create a small robot that follows a distinct target with a camera. A stretch goal is to display some sort of result using an LED display, or emit some noise, when on target. We will be using standard feedback based controllers to help ensure that our robot follows the target.

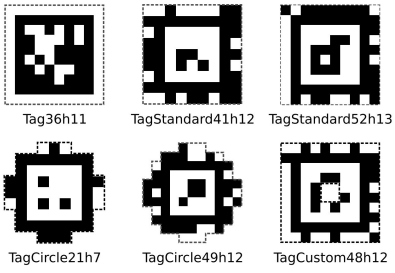
Peripherals

- ArduCam 2MP Camera
- Wifi Chip
- DC Motor + Wheels (4)
- Motor Controllers
- Accelerometer
- Encoders (2)
- LED Lights
- Speakers

Software Design

Using standard JPEG image processing techniques to analyze the image and conduct active feedback based control. We expect to track something to the effect of a large “April tag”, which allows us to track a predefined image. This will allow us to avoid pattern recognition / deep learning. We’ll compute trajectories using pixel information. We can predict paths based on both distance and angel from target. By using encoders and image values, we can ensure that we are providing proper control to the system. We are hoping to generate smooth paths.

We’d like to compute relative location by using April tags. April tags allow for specific 3d positioning relative to the tag by utilizing a well-defined mapping - similar to a QR code, but much, much larger. We believe that this tag will be more accurate than simply estimating with pixel information. Here is a set of example tags:



Since the STM32 is likely not fast enough to compute control realtime, we'd like to move image processing offline, to a seperate computer.

Website

https://sites.google.com/view/ece153b20

Peripherals Details

- ArduCam 2MP Camera
  - We will be interfacing to the camera with both SPI and I2C. The images are compressed on the device in JPEG format (though we can choose to change that).
- Wifi Chip
  - A small, low power wifi module like the ESP8266 would allow the robot to communicate with a nearby laptop that will handle the bulk of the image processing. We were thinking:
  - https://www.digikey.com/short/z3fccf
  - Or https://www.sparkfun.com/products/13678
- DC Motor + Wheels (4)
  - We will be using something to the effect of: https://www.digikey.com/products/en?mpart=2939&v=1528
  - Or https://store.arduino.cc/usa/robot-chassis
  - This will allow for 2 wheel DC drive.
- Motor Controllers
  - We expect to use a L298 motor controller
  - Or https://www.st.com/en/motor-drivers/l298.html
  - Or https://www.digikey.com/product-detail/en/dfrobot/DRI0009/1738-1078-ND/6588500
  - In a worst case, https://www.digikey.com/products/en?WT.z_cid=sp_497_0928_buynow&Enterprise=44&lang=en&Vendor=497&mpart=STEVAL-FCU001V1 has integrated motor controllers.
- Accelerometer
  - The accelerometer is built into the STM32 and we plan to leverage it to allow for additional feedback into our controller.
- Encoders (2)
  - We intend to use rotary encoders to ensure that our motors are outputting speeds which we expect and we are moving along the path we expect.
- LED Lights
  - Roughly 6 red LEDs, available at the ECE shop, will allow us to recreate a set of rear tail lights
- Speakers
  - For our reach goal, we would need an additional, small speaker that the audio DAC works with on the STM32 microcontroller.

Goals

1. Based on image input (15~ FPS), robot will adjust it's movement and determine vector

2. Based on that vector, motors and wheels will move accordingly, and encoders with image input will provide feedback to ensure we are moving as we expect to
3. LED Tail-lights will correspond with the robots stop-and-go motion
4. Stretch Goal: Make the robot make noise when it has approached its target

Group Responsibilities

Peter will be responsible for the ArduCam and the image processing that determines the robot's optimal path. Jackie will be in charge of the robot's motor control system, tail lights, and potential speaker add-on. Both will be working on how the microcontroller interprets and executes feedback, as well as overall debugging.