

Smart RC Toy Car

Tim Gayed

Advanced Microprocessors

Final Project

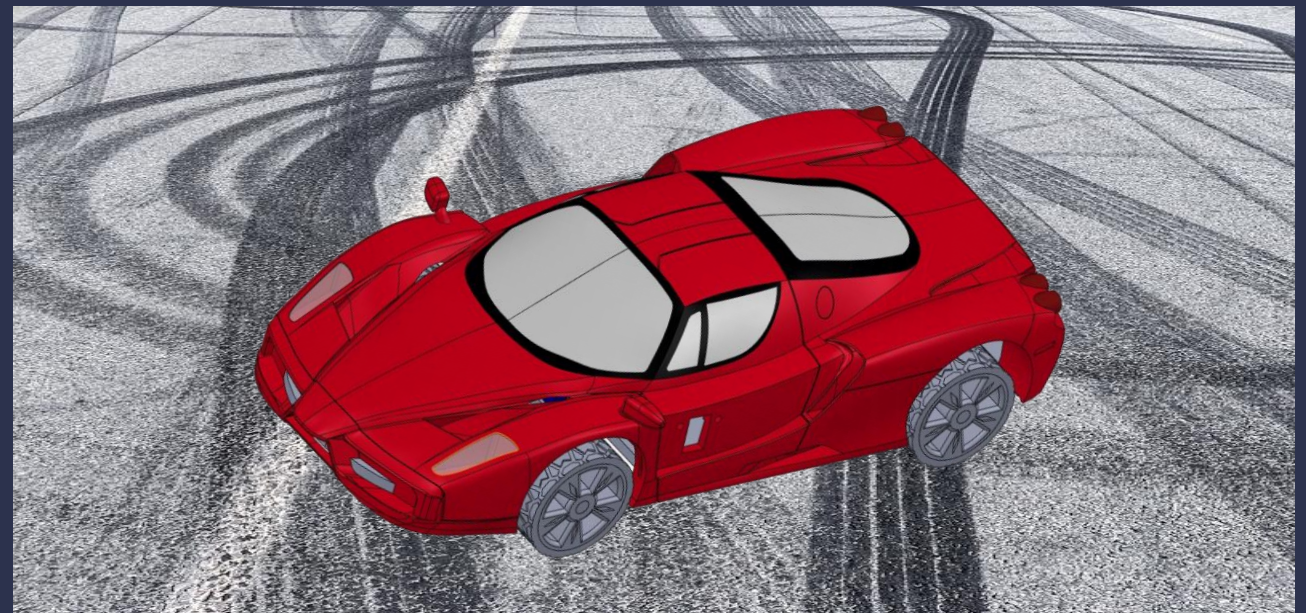
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Goal:

To Produce 2 models of affordable RC Toy Cars with an emphasis on raw performance and smart features. Target Age: Range 12+ Non-Educational

KEY Features:

- 4x 10,000 RPM Brushless motors – AWD or RWD Direct Drive
- 4x Proximity Sensors for smart parking, smart braking, and obstacle avoidance at low speeds
- LED Brake Lights
- 20 MPH top Speed (With quad ESC*)



Amazon RC Car Comparison

BEZGAR REMOTE CONTROL CAR LICENSED RC SERIES, 1:24 SCALE REMOTE CONTROL LAMBO AVENTADOR SVJ ELECTRIC SPORT RACING HOBBY TOY CAR MODEL VEHICLE FOR BOYS,GIRLS,TEENS AND ADULTS GIFT (ORANGE)

