Design of an Autonomous Vehicle for Road Safety Information Exchange

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Declaration

We, Fahmida Akther, Saimon Islam, Md. Mamun Molla, A.S.M.Diniate Didar, declare that this project titled, **"Design of An Autonomous Vehicle for Road Safety Information Exchange"** and the work presented in it are our own. We confirm that:

- This work was done wholly or mainly while in candidature for a BSc degree at United International University.
- Where any part of this thesis has previously been submitted for a degree or any other qualification at United International University or any other institution, this has been clearly stated.
- Where we have consulted the published work of others, this is always clearly attributed.
- Where we have quoted from the work of others, the source is always given. With the exception of such quotations, this project is entirely our own work.
- We have acknowledged all main sources of help.
- Where the project is based on work done by ourselves jointly with others, we have made clear exactly what was done by others and what we have contributed ourselves.

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Certificate

I do hereby declare that the research works embodied in this project entitled **"Design of An Autonomous Vehicle for Road Safety Information Exchange"** is the outcome of an original work carried out by Fahmida Akther, Saimon Islam, Md. Mamun Molla, A.S.M.Diniate Didar under my supervision.

I further certify that the dissertation meets the requirements and the standard for the degree of BSc in Computer Science and Engineering.

_____

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Abstract

In the present world road accident became a regular incident. The rate of accidental death is also very high. Most of the causes for accidental death is late hospitalization. When road accidents occur the victims can't get quick help for the lack of proper information of nearest hospital or fire service. For extreme bleeding most of the patient fell in death. To overcome these problems, we develop our system which inform the accident information and its location to the nearest hospital or fire services so that they can help the victim quickly. To develop our system, we use automated vehicles as a toy domain in the real life scenario. Esp8266 module used as communication module and Arduino board used to control the hole process. When a vehicle faces an accident and it send the information throw Esp8266 to the nearest road side unit (RSU). The RSU forward the message to the access point (AP). The AP forward the information with its location to the nearest rescue team like hospital, fire services to help them. The road side unit, access point, rescue all contain Esp8266 module for communication. We used here geolocation system to track the location. The implementation of the system is simple, inexpensive and for human welfare.

Acknowledgements

Project is like a bridge between theoretical and practical working. Through completing our project, we had to take help, suggestion and guideline from two respected person who deserve our respect and gratitude from the bottom of our heart.

We would like to show our gratitude to our Supervisor Assistant Professor, UIU, Mohammad Mamun Elahi, who introduced us with this IOT project and his passion for IOT and NETWORKING had lasting effect. His guideline in our project from beginning to end was blessing to us.

We also like to thank to our mentor Azim Uddin Chowdhury (Instructor, Cisco Networking Academy, UIU). His support and inspiration help us to complete our project in time. We are highly obliged in taking the opportunity to thanks all of our project members. Their effort and hardworking made this project complete.

We thank all the people, our classmates, our family members for their inspiration to complete our project.

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Chapter 1

Introduction

1.1 Introduction

Now a days, road accident is regular incident in our daily life. It is increasing day by day. For the road accident rate of death and injury is also increasing. One of the causes of high rate accidental death is late hospitalization. If we able to admit the injured people in the hospital so quickly the possibility of his/her death or major casualty decreases. For quick hospitalization or quick rescue, we need proper information about where the accident occurred and have to find out the nearest hospital or rescue team to help them as soon as possible. There is no such a system in our country. That's why the rate of accidental death is increasing day by day.

Road transport is essential for us to improve the transport system. We use the road to go anywhere. When we use the road every day, there are many risks. Especially in developing countries it is very much. To determine the road risks. So that we need to determine the amount of risk and It is possible to reduce the risk of users.

To solve the problem, we try to design such a system, which send the information of an accident with where it's location to the nearest proper authority to help them as soon as possible. This

1.2 Motivation

The risk of road users in developing countries is increasing day by day. The risks of the road are increasing in the streets of the system which is not improving. Many improvements or to take necessary action needs to be made to improve the road transport system. In many contexts Exchange of road safety information is one.

