AUTOMATIC BRAKING SYSTEM AND SMART SAFETY FEATURES TO AVOID AND REDUCE ROAD ACCIDENT

By

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A thesis submitted to the Department of Electrical and Electronic Engineering in partial fulfillment of the requirements for the degree of
Bachelor of Science in Electrical and Electronic Engineering

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Declaration

It is hereby declared that

1. The thesis submitted is my/our own original work while completing degree at BRAC University.
2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I/We have acknowledged all main sources of help.

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ABSTRACT

There has been a huge increase of road accident in the last couple of years. This has been quite an issue in our country as a nationwide protest was held against it. A smart system which can do not only Vehicle to Vehicle Communication but also a Vehicle to Infrastructure Communication that can be very effective to reduce unnecessary loss of human lives. Vehicles will be able to communicate with each other to send and receive information to their respective drivers to reduce road accidents. These communications will take place with the help of internet. Leading vehicle can send the data to the following vehicle if there is any vehicle or any obstacle in front of the leading vehicle. There will be a speed control system to reduce the velocity of a car if any obstacle or any vehicle comes near the car. There will be another system to cover the blind spot of the car so that if any vehicle or obstacle comes near the car from the side the driver may know about it. There is a tendency to use high headlight beam all the time so there will be another system included where if any vehicle comes across another vehicle the beam will go low automatically. If there is any unwanted mishap on the road a signal can be sent to the nearest station for emergency support as well.

Keywords: smart system, vehicle to vehicle, vehicle to infrastructure, communication, speed control, blind spot, road accident

Acknowledgement

The idea came to Abrar Murshed while he was driving in the highway at night. He conveyed the idea to his thesis mate and they both sat with their thesis Supervisor Farzana Shabnam and she gave her full support to make the project come true.

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Chapter1
Introduction

1.1 Introduction

A rapid increase in the number of cars has occurred in recent years. The possible risks of road accidents are growing due to the high number of vehicles, for which multiple people in Bangladesh as well as around the world suffer from various traffic accidents every year. Renowned newspaper BDNews24 published a statement on January 25, 2019 that; about 7221 people have died and injured 15,446 people in a total of 5,514 road accidents throughout 2019. [1]
According to a report by the National Committee to Protect Shipping, Roads, and Railways, our country had a 35 percent decline in road accidents and a 45 percent decrease in casualties in 2016 compared to the previous year. Among the wounded, 470 were women and 453 were children. In 2015, however, at least 6,823 individuals were killed in 4,592 traffic accidents, including 781 women and 762 children, while 14,026 others were injured. The figures showed that the road accidents were decreased by 35% while deaths by 50% and injuries by 39% in the just-concluded year than 2015. [2]

The table below provides accident and casualty numbers from 2009 to 2016 [3]. The number of accidents, deaths, and injuries is listed below. We can easily see from the statistics that the number of accidents, injuries, and deaths is either increasing or decreasing. Many steps have been taken, yet they are insufficient. The necessity for a Smart Vehicle Communication System has arisen as a result of the exponential development in the vehicle population, which is generating traffic accidents. The Internet of Things (IoT) market has seen enormous expansion, with new generations of gadgets getting internet connectivity. One significant application of IoT is the Smart Vehicle Communication System (SVCS), which uses modern technology to increase efficiency and safety in road transportation.

Year	Number of accidents	Death	Injury
2009	3381	2958	2686
2010	2827	2646	1803
2011	2667	2546	1641
2012	2636	2538	2134
2013	2029	1597	1396
2014	2027	2067	1535
2015	2394	2376	1535
2016 Up to July	1989	1422	1289

Table 1- Road Accidents Causalities Statistics (2009-2016) [3]

The main purpose of this project is to create a Smart vehicle communication system that enables communication from vehicle to vehicle (V2V) and communication from vehicle to infrastructure (V2I) which will enable vehicles and roadside units to get connected to each other to send and receive information about incoming and outgoing vehicles and accident warnings, which will assist the drivers with the surrounding threats while driving especially in the highways in order to make roads and highways much safer.

1.2 Data

All of the data were collected from internet and their references have been given. In this pandemic it has been difficult to implement to a real vehicle and test it and therefore a scale model was made and a mathematical expression was created to verify whether the overall system is feasible or not. Result from the mathematical expression was cross checked with a table taken from NHTSA to verify whether the mathematical expression is correct or not.

1.3 Literature review

The main intention of starting the project is to create a system which will help to avoid and reduce road accidents. In order to that let us first look at the type of accidents that occur on the road.

There are nine types of road accidents [4]

1. Rear End collisions

Rear-end collisions are among the major types of traffic accidents. When a vehicle collides with another vehicle in front of it, this type of accident occurs. It usually occurs when the rear vehicle accelerates unexpectedly and collides with the front vehicle; or the front vehicle collides with the rear vehicle.

2. Individual Vehicle Collisions

Individual vehicle collisions occur when an individual hits any obstacle on the road like a road sign, divider, street light etc. These kinds of accidents can happen due to bad weather like fog or heavy rain or due to insincerity and carelessness

3. Accidents due to over speeding

When a vehicle exceeds the speed limit set by the authorities, an accident occurs, and the majority of the time it is fatal.

4. Accidents due to influence of narcotics

This kind of accident happen if any driver is under the influence of narcotics. When someone is under the influence of narcotics they lose their normal senses, which decreases their situational awareness.

5. Distracted While Driving

This kind of accident happens when a driver is distracted while driving. A mobile call or text or turning on of entertainment systems can distract a driver.

6. Ignoring Traffic laws

Ignoring traffic laws like crossing red lights can end in a serious disaster.

7. **Not wearing safety equipment**

Safety equipment like helmets and seat belts are designed to lessen the risk of a road accident. Not wearing a helmet or putting up a safety belt can end up in disaster.

8. **Accidents at side of vehicles.**

This kind of accident happen when a vehicle hits a side of another vehicle. It happens on the intersections. A vehicle can hit a side of a vehicle with wither their own side or their front end of the vehicle.

9. **Vehicle Rollover:**

This happens when a vehicle flips onto its side or land on the roof. It can roll multiple times before ending up on its side or on the roof. It happens due to overspending in a curve or getting hit by another car or falling down from a hill or a slope.

Lots of companies are already working to make different systems that can help to decrease road accidents and some are already in the market. For instance, Toyota has Toyota Safety Sense, Honda has Honda safety plans, BMW has Active Drive assistance etc. But none of this plans and features includes inter communication between an infrastructure and a vehicles or intra communication between vehicles.

Recently, there has been a lot of interest in the intelligent transportation systems (ITS) by combining Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) communication technologies. These systems allow vehicles to share GPS based information like longitude, latitude, speed etc. Critical vehicle information such as brake, turn signal, pre-crash detection and warning system etc. are shown to the driver. [5]

The main element of V2V and V2I based system is wireless networking. There are various wireless networking systems available. We gathered all of the data from Open Electronics. [6]

Bluetooth: Bluetooth is likely to be one of the widely used wireless protocols in IoT specifications, particularly now that Apple has launched the Bluetooth Low Energy extension, often known as iBeacon. The benefits of the BLE protocol were generally recognized when Bluetooth 4.0 was announced. When Bluetooth 4.0 was released, the benefits of the BLE protocol were widely recognized. This standard's advantage is its extremely low power consumption, which allows for the creation of fully battery-powered boards with operating times of up to 2 years in some situations. Further innovation, which is currently available on many smartphones, is the ability to incorporate the management protocol directly at the kernel level without the need for user participation. This makes it easier to build up a Bluetooth mesh network with reduced latency and greater range than regular Bluetooth.

ZigBee: It is a set of high-level communication protocols for creating wireless personal area networks (WPANs) using small, low-power digital radios. The IEEE 802.15.4 standard is the foundation for ZigBee. ZigBee devices may transport data over large distances by sending data across a mesh network of intermediary devices to reach more distant ones, despite their low power consumption limiting transmission distances to 10–100 meters. ZigBee is commonly used in low-data-rate applications that demand long battery life and secure networking (because it supports 128-bit encryption), such as home automation, healthcare, and industrial control applications with short range and low bit rate. The Microchip MRF24J40MA, a certified 2.4 GHz IEEE 15 802.15.4 radio transceiver module, is one of the most popular and best-performing SoC and solutions on the market. The MRF24J40MA has a PCB antenna and matching circuitry, as well as support for the ZigBeeTM, MiWiTM, and MiWi P2P protocols. The MRF24J40MA module uses a 4-wire SPI interface to connect to hundreds of PIC® microcontrollers, making it perfect for wireless sensor networks, home automation, building automation, and consumer applications.

Wi-Fi: For IoT applications, the ESP8266 is a low-cost, high-integration Wi-Fi MCU. This device supports the entire TCP/IP protocol stack, and it also has a significant amount of computational power onboard. We can fully utilize its capabilities by implementing the logic on the board itself. As a result, sensors can be managed and their signals and measurements can be elaborated automatically. Onboard hosting of basic applications can result in a relatively compact IoT solution.

Radio RF: It refers to any electromagnetic wave frequency in the range of 20 kHz to 300 GHz, which generally corresponds to the frequencies utilized in radio transmission. There is no formal definition for the phrase, and several sources give somewhat varying upper and lower limitations for the frequency range. Electrical oscillations are commonly referred to as RF rather than mechanical oscillations.

After analyzing lots of sensors we decided to use the ESP8266 NODEMCU. This sensor has a microcontroller and a Wi-Fi. So not only this microcontroller can be used as a Wi-Fi chip, many sensors can also be calibrated to it as well. It can be also used to create and use a webserver. Some works deals with the analysis of performance of V2V and I2V multi-hop communication based on IEEE 802.11b, where the distance and loss of signal effects the overall performance and recommended ad hoc networks should extend transmission. Others have assessed the impact of turned off vehicles on road on V2V communication using IEEE802.11p, where the significantly affected the signal. Another also uses IEEE 802.11pstandard with 500-byte frame, which obtained the best performance follower by a 50-byte frame which was decreased by 60% [7]

1.4 Background

There were some projects done related to our thesis project. There was a project named “Safety and Driver Assistance in VANETs: An Experimental Approach for V2V” where 2 vehicles where communicating via NodeMCU and each vehicle had an ultrasonic sonar sensor and motor controller attached to it. Whenever the host vehicle came across any obstacle it would immediately notify the target vehicle and the target vehicle would stop immediately. [8]

There were other works related to VANET or Vehicular Network as well. Certain works deals with the implementation of VANET with the help of a VANET simulator, which used to evaluate various VANET technologies. They present techniques that support the mobility models of vehicles which is very close to realistic movement patterns [9]. Some works dealt with the evaluation of performance of V2V and I2V multi-hop communication based on IEEE 802.11b, where the distance and Line of sight are the factors influencing its performance and also suggested that the use of ad hoc networks could extend the range of transmission [10]. Some have analyzed the impact of obstacle vehicles on V2V communication using IEEE 802.11p, where the vehicles blocking Line of sight effected the signal as well. [11]. Some have analyzed the IEEE 802.11p standard, which improved safety of vehicles, but contains some downfalls in heavy traffic [12]. There is a project which worked on V2V infrastructure assistance in 5G network. [13]

Chapter 2
Proposed model

2.1 Proposed model

Our main focus is to build a type of network where the vehicles will not only get connected to one another but also with the infrastructure as well. We will also create a system that will give a full 360-degree situational awareness for the driver to ensure maximum safety on the road. The vehicles will work as receiver and sender if necessary. The infrastructure will work as a station to provide support in times of an emergency. So there are two parts in our project. One is V2V or Vehicle to Vehicle and the other is V2I or Vehicle to Infrastructure.

Let there be three vehicles and two road side units or RSU on the road. Among the three there are vehicles, 2 vehicles named car1 and car2 is equipped with 2 IR sensor, a SONAR sensor, an LED, L298N H bridge motor controller and an ESP8266 NodeMCU for wireless communication between the vehicles and the RSU. The cars will be able to communicate between themselves in times of a critical situation and if any accident occurs they will be able to send a signal to RSU as well. RSU will work as a Wi-Fi hotspot provider. The cars will get automatically connected to the nearest RSU once they are on the road.

We will also implement some situational features like automatic breaking system with L298N motor controller, blind spot coverage with LED on the car and an alert system on the road with IR and LED to maximize the safety of the driver.

In order to replicate the auto switching of headlight we have used and LDR and an LED. Whenever light falls on LDR it would make the LED turn off.

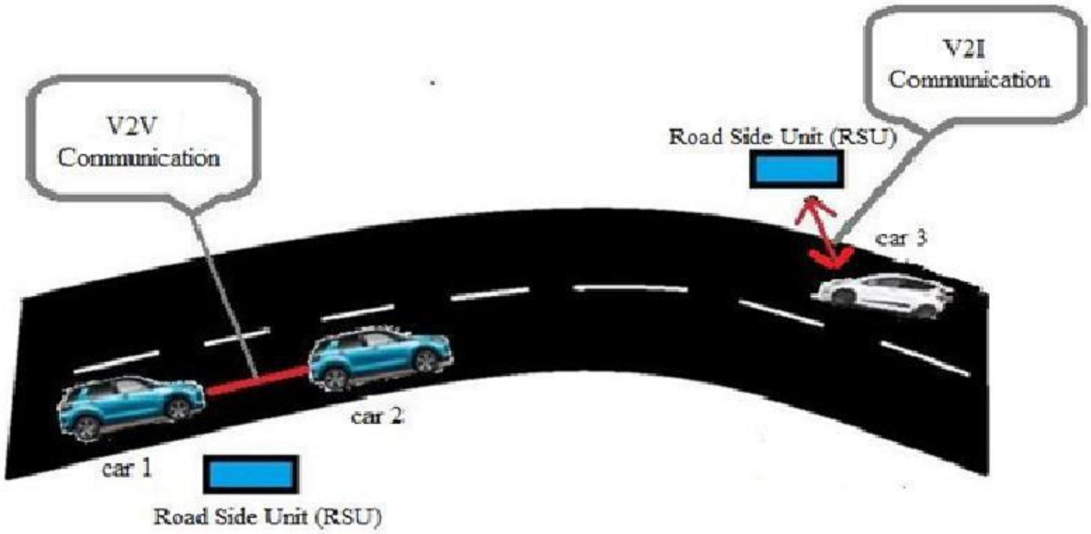

Figure 1 - V2V and V2I Communication

2.2 Model Description

In order to make the communication between the vehicles and infrastructure, we have decided to use ESP8266NodeMCU. The main reason for choosing NodeMCU is that it can be connected to the internet and thus this project will become an IoT (Internet of Everything) project. IoT is such a system where not only the devices will be connected to internet, but also they will be able to exchange and analyze each other's data if necessary. IoT devices help us to be more efficient and smart in every way possible. From medical equipment to defense hardware; from industry machineries to farming equipment IoT is being gradually included in every aspect slowly but surely.

NodeMCU is a low cost module developed for IoT projects. It has its own microcontroller (Tensilica 32-bit RISC CPU Xtensa LX106) and thus many sensors can be calibrated to it if necessary. It can be operated in low power (3.3v) as well. The Arduino Microcontroller is another important element of this project. All the sensors and as well the NodeMCU will be connected to the microcontroller. One of the sensor is the SONAR sensor. The SONAR sensor is used to measure distance. It transmits an ultrasonic wave. This wave hits an object and comes back to the sensor. The receiver picks up the wave and distance is measured by multiplying the time it took to transmit and receive the wave and how fast did the wave got transmitted and received. We can also say that, it measures the distance using the formula, distance = speed * time. To detect objects around the blind spots of the car we have decided to use IR sensor. IR or Infrared sensor is used to measure distance or detect obstacle as well. It has a transmitter and receiver that sends and receives infrared light. The effective distance is between 2cm and around 40cm.

To simulate the automatic breaking system, we used L298N H bridge motor controller. L298N H Bridge Motor Controller is used to control the speed of DC motors. We can control the rotation and speed of DC motors by controlling the voltage of the motor with the help of this module. In short to control speed PWM or Pulse Width Modulation is used. PWM is a technique where input voltages are manipulated with by turning the voltage of or on when necessary.

2.3 Vehicle to Vehicle communication

Suppose, In Figure 2, car1 wants to overtake car2. Car2 has a SONAR mounted on front. It will detect if there is any car in front of it or not. If there is any car or obstacle very near to it then it would send a signal to car1 which will let the driver of car1 that there is something in front of car2 so it is not a good idea to overtake.

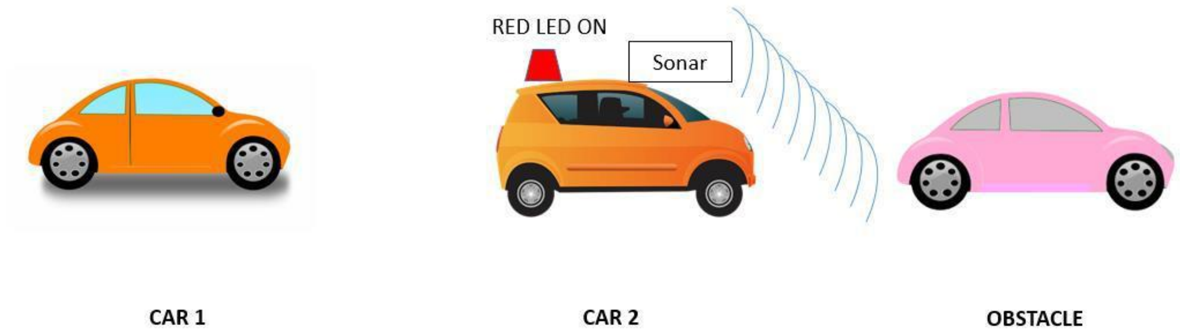

Figure 2.1 - Overtaking Situation 1

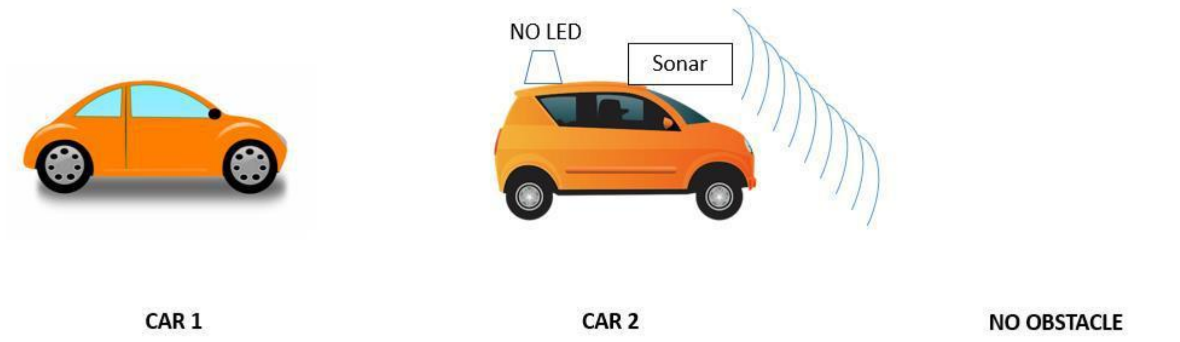

Figure 2.2 – Overtaking Situation 2

If there is an obstacle, the car 2 will automatically turn on red led. So CAR 1 will not overtake until it is safe to do it.

This communication will happen will the help of ESP8266NodeMCU. The Arduino microcontroller is connected to the NodeMCU in a serial manner. The sensors are connected to the Arduino. It will send the data to NodeMCU. The NodeMCU will act as the Wi-Fi module and send the data of the SONAR sensor to designated place via internet. Primarily data from SONAR sensor will be sent to MCU and MCU will send the data to the internet.

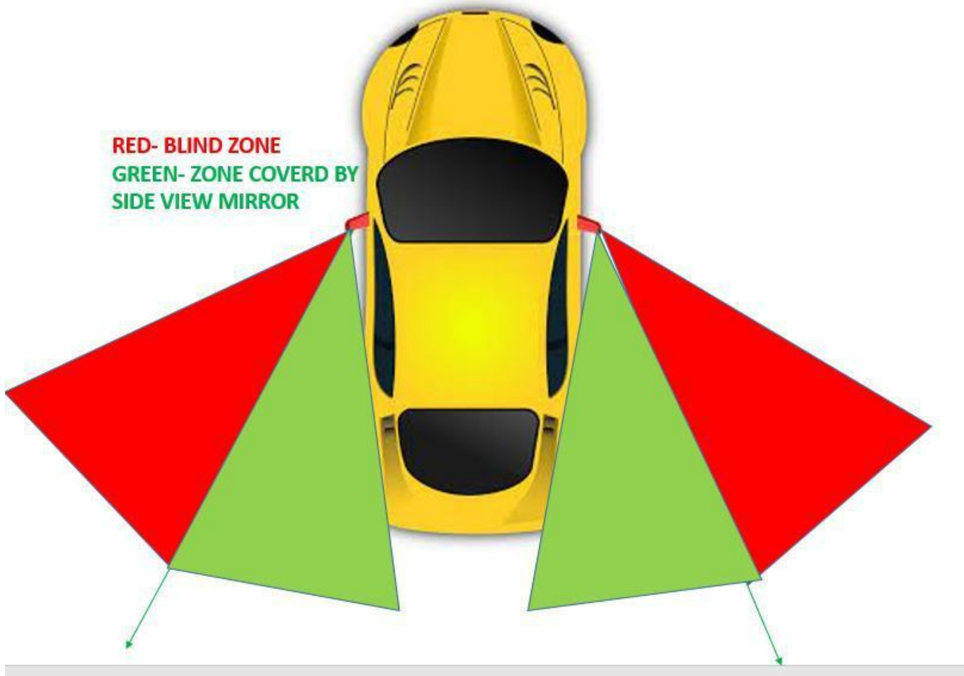

Figure 3 - Blind spot

The blind spot is such an area where a driver cannot directly look at without turning their head. This spot is usually outside of the field of view of the drivers. Field of View (or FOV) is the area where an object can be observed and represented, either directly or through devices for indirect vision. [14]

The driver's view is also limited by his or her surrounding incidents. The FOV fluctuates in proportion to the vehicle's speed. At a speed of roughly 96 km/h, the FOV angle tends to be around 35 degrees. [15].

Though the angle of FOV varies not only over vehicles but also on many things, but on average, the measured horizontal field of view was 3.5 degrees less than the calculated field of view in the left mirror and 4 degrees less in the right mirror. Given the average, horizontal, calculated FOV of 16.3 degrees on the left and 26.6 degrees on the right, drivers used an average of 21 percent (left) and 15 percent (right) of the am binocular mirror FOV to see their vehicles [11]. In the side view, majority passenger vehicles have a diagonal pillar. The angle between the horizon and the car's frontal pillar is around 40 degrees, with a thin, straight pillar. This results in an automobile with a sturdy, aerodynamic body and a large enough front door. [16]

All the cars have 2 IR sensors attached to both the sides to cover the blind sides. If anything comes very close from the sides and LED will be turned on to alert the driver. The IR sensors will be placed just beside the side view mirrors to increase the situational awareness of the driver.

2.4 Vehicle to Infrastructure

If any vehicle gets involved in an accident, a signal will be sent to the road side unit. The vehicle will send the data to the station with the help of NodeMCU. There will be a server at the station where the data will be displayed. To simulate this scenario, we have decided to use collision detector sensor. It will be attached to the NODEMCU. Whenever this sensor gets activated, a signal will be sent to the infrastructure via NodeMCU of the vehicle.

2.5 Situational awareness system

To simulate situational awareness, we decided to add 2 IR sensors to the left the right of the car. The IR sensors will cover the blind spot of the car. Whenever any objects come near the vehicle, an LED will be turned on to alert the driver.

To simulate automatic breaking system, we will use the SONAR sensor and L298N motor controller. IF any obstacle comes very close to car the L298N motor controller will stop the DC motor.

To make the roads safer, there will be an advanced road sign. The main feature of the road sign is the road side unit or RSU. The RSU will also have an LED and an IR. Let there are 2 RSU on the road named system 1 and system2. System 1 as IR1 and LED1 and system 2 has IR2 and LED2.

IR1 will be placed on beside LED 2 and IR 2 will be placed beside LED1.

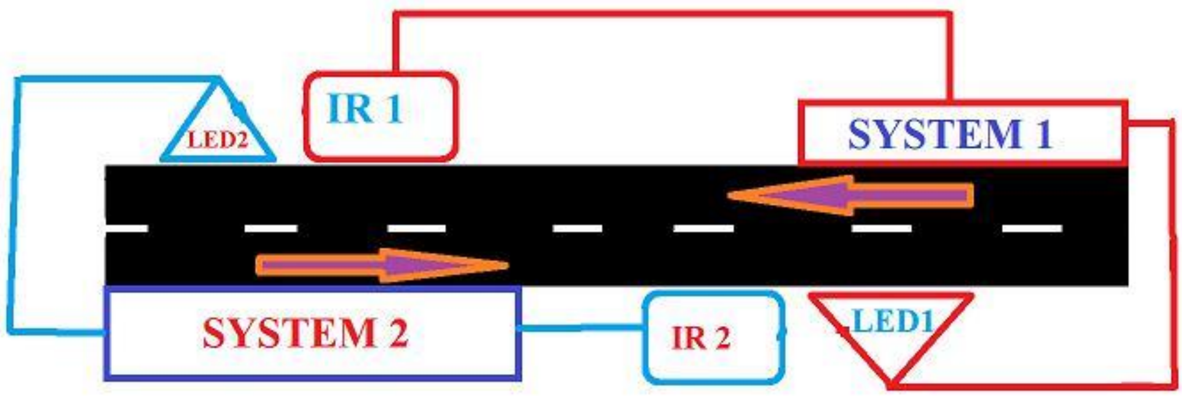

Figure 4 - Advanced Road Signs

In that way vehicle plying on the road will be able to know if there is any vehicle coming or not form the opposing side. This will benefit a lot where there is a bent. In that situation the sensor will be placed in the instantaneous position where the bent has just started.

Figure 5 - Advanced Road Signs On a Bent Road

This will enable the drivers know that a vehicle is also entering a bent road from the opposite side without even seeing it. As a result, the driver will take a more cautious approach while driving on the bent road.

2.6 Required Components

1) Arduino Micro controller
2) L298N H Bridge Motor controller
3) SONAR sensor
4) IR sensor
5) ESP 8266 NodeMCU
6) LDR
7) Wires, LED, Batteries and other miscellaneous items

Chapter 3

Mathematical expression

In order to derive a mathematical expression from scratch, we must understand the mathematics of a curved road and what happens when a vehicle gets into an accident.

Mathematics of a curved road-

Suppose a car is going through a curved road. It has 3 kind of forces acting upon it.

According to the laws of physics,

$MG=N$,

The centrifugal force, $F = mv^2/R$ where R is the radius of the curved road If the coefficient of the road is μ then

$F = \mu N$ or μmg

Therefore, $mv^2/r = \mu mg$

Or $v = \sqrt{}$

If the velocity crosses this value than the vehicle will surely skid of go to an accident in a curved road.

Mathematics of a collision-

Vehicles run on gasoline which has $56x10^6$ joules.

Although almost 80% of this energy is wasted on heat, 20% is used to make the vehicle run which is still a lot. If a vehicle is 2 tones and runs at 16.67 m/s velocity and suddenly ends in a collision the vehicle to dissipate $½ mv^2$ = 280kj amount of energy which can severely harm ma human being or even kill them.

In this mathematical model, we will try to bring out an equation which will help us to understand will an accident why do we need to place a sensor on the road.

Let vehicle A is plying on the road with V1 and velocity. As soon as the vehicle is about enter the curved area the light on the road is lit and the driver understands that there is another vehicle or obstacle on the road and he slows down to a complete stop.

We will try to find an equation to solve the braking distance and then compare it with the international braking distance of a vehicle to determine if the equation is correct or not.

IF the distance crosses the limit then an accident will occur

To find out the distance, we will use this equation

$S= UT – ½ AT^2$ (as the car is slowing down, the de acceleration value will be negative).. (9)

Here, u = V1

T = time to completely stop the car,

A= de acceleration

Let, the vehicle is plying at 30 kmh^{-1} or at 8.3 ms^{-1}.

Now, we find out the time to make the vehicle stop. In order to do that we will use the equation

$V= U – aT$

Since the vehicle has stopped we have taken V = 0, U= 8.33ms^{-1}

The average de acceleration rate of a vehicle on a straight road is 2.23 ms^{-2} …………… [17]

T = (V-U)/a = 3.72 sec……………… (2)

Now we take the value of T from (2) and put it to (1)

$S= 8.3x3.72 – 0.5\ A\ (3.72)^2$………………. (3)

This is the equation of the stopping distance. As the vehicle will enter a curved road, the de acceleration will be μg

Here, μ is the co-efficient of the road and its value is 0.7 for dry roads and 0.4 for wet roads…. [18]

g is the gravitational force.

Substituting the value of “A” on equation (3) gives us

S= -16.58 m

Here, S is the braking distance. In order to calculate the total stopping distance we need to add the thinking distance with braking distance.

Therefore, total stopping distance = thinking distance + braking distance…… [19]

The thinking distance is the distance where a driver decides to hit the brakes. That is calculated using the equation VT.

Here the thinking distance is 8.3x3.72 = 30.876

Therefore, the stopping distance is = 30.876- 16.58 = 14.29

The chart below shows the recommended safe distance approved by NHTSA

speed	Safe distance
40	46.2
50	63.5
60	83
70	104.9

Table 2- Safe Distance Approved by NHTSA

Our answer was well within range of this chart so it is safe to say that the equation is true and realistic.

Chapter 4
Experiment and Result

4.1 Calibrating all the sensors with NodeMCU:

In the beginning we had to calibrate all the sensors with NodeMCU. Which means SONAR sensor, IR sensor, LED, L298 Motor controller, Collison Detector Switch was successfully attached with the Node MCU.

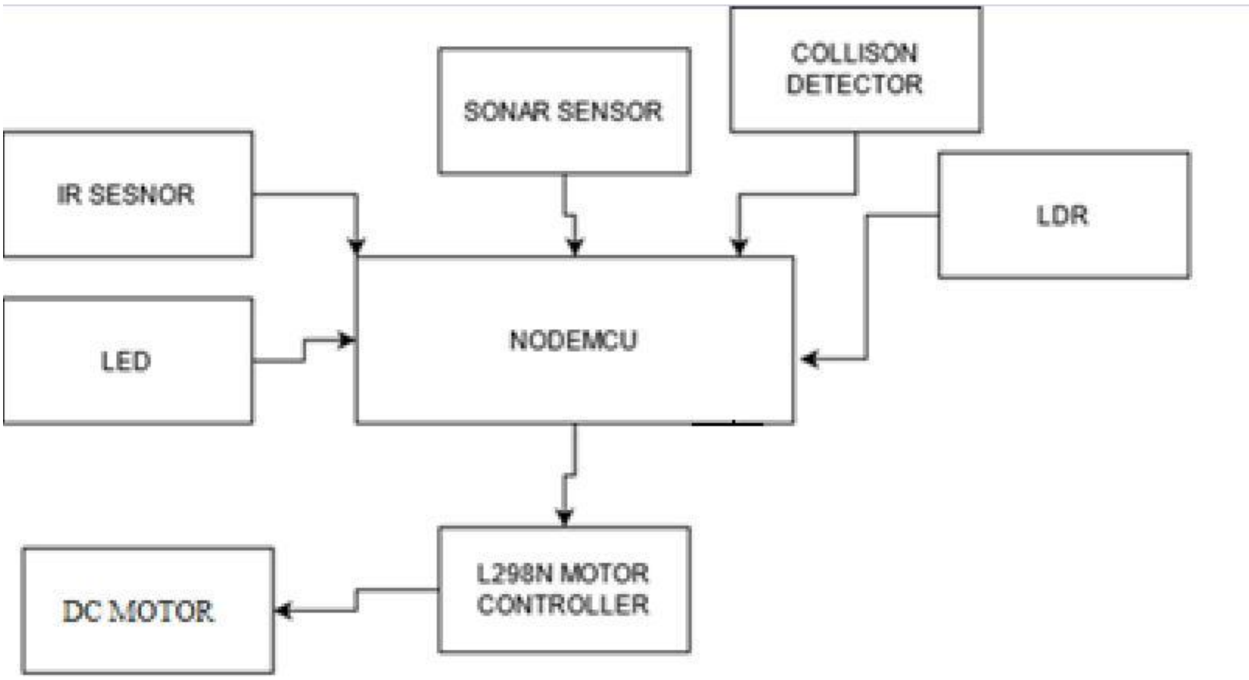

Figure 6 –Sensors Attached to NodeMCU

In this system Each and every sensor are controlled by NodeMCU. Whenever the SONAR sensor detects any obstacle it would send a signal to the NodeMCU. The NodeMCU would then send a signal to the DC Motor via L298N motor controller so that the DC motor stop operating.

If IR sensor detects any obstacle it very nearby it would send a signal to the driver of the vehicle to be aware of the surrounding of the vehicle.

If the LDR sensor detects any light it would dim the LED light to replicate that the headlight of vehicle has switched its activity from a high beam to a low beam to so that the driver of the opposite vehicle does not lose the concentration.

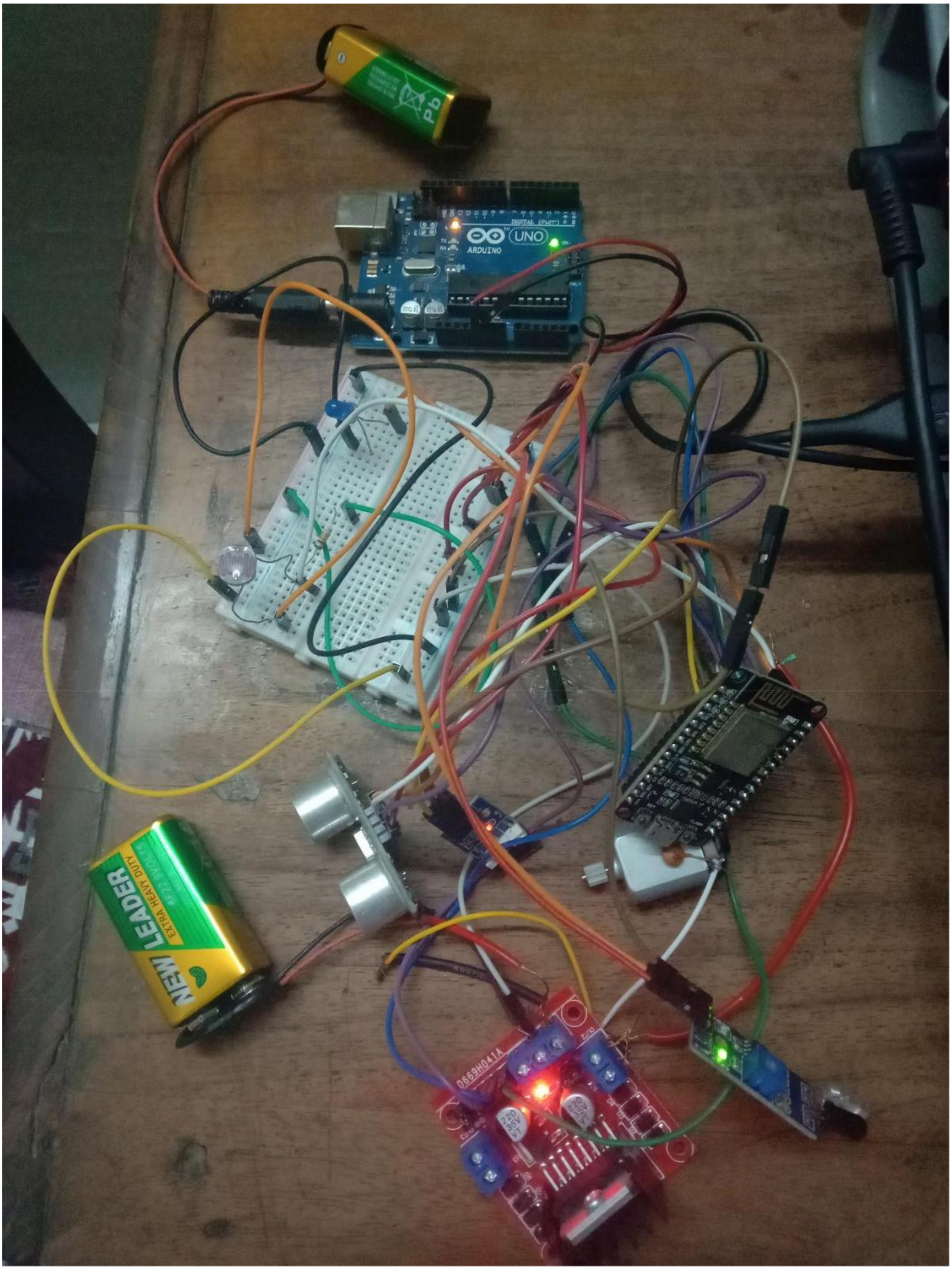

Figure 7 – The Complete Set of Sensors Attached to NodeMCU

The image above is the real image of the total system. All the sensors had to be supplied with a separate 5 volts from Arduino Uno as NodeMCU does not supply 5 volts.

The following table will describe the connection of the whole system:

SENSOR PIN	PIN NUMBER
VCC	5v
Trig (SONAR)	D5
Echo (SONAR)	D6
ENA(L298N)	D4
IN 1 (L298N)	D3
IN 2 (L298N)	D2
OUT (IR)	D7
OUT (CRASH COLLSION SWITCH)	D8
LED	D0
LDR	D1

Table 3 – Connections Between Sensor pins and GPIO pins of NodeMCU (Vehicle)

4.2 NodeMCU to NodeMCU communication (V2V):

After making sure all the sensors were working properly NodeMCU to NodeMCU communication was implemented in order to replicate vehicle to vehicle communication.

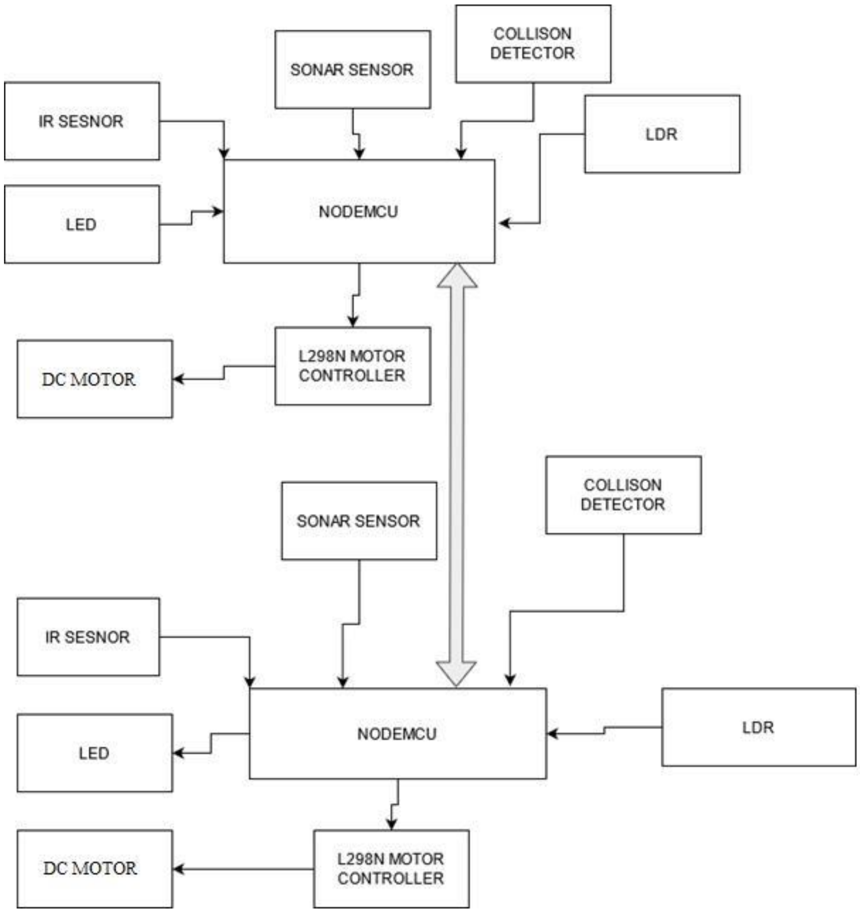

Figure 8 – System Diagram of Vehicle to Vehicle Communication

The NodeMCUs were communicating via internet. To get connected they were using Media access control or MAC address. MAC addresses are a unique identification number. It is a physical address assigned to each device and no two MAC address will ever be the same. MAC address of one NodeMCU were put to another one's code to activate the communication. Whenever a SONAR of one NODEMCU detected an obstacle it would send signal to the other NodeMCU to replicate vehicle to vehicle communication.

The image below shows the actual system consisting of two NodeMCUs delivering sensor data to one another simultaneously.

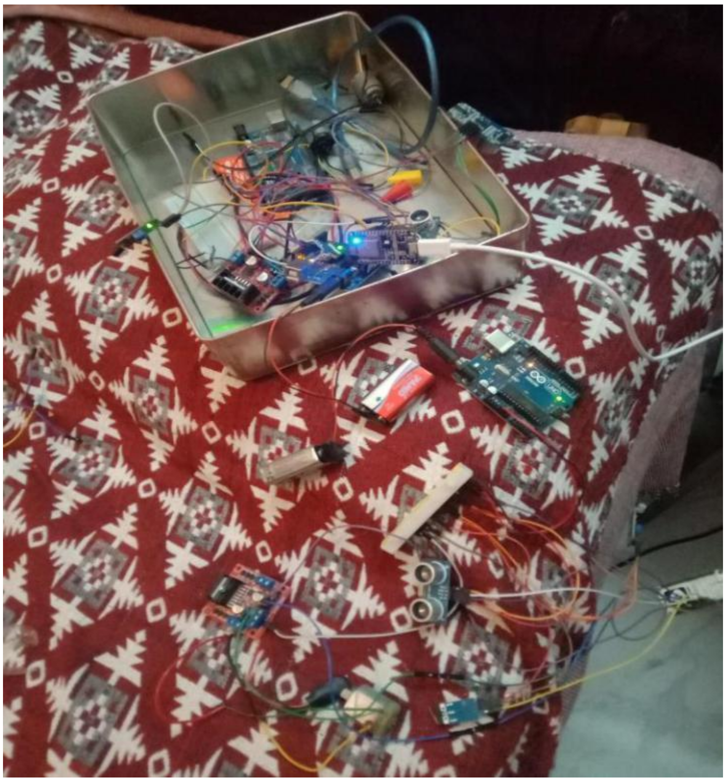

Figure 9- Vehicle to Vehicle Communication Setup

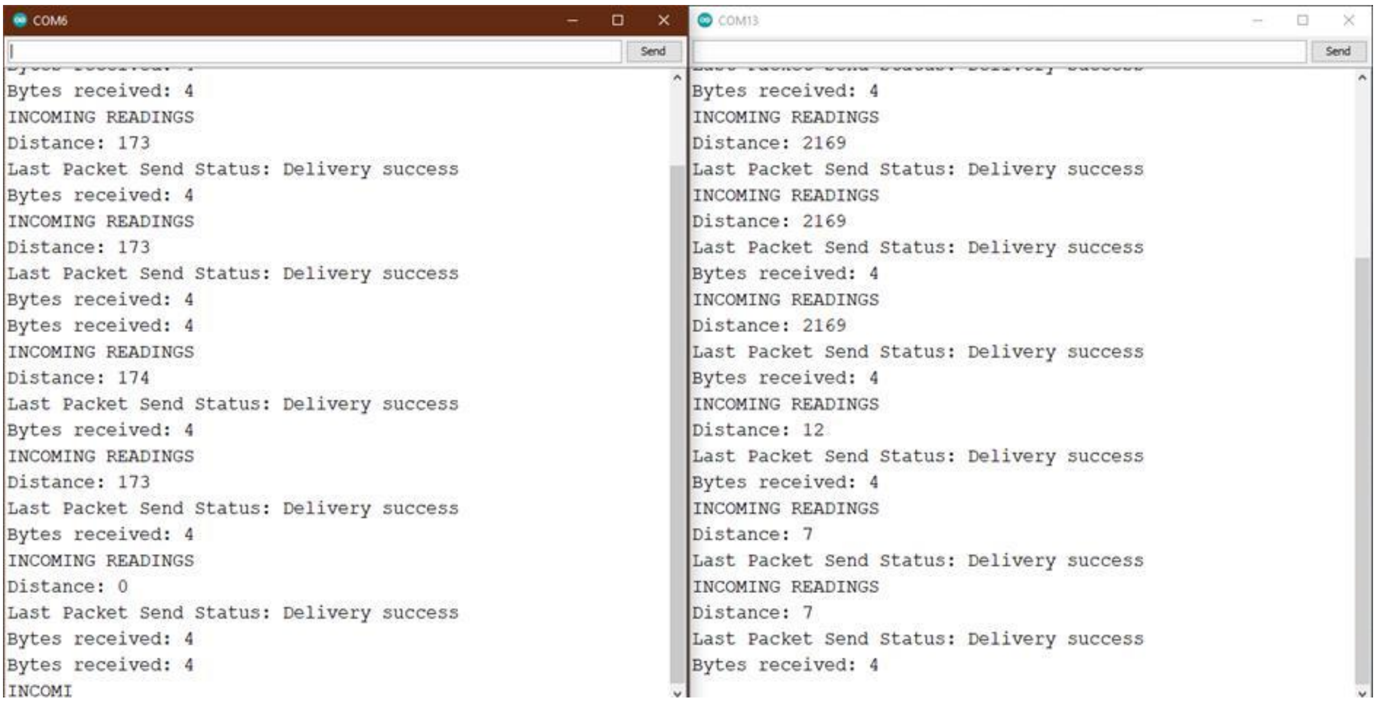

Figure 10- NodeMCU to NodeMCU Communication

In the figure above we can see that readings of one NodeMCU is received and displayed by the other NodeMCU.

The term Incoming readings depicts that the NodeMCU is showing the value sent by the other NodeMCU.

The flowchart clearly explains how vehicle to vehicle communication clearly works and what are the functions of the sensors.

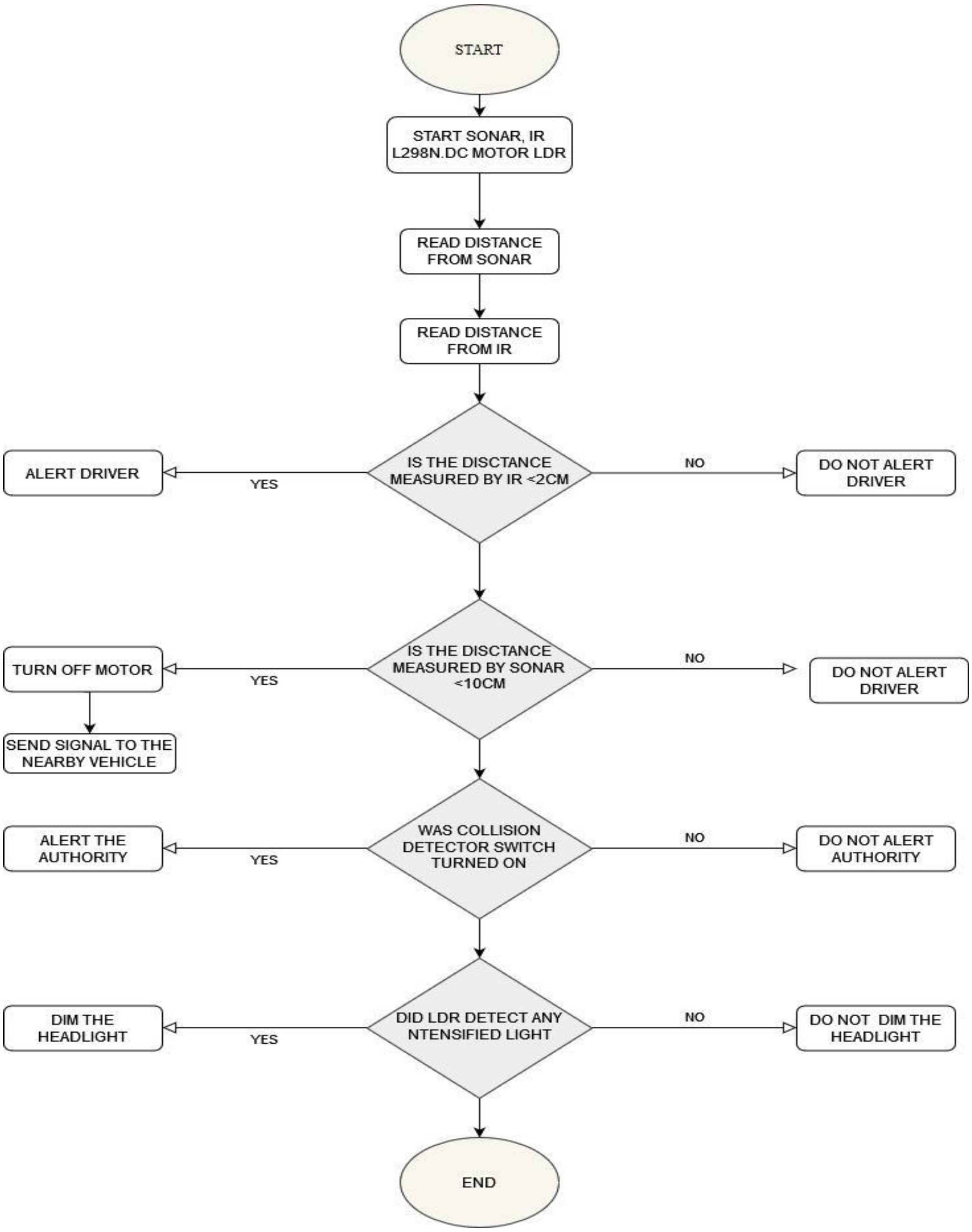

Figure11- Flow Chart of Vehicle to Vehicle Communication and Vehicle to Infrastructure Communication

4.3 NodeMCU to NodeMCU communication (V2I):

In V2I, 2 LEDs and 2 IR sensors were used. Whenever IR sensors detect any obstacle it would light up an LED to warn that a vehicle is coming from the opposite end of the curved road.

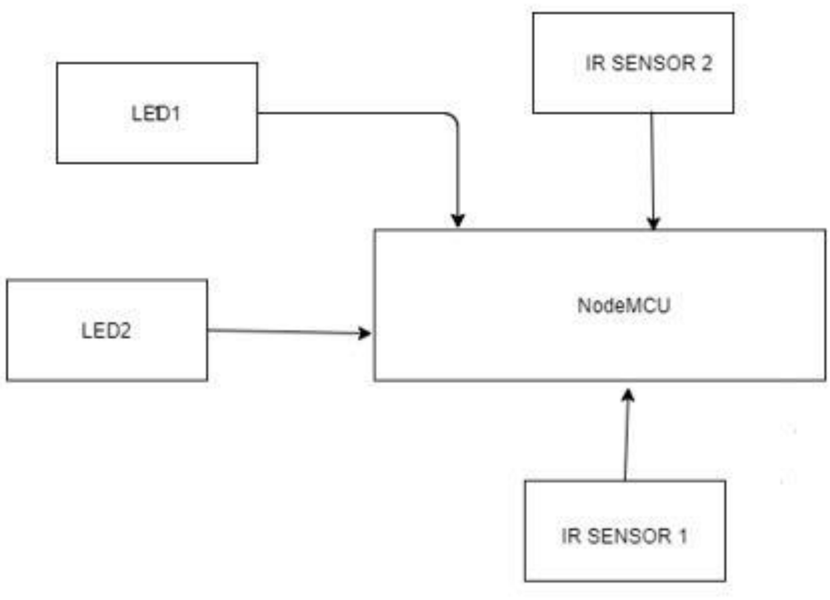

Figure 12- Sensors Used in Infrastructure Part

SENSOR PIN	PIN NUMBER
VCC	5v
IR1	D7
IR2	D5
LED1	D2
LED2	D3

Table 4 – Connections Between Sensor pins and GPIO pins of NodeMCU (Infrastructure)

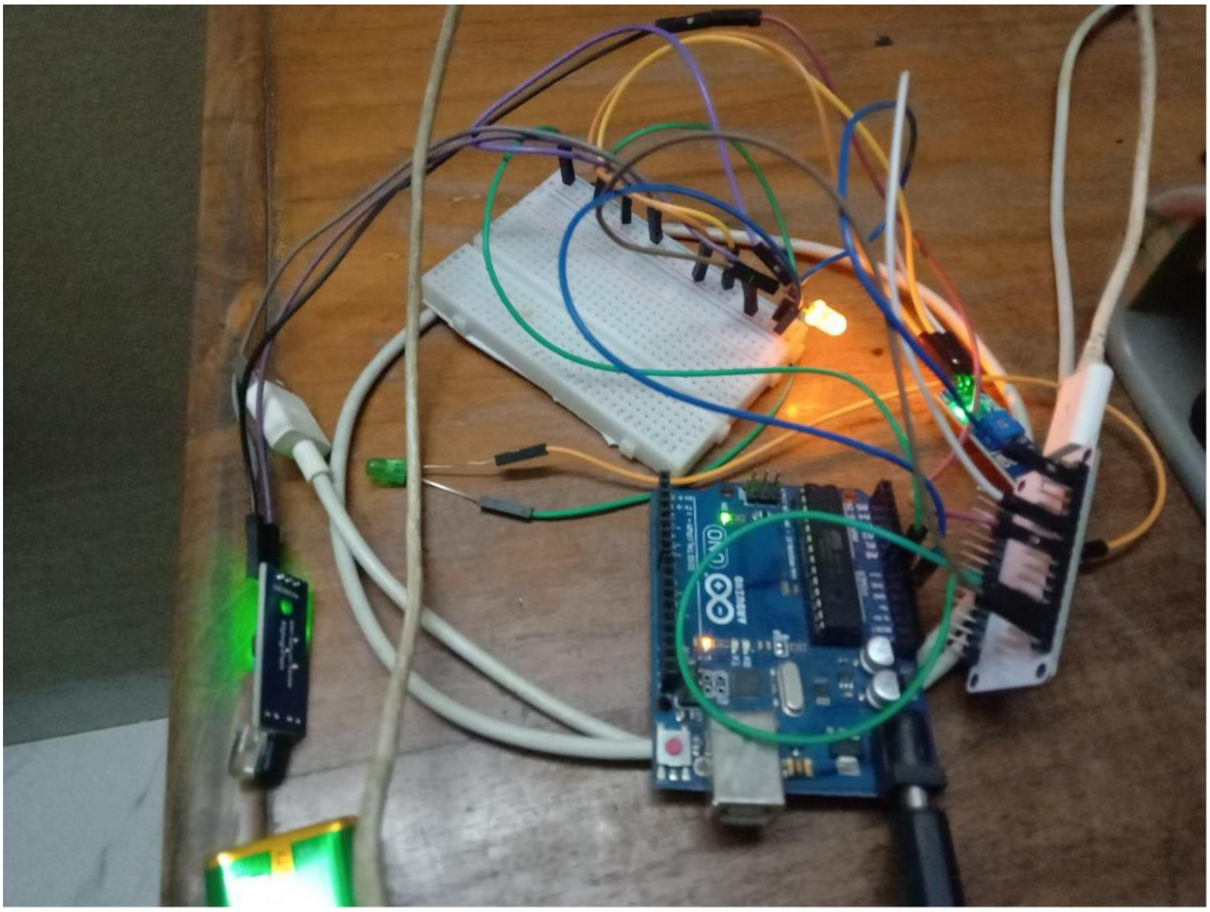

Figure 13 – Vehicle to Infrastructure Setup

Whenever the collision detector switch of the vehicle is pressed it would send a signal to the infrastructure to replicate that situation that the authority should take appropriate steps because an accident had occurred.

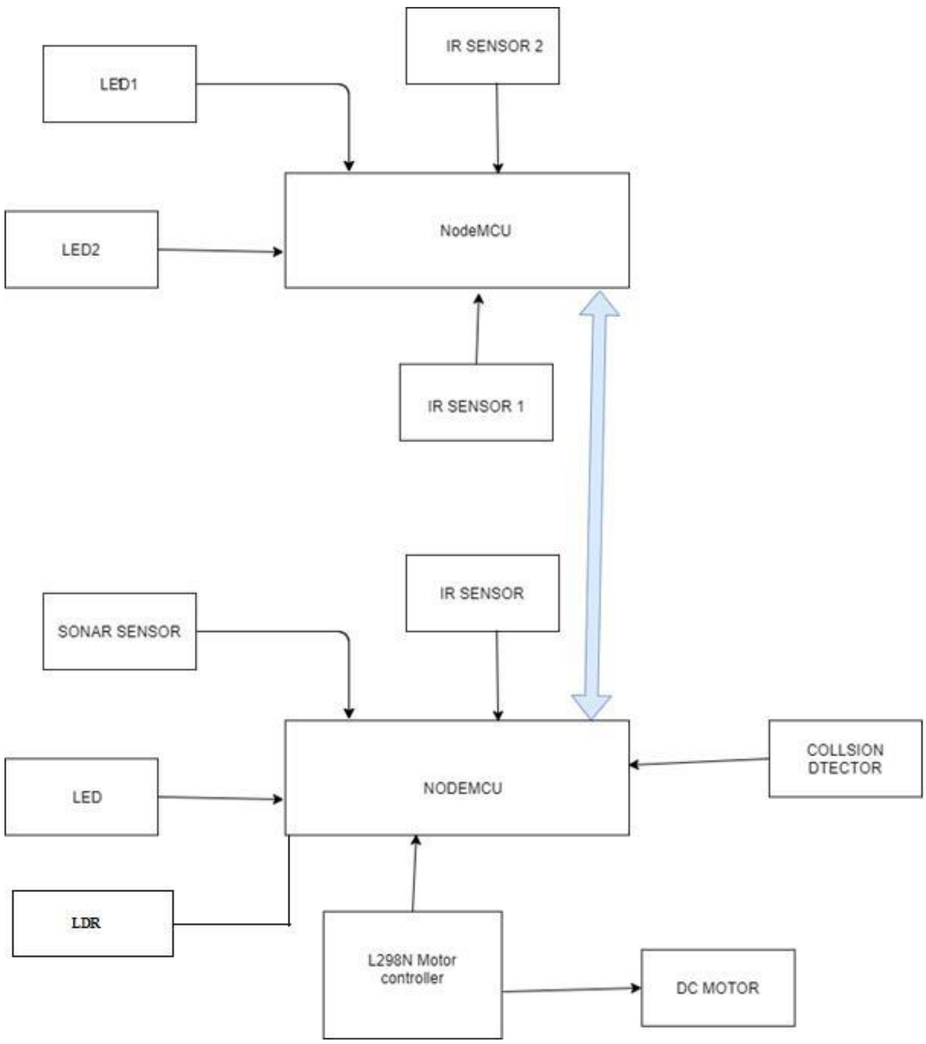

Figure 14 - Vehicle to Infrastructure Communication

As discussed before the signal will be passed from the vehicle to the station via internet with the help of MAC address. To replicate this accident scenario, the collision switch would be used and it would send a signal to the other NodeMCU which will be working as a roadside monitoring station.

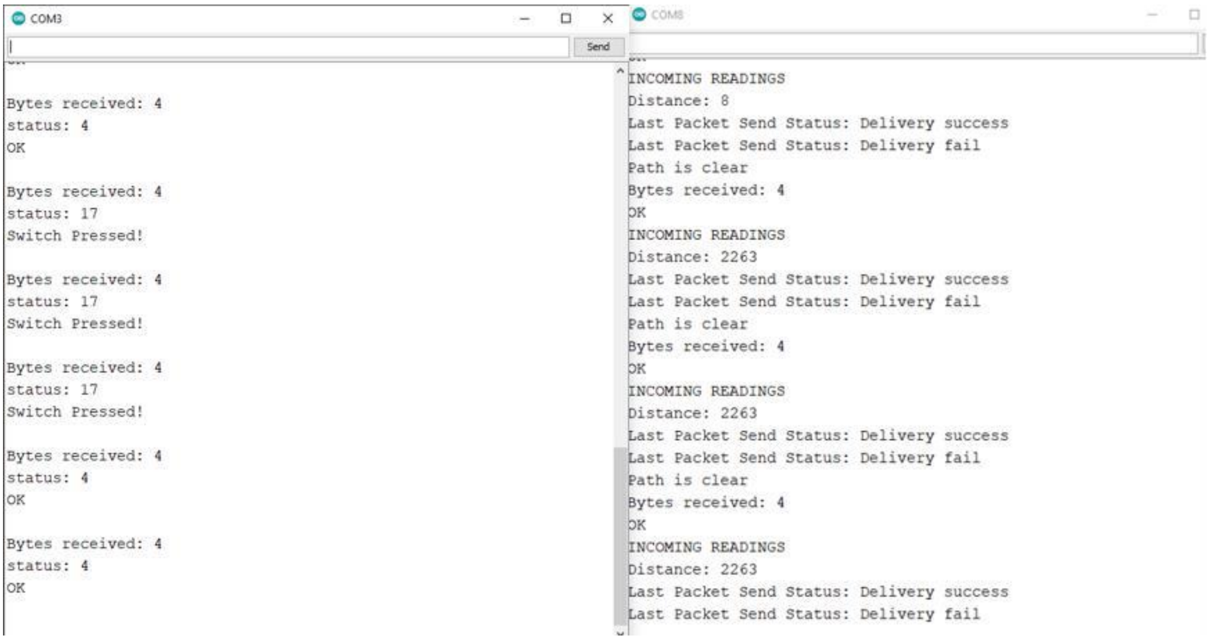

Figure 15 – Vehicle is Sending Accident Signal to the Infrastructure

Chapter 5

CONCLUSION AND DRAWBACKS

There two major setbacks in this project which we could not find a solution to:

1) NodeMCU does not have a lot of General Input Output pin (GPIO). That is why we could not install another IR sensor to the vehicle.
2) The incoming signals from other NodeMCUs were slow as the NodeMCU were processing a lot of readings at once.

But apart from these minor drawbacks the project is a success and we have successfully implement what we have planned. In the future one can install new sensors such as a GPS device and/or implement something which will eradicate the drawbacks we are have faced.

I hope if this project is implemented in real life then there will be very few road accidents in the future.

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