PRICE TAG: $41.99

TOP SPEED: 4 MPH

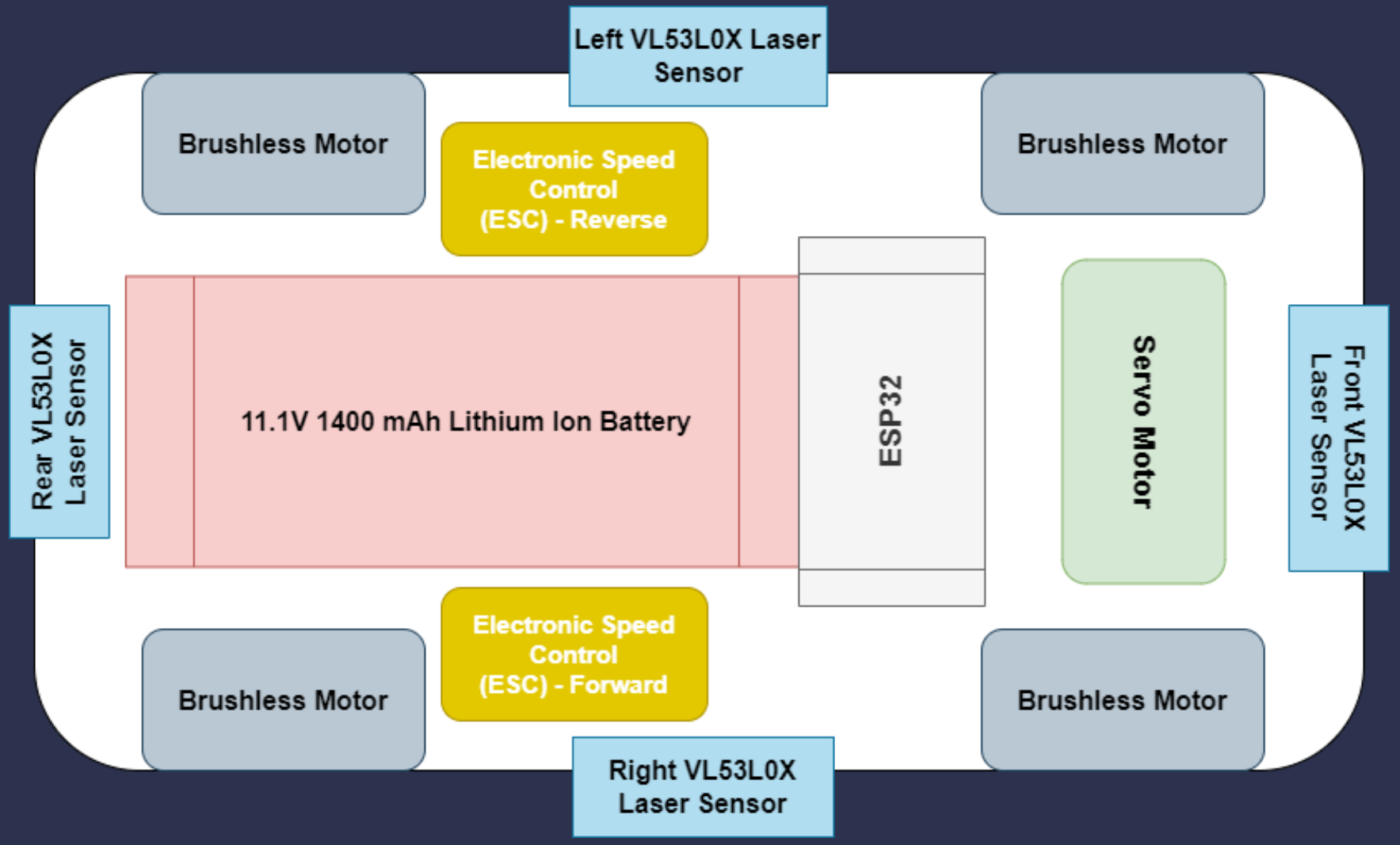


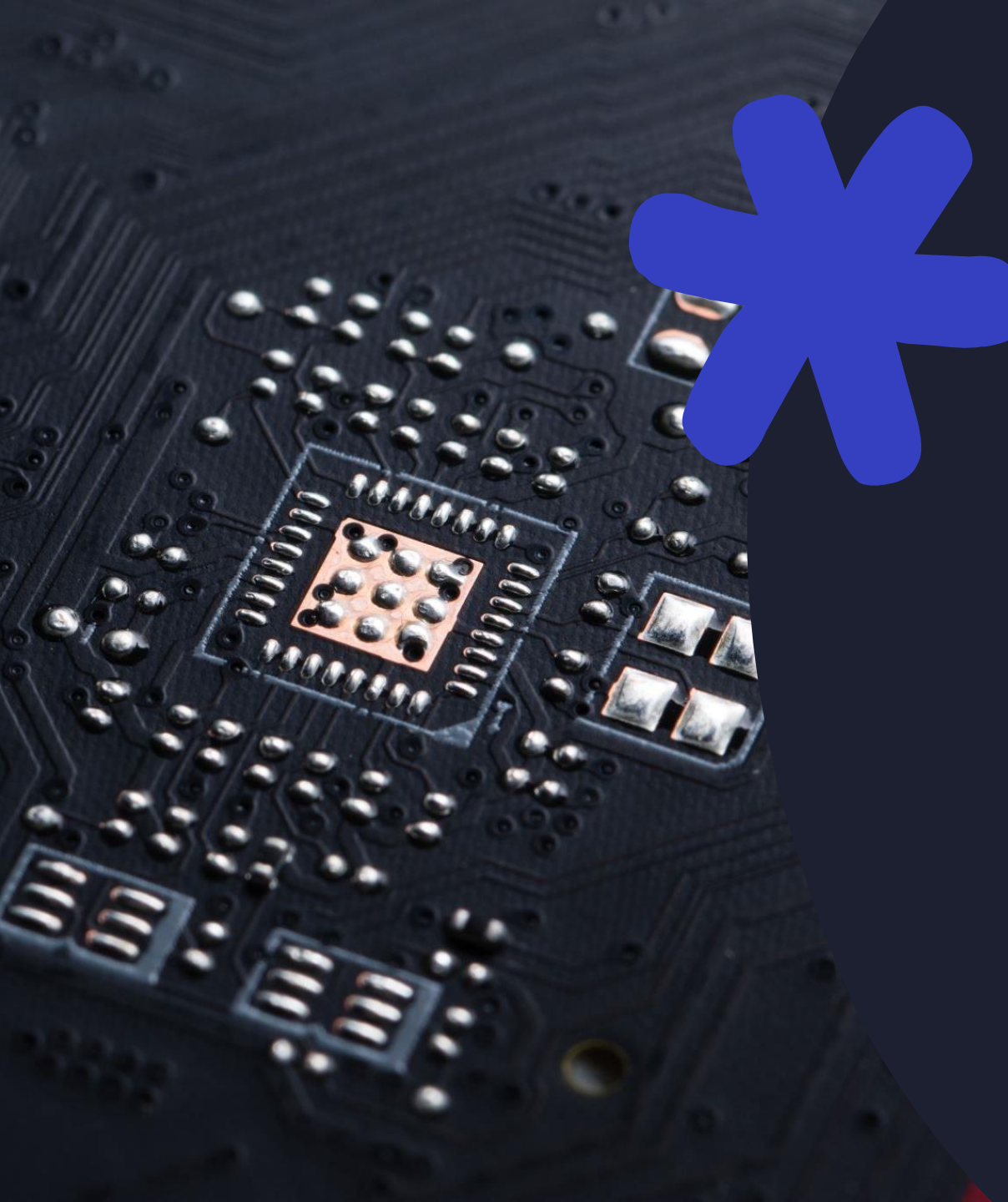
Brand	BEZGAR
Toy vehicle form	Car
Material	Plastic, Acrylonitrile Butadiene Styrene
Color	Orange
Age Range (Description)	Kid

About this item

- 【OFFICIALLY LICENSED BY LAMBOR】 1/24 scaled back on the real Lambor Aventador SVJ; model Lambor measures in 7.3 x 3.6 x 1.9 inch; great size for inside use. We strongly stand behind each item it designs and sells. Each product we sell has passed a rigorous testing process before landing at your door. These remote control cars are wonderful gifts for kids.
- 【FULLY FUNCTIONAL BEZGAR RC CAR】 Features a delicate and smooth profile and a remote controller with functions such as forward, reverse, left and right turns; Easy to control and the Lambor RC car responds well. Lambor Aventador SVJ car simulates a really powerful engine as one can expect from a famous car. The simple dual-grip remote control and a max speed of 4 miles per hour are fun to play with.
- 【STRONG MATERIAL AND SCRATCH RESISTANCE 】 Non-toxic ABS plastic and a glossy exterior, it can hold up well through lots of crashes. Smooth flexible wheels with clear patterns and an independent suspension system can reduce the friction between the tires and floor and bring the most active suspension, so it can freely run into around the house.
- 【EXCELLENT PERFORMANCE 】 2.4GHZ frequency is the updated new feature for this RC car, which provides a stable and wider control range for the play, provides a range of up to 80ft & allows you to race at a speed up to 4mph. Requires 3 * AA Batteries for the car and 2 * AA Batteries for the remote controller; Package includes 1 * 1/24 remote control car,1 * dual-grip remote-controller, and 1 * user guide
- 【IDEAL REMOTE CONTROL LAMBOR FOR BOYS/ADULTS】 Round edges to protect children from getting an injury. The model Lambor Aventador SVJ works well on a smooth surface, suitable to play inside and outside. You not only play with it using the remote control but also place it as an exhibit on a display shelf. It is a good choice for you at various festivals.