Road safety information exchange plays a vital role during the accident to avoid road accidents. So, this reason is most important to Exchange of road safety information is possible to avoid a lot of early accidents

1.3 Present problem in Road Safety

In our country, there are many accidents in this street. It is notable that many problems are significant:

- ✓ Loss of public asset
- ✓ Accidental death rates are increasing
- ✓ Infrastructure maintenance costs are increasing
- ✓ Due to lack of information exchange, delayed hospitalization

The internet of things distributes such information and in order to eliminate these problems. This is why the internet of things needs a lot in our project.

1.4 SDGs and road safety

As we know, it's called sustainable development goals. It's also Universal called. There are 17 targets here, which are based on the success of the development goals of the Millennium Development Goals. Including no poverty, climate change action, infrastructure and innovation and also other priority activities of goals.

Figure 1. 1: Sustainable Development Goals

In 17 goals, their one goal is Industry, Innovation and Infrastructure which is known as the goal of number 9 where falls in our project. This goal builds:

- ✓ Flexible infrastructure
- ✓ Foster innovation
- ✓ Promote sustainable industrialization

In this goal, here are some sub articles. In those sub articles 9.3, 9.5 and 9.c are matches our project that are implemented.

1.5 Project Objectives and Goals

Our project has some of main goals. We Select this project and Established this project to achieve specific goals. We are trying to design an autonomous car will provide to the people profiting from road accident. At first, we design vehicle with line following capability. Develop a toy domain to illustrate the activity of the proposed system.

At first, we design an autonomous vehicle with line following capability. Develop a toy domain to illustrate the activity of the proposed system. 2 Autonomous cars and 1 access point. Any vehicle can communicate with safety information to other vehicle through access point (AP).

Our main goal is to create an autonomous car which is communicate with other car via access point. Suddenly an autonomous car will victimize in the road, it sends a message into the sever, and it will forward the message to connected cars. Finally, other cars receive the message with victim location and it go to the location and help the victimize cars.

Our final goal is to connect the cars with GEO location and find the victim car automatically.

1.6 Organization of the report

The report has been sorted out as follows. Chapter 2 discuss the background of theory in our project that including the IoT based an autonomous vehicle for road safety. Chapter 3 discuss the implementation and which instruments used in the proposed system. Chapter 4 discuss the limitations and problem faced with a few of future works. Chapter 5 described the concluding part such as a short summary in the proposed system.

Chapter 2

Background Theory

When we start our project, we think our road safety condition. We want to establish a very dynamic wireless communication system. Current situation in our country when any vehicle is in accident suddenly, it is very difficult to inform the situation firstly when this support is come many life downfall in serious problem. So, considered that current situation we decided to establish a wireless communication system via roadside server and every car connected with the server.

2.1 Internet of Things (IoT)

The first step to familiarize about the network is the internet of thing whose small name is IOT. As science makes our lives easier, day-to-day IOT plays a major role in making the network easier for our lives. In 1982, Carnegie Mellon University was the first internet-connected device. Later in 1999, the word "internet thing" was created with Kevin Ashton of Procter and Gambel.

2.1.1 Definition of IoT

Internet of things (IoT) is a worldwide intercommunication device which is physically connected to the internet, exchange information and identify the other devices. Mostly Internet of things (IoT) is important for communicate cross platform.

2.1.2 Important of IoT

The Internet has made our daily life much easier. Internet is an open source communication system in the world. For the reasons one of the great qualities of the Internet of Things is, one of these devices can provide information easily to another device. Internet of things (IoT) is mostly important to communication to cross platform that means it is provides transmitting data multiple devices or one device to another device easily. It is also important to collecting data.

2.1.3 Advantages of IoT

Internet of things (IoT) is a worldwide intercommunication device that's why it has so many advantages in the network system. Some of them are given below:

- Automation and controlling: For wireless infrastructure, there is a large amount of automation and controlling in the networking. Here one device communicates information with other device to leading to faster and timely output.

- Quality of life: The IOT is full of advanced features, advantages and better system of all applications, which provides that our life quality is better improving.

- Saving money: The main advantage of IoT provides to the saving money. Most of the instruments of our project is less than amount of money saved. Because here maximum instruments costs low price, so that it is a biggest advantage of internet of things (IoT).

2.2 IoT for Autonomous vehicle

Traditionally, the vehicle has been the extension of the man's control system and driver's commands. Advances in communications, controls have changed this model, the way to the Intelligent Vehicle.

