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ECE302
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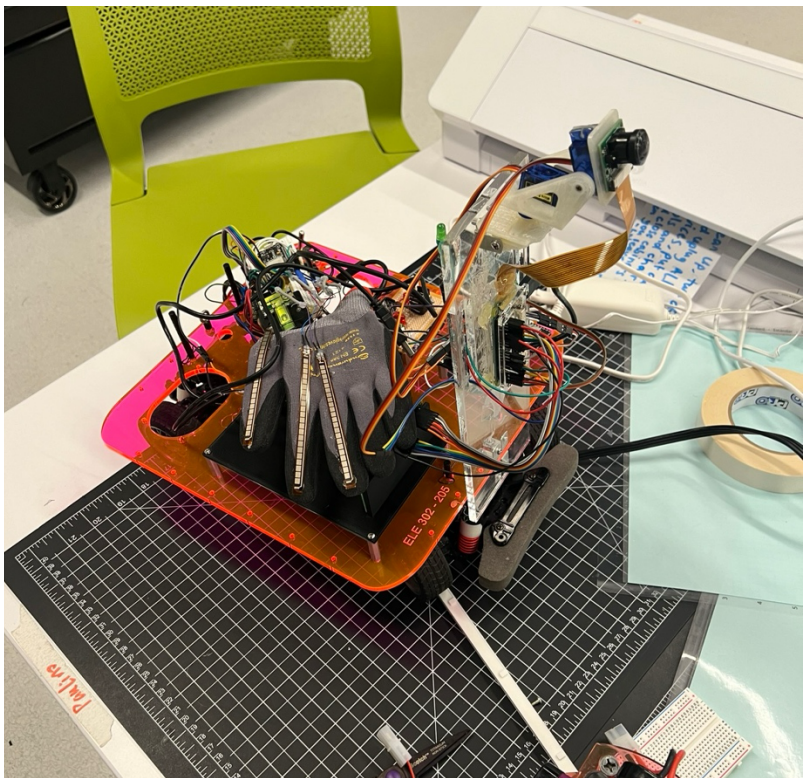
Final Project Lab Report

STATEMENT OF OBJECTIVE

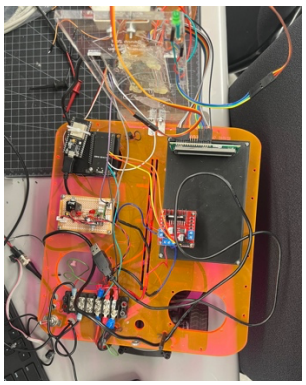
The objective of this project was to redesign the autonomous car as well as make a left-handed glove that can help the user to be able to control the car's motion. The glove, however, can only be used to control the direction of the car as well as the current state of the car(stationary/motion) but not change the speed of the car while in motion.

KEY SUB-SYSTEMS AND COMPONENTS

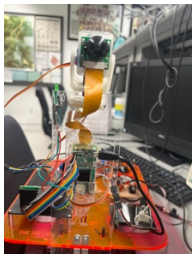


From the diagram above, the following are the main components and their subsystems:

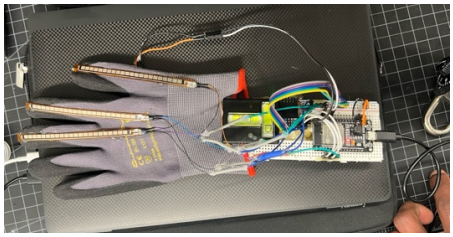
1. **Car**



- **H-Bridge:**
    - For our car, I needed to add the extra functionality where the car would be able to move both forward and backward. H-bridge motor drivers offered this extra functionality by wiring it directly to the already-existing motor of the car and reversing the direction of current through the motors.
- **Power Board:**
    - Voltage regulator, 7805: This is a voltage regulator chip that helps output 5V no matter the input voltage. The output of this voltage regulator is fed into the ESP32.
    - Voltage regulator, 7806: This is a voltage regulator chip that helps output 6V no matter the input voltage. This was left from previous projects just in-case we needed an extra power source to use.
    - LED: It is good practice to always have LEDs so as to ensure that the power board is being fed power and also enable easy troubleshooting when something isn't working.
- **ESP32 Board:**
    - 2 ESP32's: The purpose of the ESP32 is to provide wireless communication between two objects.
        - The 1st ESP32(Car ESP32) was to be used as the main controller for the car in placement of an Arduino IDE. ESP32 was favoured because of its ability to act as a controller for the car as well as act like a 'receiver' for the wireless signals sent by the ESP32 from the glove. Everything was coded in Arduino IDE and then uploaded to the ESP32.
        - The 2nd ESP32(Wi-Fi ESP32) was to be used to connect to a self-built web server. This was an extra feature to enable connection to a personally built-Wifi (named 'Isabella') and enable the user to move the Raspberry Camera either from the comfort of his phone or laptop while moving the car with the gloves.
- **Raspberry Pi Zero + Raspberry Pi Camera + LCD Display:**
    - Raspberry Pi Zero: Offers the ability to power the Raspberry Pi Camera as well as connect to our personal Wi-Fi("Isabella").
    - Raspberry Pi Camera: Offers the ability to video stream via your device(laptop/phone).
    - LCD Display: This displayed the current IP address and Port number of the web server, which were prompted whenever the user tried to access the custom-built web server.

- 

2. **Glove**

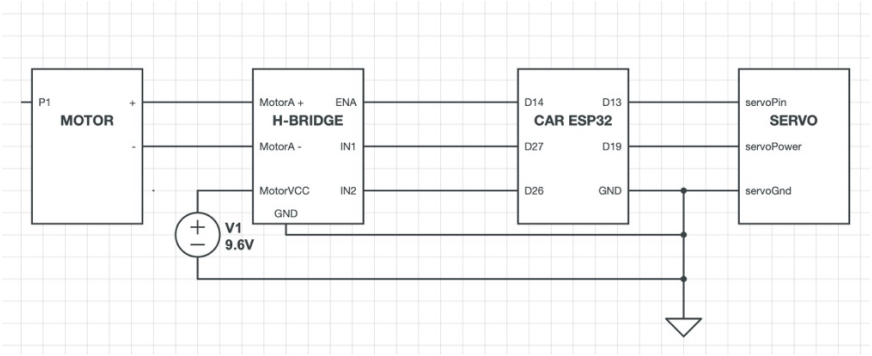


- **Breadboard:**
  - This was done to make the connections easier for both the Glove ESP32 as well as the wiring of the flex sensors.
- **The 2nd ESP32(Glove ESP32):**
  - This was used as the main controller of the gloves as well as acting like a 'transmitter' by sending wireless signals to the ESP32 of the car. Everything was coded in Arduino IDE and then uploaded to the ESP32. This can be powered either by a mini-USB cable to the laptop or to a rechargeable battery.
- **Flex Sensors + Pressure Sensors + Spirit level:**
  - The flex sensors work by capturing the change in resistance as someone flexes/bends their fingers, thereby sending analog resistance readings to the ESP32 of the car which was then coded with certain threshold values to determine what direction is left/right or backward.
    - Flex Sensor on the middle finger when bent enables the car to move to the right.
    - Flex Sensor on the index finger when bent enables the car to move backwards.
    - Flex Sensor on the thumb when bent enables the car to move to the left.
  - The Pressure Sensors put on the palm of the glove work by capturing the amount of pressure pressed on it, converting it to electrical signals and then sending analog electrical signals to the ESP32 of the car which was then coded to enable the car to move forward when pressed and stationary when not pressed.