High Level Device Layout





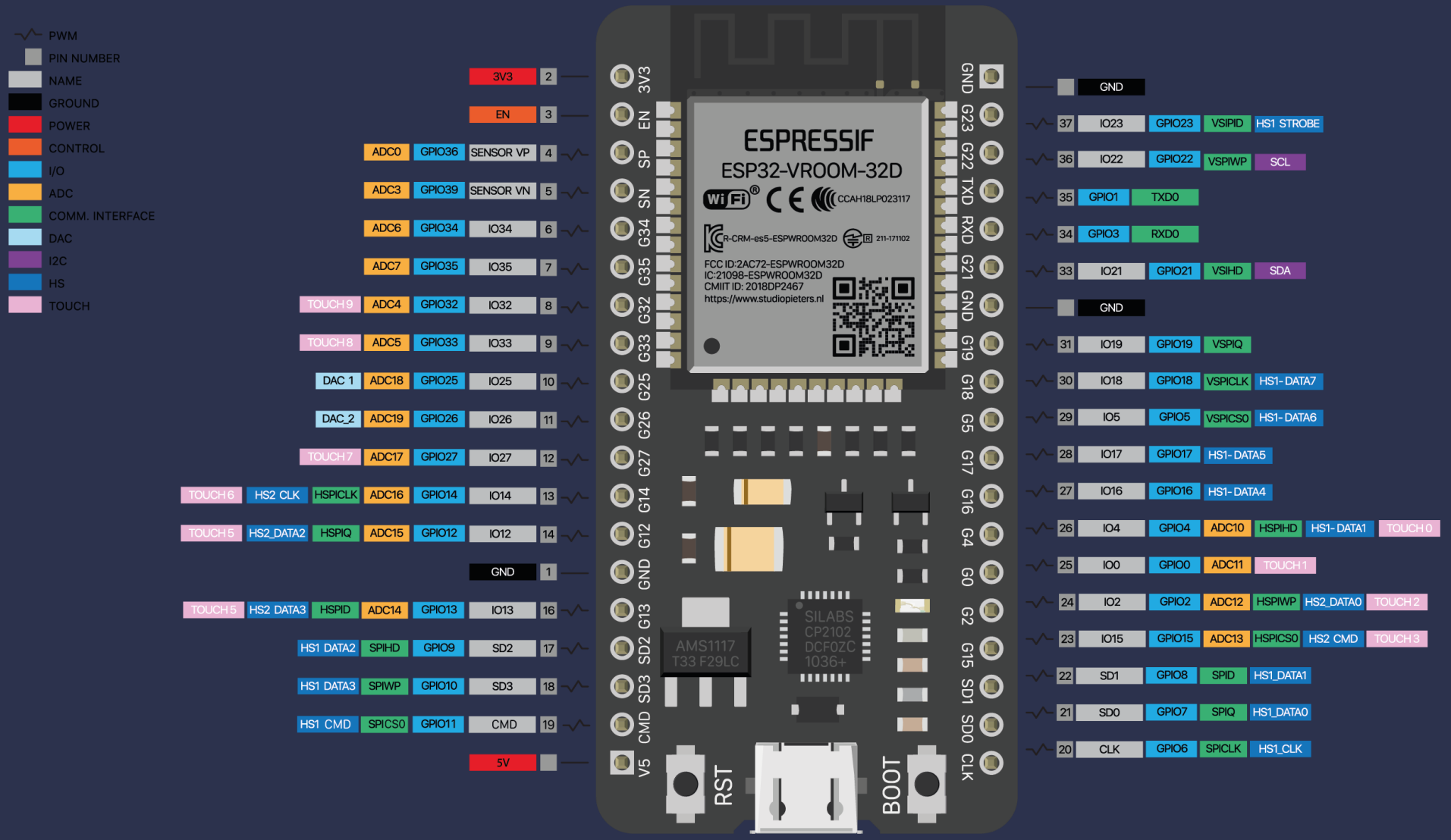
Processor

ESP-32 Processor

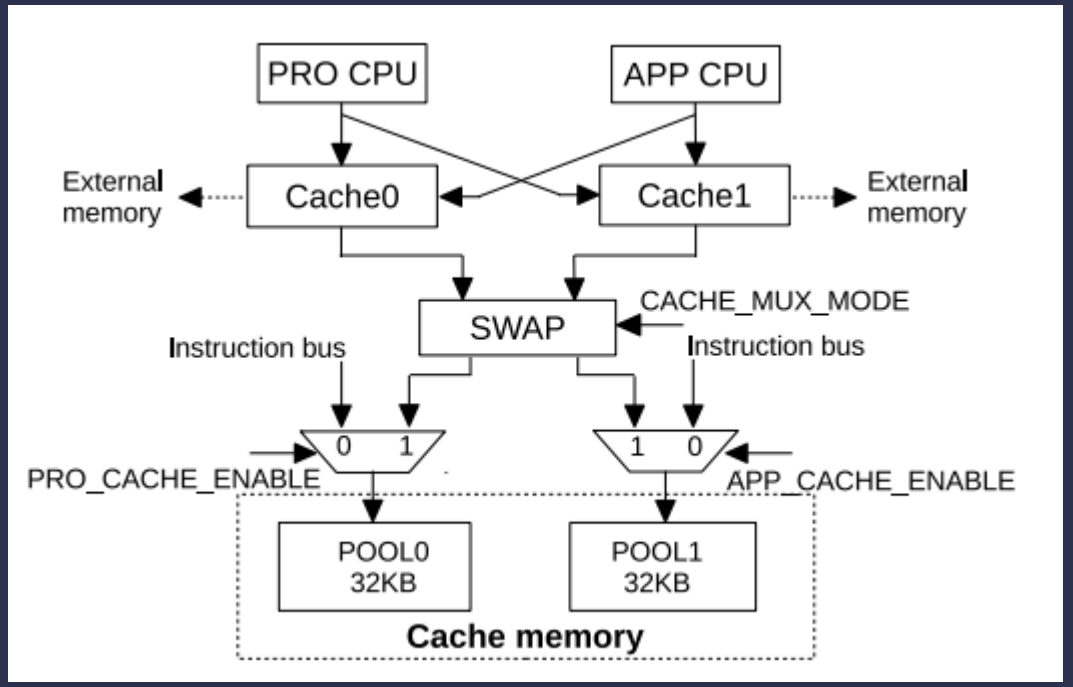


ESP32

- Built-in Bluetooth & Wifi
- Operating temperature ranging from -40°C to +125°C
- Ultra-Low Power Consumption 5v or 3.3v Input
- 36 GPIO Pins
- Serial Data (SDA) and Serial Clock (SCL) for I2C
  - 4 GPIO pins for Front/Rear Lights,
  - 3 GPIO Pins for Directional Control
  - SDA and SCL for Sensor Control

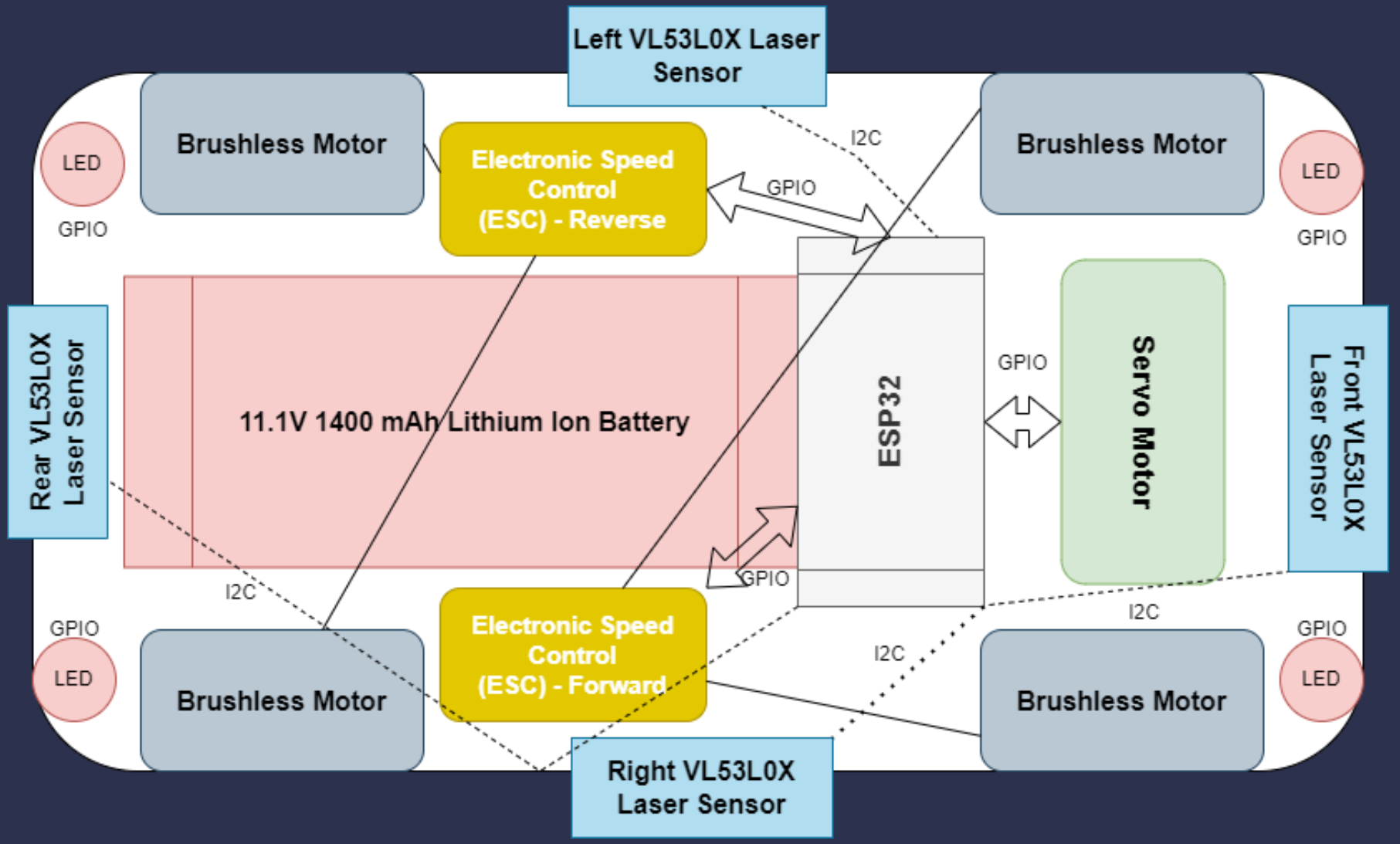


ESP32 Specs

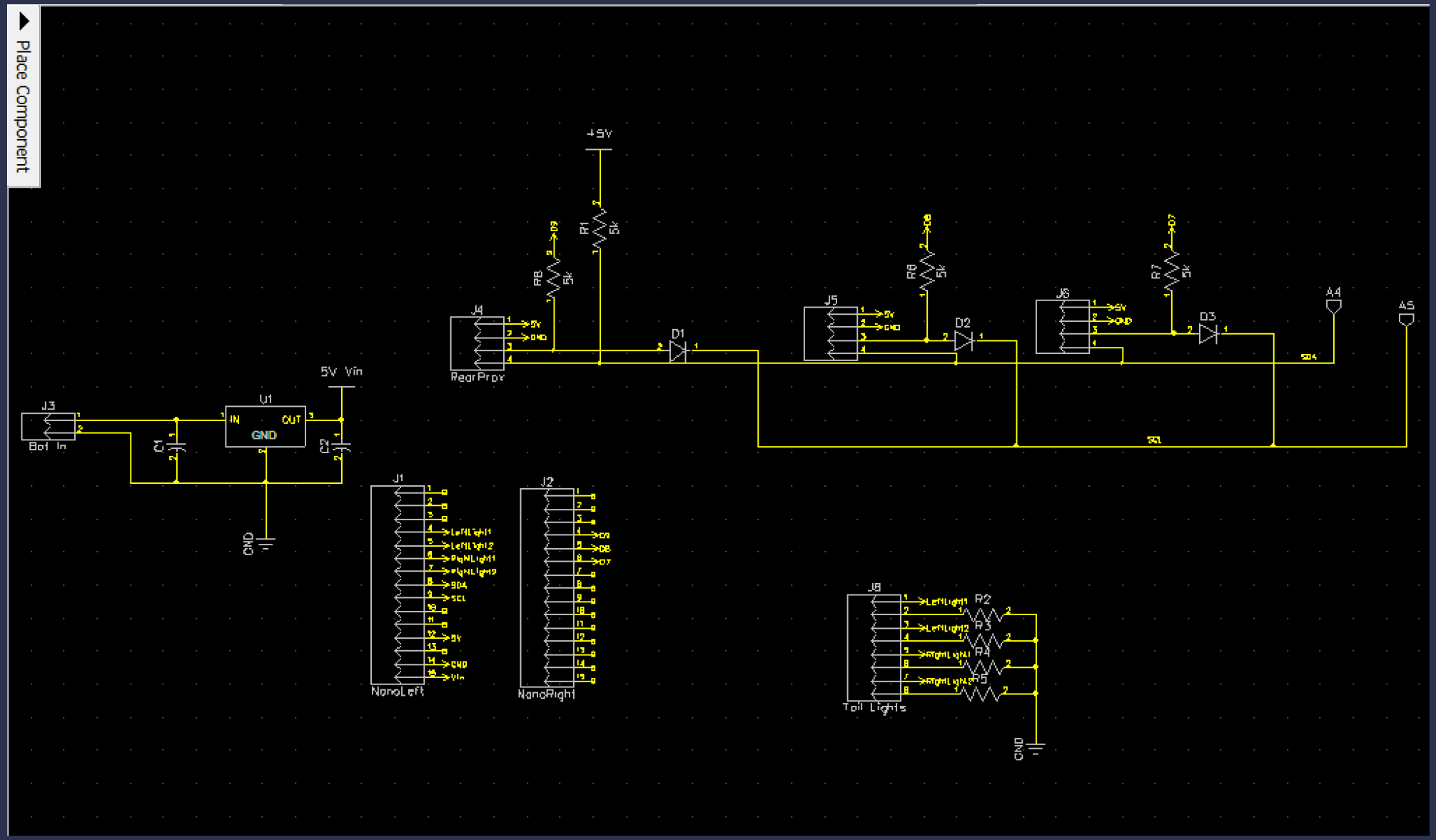


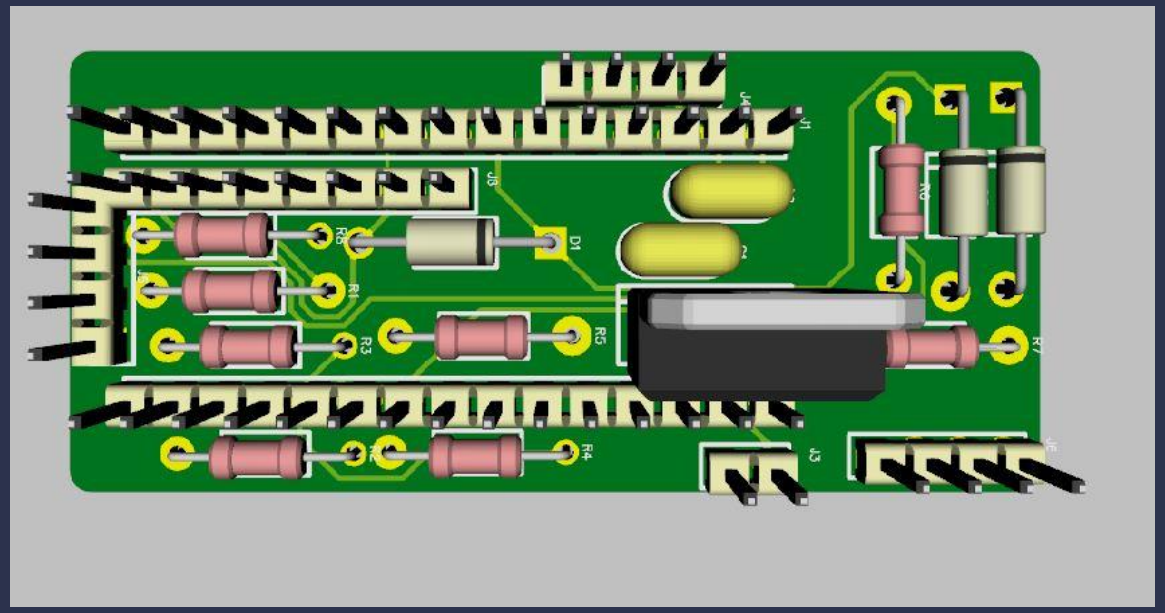
- Programmed with Arduino IDE
- 2 Pools of 32KB Cache
- Capacity of Internal ROM 1 is 64 KB.
- Features
- • Address Space
  – Symmetric address mapping
  – 4 GB (32-bit) address space for both data bus and instruction bus
  – 1296 KB embedded memory address space
  – 19704 KB external memory address space
  – 512 KB peripheral address space
  – Some embedded and external memory regions can be accessed by either data bus or instruction bus
  – 328 KB DMA address space
- • Embedded Memory
- – 448 KB Internal ROM
  – 520 KB Internal SRAM
  – 8 KB RTC FAST Memory
  – 8 KB RTC SLOW Memory
- • External Memory
- Off-chip SPI memory can be mapped into the available address space as external memory. Parts of the embedded memory can be used as transparent cache for this external memory.
- – Supports up to 16 MB off-Chip SPI Flash.
  – Supports up to 8 MB off-Chip SPI SRAM.

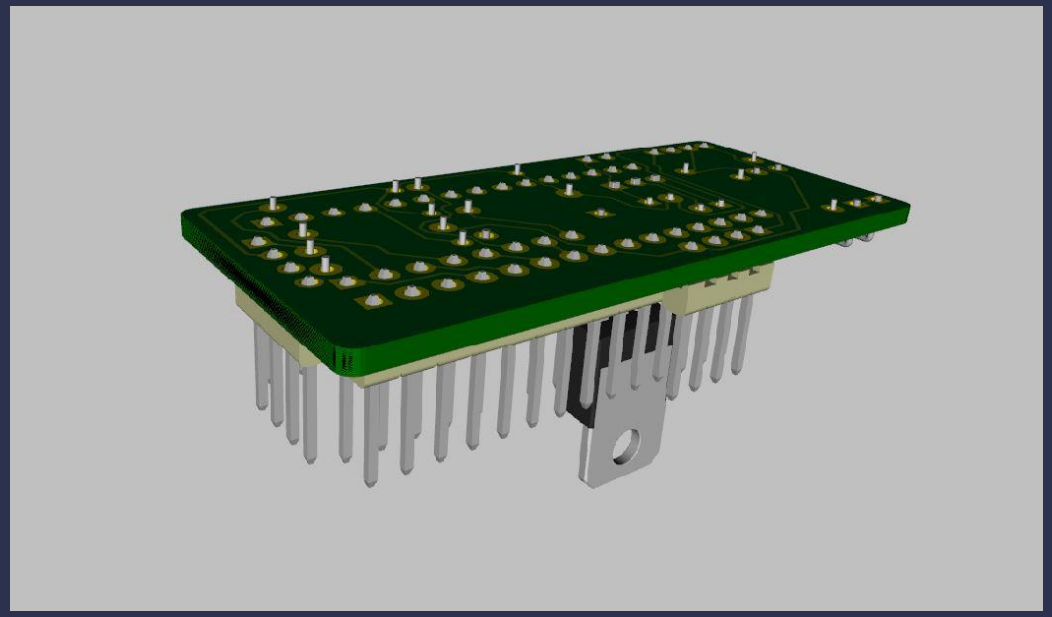
ESP32 Interface Diagram



Custom Breakout Board







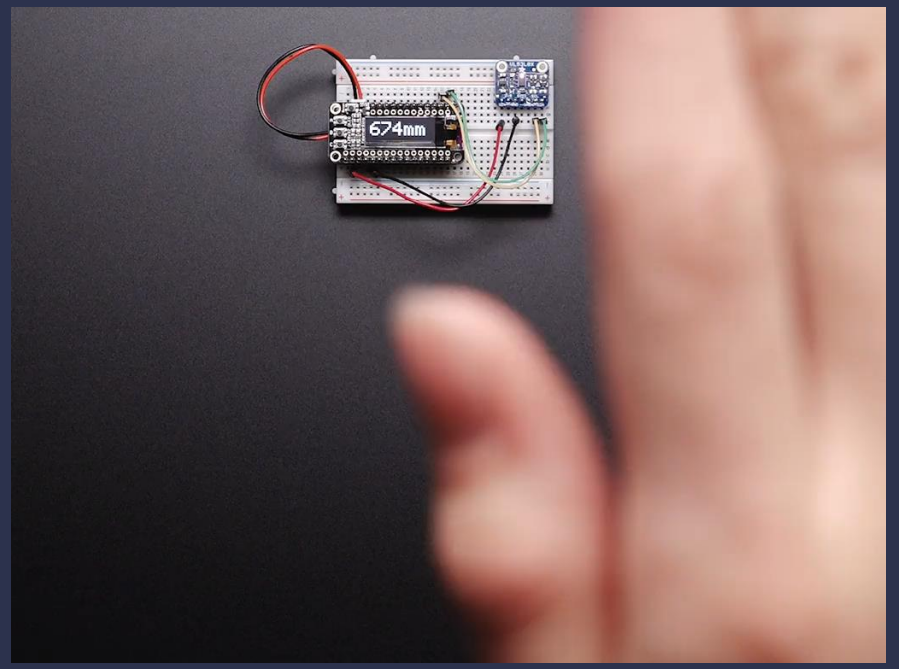


Sensors:

- 4x VL53L0X Time of Flight Laser Sensors
- Ultra Precision 30-1000mm Range
- Diverse Functionality:
  - Parallel Parking
  - Obstacle Avoidance
  - Smart Braking
- 3-5v VCC







Sensor Performance

Figure 20. Typical ranging (default mode)

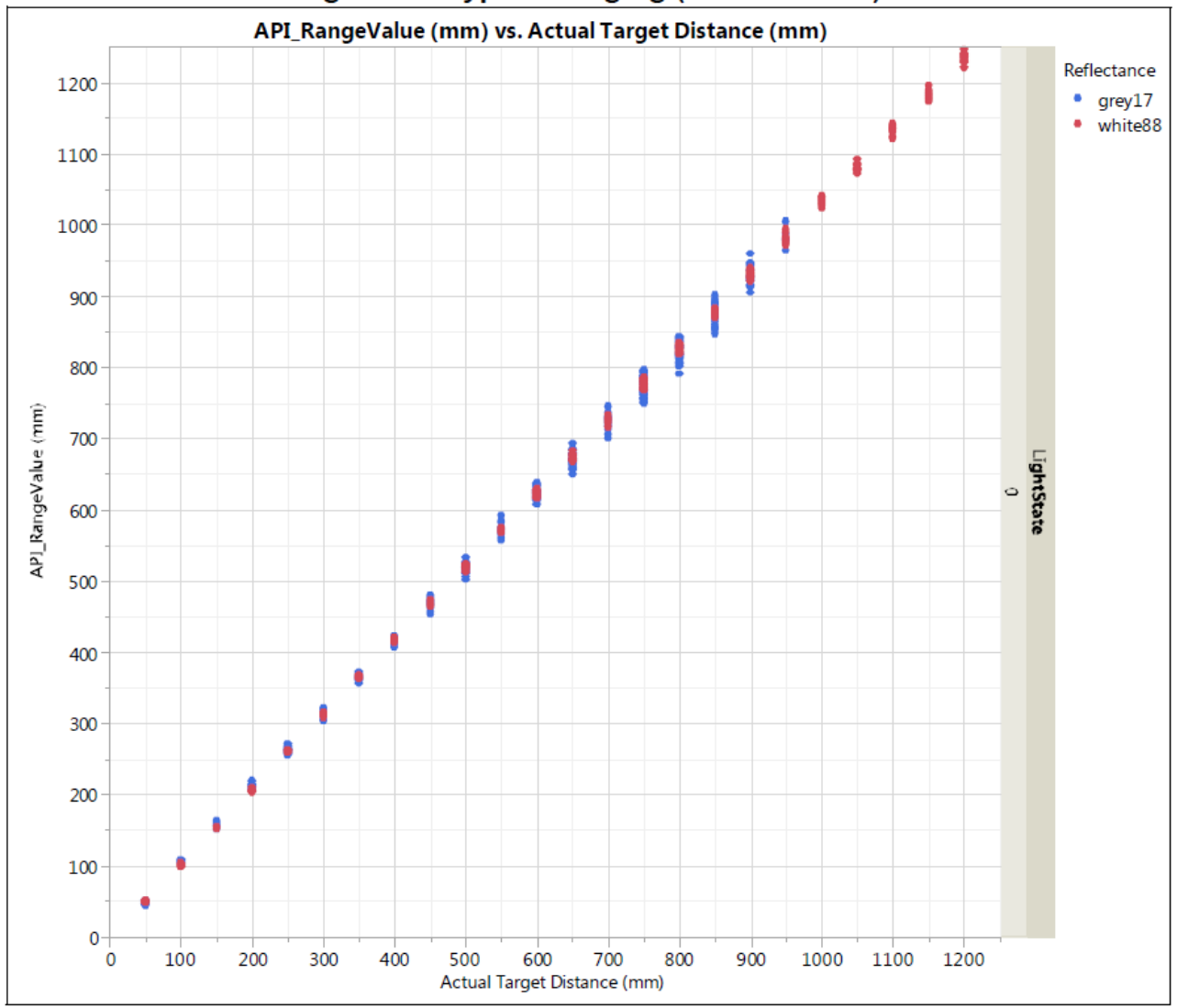


Table 12. Ranging accuracy

	Indoor (no infrared)			Outdoor		
Target reflectance level (Full FOV)	**Distance**	**33ms**	**66ms**	**Distance**	**33ms**	**66ms**
White Target (88%)	at 120cm	4%	3%	at 60cm	7%	6%
Grey Target (17%)	at 70cm	7%	6%	at 40cm	12%	9%

