PS-1 Report

APTRI Floor Assistant

PS Station: Adani Power - Ahmedabad

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Start date: **21st May, 2019**. Date of Submission: **12th July, 2019**

Duration: **2 months**

A report submitted as partial fulfillment of the Practice School -1 (PS-1)

Acknowledgement

Today, at the acme of our dissertation, with heartiness we gratefully express our sincere gratitude to our PS instructor Prof. Amit Jain without whose involvement the project would not have taken its shape.

A successful outcome in any research endeavor attributes itself to the selfless guidance of the mentor. Special thanks to Mr. Sandeep Dixit for assigning us this project and giving constant valuable feedback on it.

We would extend our gratitude to Mr. Kaushik Purohit, Mr. Yash Patel and all the other people at APTRI for their help and guidance on this project.

Lastly, a word of thanks to all ladies and gentlemen associated with this work directly or indirectly whose name we have been unable to mention as they are like the countless stars in the numerous galaxies.

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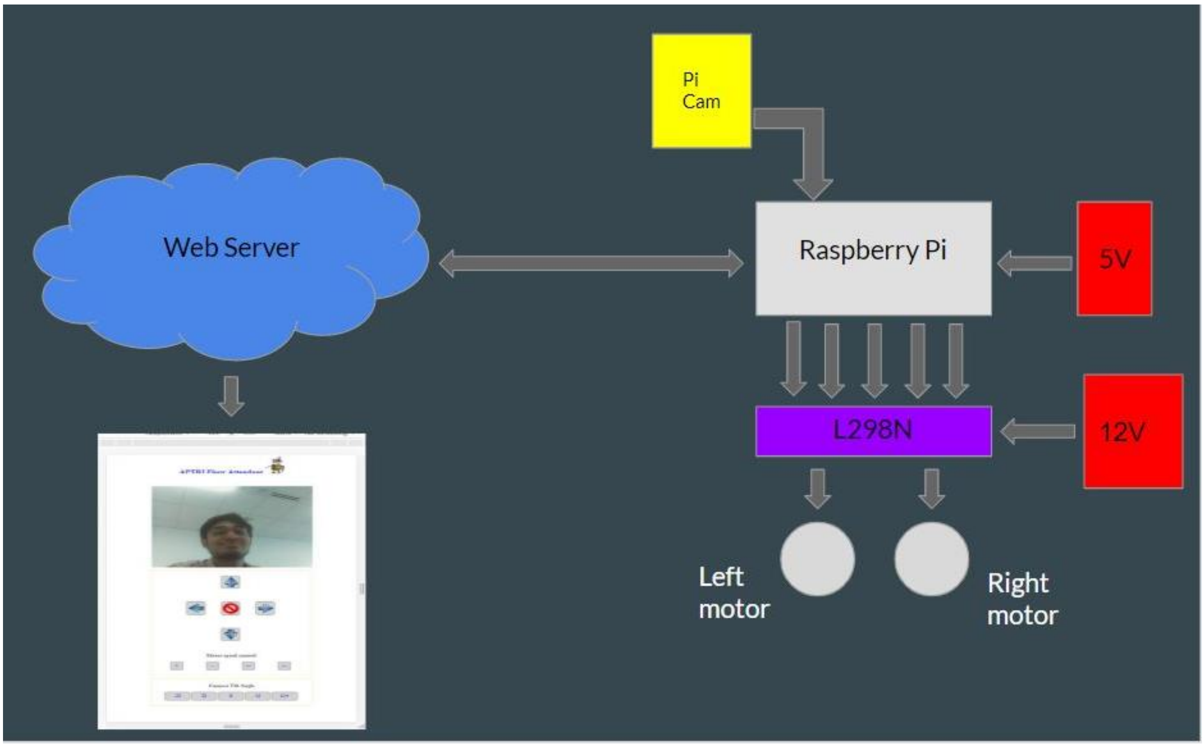
Abstract

During a tedious day work in large corporate offices, it is quite difficult to deliver multiple documents to different people. The need for an automated machine to perform this task arises. Therefore, to make this task easy, we have built a robot that could facilitate the day-to-day activities at an office. Also, the robot is integrated with the Internet of Things (IoT) so that anyone from the office can remotely control it through their internet-enabled devices connected to a common network. The user can place documents on the upper platform of the robot and then log in to the web server. Using the live camera feed provided, the user can easily control the robot via on-screen arrow keys. Using our robot, we automate the whole process of transfer of documents and various other items across the office chambers.

Keywords: IoT, mobile robot, live feed, document delivery

Project Set-up



The overview of the project is as follows. We have used the Lighttpd web server for hosting our web page. The user can view our web page by typing the IP address of the Raspberry Pi. The live camera feed is available to the user using which the user can drive the robot. The camera feed is taken in by the pi camera and provided to the user through the web server When the user presses a button, the commands are sent to the Pi through the web server which in turn sends signals to the motor driver to drive the wheels of the robot.

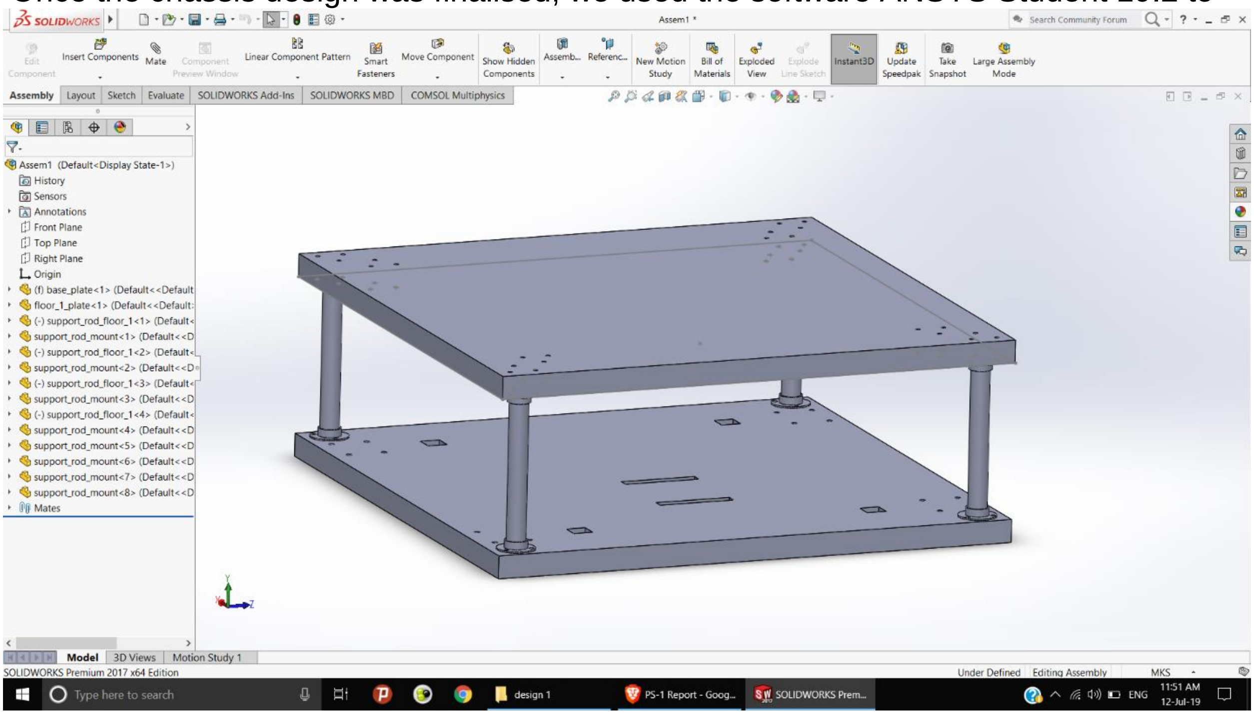
The project has been classified into three major sections, each of which will be discussed in detail:

- Mechanical
- Electronics
- Software

Mechanical:

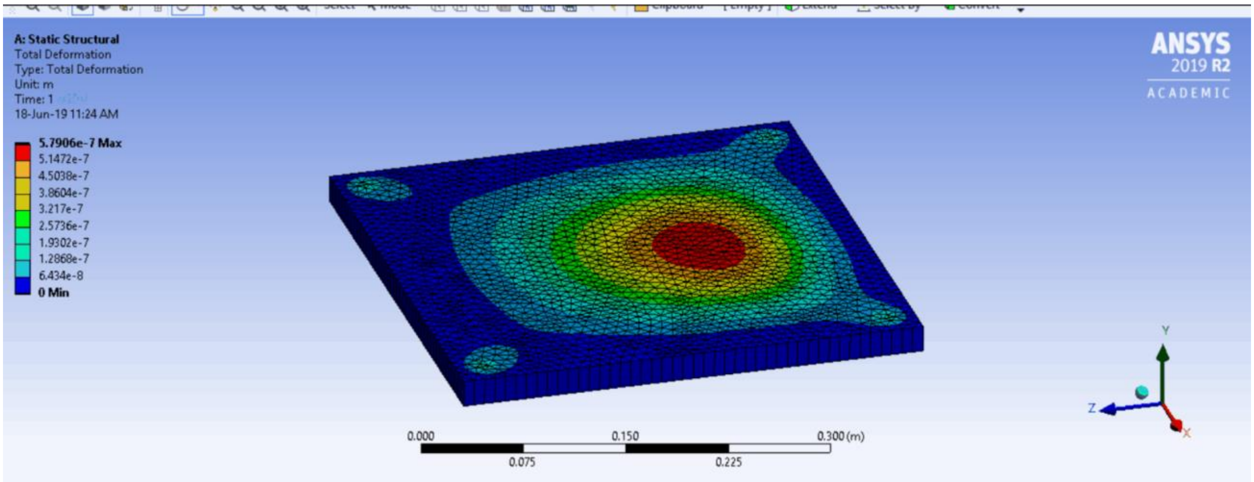
The mechanical aspect consisted of making a chassis for the robot that would be sturdy, have minimum vibrations and be able to accommodate all the electronics of the robot. We started by designing a basic chassis on Solidworks 2017.

Once the chassis design was finalised, we used the software ANSYS Student 19.2 to



CAD Design in Solidworks 2017

do structural analysis of the robot. This analysis helped us in identifying the major stress points and optimizing them by making necessary changes to the robot.



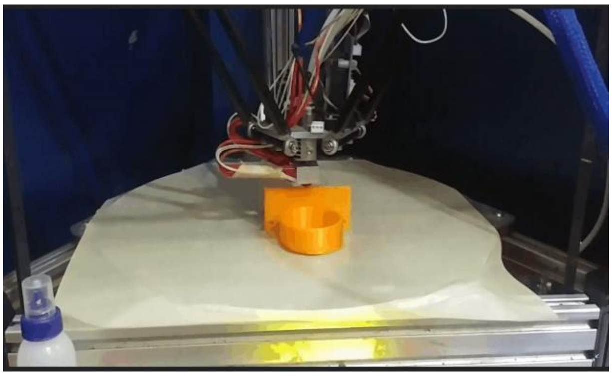
Structural Analysis on ANSYS Student 19.2

The major components of the chassis were identified as follows:

1. Base plates
2. Support Rod Mounts
3. Support Rods
4. Motor Mounts

We decided to use wooden based plates to aid in mounting the other components to it. The support rods mounts, support rods and motor mounts were all 3D Printed using the printer available at Adani Power, Ahmedabad.

The printer was a "Dimension Delta Dual" by J-Robotics. We used the slicer software: Simplify3D. Once the parts were designed in Solidworks and simulated in ANSYS, we converted them to .STL files and used Simplify3D to generate the gcode for the 3D Printer. The material used was PLA, printed at 210°C with bed temperature at 50°C. Infill was kept at 100%.

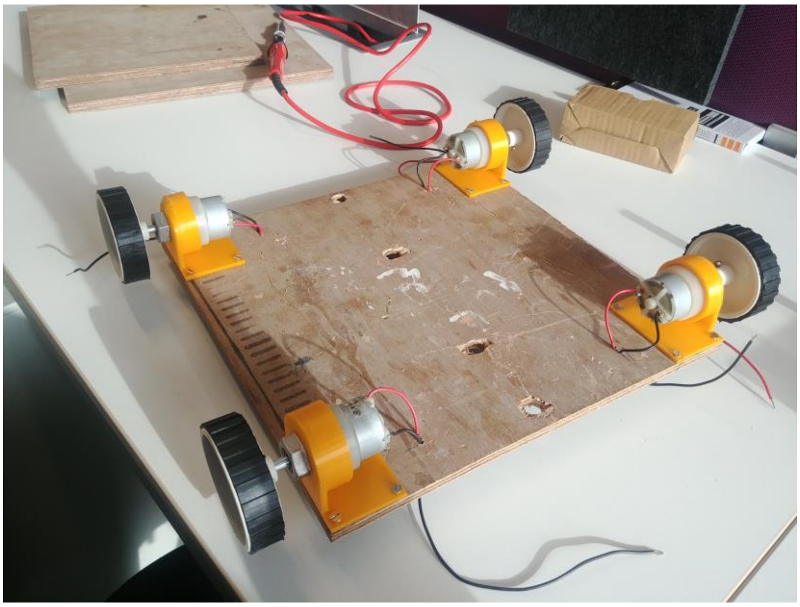


3D Printing of Motor Mount

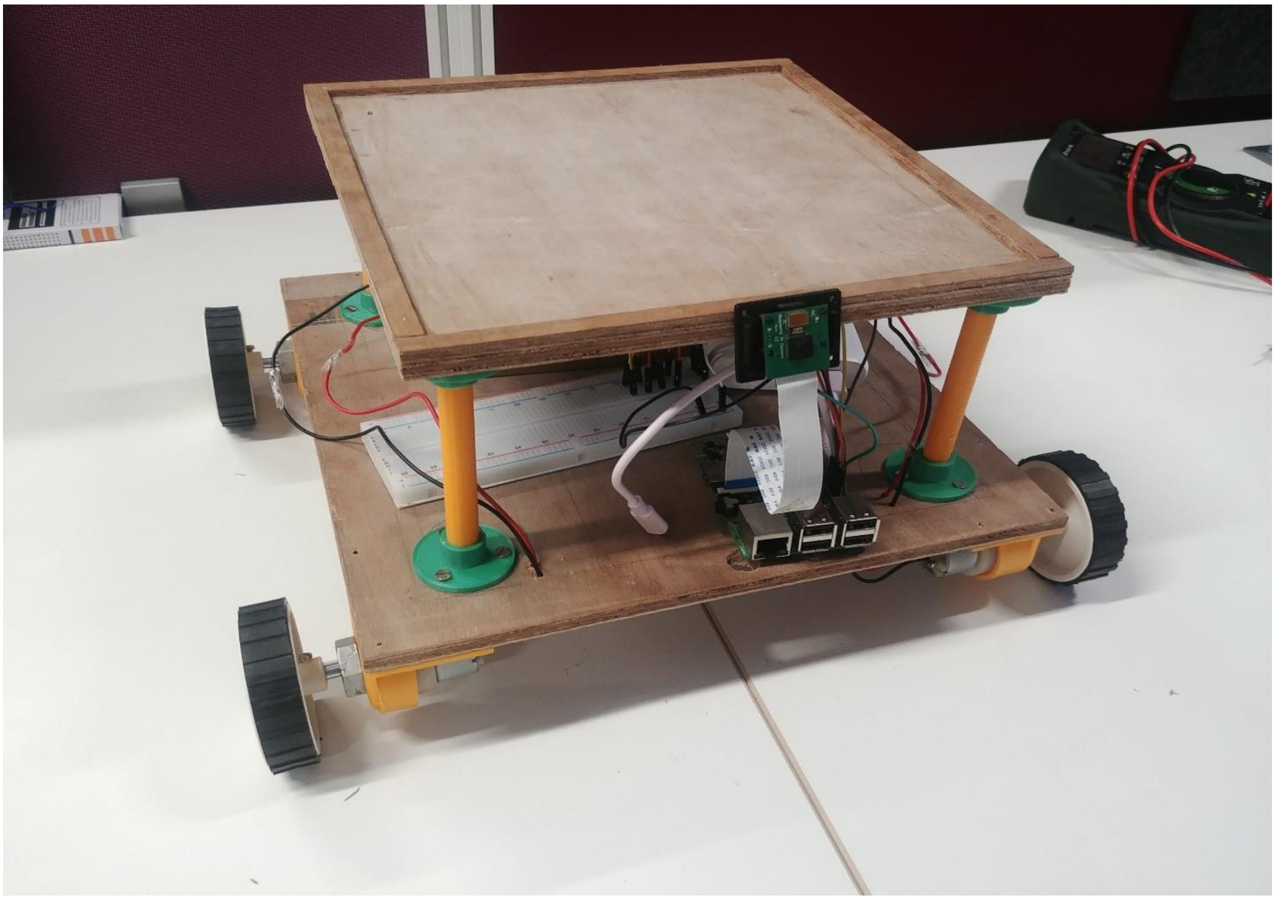
Support rod mount

Motor fixed in Motor mount

After 3D Printing all the parts, we fixed the mounts to the base plates using screws. And then the final assembly was completed.



Motor mounts and Motors fixed on the Robot



Final Assembly

Electronics:

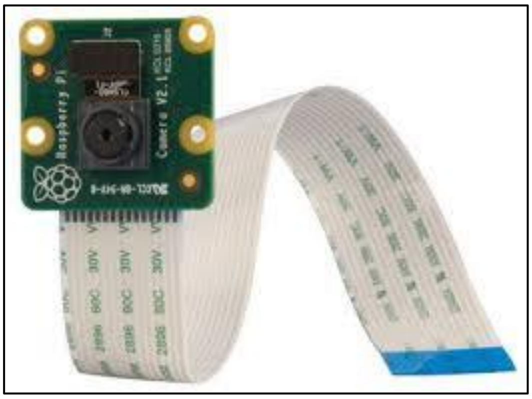
Raspberry Pi

Our main on-board computer is the Raspberry Pi. It is a small single board computer with 1GB RAM and a Broadcom processor. It is equipped with USB , HDMI, audio and ethernet ports. It has an SD card slot on which the OS is loaded and is powered by a microUSB port with 5V of supply. It has a camera port where a Pi camera can be installed.

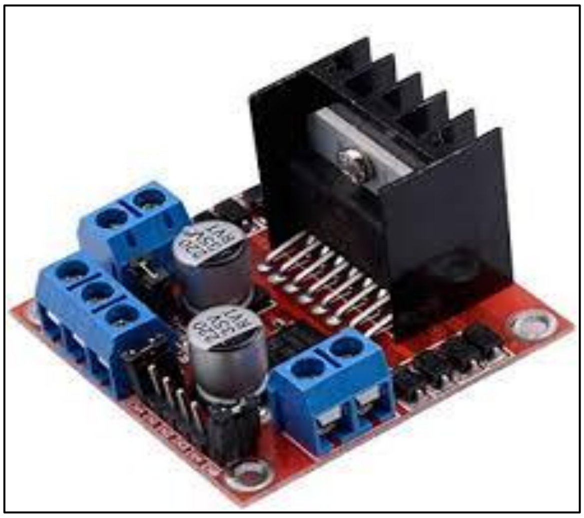
Being a computer, we ran it on Raspbian OS which was flashed on a SD card.

Raspbian OS supports a terminal similar to Linux terminal, which was used for executing various commands for the movement of the BOT and operating the web server.

For getting a live feed to the web server, Pi camera was used. Pi camera is standard camera for Raspberry Pi and is easily compatible. The camera transfers the live stream to Raspberry Pi which gets further transferred to the web server.



Pi Camera

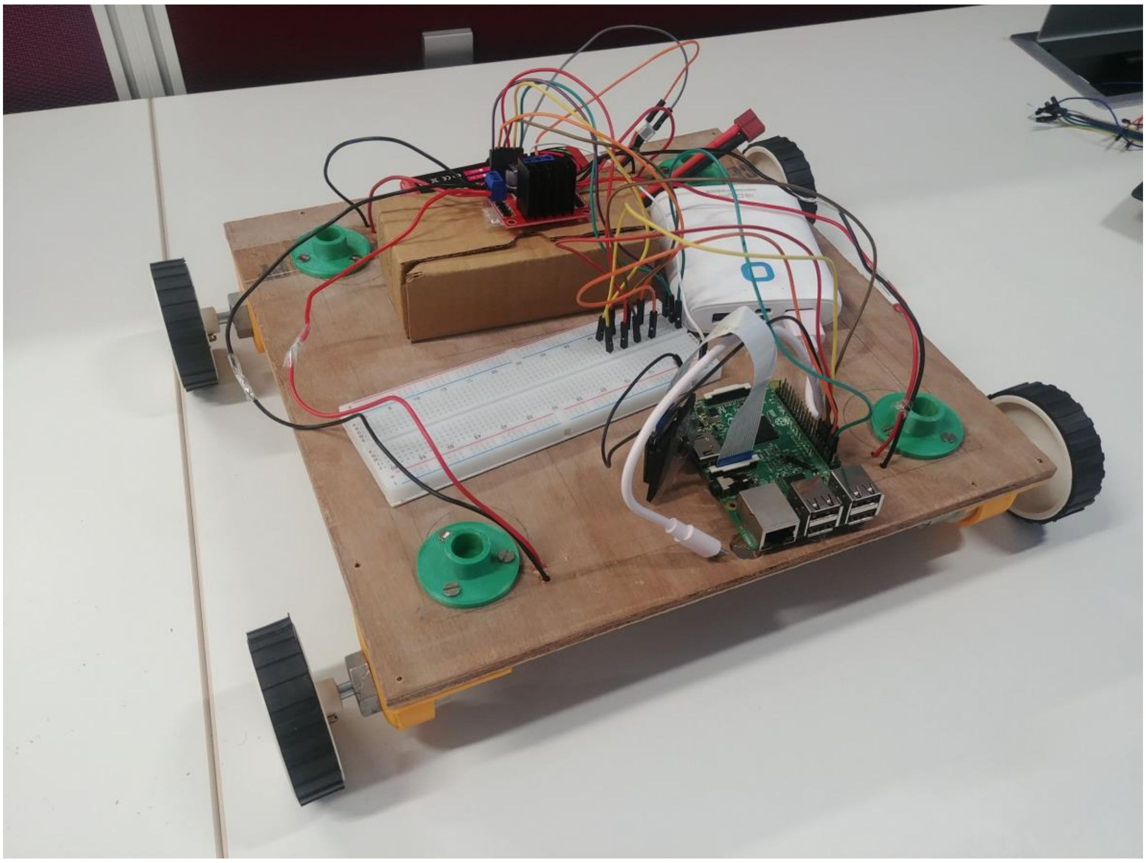


L298N Motor Driver

For controlling the movement, 12V 300rpm motors were used. L298N was used as a motor driver act in between motors and Raspberry Pi. It takes input from GPIO (General Purpose Input Output) pins of the Raspberry Pi and provides output to the motors. It is a dual H-bridge motor driver, therefore can control two motors at a time.

For powering the motors, a 4200mAh Lithium Polymer battery was used and a 10,000mAh power bank was used for powering Raspberry Pi. Using Li-Po battery helps in reducing the space required and weight.

Li-Po Battery



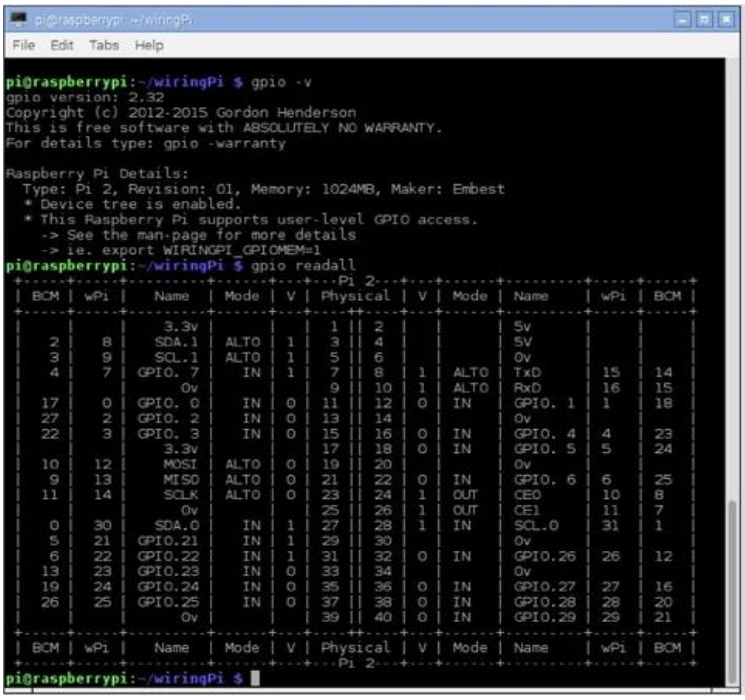
Electronics Assembly

Software:

To configure the Raspberry Pi so as to control the motors, we used Wiring Pi library of Raspberry Pi. It is a GPIO access library written in C. We used this to read, write and control the pins from shell scripts. Basically, it runs movement cgi scripts based on real time input available from the web server.

We created a webpage which provides live feed of the camera attached to the robot and also has buttons to move the robot forward, backward, left and right. This was integrated with the web server.

As a web server, we have used Lighttpd web server. This acts as an interface between the webpage and Raspberry Pi. It is an open source web server for speed critical environments while remaining standards-complaint, secure and flexible. It's advanced feature set (FastCGI, CGI, Auth, Output-Compression, URL rewriting) make lighttpd the perfect web server. We have used it's CGI and FastCGI featureset. We have used this server as it has very low memory footprint compared to other Web Servers and takes care of cpu load.



Console

So, according to the button pressed on the webpage, the web server will run a WiringPi code on Raspberry Pi and hence the motors will move accordingly. Please note that the Wiring Pi code is written in CGI scripts so the web server can easily execute them.

Calculations

Battery: **4200 mAh**

4.2 A in one hour. All four motors consume 1.2A at full load. Hence the robot lasts **upto 3.5 hours on a single charge**.

Motors: **300RPM**

The diameter of the wheels is 6.5cm. One full rotation = pi*6.5 cm.

300 rotations in 60 seconds. Therefore, 300*pi*6.5 cm in 60s.

Hence speed = **1.02 m/s**

Conclusions and Future Scope

The given project succeeded in providing its function of working as a floor assistant. All the aspects were done properly that lead to fully functioning assembled robot. The robot's specifications did match the ones that we have calculated. The robot can work in extreme temperature conditions viz -40C to 85C. It can be controlled using any internet-enabled devices such as mobile, laptop, tablet, etc. Multiple users can control the robot at the same time which eliminates the problem of user switching.

This project can surely be expanded to serve as an autonomous robot that would eliminate users from controlling the robot via a web page. It would enhance its functionality to a great extent. We have developed the code for this and simulated in on our PC, but due to unavailability of materials and time resources, we were unable to practically implement it.

It was a wonderful and learning experience for us while working on this project. This project took us through the various phases of project development and gave us the real insight into the world of robotics. The joy of working and the thrill involved while tackling the various problems and challenges gave us a feel of this industry.

It was due to this project we came to know how industrial level projects are done.

References

This section contains the links of various sources that has helped us in creating this project.

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