The next step in this evolution is just around the corner: An Autonomous Vehicles can communicate each other over the wireless communication. Like other important instantiations of the Internet of Things, the autonomous of Vehicles will have communications, storage, intelligence, and learning capabilities to anticipate the road' intentions.

Now world is very fast, and IOT helps us to maintain our road safer and also transmit information using DHCP communication stack and it will be dynamic and useful.

2.3 Hardware Used

Significant work that we have done in the hardware that we have met in our project. In our project, we are used in two types of module. These are:

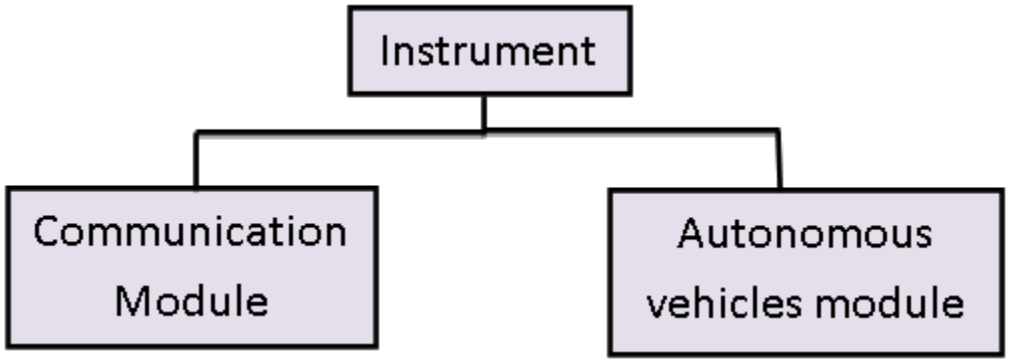

Figure 2. 1: Used of instrument in our project

2.3.1 Communication module

In communication module, we are used in ESP8266-01. In 2014 the first edition of ESP8266 was discovered. Now describe in ESP8266.

2.3.1.1 Description of ESP8266

An ESP8266 is a high integrated Wi-Fi module. It has both enough full TCP/IP stack and microcontroller capability which is created by Shanghai based ESPRESSIF System with Smart Connective System.

It's main advantage of a set of high performance with a low cost wi-fi microchip. It is also a high integrated wireless SOCs. The ESP8266EX provides a self-contained and a perfect Wi-Fi networking system solution, which is used to a host application.

In the industry the ESP8266EX is the maximum compact of Wi-Fi chip. It compacts the low noise receive amplifier, power management modules, many power amplifiers etc. It also is schematic to hold the minimum PCB area. Including front-end module security, it provides the entire solution with minimum external security.

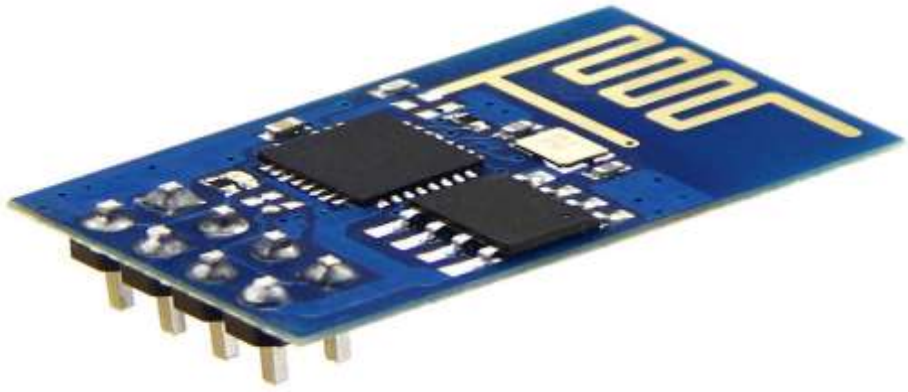

Figure 2. 2: ESP8266 version 01

2.3.1.2 ESP8266 Wi-Fi main Features

a) It supports 802.11 b/g/n
b) TCP/IP stack support
c) Power amplifier, power management units support
d) Integrated antenna diversity
e) Wi-Fi 2.4 GHz with support WPA or WPA2
f) Integrated 10-bit ADC and low power with 32-bit multipoint control unit
g) Support both iOS devices and Android
h) In 802.11 mode it supports +20dBm output of power

2.3.1.3 Identifications of ESP

Before using esp8266 in the project, we have read a lot about it. For which we have learned that there are 3 features of ESP8666. They are shown in the diagram below:

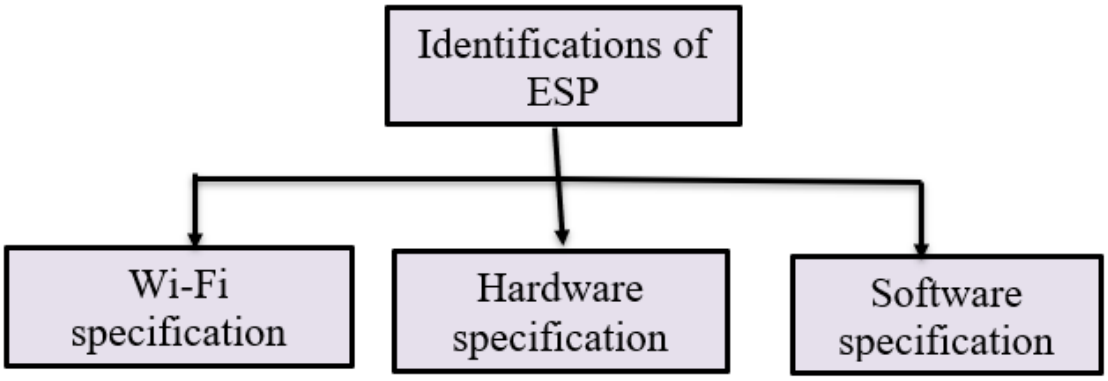

Figure 2. 3: Identifications of ESP

Now we have to discuss some of the three features of ESP 8666. They are shown in the below:

a) **Wi-Fi specification:** It includes documents or certifications, Wi-Fi protocol, Antenna, Tx power, Rx sensitivity and range of frequency. Descriptions of these functionalities shows as a table-1:

Points	Parameters
Documents/ Certifications	Wi-Fi alliance
Wi-Fi protocols	802.11 b/g/n
Antenna	Ceramic chip, PCB trace, External, IPEX connector
Tx power	**802.11 b: +20 dBm** **802.11 g: +17 dBm** **802.11 n: +14 dBm**
Rx sensitivity	**802.11 b: -91 dBm (11 Mbps)** **802.11 g: -75 dBm (54 Mbps)** **802.11 n: -72 dBm (MCS7)**
Range of frequency	2.4G-2.5G (2400M-2483.5M)

Table 1: Wi-Fi specifications details

b) **Hardware specifications:** It includes Peripheral bus, operating current, operating voltage, operating temperature range, ambient temperature range, package size, external bus. Descriptions of these functionalities shows as a table-2:

Points	Parameters
Peripheral bus	**GPIO/PWM** **UART/SDIO/SPI/I2C/I2S/IR Remote Control**
Current	Average value: 80mA
Voltage	3.0~3.6V
Operating Temperature Range	-40°~125°
Ambient Temperature Range	Normal
Package Size	5x5mm
CPU	Ten silica L106 32-bit processor
External Bus	N/A

Table 2: Hardware specifications details

c) **Software specifications:** It includes Wi-Fi mode, Data Encryption, Security, Firmware Upgrade, Software Development, Network Protocols, User configuration. Descriptions of these functionalities shows as a table-3:

Points	Parameters
Wi-Fi mode	Station/Soft
Data Encryption	WEP/TKIP/AES
Security	WPA/WPA2
Firmware Upgrade	UART Download/ OTA (via network)
Software Development	Cloud Server Development/ SDK for customer firmware development
Network Protocols	IPv4/TCP/UDP/HTTP/FTP
User configuration	AT Instruction Set, Cloud Server, Android/ iOS App

Table 3: Software specifications details

2.3.1.4 Esp8266's Applications

There are many applications of IoT using ESP8266. Some of are:

- Sensor network
- IoT projects
- Access point portals
- An automated vehicle
- Security ID tags
- IP cameras
- Wearable electronics
- Baby monitors

- Industrial wireless control
- Smart Home applications
- Smart Home automation
- Wi-Fi location aware device
- Wi-Fi position system beacon

2.3.1.5 ESPs Power consumption

In current costs supply 3.3V and based on 25°C internal controller. Assessment are complete with antenna port by 90% duty cycle.

