Rock N' Rover

Group 15

Laila El Banna, Ryan Kohel, Sanya Wadhwa, & Michael Patalano

Meet the Team

Laila El Banna
Computer Engineering

Ryan Kohel
Electrical Engineering

Sanya Wadhwa
Computer Engineering

Michael Patalano
Electrical Engineering

Motivation & Background

- Idea stemmed from bomb defusal robots with robotic arm extensions
- The motivation was to construct a remote controlled car with a custom PCB controller and companion app based on a combination of our interests

Michael Patalano
Electrical Engineering

Goals & Objectives

- ➔ Functional Robotic Car
- ➔ Create a custom PCB Controller
- ➔ Program a Companion App to control an monitor car
- ➔ Esp32 Camera module to track car
- ➔ Meet the 3 Demonstrable Engineering Specifications

Sanya Wadhwa
Computer Engineering

Stretch Goals

- ➔ Small Turn Radius
- ➔ Music Streaming Capabilities on App
- ➔ LED lights control
- ➔ Ultrasonic Sensor for Emergency Braking

Demonstrable Engineering Specifications

Sanya Wadhwa
Computer Engineering

1. Car must be able to move in 4 Directions with 90% accuracy: Front, Back, Left & Right
2. Car must move a distance of at least 10 feet
3. Car must travel 10 feet in 10 seconds

Comparison & Selection of Hardware

Comparison & Selection of Car Kit

	ELEGOO Conqueror Robot Tank	TT04 4WD Intelligent Tracked Robot Tank	ELEGOO UNO R3 Smart Robot Car
Price	$130	$21	$80
Key Components	Arduino, Camera Module, Ultrasonic Sensor, Four Motors, Line Tracker Module, and rechargeable battery	Four Motors and Metal Frame	Arduino, Camera Module, Ultrasonic Sensor, Four Motors, and Line Tracker Module
Pros	It's a tank!	Super inexpensive and leaves room for creativity	More reasonable price and compact
Cons	Very expensive and large	Time and money gathering all of the other components	Not a tank!

Michael Patalano
Electrical Engineering

Comparison & Selection of Microcontroller

Ryan Kohel
Electrical Engineering

	ESP8266	RP2040	ATmega328P	ESP32 Series
Manufacturer	Espressif Systems	Raspberry Pi Ltd.	Atmel	Espressif Systems
WiFi?	Yes	No	Yes	Yes
Bluetooth?	No	No	No	Yes
Internal Flash Storage?	No	No	Yes	Depends on model number
SRAM Capacity	50 KB	264 KB	2 KB	520 KB
Operating Voltage	3.3 V	3.3 V	3.3 V/5 V	3.3 V
Maximum Current Draw	12 mA	50 mA	14 mA	500 mA
Price	$1.60	$0.70	$1.56	$1.85

Comparison & Selection of IR Transmitter

Ryan Kohel
Electrical Engineering

	CSL1501R3T1	VSMB10940	IN-S126ESGHIR
Manufacturer	ROHM Semiconductor	Vishay Semiconductors	Inolux
Max. Power Dissipation	100 mW	104 mW	180 mW
Max. Forward Current	50 mA	65 mA	100 mA
Max. Peak Forward Current	200 mA	130 mA	1000 mA
Forward Voltage	1.5 V	1.3 V	1.5 V
Radiant Intensity	2.5 mW/sr	3.05 mW/sr	92 mW/sr
Viewing Angle	70 degrees	75 degrees	30 degrees
Wavelength	940 nm	940 nm	940 nm
Cost	$0.71	$0.39	$0.55

Comparison & Selection of IR Receiver

Ryan Kohel
Electrical Engineering

	TSOP4838	TSOP38238	GP1UM271RKVF	IRM2638
Manufacturer	Vishay Electronics	Vishay Electronics	Sharp Microelectronics	IRM2638
Supply Voltage	3.3 V/5 V	3.3 V/5 V	5 V	5 V
Current Usage	0.45 mA	0.45 mA	0.5 mA	1.1 mA
Maximum Transmission Distance	24 meters	30 meters	8.5 meters	12 meters
Cost	$1.17	$0.99	$0.604	$0.239

Comparison & Selection of Motor Driver IC

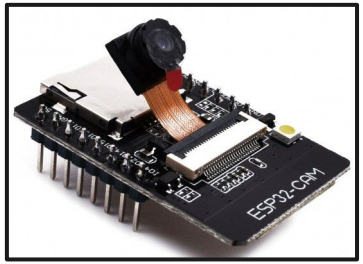
Ryan Kohel
Electrical Engineering

	DRV8835DSSR	TB6612FNG	STSPIN948	MTS2916A
Manufacturer	Texas Instruments	Toshiba	STMicroelectronics	Microchip Technology
Max. Motor Voltage Input	11 V	15 V	58 V	40 V
Logic Voltage	3.3 V/5 V	3.3 V/5 V	3.3 V	5 V
Max. Output Current	1.5 A	1.2 A	4.5 A	0.75 A
Cost	$1.58	$1.97	$5.02	$1.29