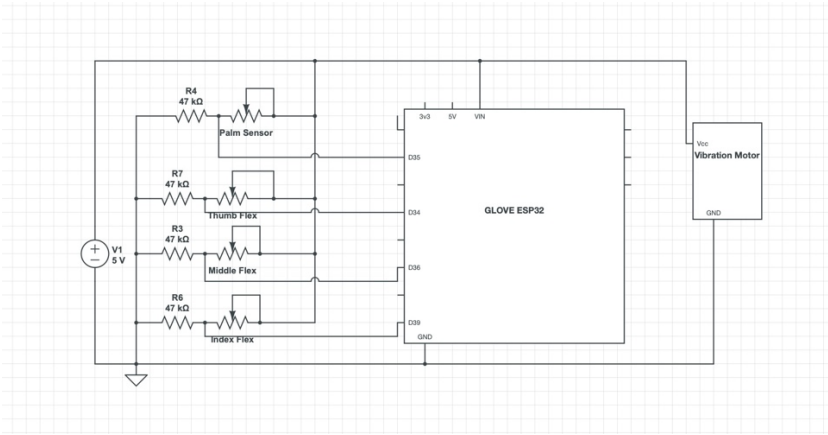
SCHEMATIC DIAGRAM OF CIRCUITS

OVERVIEW SCHEMATIC:

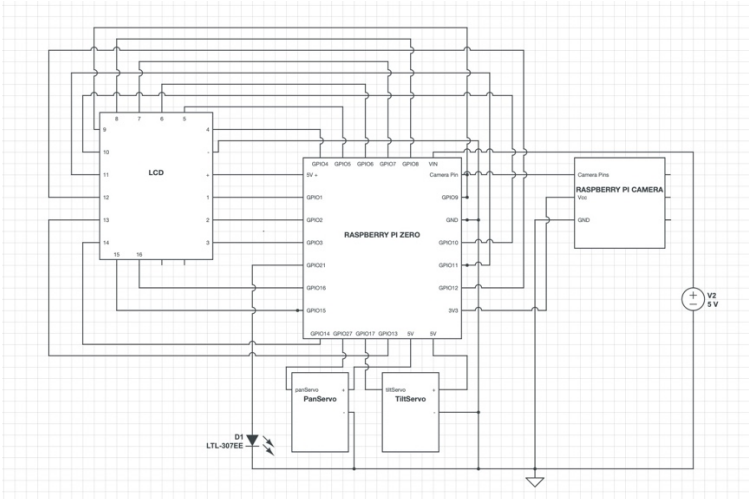
(1) Car Schematics



(2) Glove Schematics



(3) Raspberry Pi Zero + Raspberry Camera + LCD Schematics



CHALLENGES & DESIGN CHOICES MADE

(1) The car was heavy because we used rechargeable batteries for some of our components that specifically only allowed USB ports. This made the car move slowly even at the highest PWM signal of 255. However, the car easily moves when tested on a stand.

(2) The car was unable to turn left. Perhaps this was because of a loose connection or a fried flex sensor.

(2) Working with XBees for communication was difficult. At first, I tried to make use of the XTCU software to configure two communication XBees as “coordinator” and “end” devices (transmitter & receiver) to no avail. This proved to be difficult and hence why I switched to using ESP32.

(3) I discovered sparks between screws and some of the boards that were placed on top of the car. This was probably because some of the wires had loose connections and this could have been easily improved by resorting to other ways of wires connections i.e heat shrinking, twisting pair, other than jumper wires (for cases where jumper wires weren’t the only solution!).

WHAT COULD BE IMPROVED?

(1) Instead of gluing the Raspberry Pi Zero to the mast, I could easily have 3D-printed a board and screwed it on the mast (with drilled holes). This could have aided in a better-looking car.

(2) The glove could have easily been made more appealing. Perhaps, connecting every piece together on a 3D-printed cover for the hand could have helped hold everything in place.

(3) Sticking to good colour coding for the wires. RED/YELLOW = power, BLACK/GREEN = ground.