1. **Use ESP32 GPIO pins, a switch, an LED and resistors to read the state of a switch and light an off board LED when the button is pressed. Submit your code and a drawing of your circuit.**

   The code is submitted separately on Canvas.

   The circuit diagram is shown as follows:

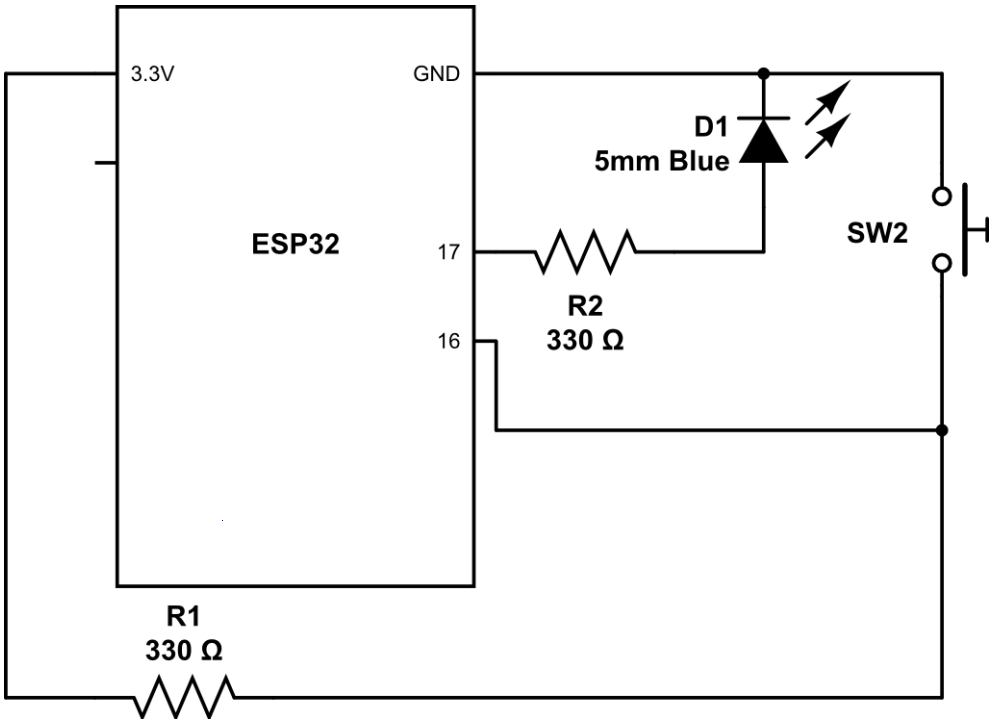


Figure 1 Circuit Diagram of 4.1.1

2. **Add a potentiometer in a voltage divider circuit to be read as an analog signal and control the 50% duty cycle blinking speed of an LED based on the reading. Submit your code for this, a drawing of your circuit, and a video link of your LED as you turn the pot.**

   The code is submitted separately on Canvas.

   The video is in the link:

   https://drive.google.com/file/d/121-RcGom4o9vUW74v06DTM9xLCEcrqjS/view?usp=sharing

   The circuit diagram is shown as follows:

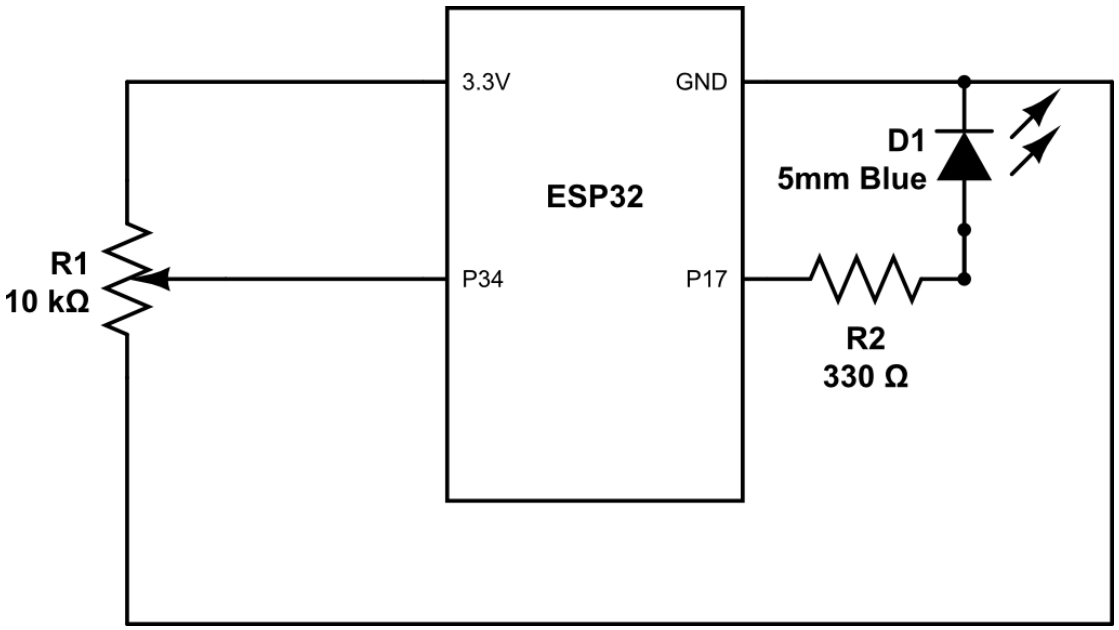


Figure 2 Circuit Diagram for 4.1.2

3. UDP peer-to-peer communication

Partner: Shallchee Shih

We together write the AP mode code and Station mode code. The two copies of code is submitted separately on Canvas.

The video is in the link:

Video part1:

https://drive.google.com/open?id=1rN19aRkWyEq7EvyCQeKXVPb0-uBmQjD2

Video part2:

https://drive.google.com/open?id=1U9wGTNqeYzeRpjhAmGiVFWdVHN5y2_Pn

The circuit diagram is shown as follows:

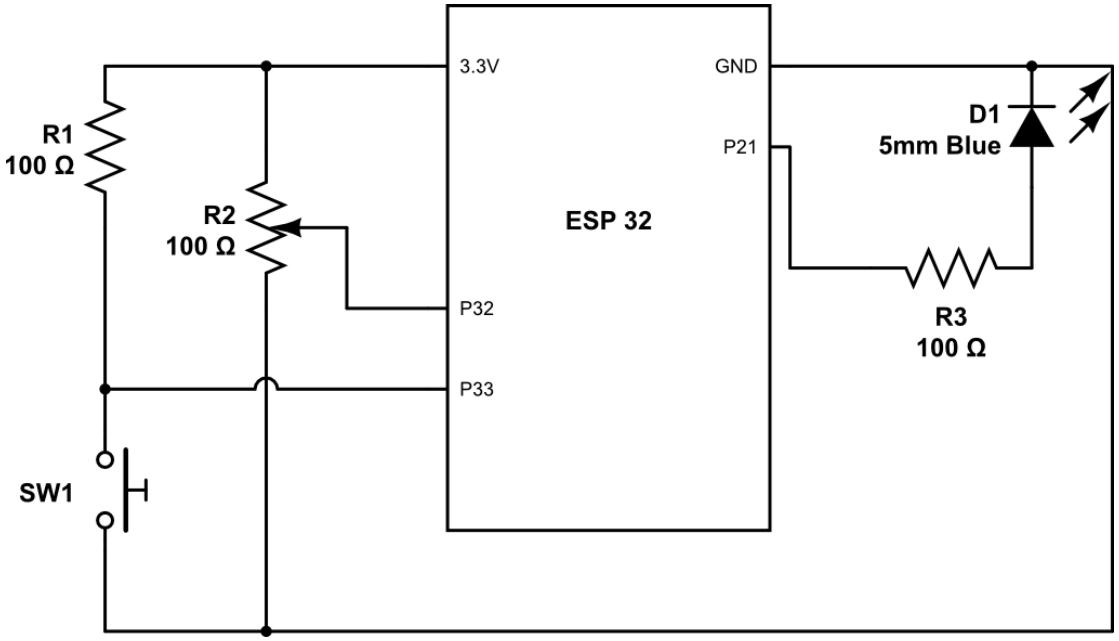


Figure 3 Circuit Diagram for 4.1.3

4. **Form your team and discuss your car design and what you will need to do to control the car. Sign your team up on Canvas including a creative name. Submit a list of your team members and your ideas for your car design and control.**