Table 11. Max ranging capabilities with 33ms timing budget

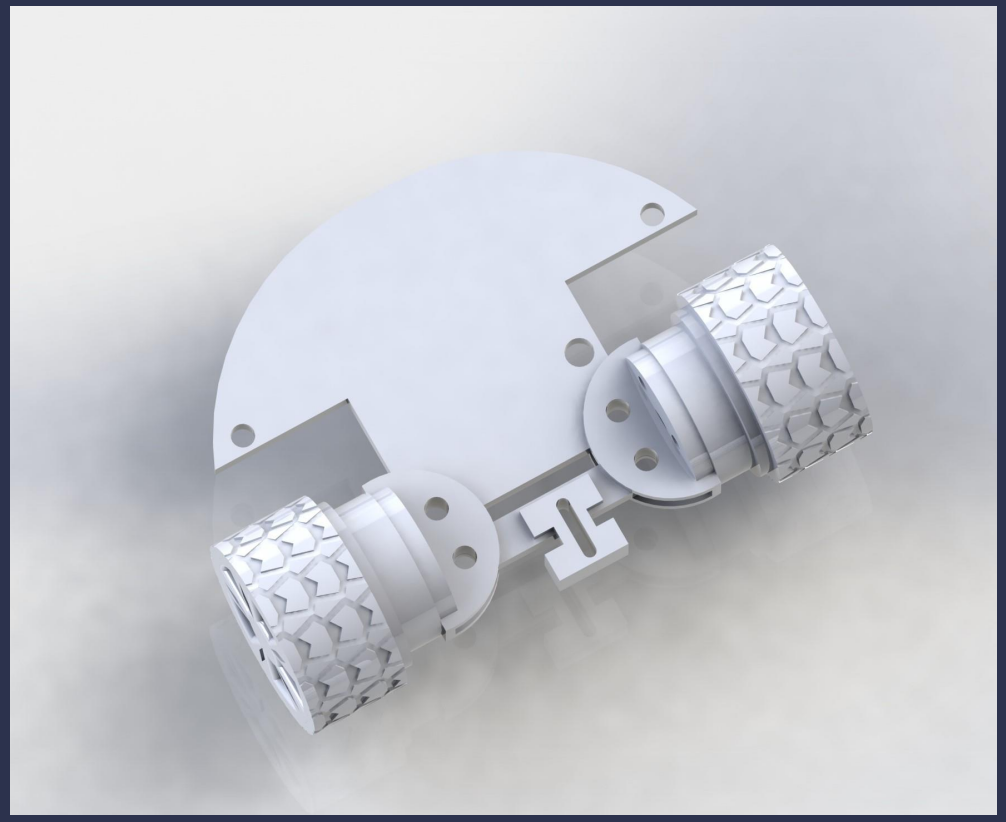
Target reflectance level (Full FOV)	Conditions	Indoor (2)	Outdoor overcast (2)
White Target (88%)	Typical	200cm+ (1)	80cm
	Minimum	120cm	60cm
Grey Target (17%)	Typical	80cm	50cm
	Minimum	70cm	40cm

Note (1): using long range API profile

Wireless Communication

- Wireless communication will be achieved via Bluetooth
- Bluetooth consumes less power than Wifi
- The simple directional commands are better suited for Bluetooth
- Can be achieved with a smartphone app
- Ideally Designing a separate custom controller

Steering





Speed Control



Bill Of Materials and Cost

Components:

- 4x Brushless motors 920KV Brushless Motors **$40**
- 1x Servo Motor (20KG Servo motor) **$17**
- 1x 11.1 V 1400 mAh Lipo Battery Dasai Airsoft Lipo Battery, 11.1V 1100mAh 25C High Discharge Shock Version Airsoft Gun Battery $15
- 1x ESP32 DEVKIT 1 **$9**
- 2x Electronic Speed Controls (2 Additional Optional for more power) **40A Brushless ESC 2-6S UBEC 3A 5V Electric Speed Controller for RC Car Boat Underwater Propeller $21 x2 = $42**

- 4x VL53L0X Laser Sensor **$13x4 = $52**

Breakout Board Components (4 Capacitors, 4 Diodes, 4 Resistors, 5v Regulator, 4 LEDs) **~$8**

Total Cost in Electrical Components $168

Bill Of Materials

Assembly Parts:

- 3D Printed Steering Assembly
- 3D Printed Rims
- 3D Printed Car Shell
- 20x Rubber O-Rings for Tires
- 2x M4 Bolts
- Paint (Optional)
- Tape (Optional
- Plaster (Optional)

Total Assembly Cost ~$15

Total Cost in Electrical Components $168

Total Cost ~$183

Total Retail Cost with 30% Profit Margin = $237.99

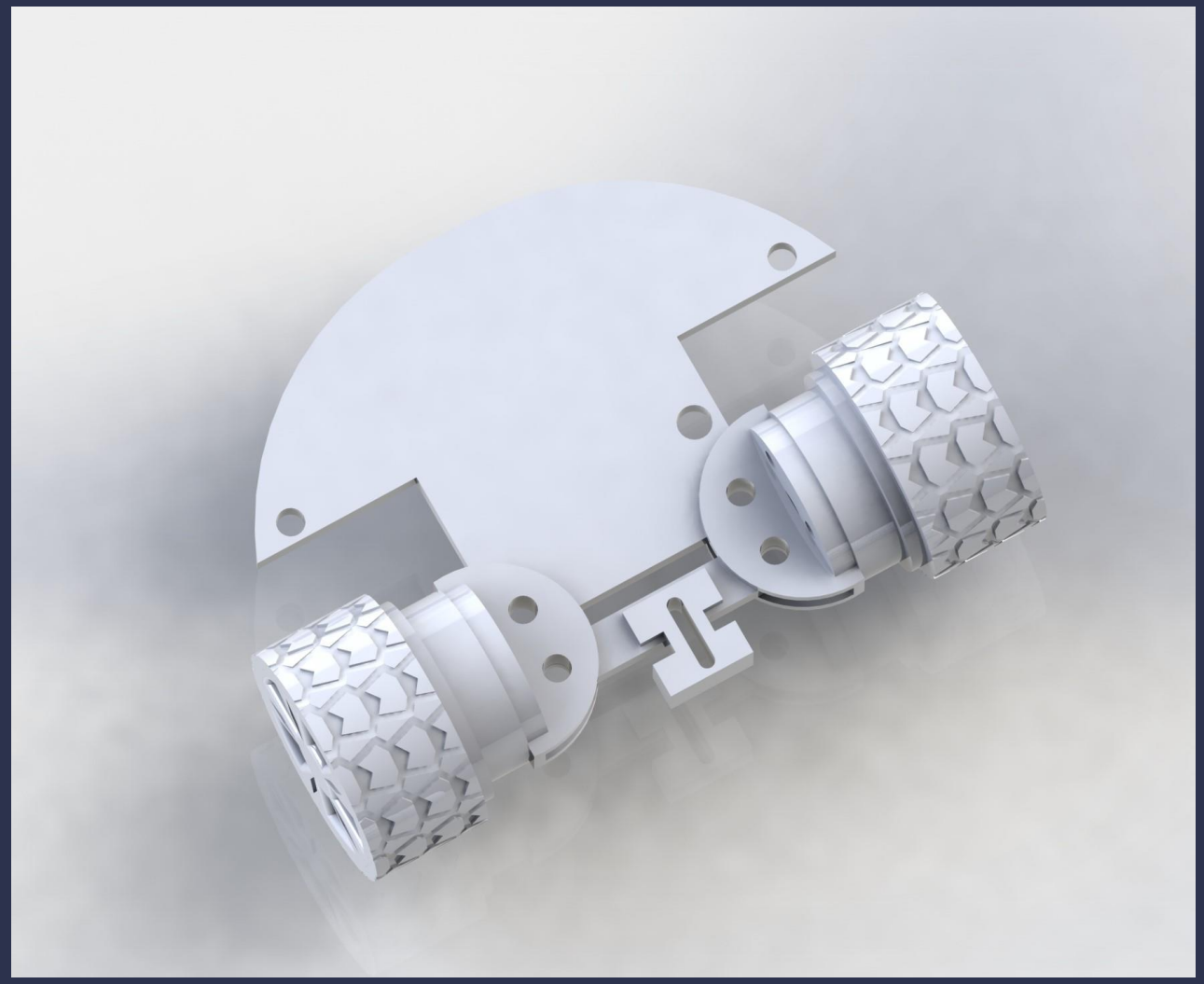
Power Consumption Calculation

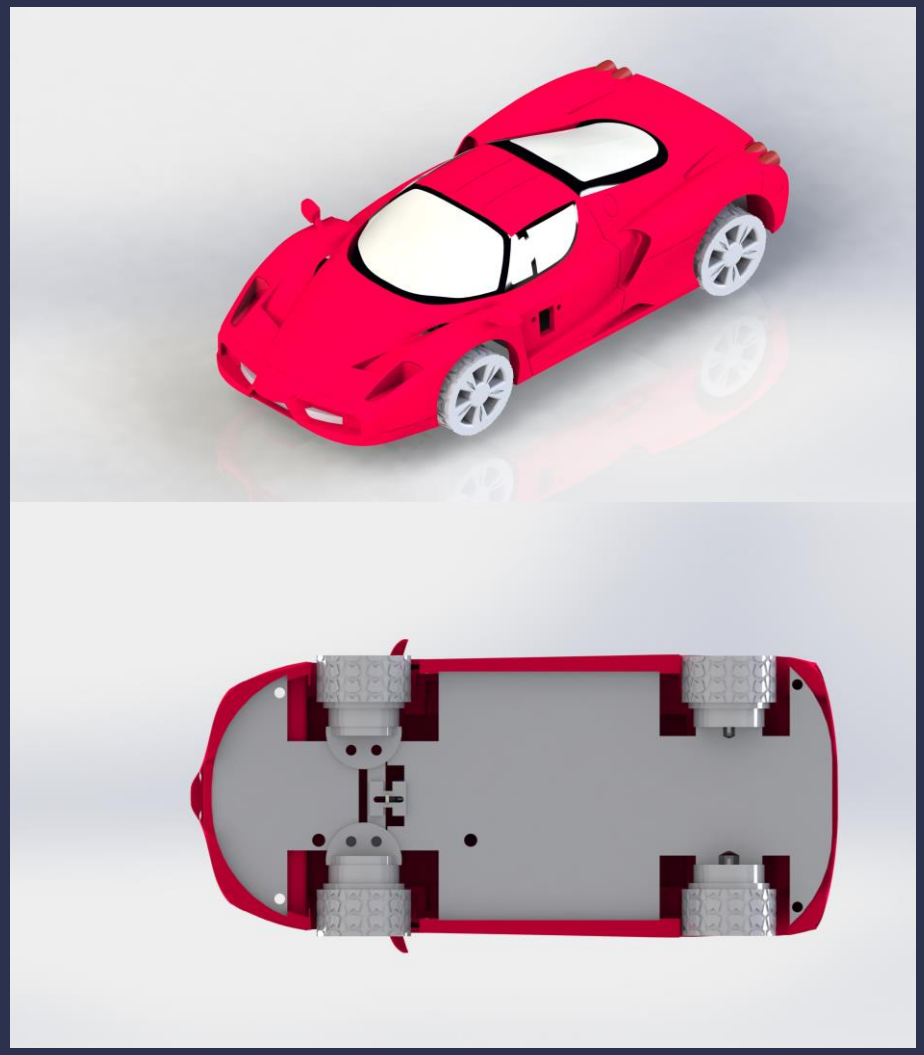
- 11 V
- 1400 mAH Battery
- = 1200 Watt Hours (Wh)
- 50C Battery
- Estimated Battery Life with 20% Safety Factor = ~30 mins

Future Work

- Car is very expensive, but can be prototyped and 3D Printed.
- Potential Added Features include custom made Remote Control
- Cost of Plastic Injection Molding would depend on volume of production

3D Models and Renders





Code

```
#include "BluetoothSerial.h"
#include <ESP32Servo.h>

BluetoothSerial SerialBT;
Servo stearingServo;

int freq = 250;
int channel1 = 4;
int channel2 = 5;
int channel3 = 2;
int channel4 = 3;
int resolution = 10;
int durtyCycle = 256;

char controllerInChar = 'S';
int speedState = 0;

int servoPin = 18;
int servoCenter = 40;
int servoRight = 50;
int servoLeft = 26;
int servoCrnt = 40;

void setup() {

  Serial.begin(115200);
  if(!SerialBT.begin("Ferrari")){
    Serial.println("An error occurred initializing Bluetooth");
  }
  ledcSetup(channel1, freq, resolution);
  ledcSetup(channel2, freq, resolution);
  //ledcSetup(channel3, freq, resolution);
  //ledcSetup(channel4, freq, resolution );
  ledcAttachPin(12, channel1);
  ledcAttachPin(27, channel2);
  //ledcAttachPin(26, channel3);
  //ledcAttachPin(25, channel4);
  ledcWrite(channel1,125);
  ledcWrite(channel2,125);
  //ledcWrite(channel3,125);
  //ledcWrite(channel4,125);

  stearingServo.attach(servoPin, 500, 2400);

}

void loop() {
  while(SerialBT.available()){
    controllerInChar = SerialBT.read();
  }
  if(controllerInChar == 'S'){
    servoCrnt = servoCenter;
  }
  else if(controllerInChar == 'R'){
    servoCrnt = servoRight;
  }
  else if(controllerInChar == 'L'){
    servoCrnt = servoLeft;
  }
  else if(controllerInChar == 'F'){
    speedState += 1;
    controllerInChar = 'S';
  }
  else if (controllerInChar == 'B'){
    speedState -=1;
    controllerInChar = 'S';
  }

  switch (speedState){
    case -1://reverse
    ledcWrite(channel1, 256);//forward
    ledcWrite(channel2, 290);//Back
    break;
    case 0://stop
    ledcWrite(channel1, 256);//forward
    ledcWrite(channel2, 256);//Back
    break;
    case 1://slow
    ledcWrite(channel1, 280);//forward
    ledcWrite(channel2, 256);//Back
```

```
    break;
    case 2:// medium
    ledcWrite(channel1, 320);//forward
    ledcWrite(channel2, 256);//Back
    break;
    case 3:
    ledcWrite(channel1, 350);//forward
    ledcWrite(channel2, 256);//Back
    break;
  }

  stearingServo.write(servoCrnt);

  Serial.print("In: ");
  Serial.print(controllerInChar);
  Serial.print("    Servo Pos: ");
  Serial.print(servoCrnt);
  Serial.print("    Speed: ");
  Serial.println(speedState);
}
```

References

- Sensor Performance
  https://chicagodist.com/products/adafruit-vl53l0x-time-of-flight-distance-sensor-30-to-1000mm
- ESP32 Pinout
  https://www.studiopieters.nl/esp32-pinout/
- ESP32 Datasheet
  https://www.espressif.com/sites/default/files/documentation/esp32_technical_reference_manual_en.pdf