Seneca

CAMERA ON WHEELS

TPJ452 PROJECT REPORT

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Date – APRIL 3, 2020

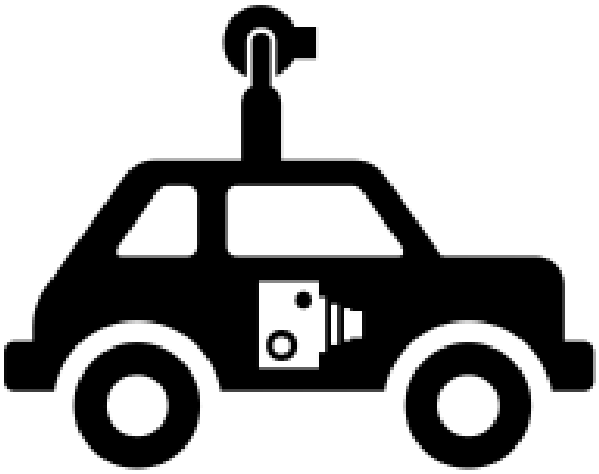

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Table of Contents

Acknowledgement

The satisfaction and euphoria that accompany the successful completion of any task would be incomplete without the mentioning of the people whose constant guidance and encouragement made it possible. We take pleasure in presenting before you, our project, which is result of studied blend of both research and knowledge.

We express our earnest gratitude to our *Professor B. Shefle*r, our project guide, for his constant support, encouragement and guidance during such times when face to face communication wasn't possible. We are grateful for his cooperation and his valuable suggestions.

Executive Summary

This document describes the design and creation process of “Camera on Wheels”, that is our TPJ452 final project. Our project aims to provide a robotic vehicle equipped with a wireless camera having night vision capability for remote monitoring/spying purposes. The night vision camera allows for transmitting real time night vision video even in dark environments. Whatever is recorded by the camera can be viewed easily on any handheld device or PC.

Such a system can prove useful during wars and night surveillance of commercial buildings. It can also be used to operate in jungles and other environments where humans cannot possibly enter during the night. The vehicle can be controlled remotely from a web browser for easy operation. The commands are coded in python to move in front, back and left right directions. The vehicle consists of a Raspberry PI unit. On receiving command from the user, the Raspberry PI then operates the movement motor through a driver IC.

This project report includes product specifications and explains the operation of the project. Diagrams and schematics are given wherever necessary for easier understanding of the user. The report explains in detail how it was programmed to operate and describe how online controls are created that initiate the movement of this vehicle. A breakdown of Bill of Materials is provided as well. Our project design has a lot more potential for further developments.

The latter part of the report discusses what other features can be added to the current design thus proving that this project is scalable. It also mentions the possibility to use other wireless signal mediums such as Bluetooth to control this vehicle.

Introduction

With the ever-growing population, the crime rate has been on the rise as well. Most criminals that commit petty crimes get away with it due to lack of evidence. Security personnel can not be present everywhere at every time. This problem was partially solved when video surveillance cameras were introduced. The major drawback of a CCTV camera is that it is stationary. It has limited surveillance area. We need to install multiple cameras to monitor the activities. Our team has come up with a solution by combining two of the most impactful inventions in human history, that is Camera and Wheels. We plan to build a video surveillance camera car whose movement is controlled wirelessly from a handheld device.

Our design includes mounting a camera on top a moving frame that has two motors connected to the wheels. The project demonstrates bi-directional communication that is taking place as we give commands from the handheld device and in turn receive the live video output. The team undertook this project as it has various real-life applications. It can be used in army or in event security. The Camera-On-Wheels is portable. We can easily transport it to the place where security is needed temporarily. Even the presence of such device at any place can help in discouraging criminals even before committing any offence. The creation of this project involved applying our knowledge that we have gained during Electronics Engineering Technician Program.

The project is scalable as well. We have kept in mind that scalability is one of the major factors in current market. Our project is designed in such a way that it can switch its wireless connection medium from WiFi to Bluetooth with some minor tweaks.

Product Specifications

- Raspberry Pi 3
    - Source Voltage: 5V DC
    - Typical source current: 700-1000A
    - Signal Output: 3.3V signal
    - Maximum Combined Output Current: ~ 50mA
    - Dimension: 85mm x 56mm x 17mm
- L293D Motor Driver IC
    - Pins – 16 (8 each side)
- 0.3 Megapixel Webcam
    - Supports 640x480 pixels @ 60 hz
    - 320x240 pixels @ 120 Hz
    - Connection Type – USB 2.0 (type-A)
- 2 Brushless Motors
- A steel chassis
- Programming Language – Python
- Custom PCB with 1 transistor, 3 Resistors, 2 Capacitors & 2 Diodes.
- Weight – ~350g
- Turning Radius – About 5-8 cm
- Wireless Signal Range – About 300 feet
- Signal Type – Supports WiFi 2.4/5 GHz
- Device Compatibility – Universal (Windows, iOS, Android and All major OS with a web browser)

Operating Instructions

Initial Setup

To operate the vehicle, the raspberry pi needs to power on with the given battery. The PCB has an on/off switch that can be used to accomplish this. To verify that it is powered on, Pi flashes green light and we have soldered a red LED light on PCB as well. An ON red light means PCB connections are fine and you can proceed further. When the Pi boots up it automatically connects to the Wi-Fi. It usually takes about 5-10 seconds in total to get connected to the internet.

Note - *To make Pi connect to a different Wi-Fi hotspot, you need to manually do some tweaks. Take out the SD Card from the Pi and plug in into computer. In the root folder, there exists a file called wpa_supplicant.conf Open this file with a text editor and add the following lines -*

```
network={
ssid="PutYourNetworkNameHere"
psk="PutYourPasswordHere"
}
```

After saving it, put the SD card back in Pi and let it boot.

When Pi is up and running, next step is connecting your mobile phone or PC to the same Wi-Fi network. Before proceeding to next step, it is advised to note down the IP Address assigned to Raspberry Pi. If you are on PC, an app named *Advanced IP Scanner* can be used or you can log in to your router settings to know about the IP Address as well. A similar procedure is for smartphone users. Whether android or iOS, download an app named *Fing* to scan IP addresses or just log in to your router settings on the browser.

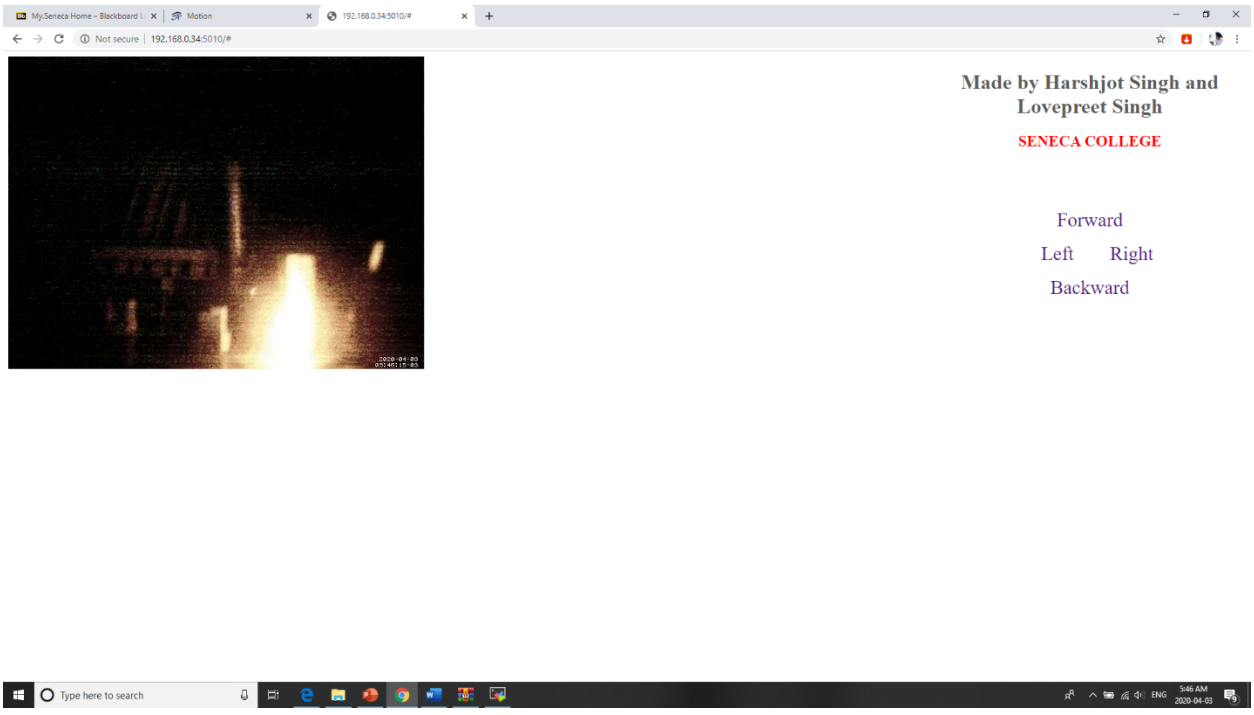
We have given the **static IP address of 192.168.0.34** to the Pi. The IP address of the scanned result should match the given static IP unless the network is crowded. Always verify the IP address before use.

Controlling the Vehicle

Next and final step is accessing the server. Once the Pi is registered on the network, the user should be able to access the live stream from the webcam by typing in **192.168.0.34** the web browser. Typing this address in only streams the camera and does not provide control buttons.

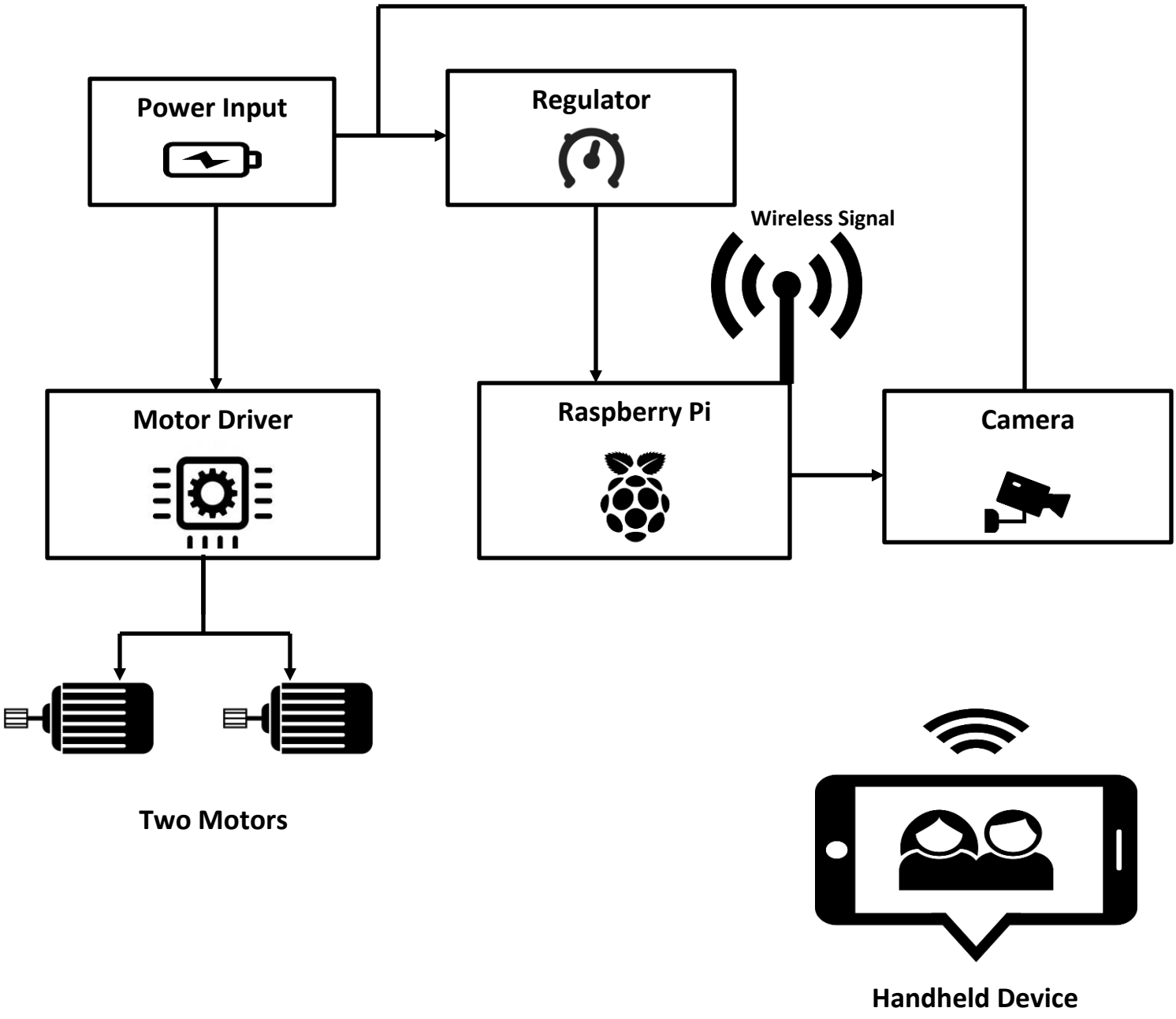
To access the full features of this vehicle, user needs to type in **192.168.0.34:5010** After this a user is greeted with a similar screen as shown below in *Figure 1* with all the movement controls. These movement controls work smoothly. Pressing any of the buttons initiates the movement. Click outside and the vehicle stops.

The setup is complete. The livestream can be easily accessed from any smartphone or PC on the same network.



(Figure 1 – A screenshot of the HTML page)

Block Diagram

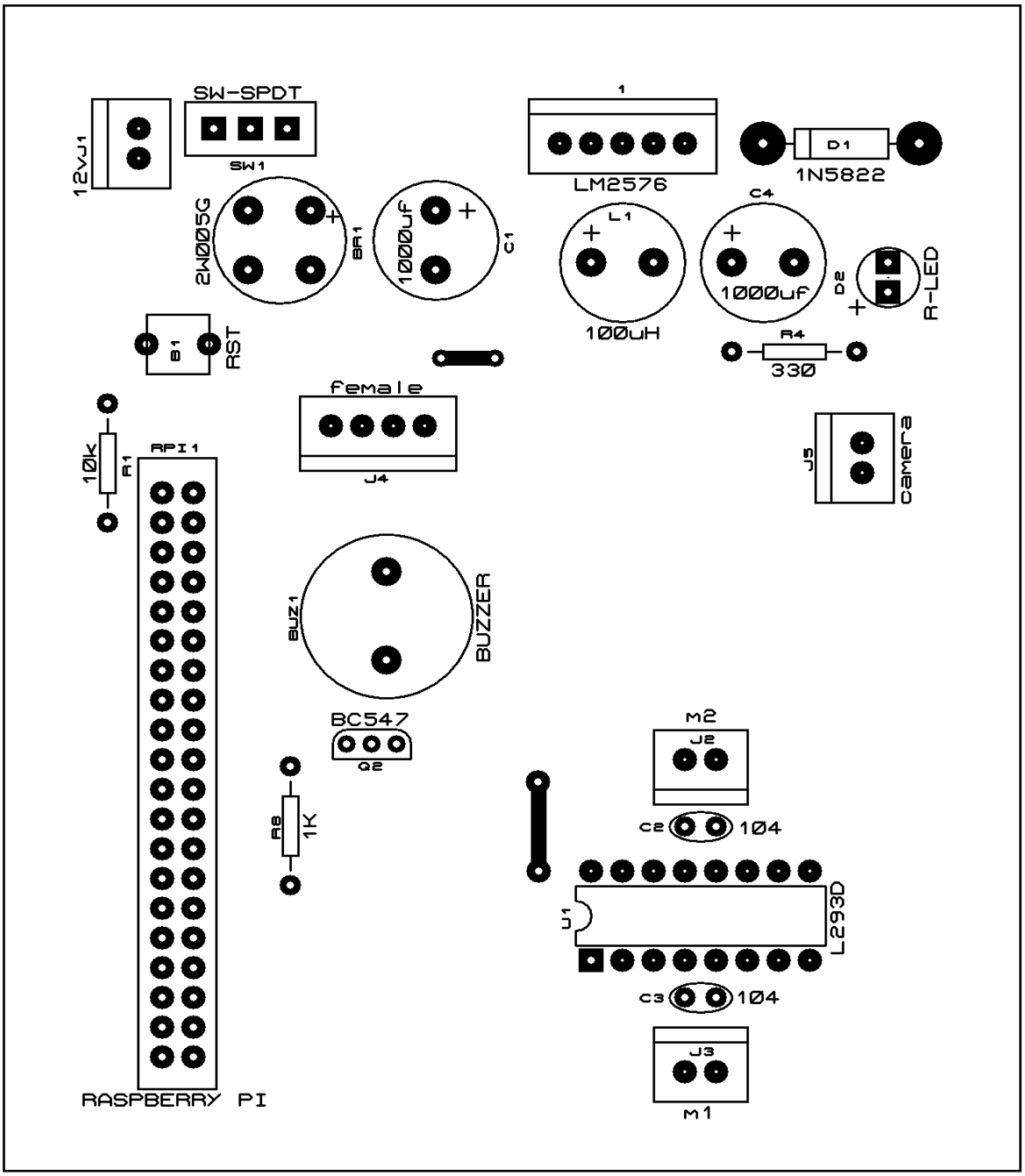


(Figure 2)

Project Design

PCB Layout

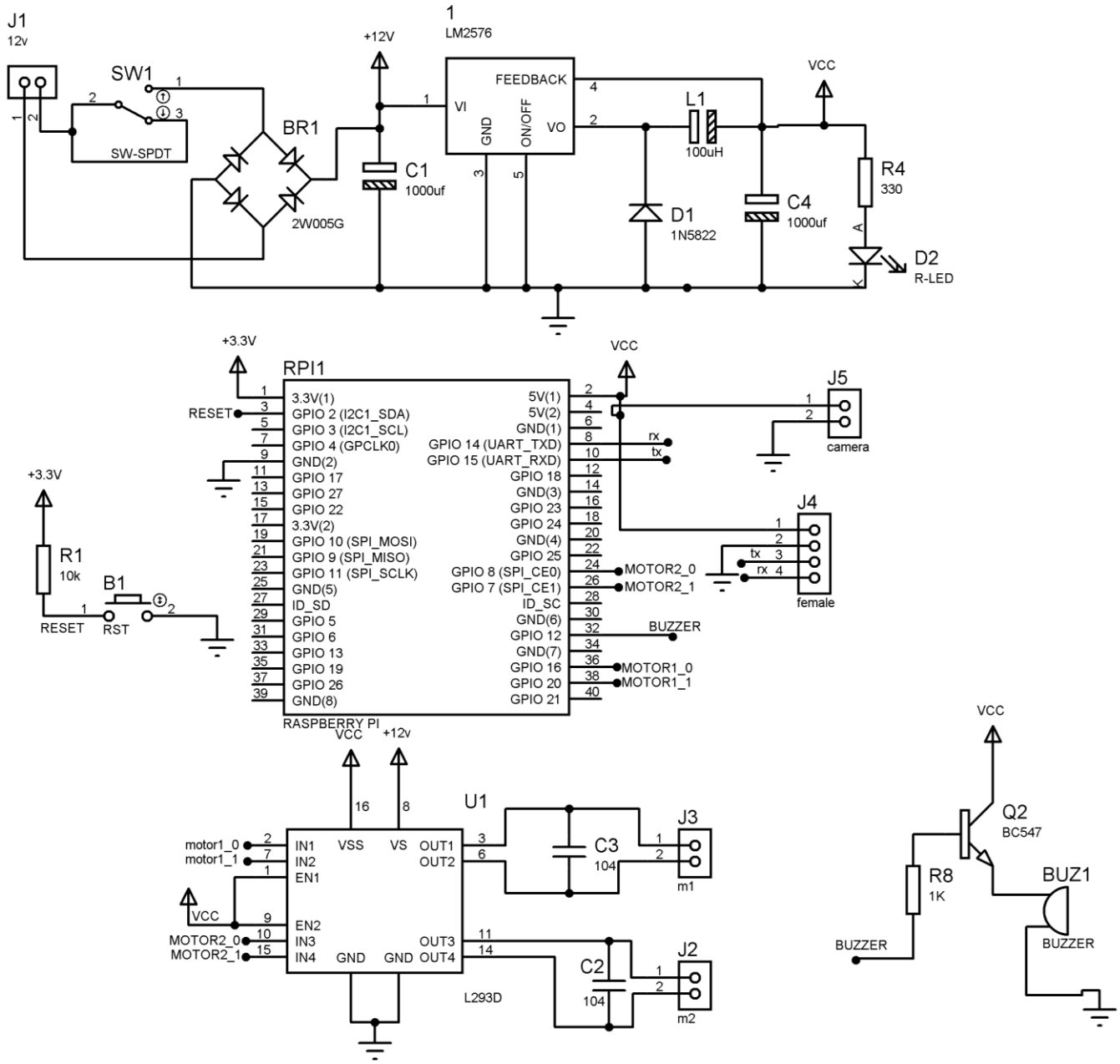
The PCB layout was designed by keeping in mind to operate this system using Bluetooth as well. So, it includes a slot for a Bluetooth receiver at J4. The layout is marked for reference purposes



(Figure 3)

Electric Circuit Diagram

Following diagram explains the circuitry of this design, how each and every component is connected.

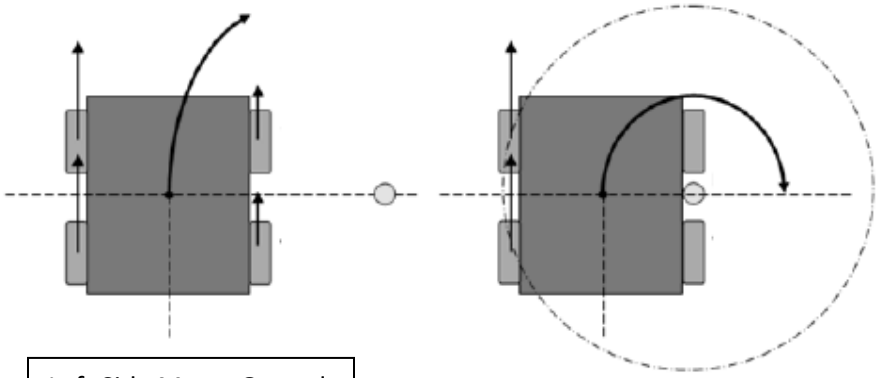


(Figure 4)

Theory of Operation

Differential Steering

It is a technique used for steering vehicles such as battle tanks by altering the drive torque to one side of the vehicle. We have built the vehicle just like a battle tank. The front and rear wheel are connected using a plastic chain identical to bulldozers and excavators. When turning this vehicle to the right, the right-side motor shuts off and left side motor remains on and functional. This allows us to smoothly turn the vehicle. The following image illustrates taking a right turn -

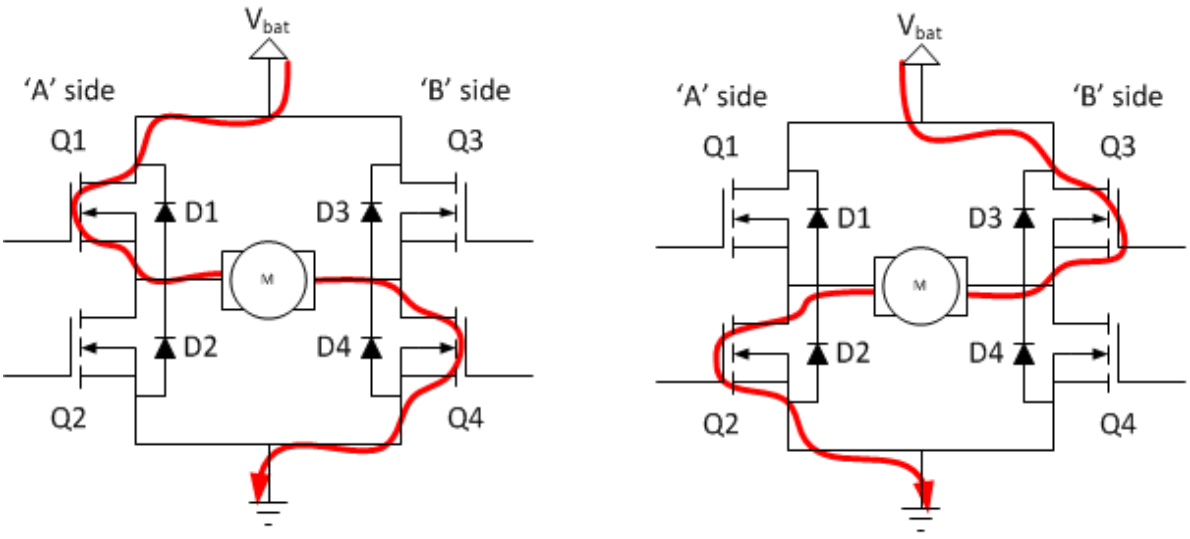


(Figure 5)

H-Bridge Operation

Our project design implements the H-Bridge configuration to run two motors. We use the motor IC L293d. It is a 16 pin IC dedicated to the controlling of a motor. There are 2 INPUT pins, 2 OUTPUT pins and 1 ENABLE pin for each motor. L293D comprises of two H-bridge. H-bridge is the simplest circuit for controlling a low current rated motor. It controls the direction of DC Motors by manipulating the current flow. It switches the polarity of a voltage applied to the load. The load in our case is a motor.

The following image depicts the H-Bridge Operation. The red line represents the flow of current.



(Figure 6)

Wireless Communication & Web Application

Our project relies on Wi-Fi to communicate effectively. Wi-Fi is typically used to access the internet on portable devices like smartphones and laptops. Wi-Fi itself is used to connect to a router or other access point which in turn provides the internet access. Wi-Fi is a wireless connection to that device, not the internet itself. It also provides access to a local network of connected devices. When the Pi and the receiver smartphone are connected to same Wi-Fi network, user should be able to access the live stream from the webcam and robot control buttons by typing in **192.168.0.34:5010** in the web browser.

When the user visits the IP address, a static HTML page is shown. It is made using Notepad. The application that performs all this is coded in Python language and is embedded in Raspberry Pi. It is a small python code that uses *Flask* to call our HTML landing page and initiate robot controls.

(Please refer to attached files androidcontrolled.py and webpage.html)

Webcam Server

The streaming of live video is achieved using *Motion*. It can be easily installed on Pi using the command ***sudo apt-get install motion.*** It monitors an incoming camera stream and detects 'motion' by finding the pixel values that have changed from frame to frame. It includes an inbuilt webserver offering video stream. Motion provides high range of configurations. Frame rate, resolution and livestream's port number can be easily changed from the settings.

Bill of Materials

Component	**Cost (in CAD)**
Raspberry Pi 3 Kit	$89.95
Motors + Plastic Wheels	$41
Camera	donated
IC Drivers	$4
Voltage Regulators (5 pc)	$7
Resistors & Capacitors	$31
Chassis (Steel)	donated
Battery	$25
Misc. (Connectors, Wires and Switch)	$15
PCB	Free (Custom Printed)
Total	**$212.95***

*Including Tax

Further Developments and Conclusion

We initially planned to build a cost effective and a practical project. So far, our team has been able to build as proposed with minor tweaks. Given more time and resources, this project can be developed to transmit audio as well. A better camera and internet connection can hugely improve the quality of the video. We designed the PCB in such a way that it can support Bluetooth communication without any changes to the design. Using the Bluetooth, you can control the movements of the vehicle very easily but to stream video over it is a difficult task. The video will be extremely laggy and frame rate will be very low. Overall, our team is satisfied with the outcome of this project.

Contact Info

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