Comparison & Selection of Camera

Michael Patalano
Electrical Engineering

	ESP32 CAM	ESP32-WROVER Camera-V1.5
Manufacturer	AI Thinker	Elegoo
Processor	ESP32-S	ESP32-D0W DQ6-V3
Micro SD	External	Internal
Max. Output Current	9	22
Cost	$2	$8



ESP32-CAM

ESP32-WROVER Camera-V1.5

Comparison & Selection of Software

Comparison & Selection of Software IDEs

Laila El Banna
Computer Engineering

Tool	Ease of Use	Popularity	Complexity
Arduino IDE	**4/5 - User-friendly for beginners**	**5/5 - Popular in the maker community**	**3/5 - Straightforward for basics, complex for advanced**
BLE	**3/5 - Moderately challenging for beginners**	**4/5 - Widely used in IoT and mobile apps**	**4/5 - Complex due to pairing, security, and compatibility**
MIT App Inventor	**5/5 - Visual drag-and-drop interface**	**4/5 - Popular among educators and hobbyists**	**2/5 - Lacks flexibility for complex projects**
Blynk	**4/5 - Intuitive with drag-and-drop widgets**	**4/5 - Popular in IoT community**	**3/5 - Requires technical expertise for advanced features**

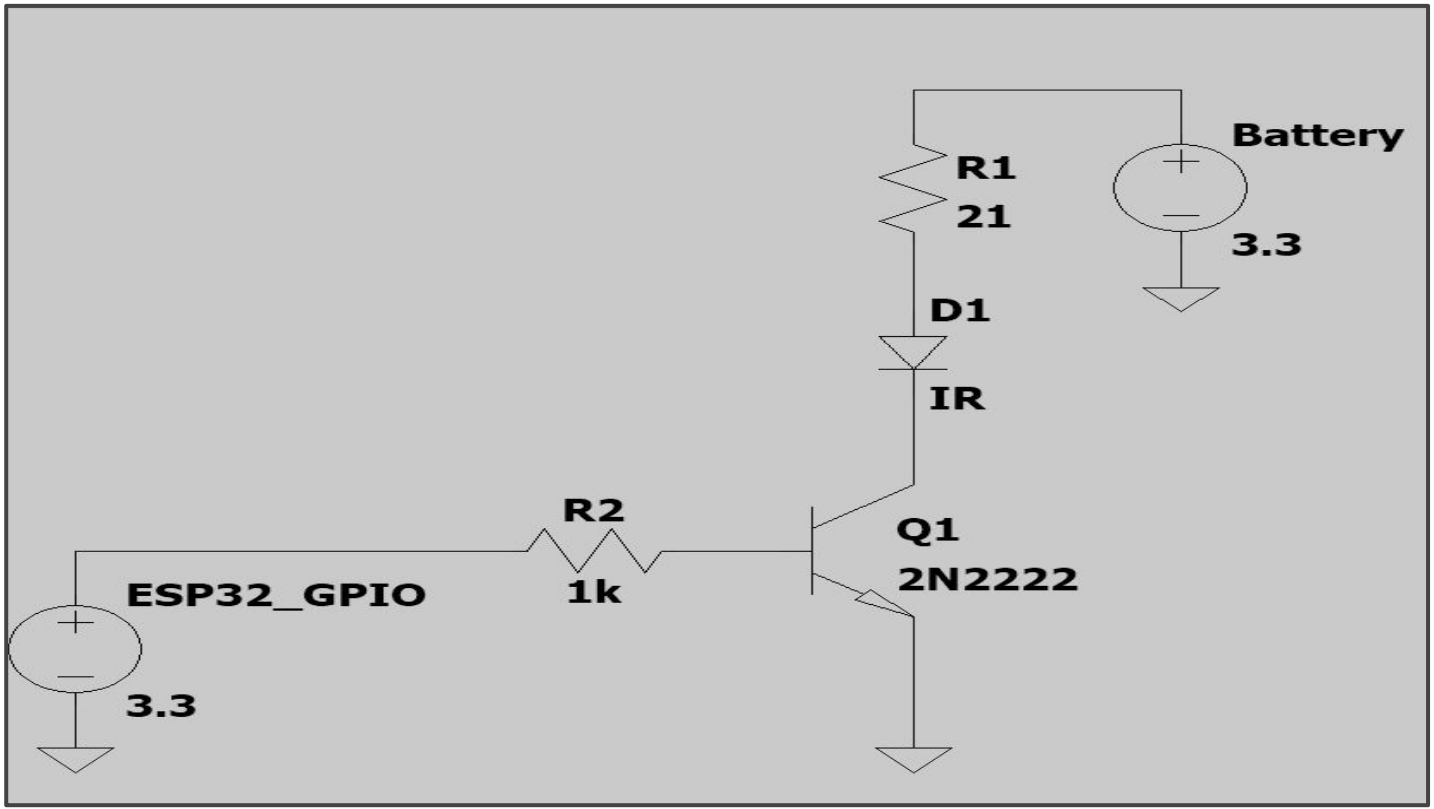
Hardware Design

IR Transmitter Design Problem

Ryan Kohel
Electrical Engineering

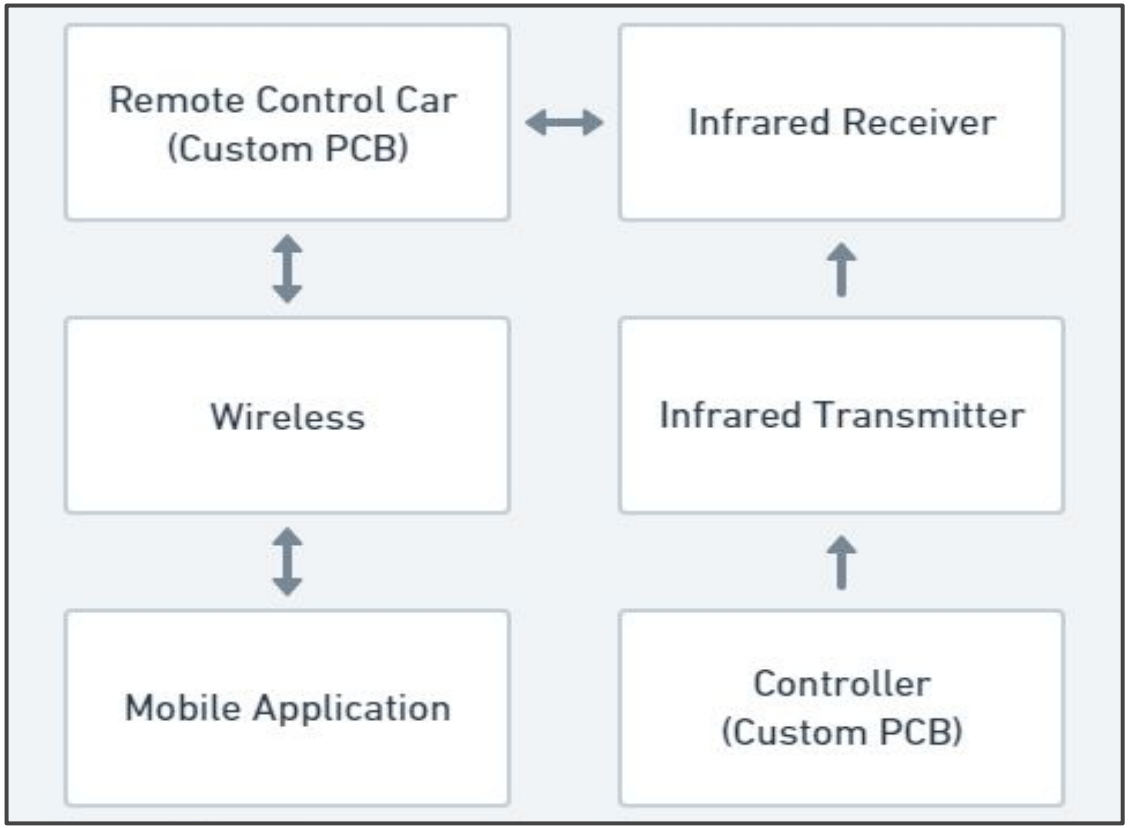
- Each GPIO pin is rated for a maximum current of 40 mA.
- The IR transmitter can draw up to 100 mA.
- In order to prevent damage to the microcontroller, the current flowing through the GPIO pins must not exceed 40 mA.
- If we limit the current flowing through the IR transmitter to 40 mA, it will limit the brightness of the IR transmitter and reduce the range.
- Therefore, there are two options: limit the current to 40 mA OR use a transistor to switch the IR transmitter ON/OFF.

IR Transmitter Design Solution



Ryan Kohel
Electrical Engineering

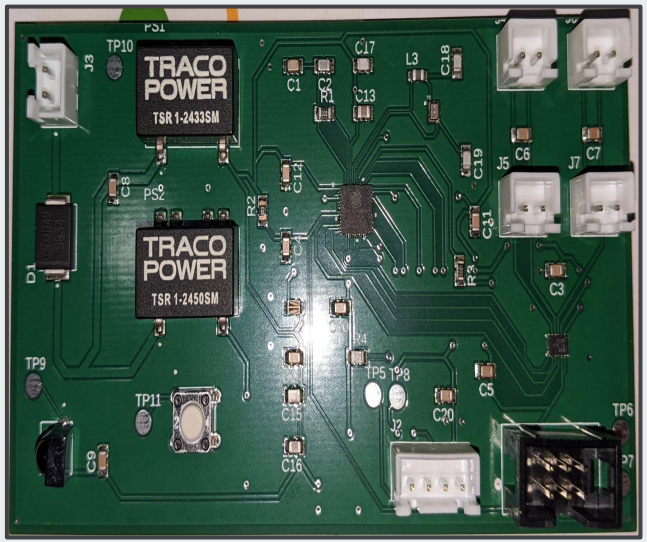
Final Hardware Design Diagram



Michael Patalano
Electrical Engineering

PCB Design

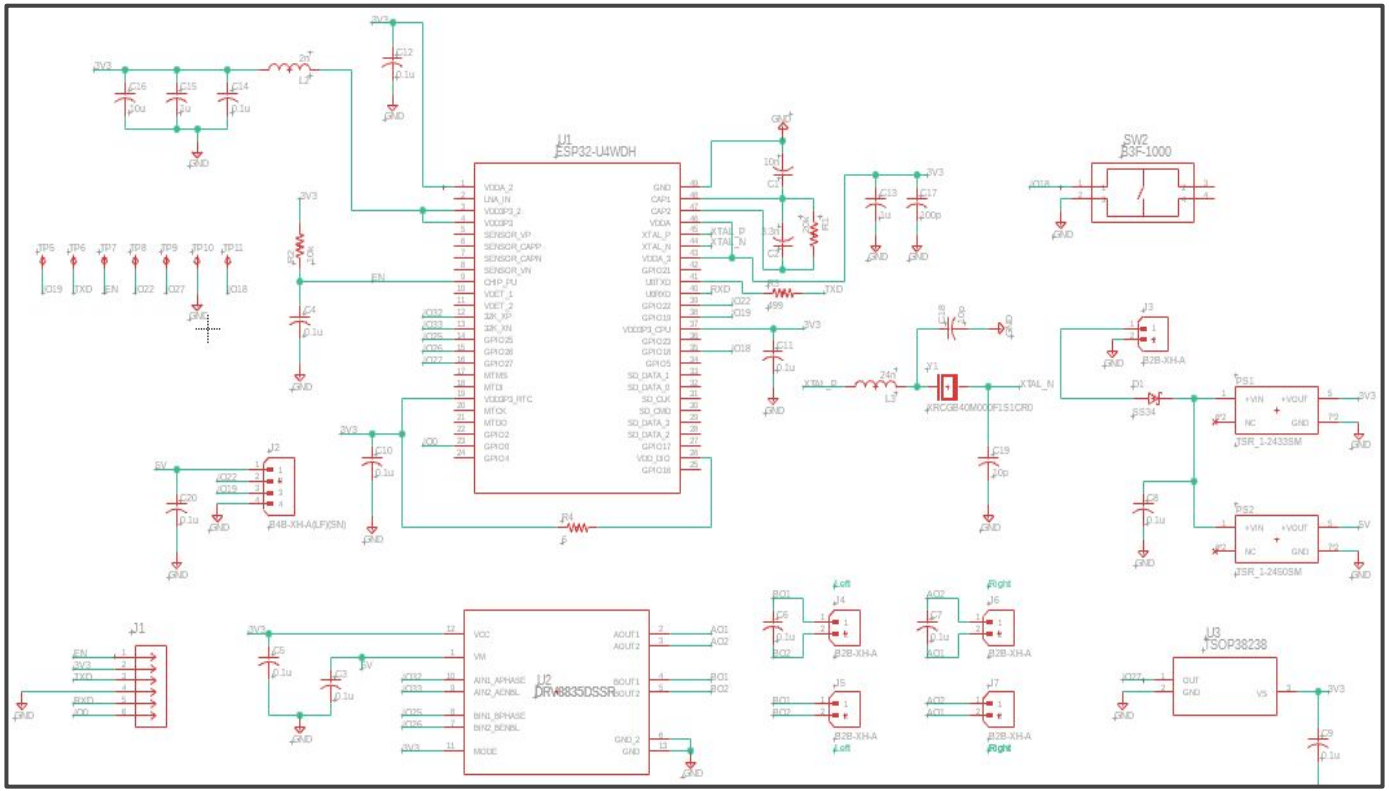
PCB #1: Car PCB



Ryan Kohel
Electrical Engineering

- This PCB will be used to control the remote control car’s peripherals.
- This PCB consists of:
  - Connector For 7.4V Battery
  - 5V Step-Down Converter
  - 3.3V Step-Down Converter
  - ESP32 MCU
  - IR Receiver
  - Connector For Ultrasonic Sensor
  - Connector For Camera
  - Connectors For DC Motors
  - Motor Driver IC

PCB #1 Schematic



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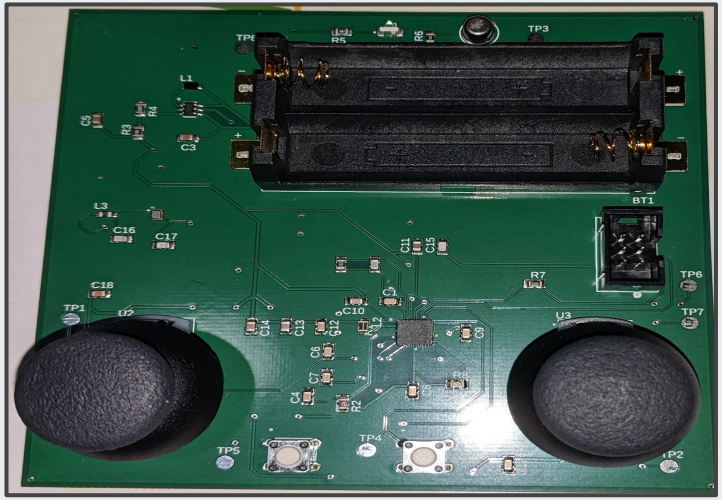
Electrical Engineering

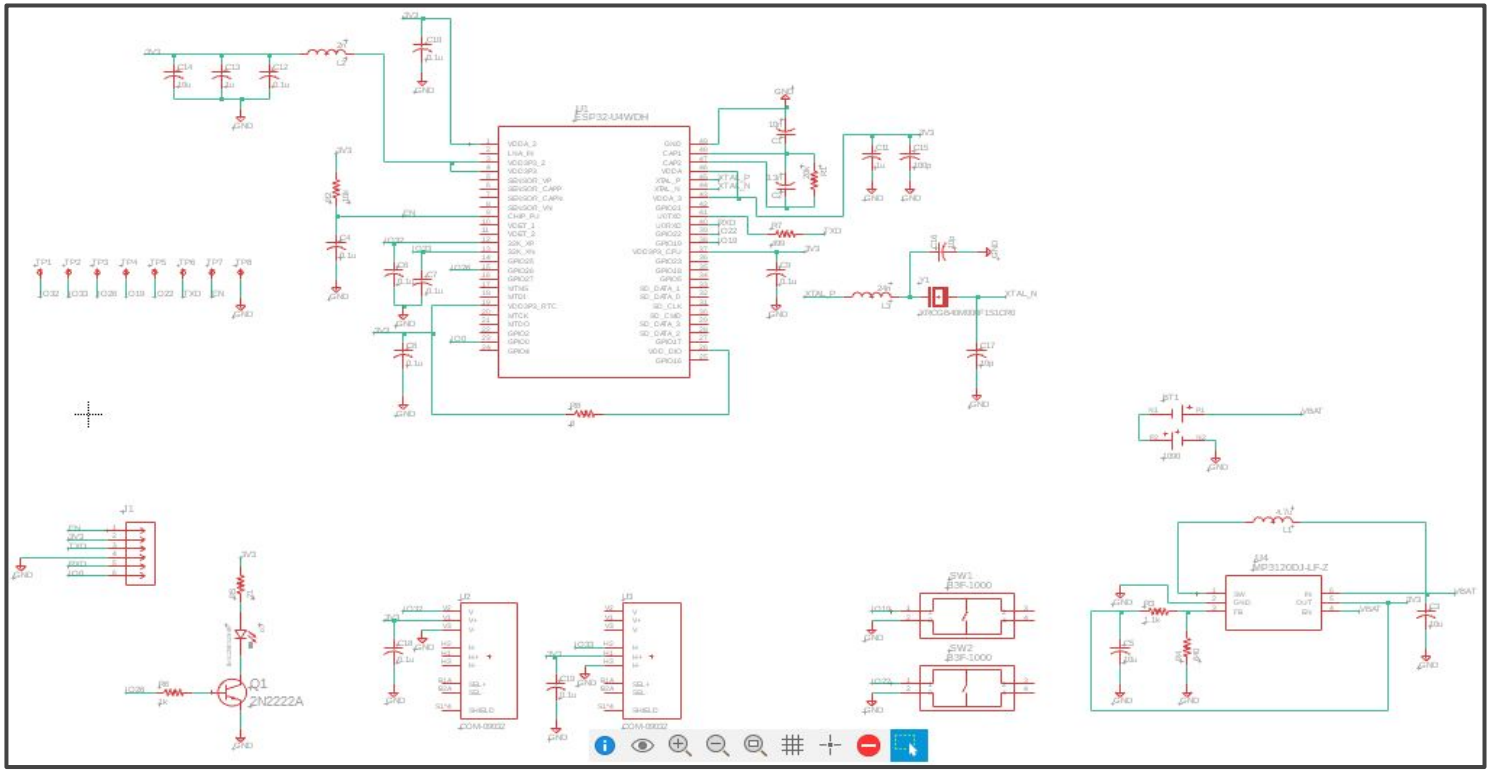
PCB #2: Remote Controller PCB



Ryan Kohel
Electrical Engineering

- This PCB will be used to send commands via IR transmission to the remote control car to steer the remote control car.
- This PCB consists of:
  - AA Battery Holder
  - 3.3V Step-Up Converter
  - ESP32 MCU
  - Buttons
  - Analog Sticks
  - IR Transmitter

PCB #2 Schematic



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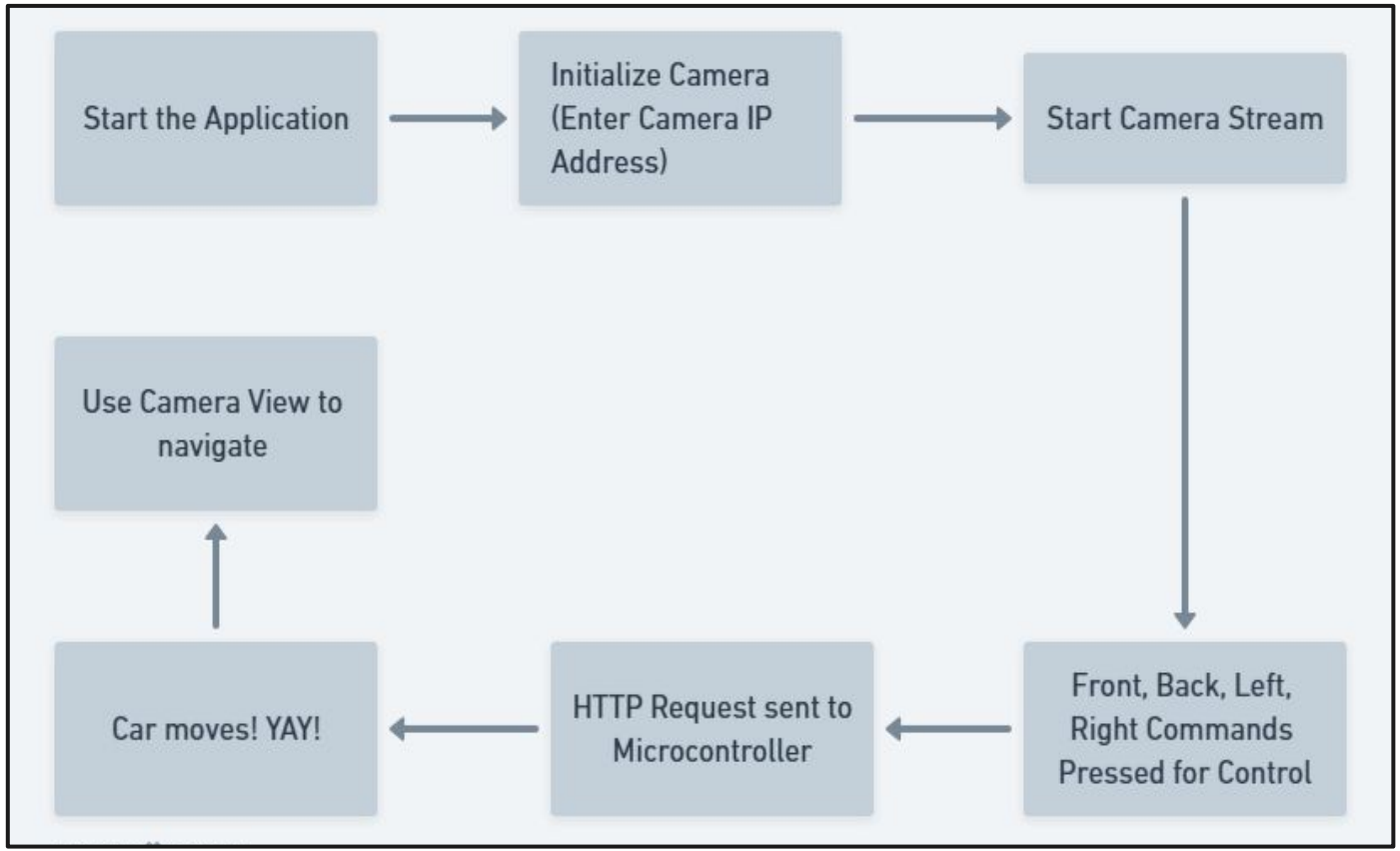
Electrical Engineering

Software Design :
Rock N' Rover App

Software Design Diagram



Sanya Wadhwa
Computer Engineering

Sanya Wadhwa
Computer Engineering

Technologies Used

1. Figma - App Prototyping

2. Visual Studio - App Design, Programming, and Testing in HTML, CSS, and Javascript

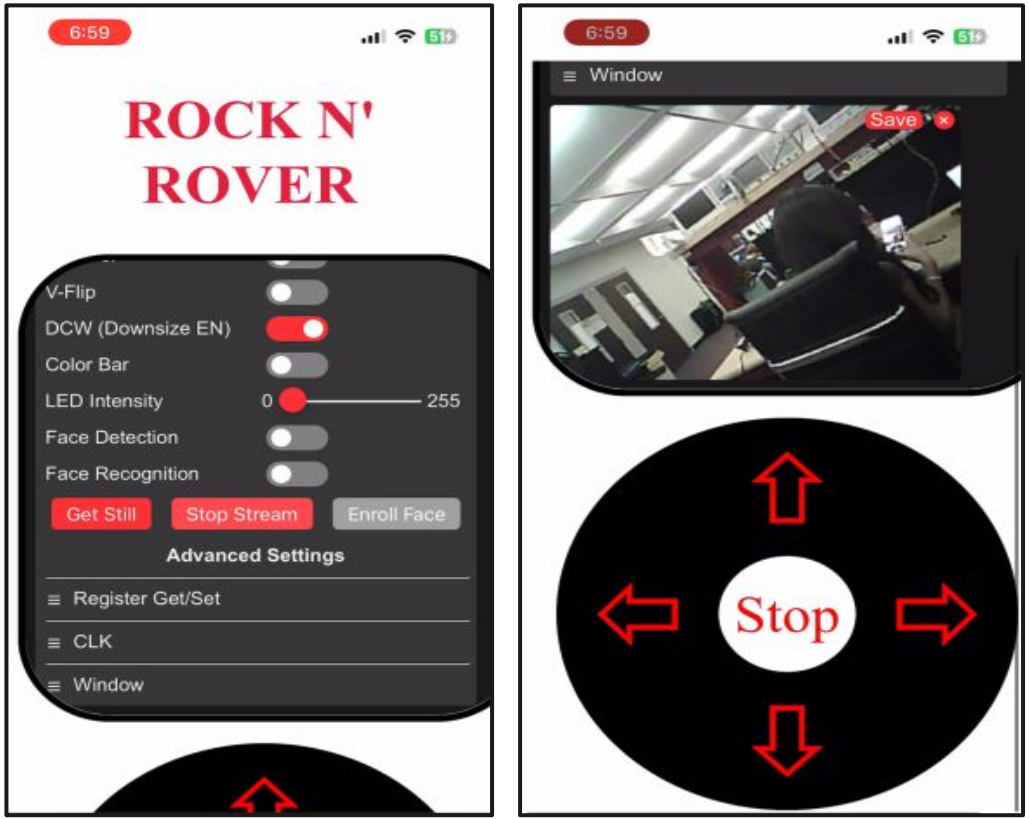
3. Arduino IDE - Programming and Testing App with Microcontroller

Rock N’ Rover App UI

Laila El Banna
Computer Engineering

- **User-Interface**: The landing page has intuitive buttons for maneuvering the RC car
- **Camera Connection**: A search box at the top allows users to enter the car's camera IP address for real-time video feed

Rock N’ Rover App UI



Sanya Wadhwa
Computer Engineering

- **Upon entering the correct IP address:** The camera settings will appear, allowing users to configure their camera.
- **From the camera settings:** Users can start the video stream and begin navigating using the provided controls.

App Design Problem

Laila El Banna
Computer Engineering

- Driving the car with the IR receiver allowed for the car to stop when no IR signal was received
- Our app included a stop button to manually halt the car
- These differences caused conflicts, so we rebuilt the app from scratch to avoid issues
- MIT App Inventor was too restrictive for our needs

Current App Design

Sanya Wadhwa
Computer Engineering

- We changed our approach from MIT App Inventor to hard coding with HTML, CSS, and Javascript
- The code sends Http requests to the car when a “command” (the action when Front, Left, Back, Right, & Stop Buttons are pressed)

Hardware & Software Testing

Hardware Testing

Ryan Kohel
Electrical Engineering

To test the hardware:

- We wrote test code to turn the motors on and off in a loop to verify the motors and the motor driver IC were working
- We wrote test code to check that the IR receiver was receiving commands
- We wrote test code to send out a “test” command in a loop to verify that the IR transmitter on the remote controller was working properly

Software Testing

Laila El Banna
Computer Engineering

- **Driving the Car**: Testing the responsiveness and accuracy of the car's movements
- **Video Integration**: Ensuring the car's video feed displays correctly in the app
- **Control Transmission**: Verifying that commands from the app are sent and executed by the car seamlessly

Difficulties Faced

Ryan Kohel
Electrical Engineering

During the project, we faced several difficulties:

- The voltage from the step-up converter on the remote controller had a fluctuating voltage output
- The IR LED was not transmitting IR commands initially
- We had issues getting websockets to work
- The microcontroller on our main PCB malfunctioned a few days before the final demonstration

Solutions

Michael Patalano
Electrical Engineering

- To fix the step-up converter, the schematic and board layout of the external components for the IC were changed so the voltage output was stable
- The IR LED was a side-mount IR LED, but when it was mounted on its side, it could not form a proper connection with the copper, so the IR LED was re-soldered with it facing upward, rather than sideways.
- Instead of websockets, we used http requests to communicate from the app to the car PCB.
- A new microcontroller was soldered on to the car PCB.

Administrative Content

Budget

Component	Cost
Car Kits	$136.30
PCBs (w/ Assembly)	$415.00
Micro Controllers	$25.00
USB to Serial	$40.00
ESP32-CAM	$20.00
Micro SD cards	$13.00
Headlights	$8.00
IR Kit	$15.00
Total	**$672.30 (Under our $800 Goal)**

Michael Patalano
Electrical Engineering

Work Distribution

Michael Patalano
Electrical Engineering

Laila El Banna

- Coding App
- App interface
- Connecting PCB to App

Ryan Kohel

- PCB design
- Coding PCBs
- Connecting PCB to App

Sanya Wadhwa

- Coding App
- App interface
- Connecting PCB to App

Michael Patalano

- Car Assembly & Soldering
- Coding ESP32 Camera
- Connecting Camera to App

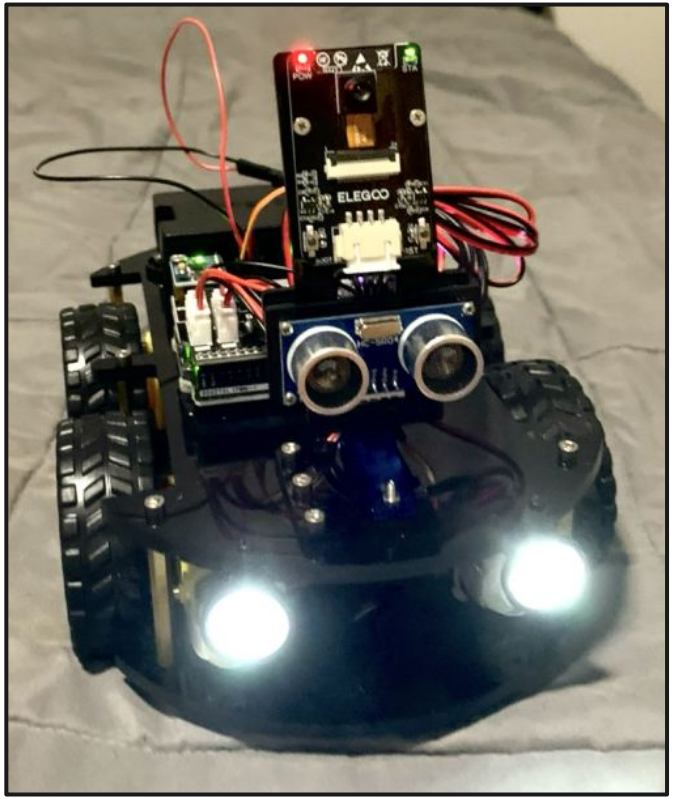
Future Ideas

Michael Patalano
Electrical Engineering

- Speaker on the car and microphone in the app
- Expand the controller PCB to use the onboard buttons and buttons on the Joystick
- Use a different motor driver that supports speed control
- Use the Ultrasonic sensor as an “emergency break”
- Have a comprehensive interface for all of the car’s features, that update in real time

Conclusion

This concludes the Rock N' Rover Presentation. Our team diligently worked to meet all guidelines to ensure the successful completion of our project. We appreciate your support and look forward to sharing our progress. Thank you for your attention.



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