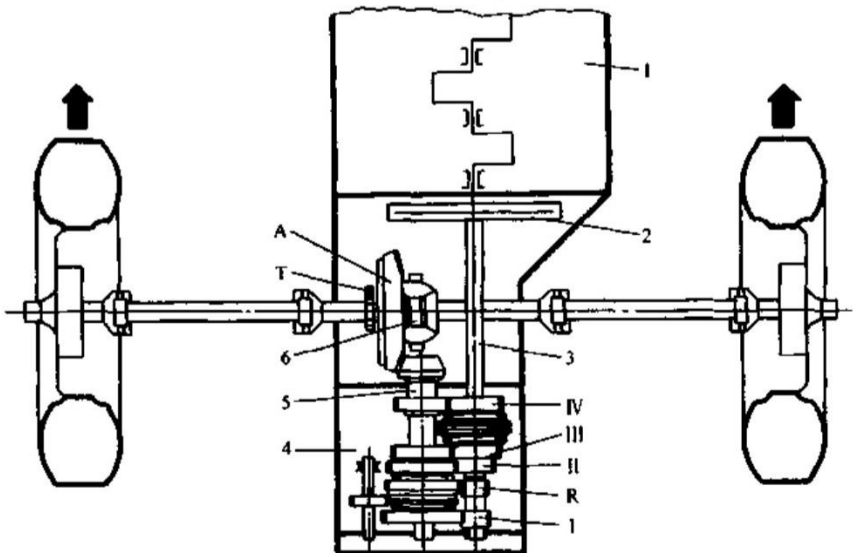
   Group Member: Yuchen Sun, Zhiyuan Yang, Shallchee Shih.

   Group Name: Mario Kart 510.

Control of Car:

For this part, we plan to create a front-wheel drive vehicle.

The symbolic representation of a general FF passenger car could be expressed as follows:

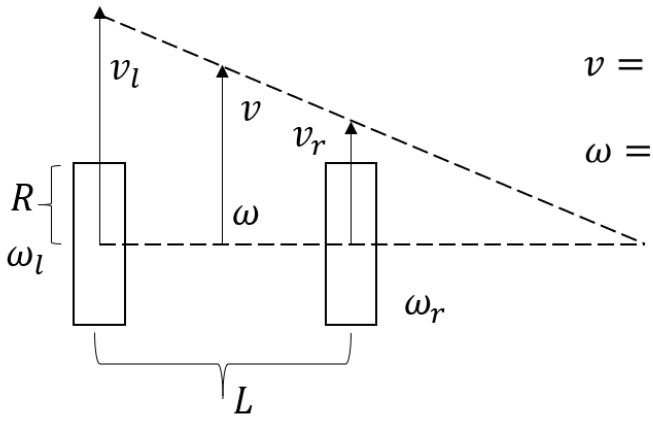


1- The engine 2- The Clutch 3- Transmission Input Shaft 4-Transmission 5- Transmission Output Shaft 6- Differential

We plan to mount the 2 motors on the front-wheel respectively to drive the whole car. The motors are mounted on the frame of the car and the shafts the motors are directly connected to the front wheels so that we could cancel universal joints and transmission shafts in the normal car.

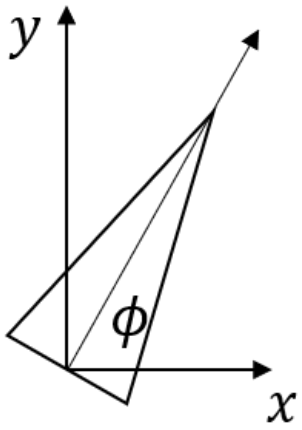
By mounting the motors respectively to the front wheels, we could write code to control the speed of the motor so that the speed, the torque and the steering of the car could also be controlled. In this case, we do not need to design the mechanical parts like transmission and differential, etc.

Since we plan to use the motor to control all the motions of the car, we could therefore cancel the mechanical steering system as well. When the two wheels have different speed, the car will yaw in a certain angle. Since we plan to cancel the mechanical steering system, the differential steering method should be applied in the motor car. The theory of differential steering could be described as follows:



$$v = \frac{R}{2}(\omega_r + \omega_l)$$

$$\omega = \frac{R}{L}(\omega_r - \omega_l)$$



$$\dot{x} = v\cos\phi$$
$$\dot{y} = v\sin\phi$$
$$\dot{\phi} = \omega$$

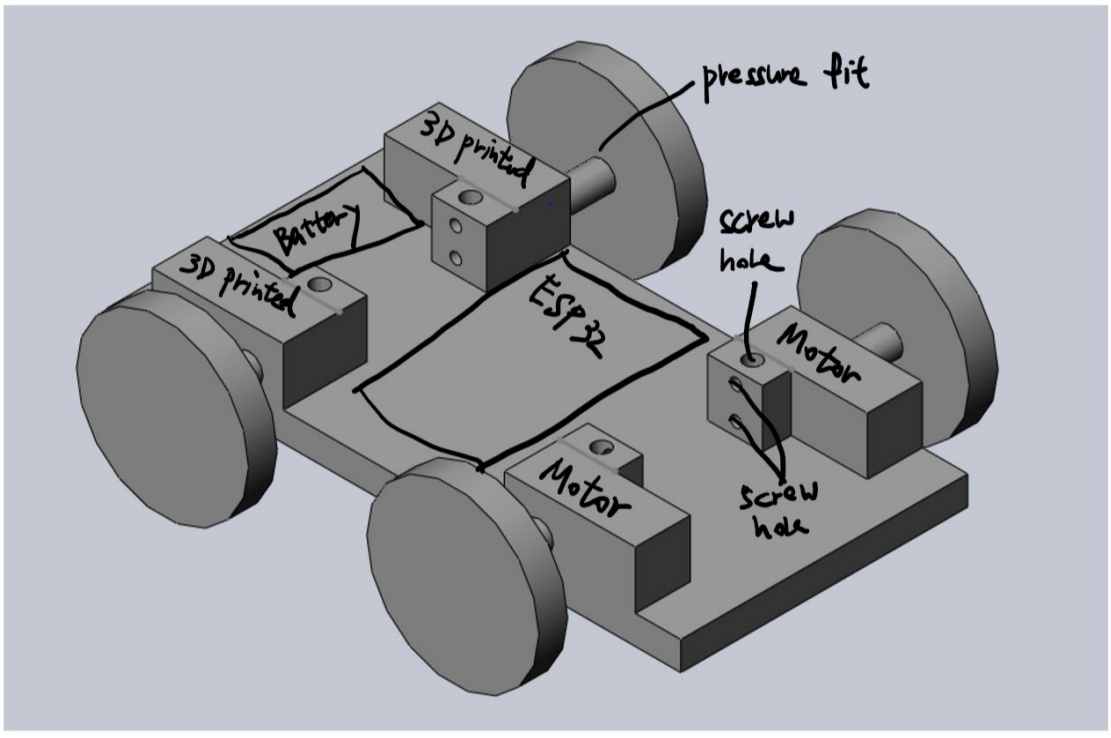
Therefore, the velocity distribution of the motor could be expressed as follows:

$$\dot{x} = \frac{R}{2}(\omega_r + \omega_l)\cos\phi$$
$$\dot{y} = \frac{R}{2}(\omega_r + \omega_l)\sin\phi$$
$$\dot{\phi} = \frac{R}{L}(\omega_r - \omega_l)$$
$$v_r = \frac{2v + \omega L}{2R}$$
$$v_l = \frac{2v - \omega L}{2R}$$

For the Remote Controller part, we plan to use the Analog 2-axis Thumb Joystick with Select Button + Breakout Board. There are two DOF of the Joystick, and therefore we could remote control the steering of the car.

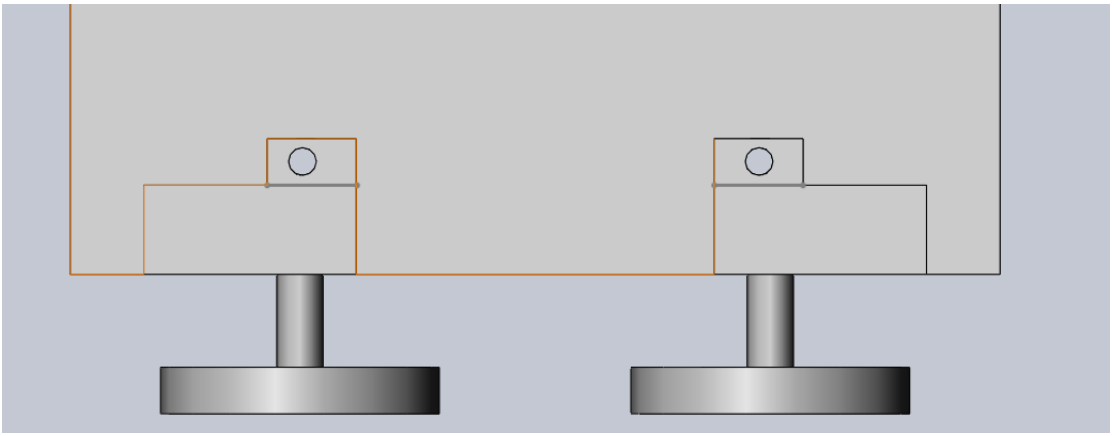
We are planning to use batteries to power the car. The motors have rated voltage: 3V/6V, Current: ≤180mA/≤250mA. We will use H-bridge motor driver or current sensor if necessary. The ESP32 and two motors will be powered by 5V battery.

Mechanical Design:



ESP32 and Battery box are mounted on the profboards

Top View:



Bottom View: