Palestine Polytechnic University

College of Information Technology and Computer Engineering

Tracking and monitoring vehicles system

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This project was done for fulfilling graduation requirements of Computer Systems Engineering

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Abstract

Our project aim to allow companies to monitor and track their vehicles through android device system contains the company's identity, as the program on their android allows companies to identify the driver ,locate the vehicle on the map, and to monitor the vehicle, so we make vehicles under the company's monitoring, and nobody can steal vehicles of the distributed vehicles network while driver get out of the vehicle and leaves the keys in the truck.

Our system is implemented using Raspberry PI 3 microcontroller, MQ-2 gas sensor, motion sensor, DHT22 humidity and temperature sensor,RaspiCam V2, android application and a website to make connection between Raspberry PI and the company android device.

The system successfully implemented and deployed as a prototype.

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Chapter 1
Introduction

1.1 Overview of the project

These days, some life parts is fundamentally dependent on the Internet and software applications so we should develop programs, projects, serving industry and corporate development, so we tried in our project to connect a company with its vehicles..

On the other hand, large companies and big trade owners are exposed to many thefts and the company has suffered a lot of losses, which itself will make our project something that solves a big corporate problem and is wanted to have, to it's going to reduce the loss, in our project, we will monitor the driver and the car so that if you were robbed, it would make it easier for the company to locate and monitor their vehicles

1.2 Motivations

Out of the comprehensiveness of this project, we will reflect a lot of what we have learnt from the courses that we took in our field (Computer Systems Engineering). Such as hardware design related courses (Microprocessor and Interfacing, Digital Design and Embedded Systems). As well as software related courses (Object oriented, Data structure and Mobile programming).

In recent years, technology has come to a place where people cannot easily give up, this is in addition to the fact that the major companies in the world are companies producing software and electronic pieces, this the order has made technology constantly evolving and our field of work is the same area, making a new project in the same field adds something new to the evolution of the world, increasing our experience in the field as we deal with our project with three parts: software part, hardware part, web and Android.

The project idea is not the first of its kind, but we are concern in developing a system, which provides high level of tracking, and monitoring using internet.

The outcome of this project will be a profitable product. Since it has intended to be used by a large vehicle companies.

1.3 importance

The importance of this project is to monitor your vehicles anywhere in the country, it allows company to monitor and track their vehicle from any point on the world, avoid stealing and violations by the drivers such as speed.

Also, monitoring the company vehicle without this project would be very expensive, because the only way to watch are the driver, it will cost the company a lot of calls, which is very expensive in our country, as well as to monitor all vehicles at the same time is extremely difficult, but with this project would be possible and simple and this saves time and money.

On the other hand, thieves will find it hard to steal any vehicle any more.

1.4 Objectives

The main objectives that we are looking to achieve in our project are the following:

- Build a microcontroller tracking and monitoring vehicle using raspberry pi microcontroller and GPS
- Build Android application to send information to company to detect and describe a state of the vehicle such as violation.
- Build a cloud server to be an API (Application programming interface)
- To apply the monitoring and tracking process between android and the microcontroller.

1.5 Problem Analysis

Many companies suffers from a delay in delivering the orders, stealing cars, and high speed violations, so our project idea to decrease these problems by providing a tracking and monitoring system, the company supervisor can get the current state and the speed of the vehicle in real time using his phone, also it provides a monitoring on the driver who's in the vehicle.

Unfortunately, this system is not used in our country until now, that is why the company loses a lot by driver's careless, late deliver and stealing.

1.6 List of Requirements

System requirements can be summarized as:

- The system must be user-friendly to be used by a beginner and advanced users
- Transmit data, information and keys between company and vehicle
- One android device can track and monitor more than one vehicle in real time.
- Advanced and complex monitoring (keys) instructions included by the future development of the system.
- Warn the company with any kind of violations

1.7 Expected Results

- Monitoring and tracking the company vehicle.
- Reduce vehicle driver's violations.
- The hardware components can be attached easily and the system runs smoothly.
- Monitor vehicle speed, location, and a driver who is infringe.
- System allow company check on vehicles without connection cost and save time.

1.8 Literature Review

There is a previously projects that tracks and monitor your vehicles. There is differences between them and our project, the first similar project is "VEHICLE TRACKING SYSTEM USING GPS AND GSM" [1], which provides a SMS message with latitude and longitude of the vehicle current position using GSM modem as a sender connected to arduino, on the other side there is a GSM receiver connected to arduino also. Company sends SMS message to the vehicle sim card includes the authentication information; sender sends the latitude and longitude to the receiver. Data transmitted through serial port to a visual basic application to locate vehicle on map.

Our project differs in this point that it sends the data through internet instead of SMS, also we used an android device not a personal computer application based on visual basic language.

The second similar project is "Home Automation Based on Raspberry Pi Single Board computer" [2], a security system that detects any motion on the house front door, then capture a photo and sends it to homeowner using local network. Picture saved on raspberry pi storage.

The advantage of our project that the photo accessed from any external network, because it is stored on web server.

Another similar project is "RASPBERRY PI BASED VEHICLE TRACKING AND SECURITY SYSTEM FOR REAL TIME APPLICATIONS" [3], this system include real time monitoring and monitoring using raspberry PI with modules and sensors.

Our system is improved with raspiberry pi camera, which add monitoring function to our system.

Chapter 2
Background

2.1 Overview

This chapter introduces the theoretical background of our project, short description of the hardware components that will be used in the system, design specifications and constraints, short description of the software components and some additional information about the system.

2.2 Software components of the system:

This subsection illustrates the main technologies to be used in this project and what task they do.

1. Raspbian OS:

"Raspbian is a free operating system based on Debian optimized for the Raspberry Pi hardware. An operating system is the set of basic programs and utilities that make your Raspberry Pi run" [4]

2. Text Editor:

Editor used to write raspberry PI instructions in python and for programming the web page.

3. Android Studio:

Android IDE (integrated development environment) to develop the android application of the system.

2.3 Hardware Components of the System:

In this Section, we will describe the main hardware components needed to construct vehicle-tracking system; also, it illustrates the function of each component.

1. Raspberry pi 3:

"The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people to explore computing, and to learn programming." [5] We chose raspberry pi 3 for our project, because it has a wireless LAN so we don't need to use a USB Wi-Fi,.

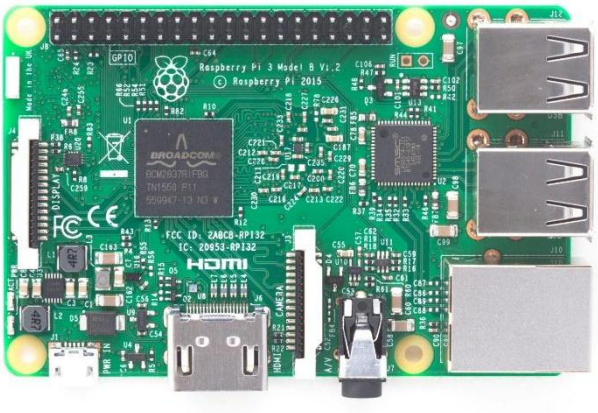

Figure 2.1 Raspberry Pi3 1

Moreover, we chose it because it has all the features needed in our project, and those features are:

a. 1GB RAM
1. 4 USB ports
2. 40 GPIO pins
3. Full HDMI port

4. Ethernet port
5. Combined 3.5mm audio jack and composite video
6. Camera interface (CSI)
7. Display interface (DSI)
8. Micro SD card slot (now push-pull rather than push-push)
9. VideoCore IV 3D graphics core

Using these features of the raspberry pi will give our system the ability to implement a high-level application, and since our project is a high processing project, and Raspberry pi has graphics core, it will be the best choice for using it to build our system.

2. Micro SD card:

Secure digital are small cards that hold rows of memory chips within pins. They plug into compatible SD slots on consumer electronics devices and hold flash memory that is retained even when the device is turned off.

Figure 2.2 Micro SD card 1

Used for download the operating system and libraries for raspberry pi.

3. GPS Module:

A module get the latitude and longitude of the current location.

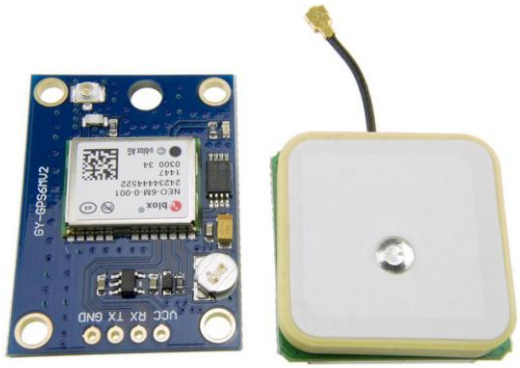

Figure 2.3 GPS Module 1

4. Power bank:

- a 10000 mA power bank used a power source for the raspberry pi 3

Figure 2.4 Powerbank 1

5. MCP3008

Analog to digital converter uses serial peripheral interface “SPI”

figure 2.5 MCP3008 1

We had to use it to convert measures from MQ2 gas sensors from analog to digital because raspberry pi does not accept analog data.

In our system, we will use a group of sensors that make the system able to support wide range of application:

1. Pir Motion sensor: PIR sensors allow you to sense motion usually used to detect whether a human has moved in or out of the sensors range.

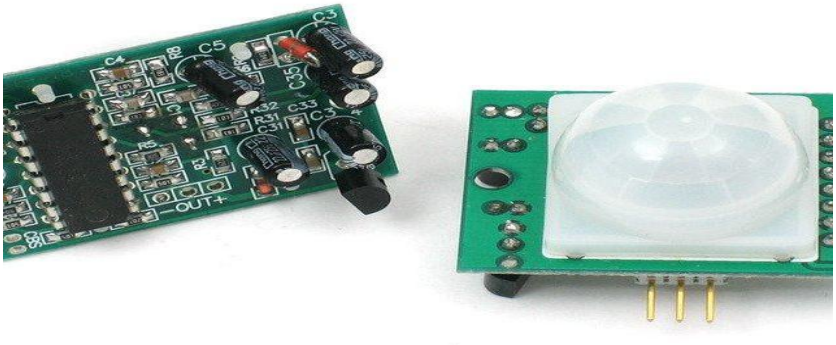

Figure 2.6 Motion Sensor 1

2. DHT22:

" It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed)"[6]

DHT22 pins	
1	VCC
2	DATA
3	NC
4	GND

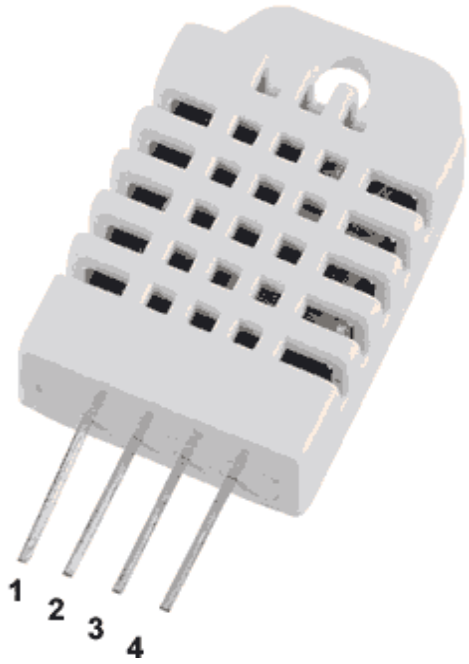

Figure 2.7 DHT22 sensor 1

3. Raspberry Pi Camera:

" The Raspberry Pi camera module is capable of taking full HD 1080p photo and video and can be controlled programmatically." [7]

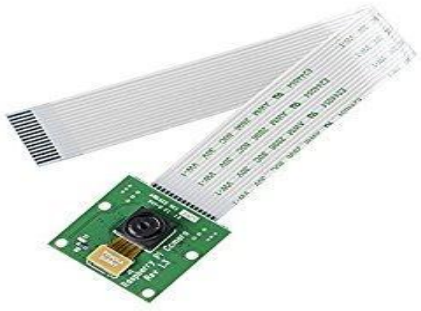

Figure 2.8 Raspberry PI camera 1

4. MQ2 Gas Sensor: “The Grove - Gas Sensor (MQ2) module is useful for gas leakage detection (home and industry). It is suitable for detecting H2, LPG, CH4, CO, Alcohol, Smoke or Propane. Due to its high sensitivity and fast response time, measurement can be taken as soon as possible. The sensitivity of the sensor can be adjusted by potentiometer.”[8]

Figure 2.9 MQ2 gas sensor 1

2.4 Design Specifications and Constraints

2.4.1 Design Specifications.

Our project contains two parts; the first part is the android application, which will be the interface for company supervisor. So it must be visually appealing, professional, interesting, and suitable for all user level. Supervisor can add new vehicles to the application to track.

The second part is the hardware system which must be designed with high processor microcontroller so it can process video, and gives supervisor the ability to add their special extension that meet their application needs, for example, additional sensors … etc.

Here are some properties that can be done by our application:

1. Track Vehicle: The supervisor can track and get real time location of his vehicle from anywhere using his smartphone.
2. Monitor Vehicle: Monitor driving room
3. Read Measures: read measures from sensors on the vehicle like temperature, humidity and gas.

2.4.2 Design Constraints.

- Cost of implementation
- No real vehicle to test on, so we used a prototype as plastic cars to test
- No 3G internet available in Palestine while system requires internet
- Raspberry pi does not support analog input.

Chapter 3
System Design

3.1 Overview

This chapter discusses the conceptual design of the system; it shows a block diagram of its hardware and software components, a flow chart, Schematic diagram, and Sub circuits.

3.2 Brief description of the system

The system consists of three main parts:

- An Android system that represents the main interface of the project beneficiary will be programmed as a connector between supervisor and the hardware part (raspberry pi)

- A website to link the vehicle to the application on the smartphone, and microcontroller, it will be programmed to send and receive data from and to software part and hardware part.

- Raspberry pi - the hardware part receives measures from sensors and sends measures to supervisor through the website.

Basic tasks record details-such as speed, temperature and the current location of the vehicle-through the sensors, send them to the site and receive them through the company Android application.

The company will determine through the application any car you need to know its details and thereby determine the condition of the vehicle, and there will be messages if violations of the vehicle occurred through the driver as speeding or the driver's identity changed.

The system will screenshot when there is a motion inside the vehicles and sends as a notification, while other data are real time, these updates sent to the site.

Communication between the application and the vehicle's system will be made through an online site, and this site will gather information, analyzes them, and arranges them for the special vehicle so that the information of the different vehicles and companies does not overlap. We are going to store the keys as numbers in micro-controllers so that we know the operation with a specific number, and this number will be an e-piece of the site that makes the system faster and safer.

3.3 Design Options

3.3.1 Hardware Design

During our search, we`ve encountered microcontroller alternatives options.

3.3.1.1 Arduino

Arduino mega microcontroller board to program and control the system circuit.

- Advantages
    - No operating system required
    - Supports analog input
    - Low power consumption
- Disadvantages
    - No built in WIFI
    - No graphics support
    - runs one program at a time

3.3.1.2 Raspberry Pi3

Raspberry pi microcontroller board.

- Advantages
    - High graphics processing
    - Runs complex programs
    - Can be programmed with more than programming language
    - No shields required to use internet
- Disadvantages
    - Doesn't support analog data
    - High power consumption

According to the discussion, we used Raspberry pi 3 model b, because our system requires a high graphics processing.

3.4 Sub circuits

3.4.1 Raspi Camera V2

This circuit in figure 3.1 below shows the connection of camera with raspberry pi 3

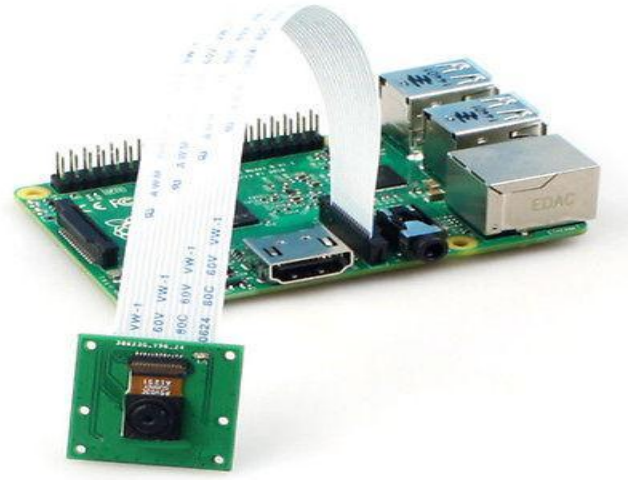

figure 3.1 Raspicam connection 1

This circuit in figure 3.2 below shows the connection of Motion sensor with the raspberry pi 3. This sensor will be used to get the detect a motion in the car, sends an alert to website and asks raspicam to take a snapshot and sends it to the website

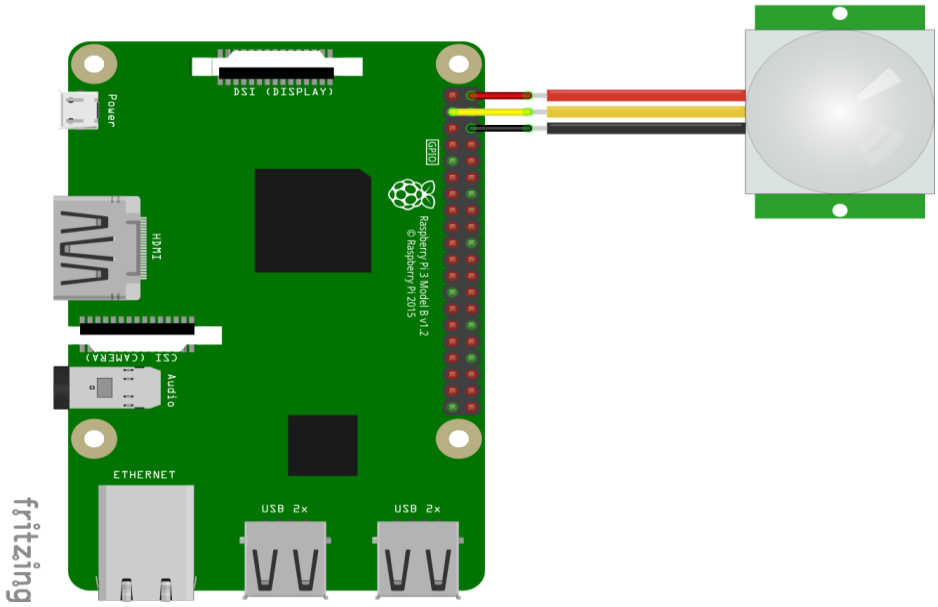

figure 3.2 Motion sensor circuit 1

3.4.3 DHT22 temperature and humidity sensor circuit

This circuit in figure 3.3 below shows the connection of DHT22 sensor with raspberry pi. This Module will be used to get the temperature and humidity of the vehicle.

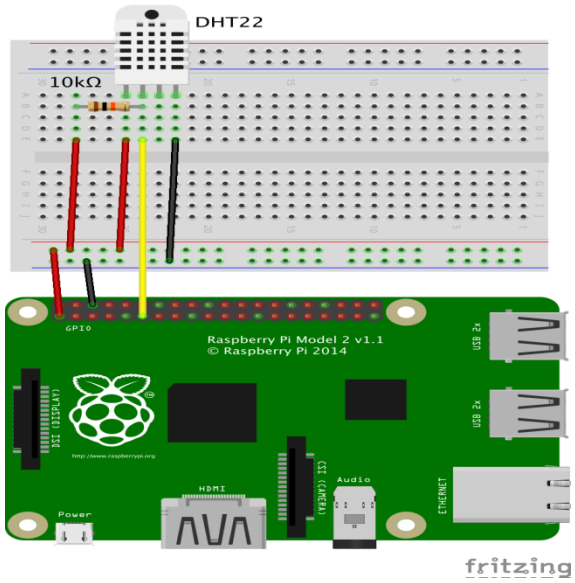

figure 3.3 DHT22 circuit 1

3.4.4 MQ-2 Gas sensor circuit

This circuit in figure 3.4 below shows the connection of MQ-2 sensor with raspberry pi. This Module will be used to get the gas level or smoke in the vehicle..

- this sensor output an analog signal, and raspberry pi doesn't support analog input
- MCP3008 chip used to convert analog signal to digital

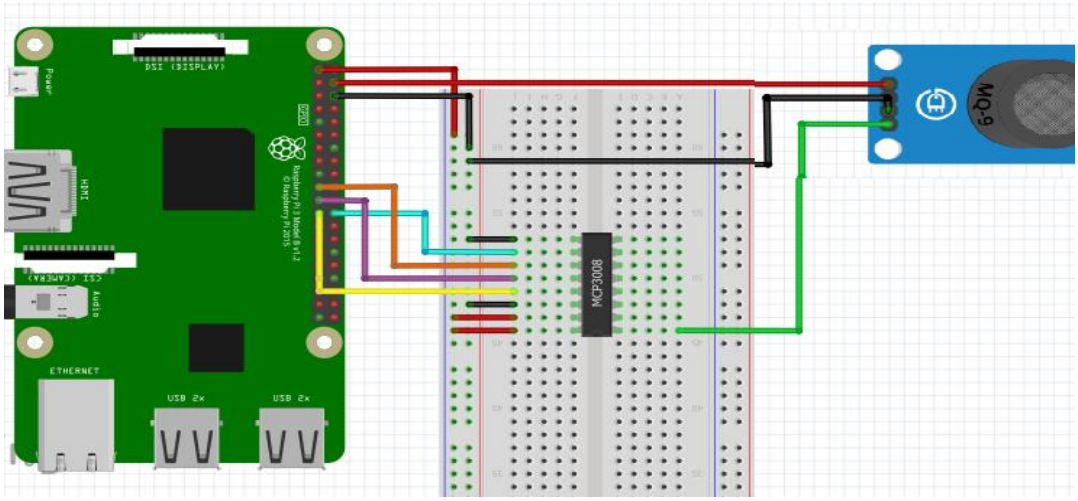

figure 3.4 MQ-2 sensor circuit 1

3.4.5 GPS neo6m circuit

This circuit in figure 3.5 below shows the connection of GPS neo 6m v2 module, this module will be used to locate the position of the vehicle on the map and measure the speed

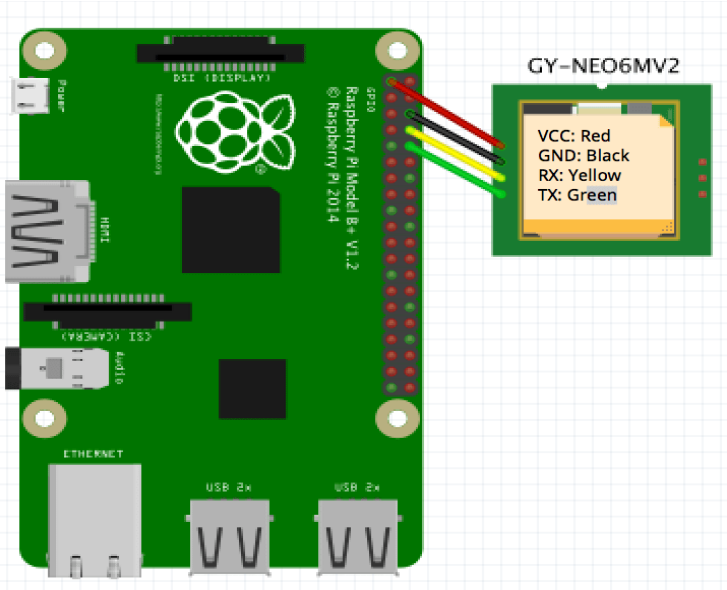

figure 3.5 GPS neo6mv2 circuit 1

3.5 Circuit diagram

This figure 3.6 below shows all components connected to the raspberry pi

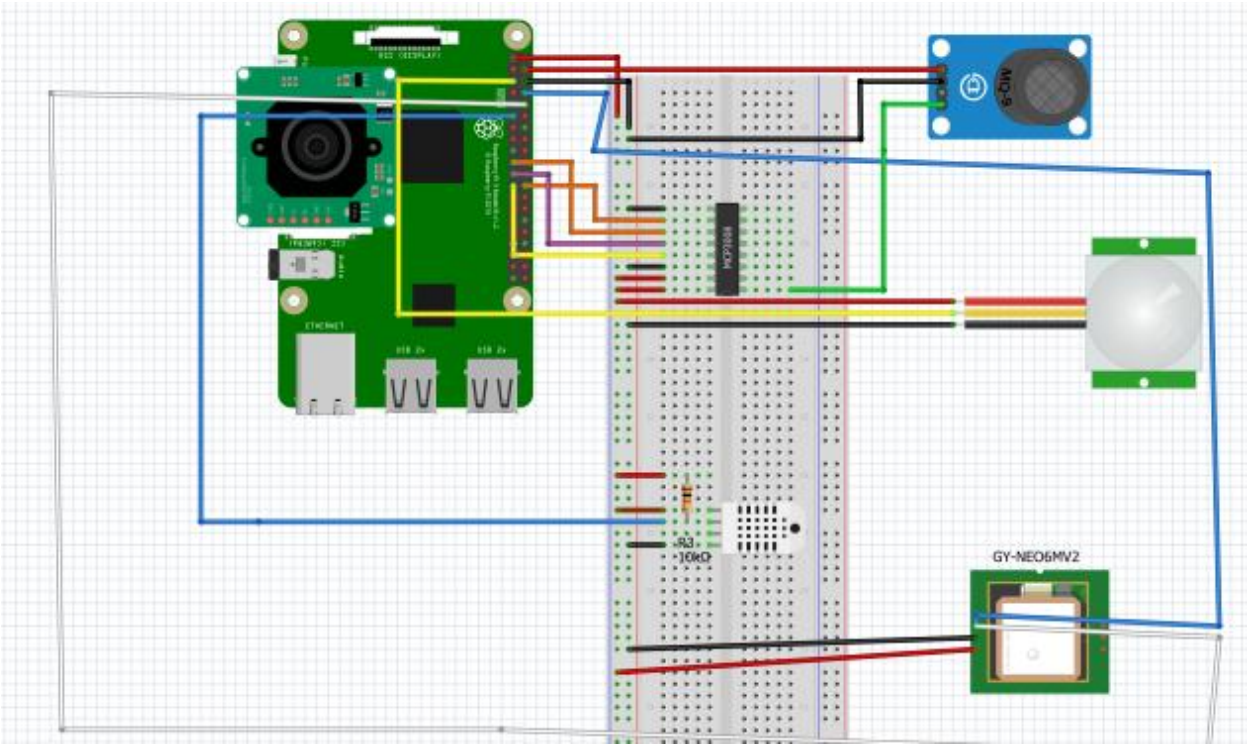

figure 3.6 full system circuit 1

3.6 Block Diagram

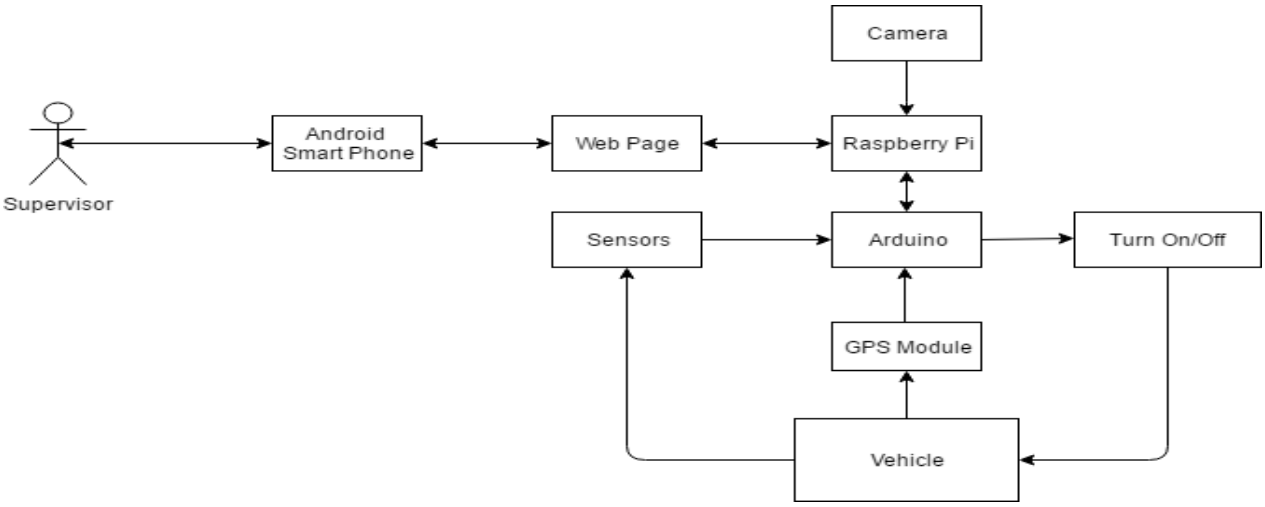

Figure 3.7 Block diagram 1

- Supervisor: Receives data from the raspberry PI using his smartphone through the website.
- Smartphone : a user interface connects between user and the system
- Website : a programmed web used as a connection between Raspberry PI and the smartphone, receives data from PI and sends to smartphone
- GPS Module : Uses satellite to get the current latitude and longitude and sends to raspberry PI
- Motion sensor : detects if there is any motion in the vehicle
- Camera : capture if there is any motion
- Raspberry PI : a microcontroller that receives data from sensors and camera and sends to web, receive instruction from web to execute it
- MQ2 Gas :sensor check the gas level in the vehicle if there's a leak
- DHT22: measures the temperature and the humidity inside the vehicle

3.7 Sequence Diagram

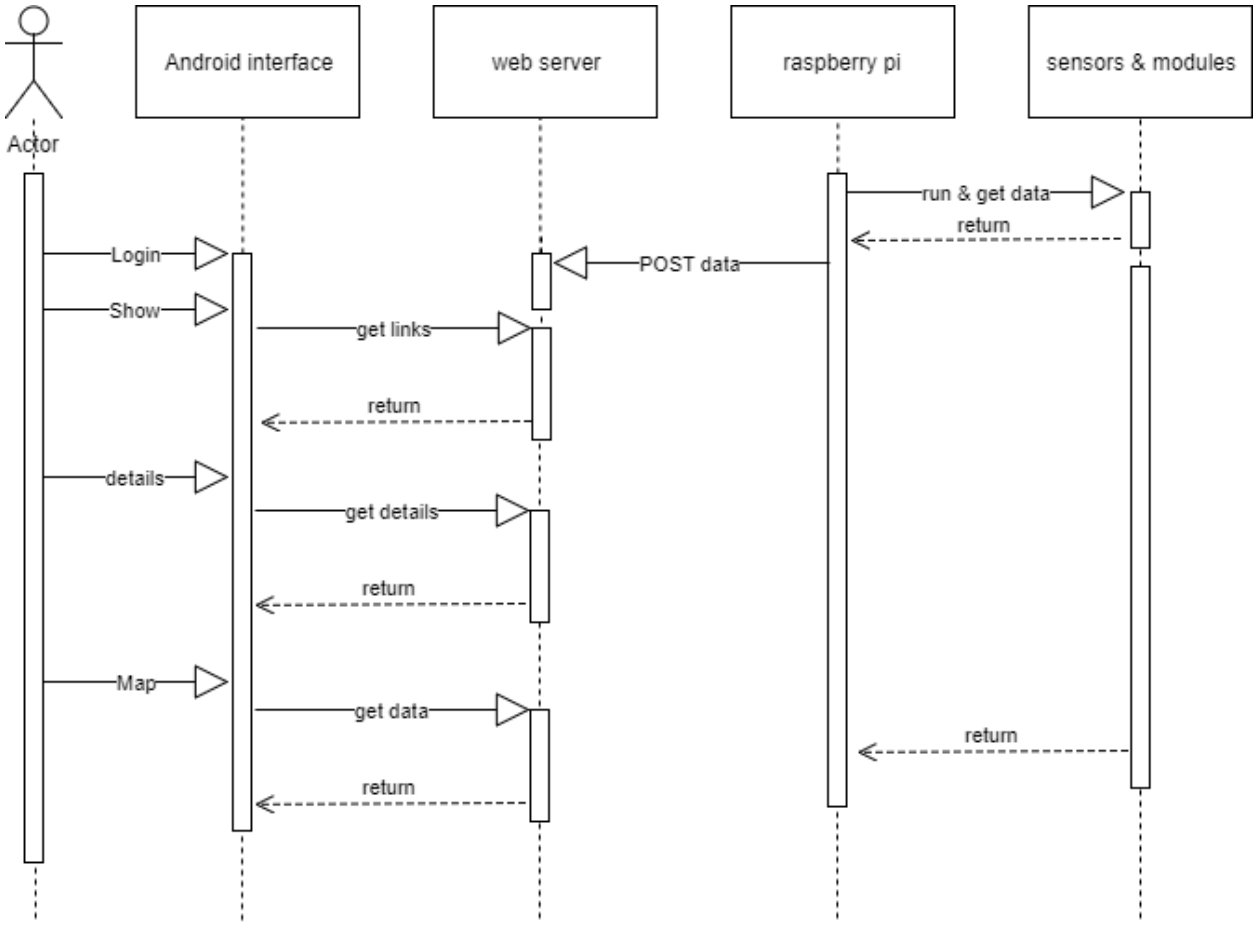

Figure 3.8 Sequence diagram 1

Figure 3.9 shows the sequence diagram for whole system, as the figure shows a raspberry gets data from sensors and modules, raspberry sends data to website. When a supervisor logins to android application, the application starts receiving data from website and show on the screen

3.8 System Flowchart

3.8.1 Temperature flowchart

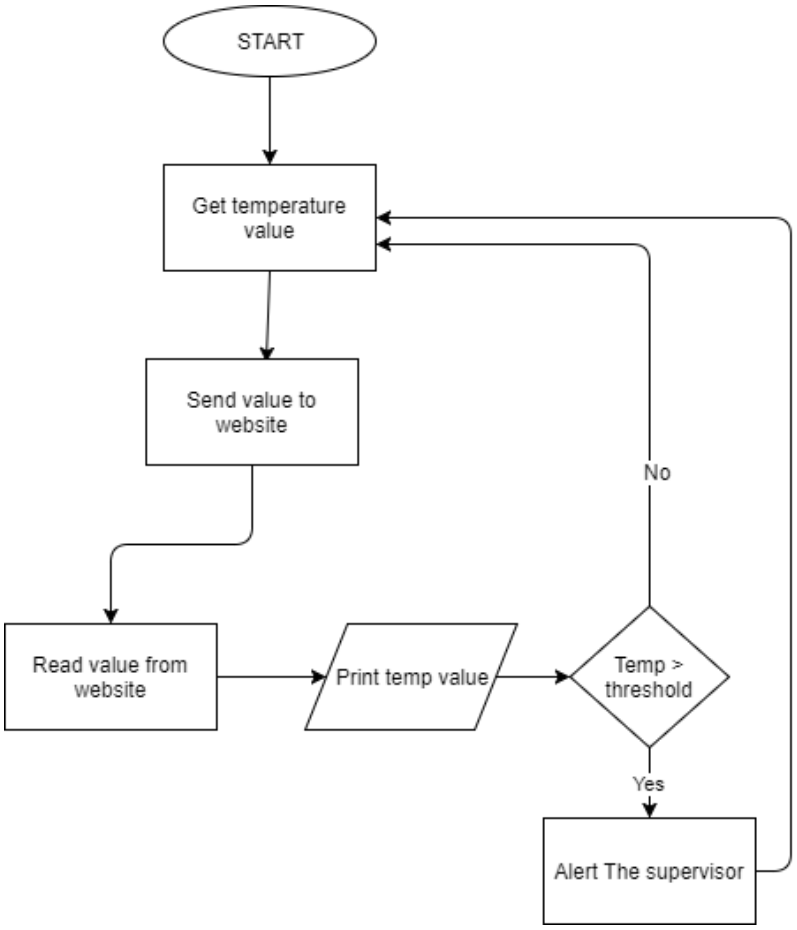

Figure 3.9 Temp flowchart 1

3.8.2 Motion detection flowchart

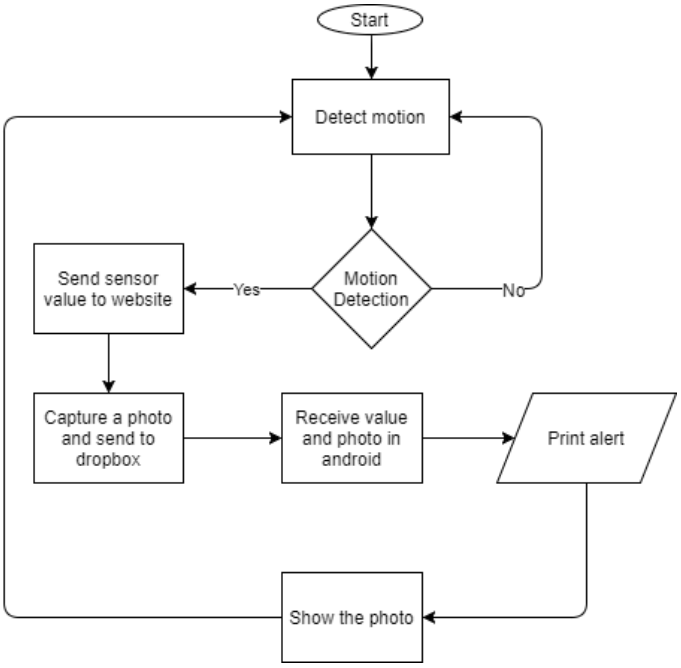

Figure 3.10 Motion detection flowchart 1

3.8.3 Speed limit flowchart

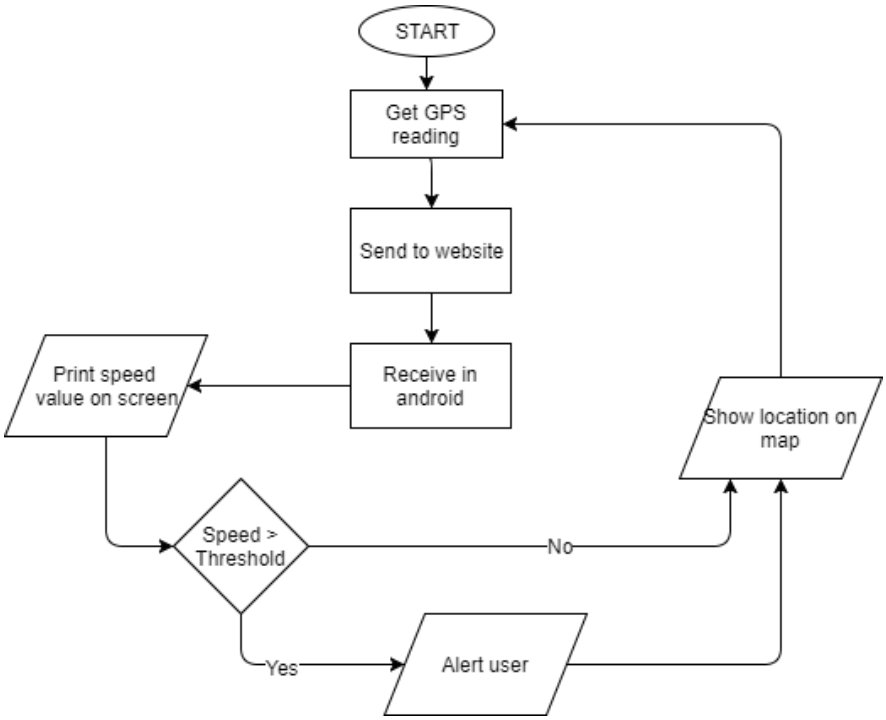

Figure 3.11 Speed Flowchart 1

3.8.4 Gas sensor flowchart

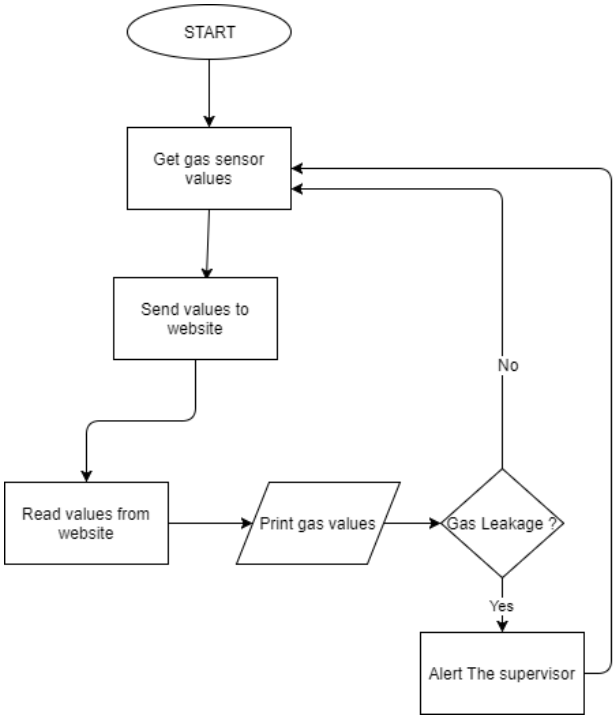

Figure 3.12 Gas detection flowchart 1

Chapter 4

Software & Hardware Implementation

4.1 Overview

In this chapter, we will describe the implementation of software and hardware components that are used in our project, such as the mobile OS, IDE's, PHP and python.

4.2 Operating System for mobile

There were many operating systems for mobile to be used to handle the software and hardware resources of our system such as Android and IOS. We have chosen android OS rather than IOS OS because it is the world's familiar mobile operating system. In addition, it is easy to be used and work with an Android device, because it is working perfectly with Windows OS and it needs only to download Android studio program with unity android support. However, IOS device needs a complex procedure, since it needs a mac OS in the laptop (Apple laptop) with XCode program. "XCode is a Mac-only integrated development environment (IDE) containing a suite of software development tools developed by Apple for developing software for OS X, iOS"[9].

4.3 Software Implementation tools

This section will provide some information about the main programs and software Technologies used in our project.

4.3.1 Android studio IDE

Android Studio is the official Integrated Development Environment (IDE) for Android app development we have used this ide to develop our application.

Our application consists of five user interfaces, which are:

- Login interface where each company has its own username and password when supervisor press the login button the application moves to the vehicle interface

- Vehicle interface which consists 3 buttons and a spinner when user press on show my cars, a list of company vehicles will be loaded, when user press on live it will start the activity of the selected vehicle live stream video, and when supervisor press on details it will start vehicle details activity

- Live interface will open last detected photo.

- Details interface consists of 6 measures or details which are
    - Car Speed
    - Liquefied petroleum gas 'LPG' measurement
    - Smoke measurement
    - Driver status, in vehicle or not
    - Temperature the measurement of vehicle temperature
    - Humidity the measurement of vehicle humidity

    Also it contains a button starts up the map activity
- Maps activity which has the latitude and longitude of the vehicle and marks it on map

All the interfaces are auto updated to be a success real time system.

List of figures from 4.1 to 4.5 show the system interfaces and how it works

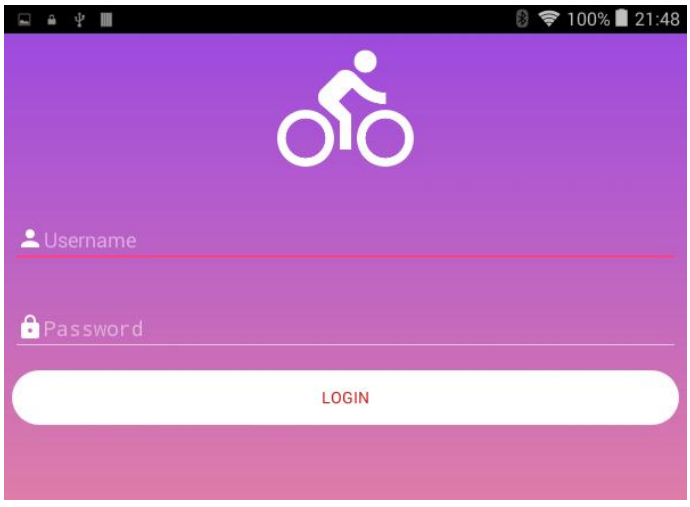

figure 4.1 Login interface 1

Where supervisor enters username and password of the company, systems check the validity of the entered details in the database, if it is correct it moves to the second activity, which shows company vehicles

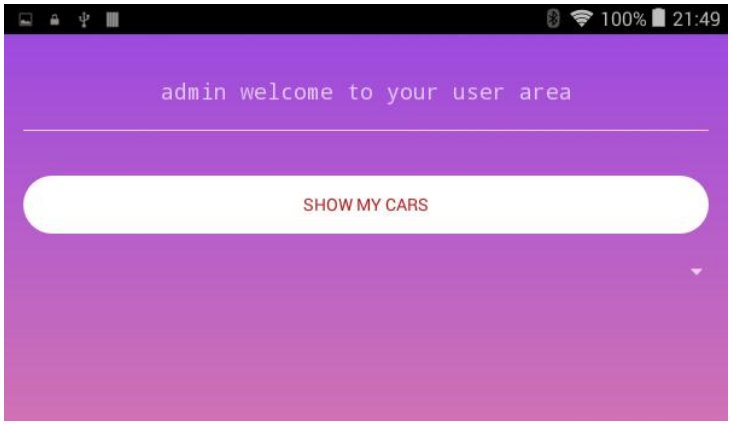

figure 4.2 Select a vehicle 1

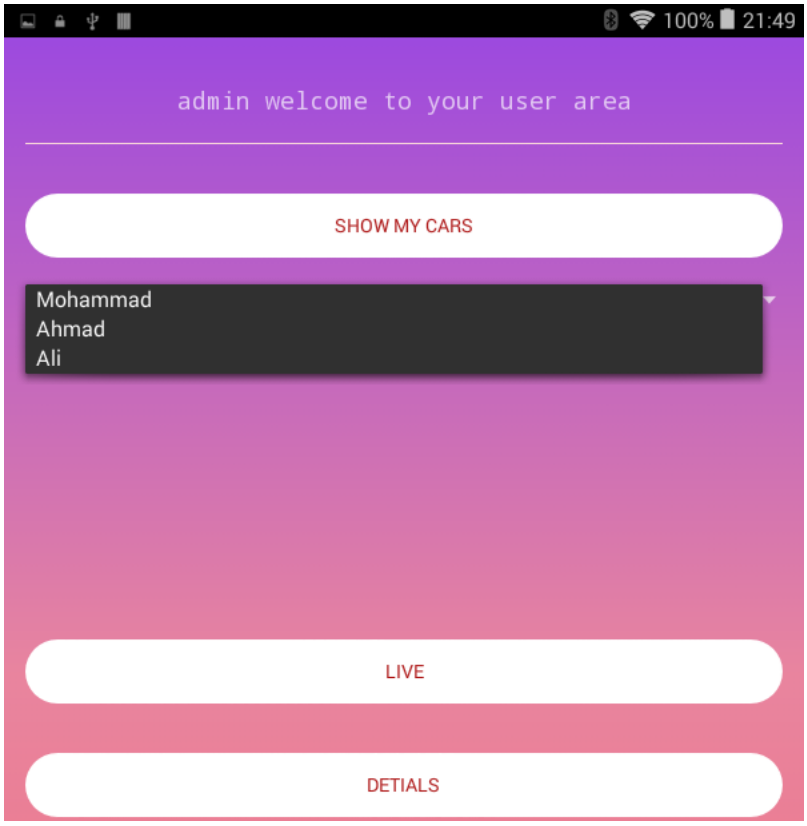

figure 4.2 Select a vehicle 2

This figure show the vehicles of the company, the spinner will be loaded when you press on show my cars.

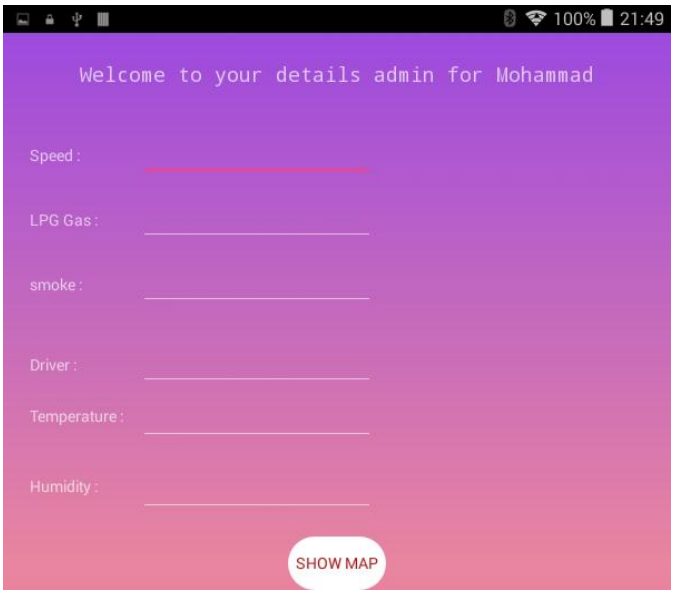

figure 4.3 Details interface 1

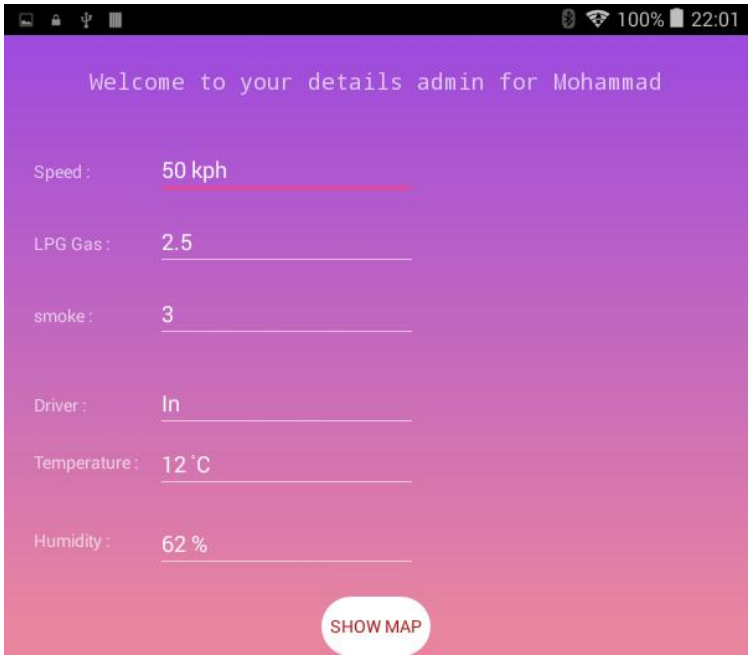

figure 4.3 Details interface 2

In this activity data will be loaded from website and showed up on the supervisor screen, these data will be auto updated every 5 seconds, time chosen to get a high accuracy of reads, 1 to 4 seconds reads the same value more than one time, 5 seconds was the best time to give the raspberry pi the chance to send all measures.

figure 4.4 Map interface 1

Maps activity gets the value of the latitude and longitude of the vehicle from website and shows a pin on map of the location of the vehicle.

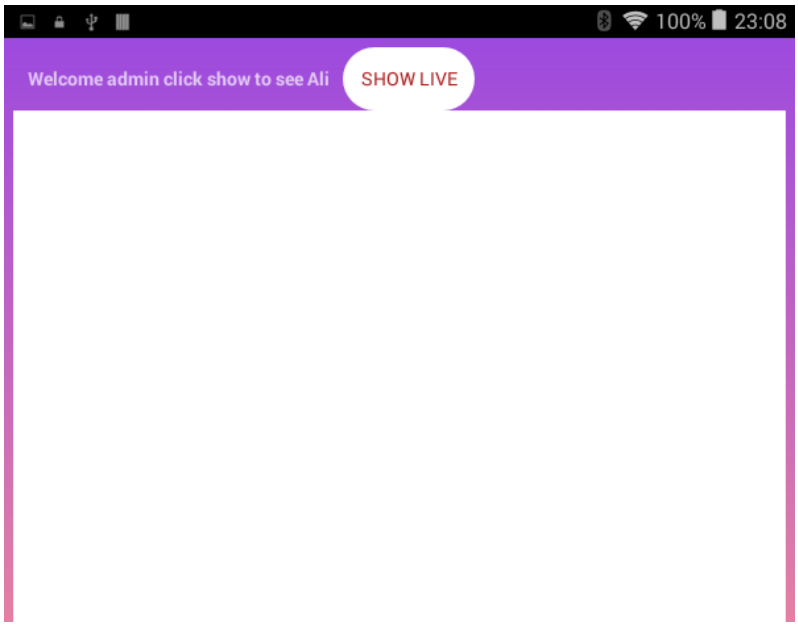

figure 4.5 Live interface 1

User can view the last detected photo by accessing the live activity. In this activity supervisor gets last photo sent to website from the raspberry pi after detecting a motion.

4.3.2 Python script

Python programming language codes written for raspberry pi to execute the system requirements, python used in our project as a main part, which used to communicate between sensors, plugged to raspberry pi, raspberry and the website.

4.3.3 Sublime text editor

A text editor used to write the php codes in our project, which was the communication link between Raspberry pi and website, on the hand between website and the android application of the supervisor

4.4 Hardware Implementation

This section will provide some information about the hardware implementations done through our project.

4.4.1 Motion sensor configuration

For the system, we have used Motion sensor to detect if there is any motion in the car or not, by this sensor work by two slots when the sensor is idle the slots have the same value of IR, when there is a movement it cause a difference change between IR of the two slots.
Figure 4.8 shows the principle of the sensor working

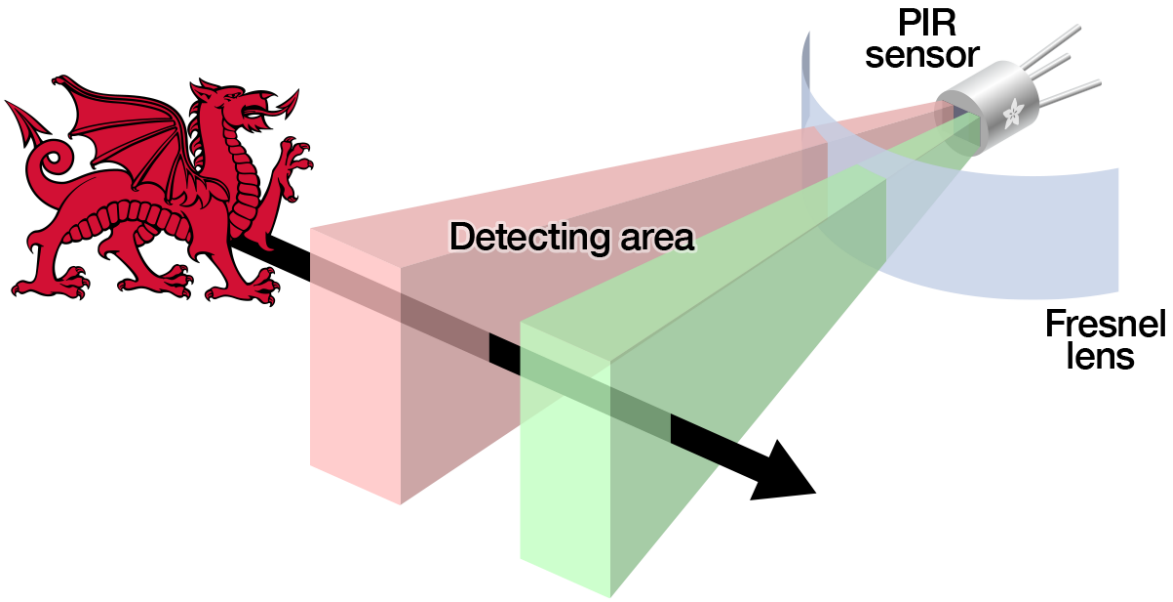

figure 4.6 Motion working principle 1

figure 4.7 Motion sensor connection 1

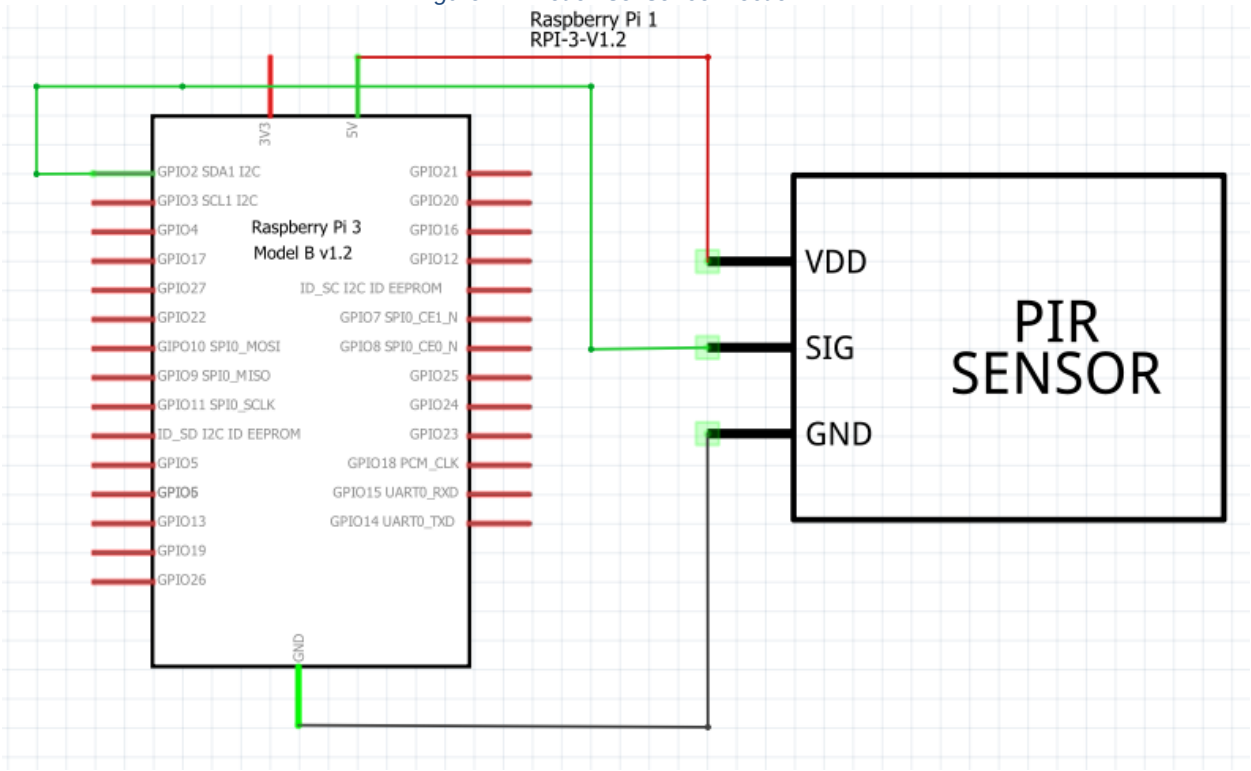

Figure 4.8 Motion schematic diagram 1

4.4.2 DHT22 sensor configuration

This sensor used in our project to measure the temperature and humidity inside the vehicle to keep orders safe, this sensors works by change in the resistance of the humidity sensor or the NTC " Negative Temperature Coefficient"

Figures 4.9 and 4.10 shows the sensor working principles

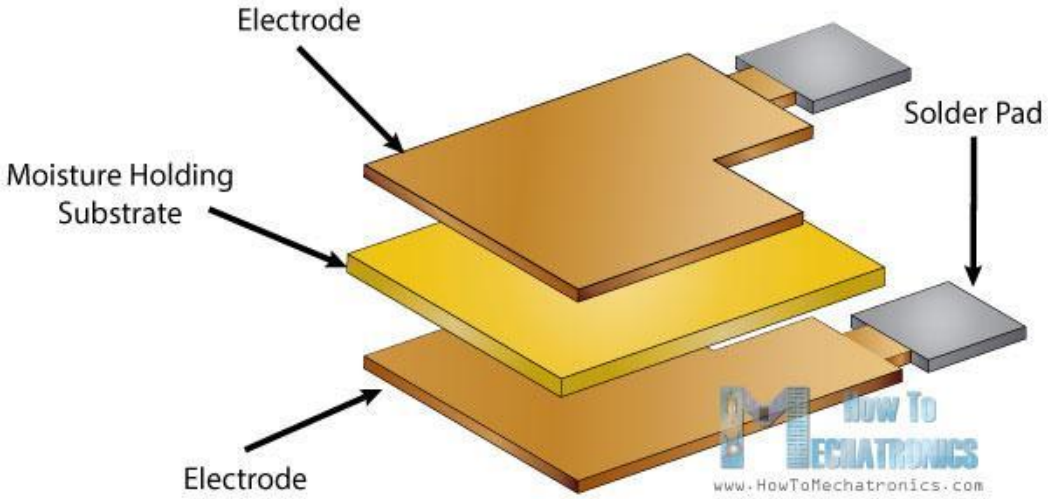

Figure 4.9 Humidity working principle 1

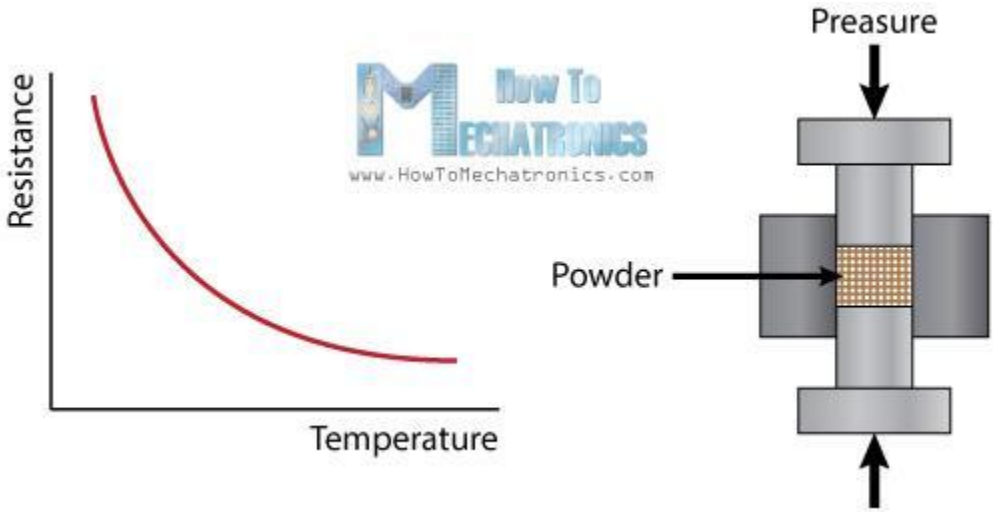

Figure 4.10 Temperature working principl 1

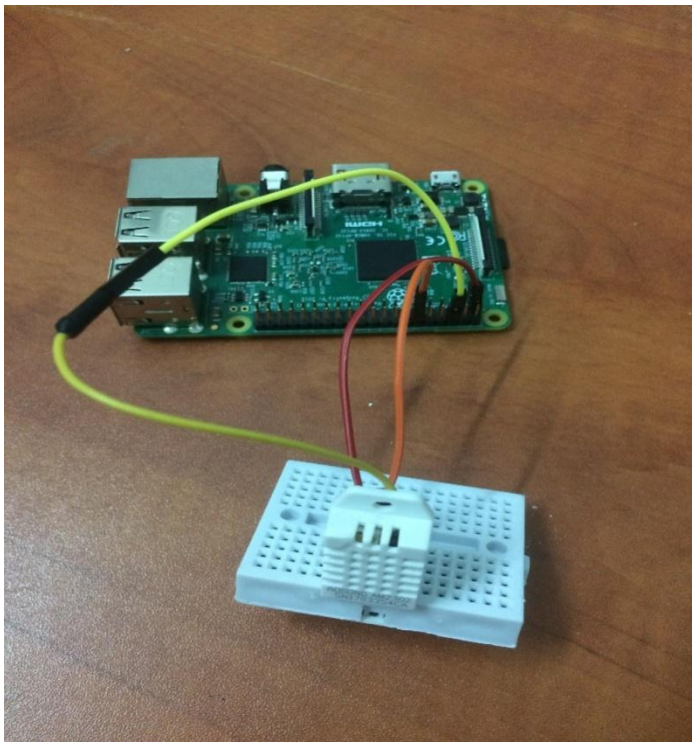

figure 4.11 DHT22 connection 1

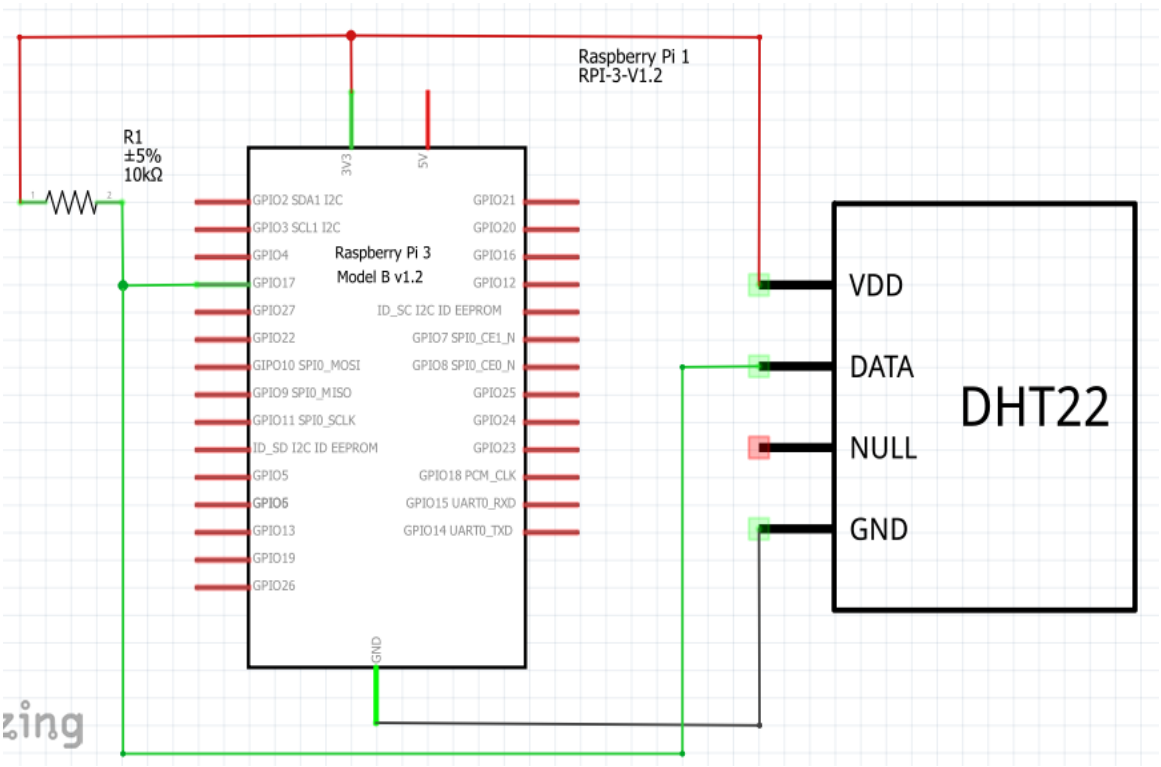

Figure 4.12 DHT22 schematic diagram 1

4.4.3 Camera module configuration

The camera module used to capture and record images and videos, but in our project the camera module used to capture a photo when there is motion.

figure 4.13 camera connection 1

4.4.4 MQ-2 Gas sensor configuration

The gas sensor was used in our project to determine the leakage of the gas in the vehicle or if there is a fire which can recognize the smoke. This sensor works by changing the resistance for different types of gases, the sensor has different sensitivity for different types of gases.
And since this sensor works with analog values, the heater value changed due to change in the resistor. We had to use analog to digital converter to read data by the raspberry pi.
Figure 4.14 shows the analog to digital converter.

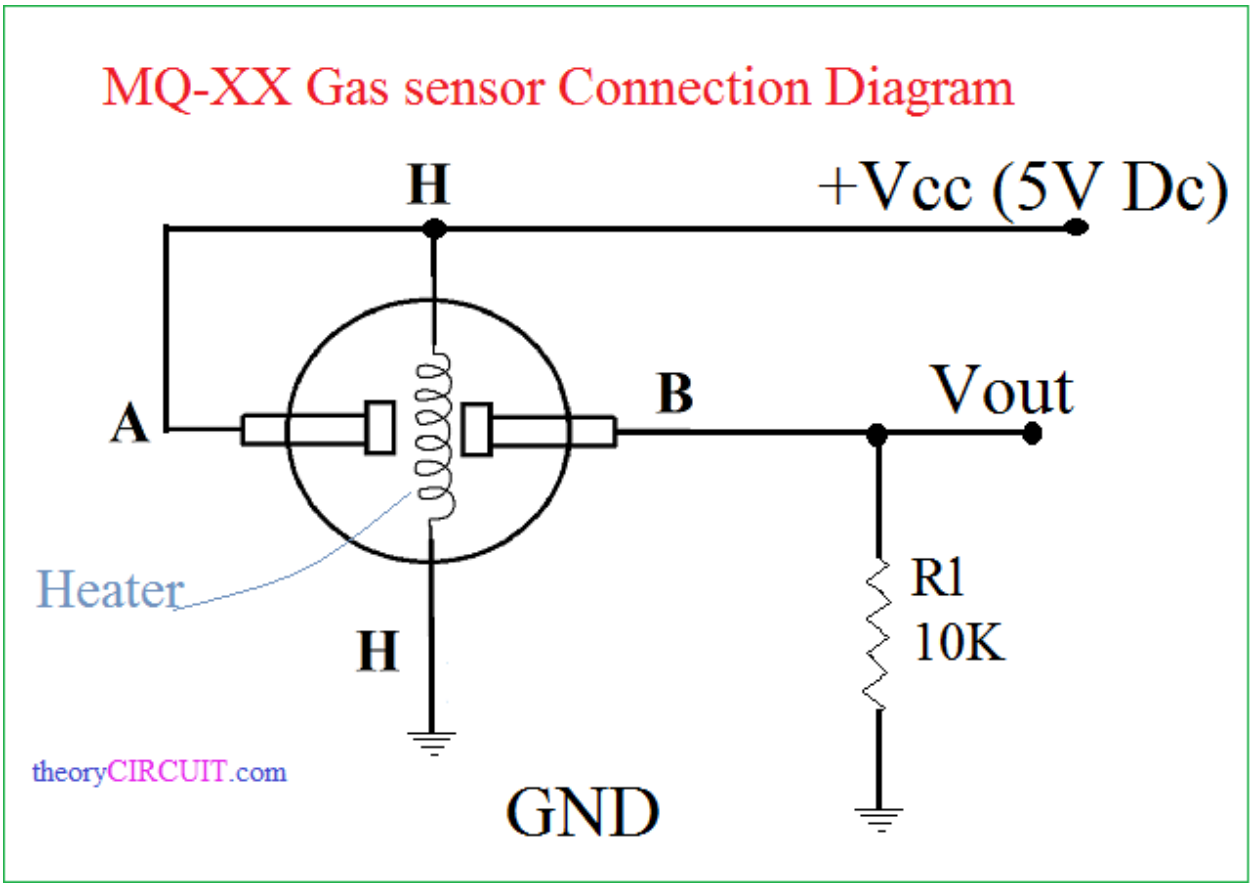

figure 4.14 MQ-2 gas working principle 1

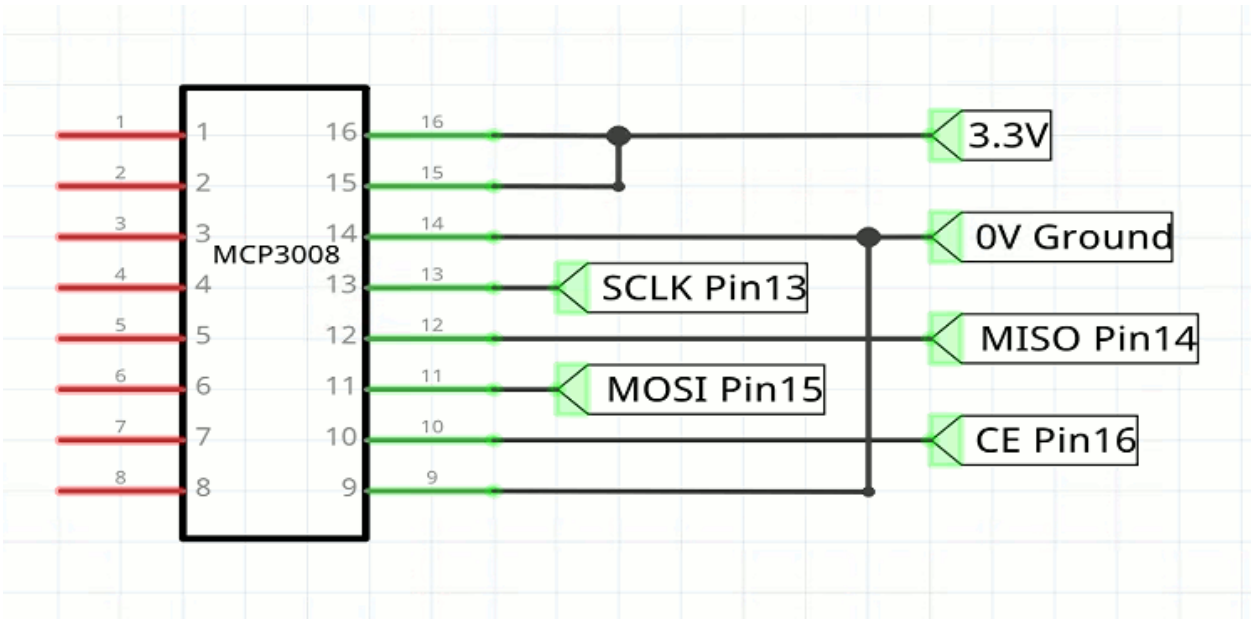

figure 4.15 MCP3008 working principle 1

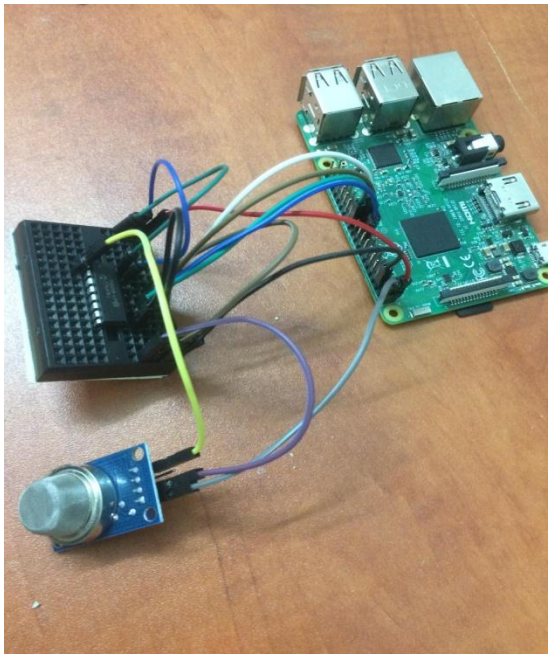

figure 4.16 MQ2 & MCP3008 connection 1

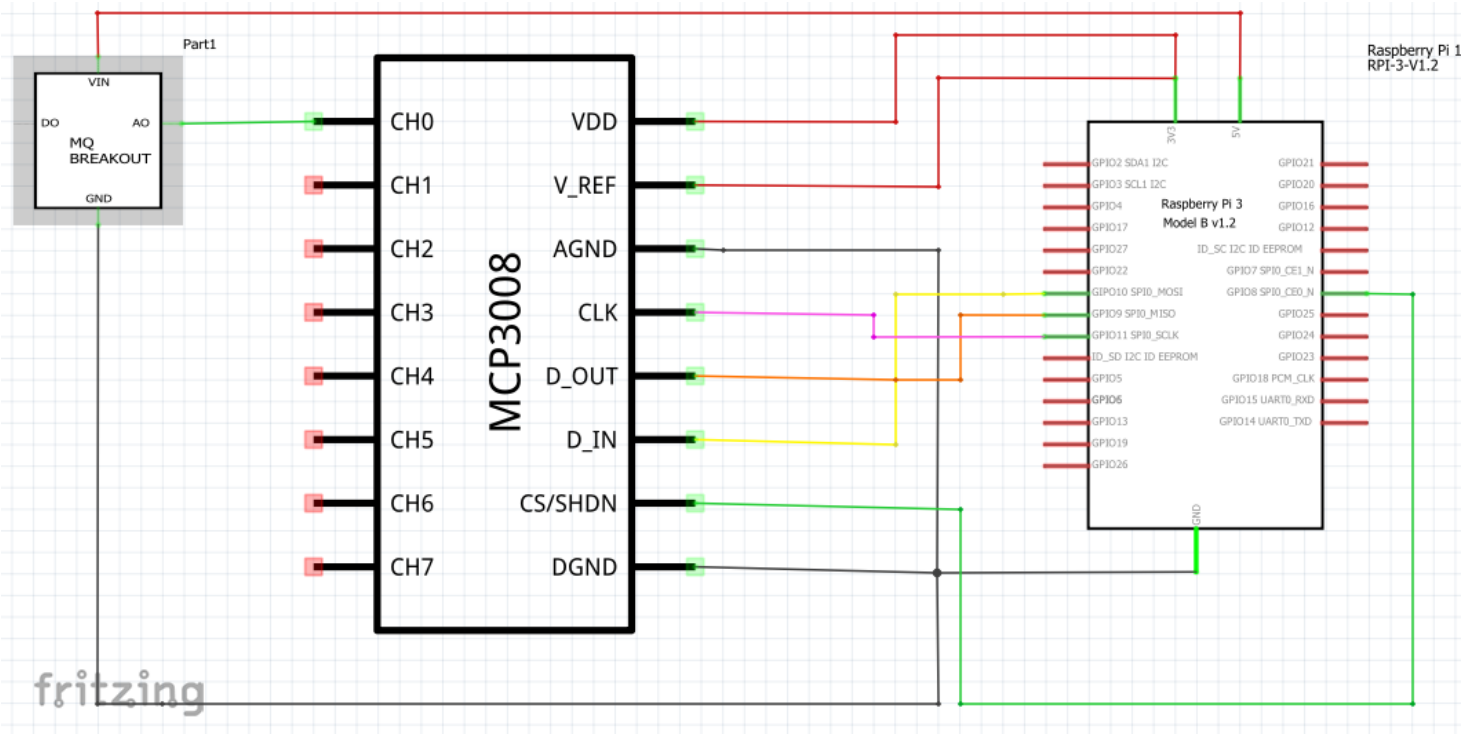

Figure 4.17 MQ2 schematic diagram 1

4.4.5 Neo6m GPS module configuration

we have used the GPS module in our system to detect the driver location and speed, this module working by sending signal to nearest satellites and each satellite send the distance between it and the object, note that the satellite position is fixed so by distances collected an accurate position can be gained, and for speed the GPS module measure time of the object in 2 different positions and gets the speed using (Speed = distance/time)

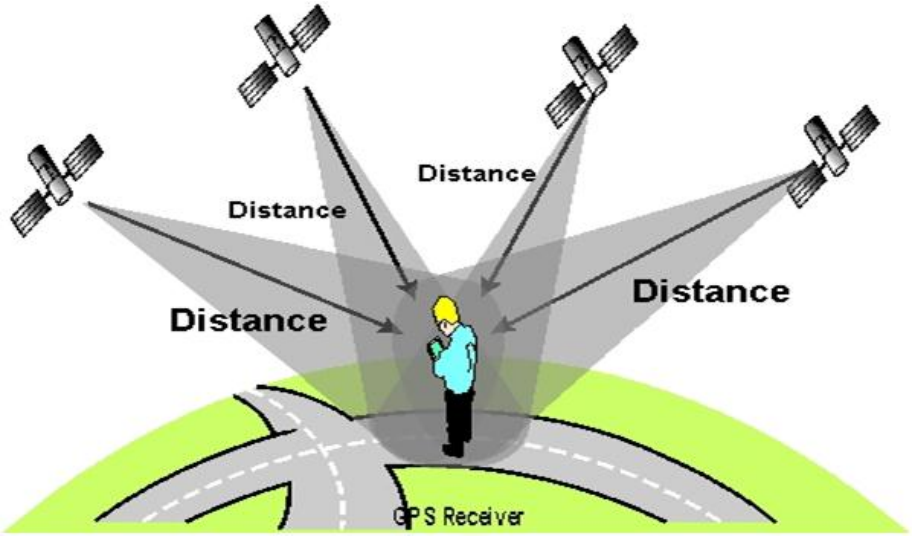

Figure 4.18 GPS working principle 1

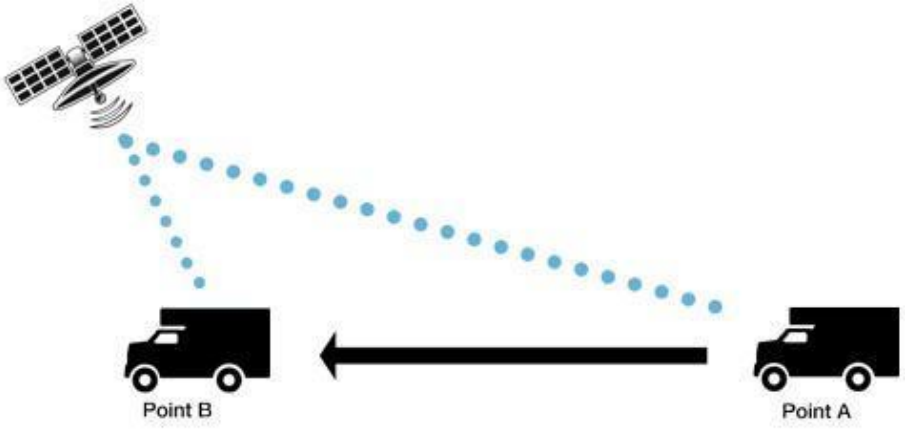

Figure 4.19 speed measurement principle 1

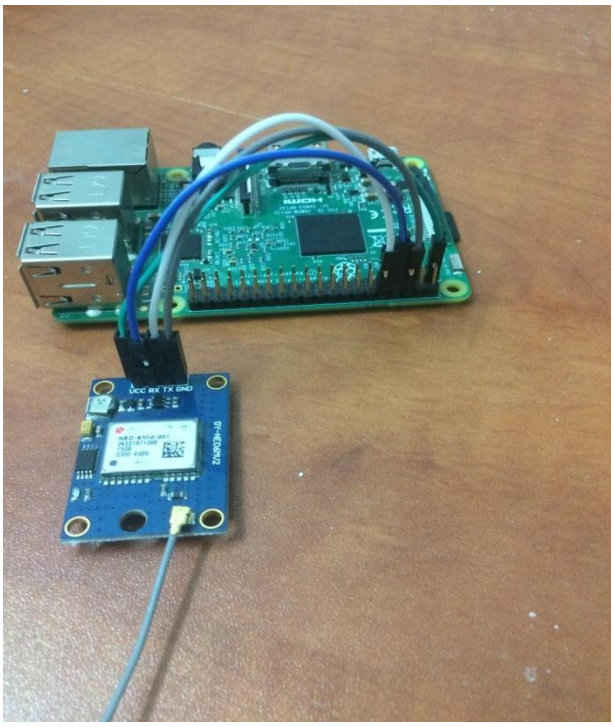

Figure 4.20 GPS connection 1

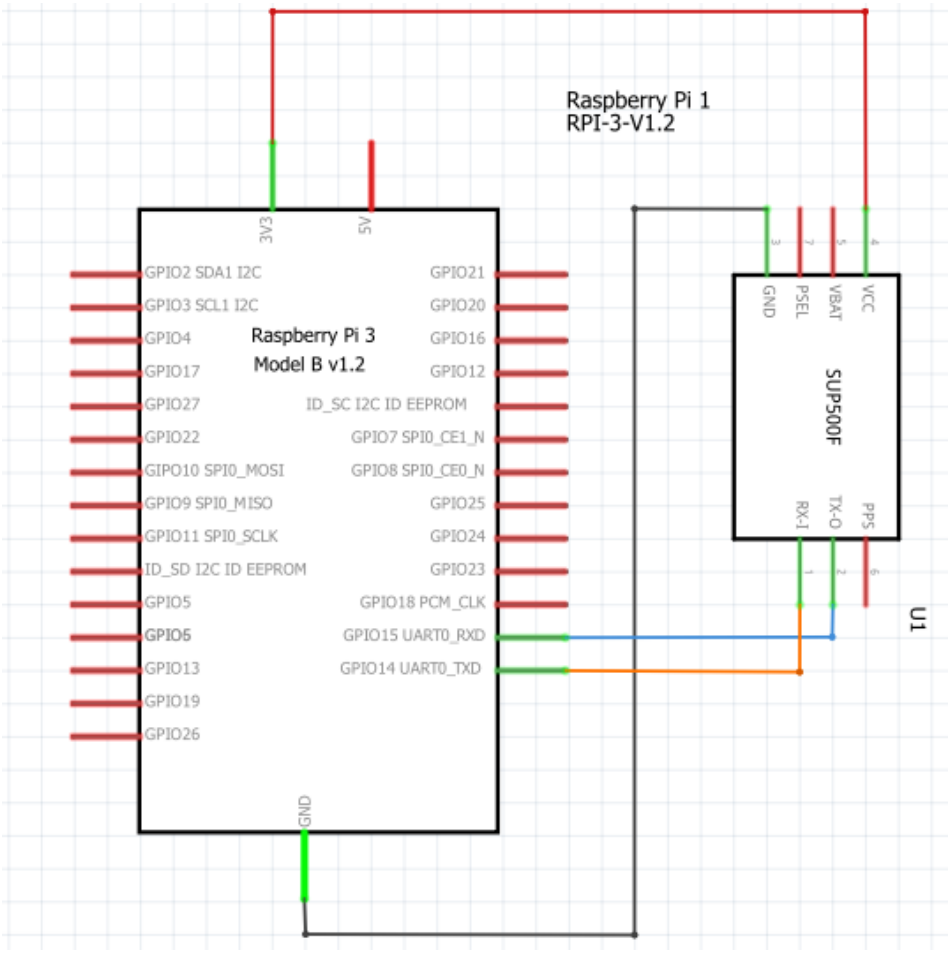

Figure 4.21 GPS schematic diagram 1

4.4.6 All system gathered

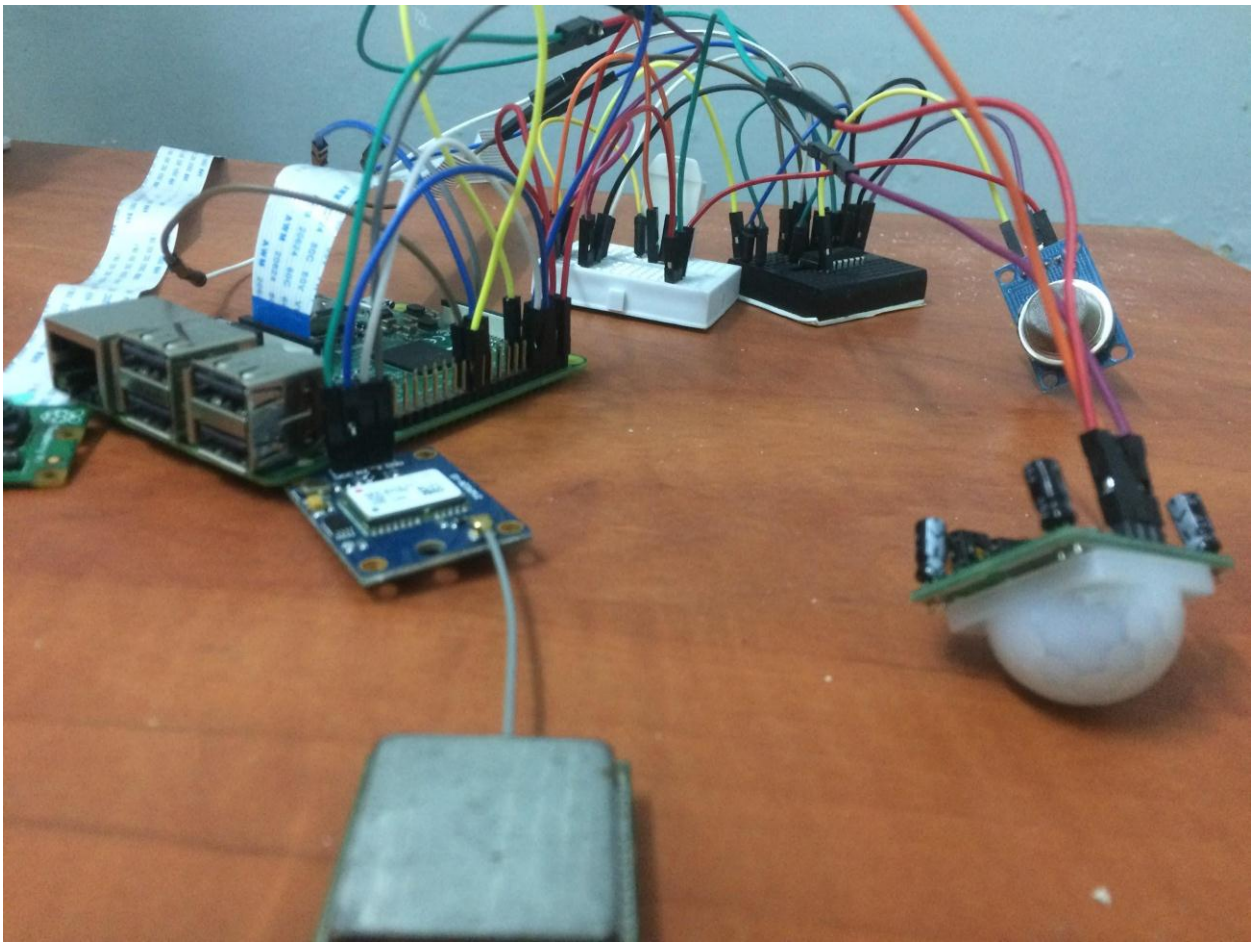

Figure 4.22 All system gathered 1

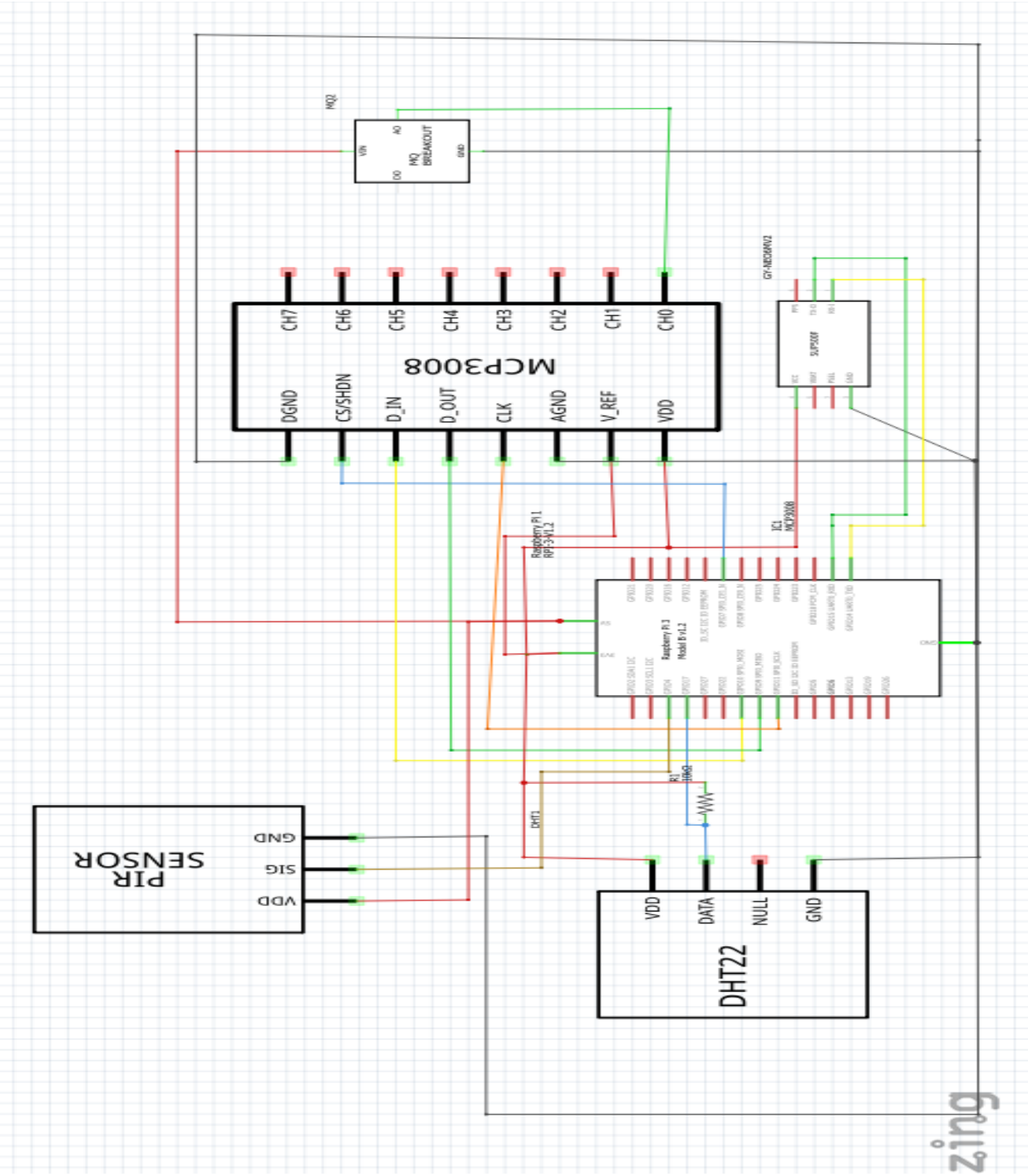

Figure 4.23 System Schematic diagram 1

Chapter 5

Testing

5.1 Overview

In this chapter, we will describe and discuss the steps, results of the implementation and the testing of the system.

5.2 Unit testing

We starts by testing all the parts to ensure that all of the functions works perfectly and without errors.

5.2.1 Hardware components testing

1. Testing the GPS sensor
2. Testing the DHT22 humidity and temperature sensor
3. Testing the Motion sensor
4. Testing the raspberry pi camera module
5. Testing the MQ-2 gas sensor
6. Testing the MCP3008 chip

5.2.2 Website testing

1. Testing connection between GPS sensor and website
2. Testing connection between DHT22 sensor and website
3. Testing connection between Motion sensor and website
4. Testing connection between Camera module and website
5. Testing connection between MQ-2 sensor and website
6. Testing SQL data stores
7. Testing SQL data selects

5.2.3 Android Application Testing

1. Testing the android SDK
2. Testing the design of each activity

5.3 Integration testing

After ensuring that all the parts is working well, we started assembling and integrating the parts with each other to make the system ready to operate.

5.3.1 Raspberry pi sensors - Website integration test

After testing each sensor as a separate unit, we integrate sensors and starts sending data to website, we tested that the website recorded values same as the raspberry measured values.

5.3.2 Android - website integration test

After receiving data from raspberry pi on website and testing the validity of it, we moved to test android activities integration with website

- Test Login activity
- Test live activity working
- Test received details is the same as the website data
- Test map activity that receives accurate position from website

And everything works well without any problems.

Chapter 6

Conclusion

6.1 Overview

In this chapter, we will conclude the challenges, final result and future work of our project.

6.2 Implementation challenges and issues

We faced several problems while working on the project either on Software and Hardware.

6.2.1 Hardware challenges

- Damaged GPS module ,we had to wait couple of months till the new one delivered
- SD card crashed, after 2 months of working a mistake leaded to crash the SD card into two pieces
- MQ-2 gas sensor required an analog to digital converter, when the integrating test started we discovered that mq2 doesn't work without converter, we had to buy it from local market with 5X price.
- One of the raspberries wireless stopped working, we had to use USB wireless dongle.

6.2.2 Software challenges

- Python and PHP: we were beginners in python and PHP so we had to watch YouTube tutorials until we successfully reached a level that helps us to deal with those environments.
- Android auto update data: we faced many collisions how it will update by pulling or pushing services and many errors occurred, but finally pulling service worked successfully.

6.3 Final Result

The system was able to measure many values through sensors then move these values to raspberry pi, which send these values through internet connection to website. On the other hand, the android application was able to reach and get these values from website in real time.

The main system's components, which are: Raspberry pi, sensors, website and android application, were all combined together, and formed an integrated system that is succeeded in loading sensors measures into mobile via website, integrating raspberry pi with android application via website, read measures and sends to supervisor in real time .

6.4 Future Work:

1. Vehicle controlling
2. Add a fan to run automatically when temperature reach threshold

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