2.3.1.6 Electrical Identifications of ESP

ESP8266 has some electrical identifications such as shown in table-4:

Items	Minimum	Normal	Maximum
Storage Temperature	-40°C	Normal	125°C
Maximum soldering temperature			260°C
Working voltage	3.0V	3.3V	3.6V
Input/ Output **Vil/Vih** **Vil/Voh** **Imax**	 **-0.3/0.75iV** **N/0.8VioV**		 **0.25Vio/3.6V** **0.1Vio/N V** **0.1Vio/N V**
Electrical discharge (HBM)			2KV
Electrical discharge (CDM)			0.5KV

Table 4: ESP8266s Electrical Identifications

2.3.1.7 Impressionability of receiver

Receiver impressionability is shown in table-5:

Points	Minimum	Maximum	Normal	Unit
Frequency	2412	2484		MHz
Impedancy			50	Ω
Reflection		-10		dB
Output power of PA for 72.2 Mbps	15.5	17.5	16.5	dBm
Output power of PA for 11b mode	19.5	21.5	20.5	dBm

Table 5: ESP8266s Receiver Impressionability

2.3.1.8 Micro Control Unit of ESP

ESP8266EX is built with the L106 32-bit micro controller (MCU) designed to cost much less electricity. The CPU clock speed range minimum to maximum is 80MHz-160MHz. When it is connected to the MCU in ESP8266EX; it has some specific key:

a) Data RAM Bus
b) Visit the register
c) Programmable ROM/RAM Bus

2.3.1.9 Memory Identifications of ESP

ESP8266EX has two types of memory. They are Internal SRAM and ROM and External SPI Flash.

a) Internal SRAM and ROM:
   - Current specification of internal SRAM and rom which RAM size is 50KB.
   - External SPI flash mostly stored but here is not available programmable ROM.

b) External SPI Flash: Here is many SPI flashes available, including an External SPI flash, Dual SPI, DIO SPI, Standard SPI, QIO SPI, etc. Here both OTA enable and OTA disable present.
   - OTA enable is provide minimum flash memory with 1MB.
   - OTA disable is minimum flash memory with 512KB.

2.3.1.10 Pins assignment

ESP has its own pin which we use in our project. ESP is a small Wi-Fi module that has eight pins. These are shown in the picture below:

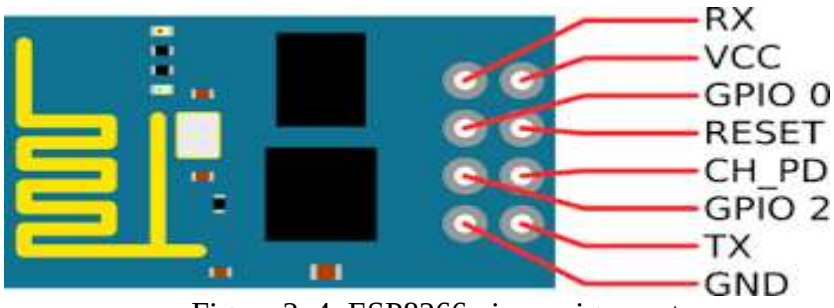

Figure 2. 4: ESP8266 pins assignment

2.3.1.10.1 Descriptions of Pins

a) **Rx**: It is actually used for General Purpose Input/ Output pin that's why it many times known as pin GPIO-3. When we do not use it as Rx, we use it as a GPIO-3.

b) **VCC:** It is always connected with +3.3V and it changes according to the need.

c) **Reset:** It is known as Reset Button which is used for uploading new code

d) **CH-PD:** It is used to active high for enable point.

e) **GPIO-2:** this pin used for normally General Purpose Input/ Output pin.

f) **GPIO0-:** GPIO means General Purpose Input/ Output Interface. In GPIO, here 17 pins and internal pull-up configuration present. In GPIOs has microcontroller ICs. GPIOs have some implementations capability:
   - Input/ Output pins configuration
   - Write or read output values
   - Enabled/ disabled pins present
   - Inputs are only readable which is high or low

g) **Tx:** It is connected always to Rx pin for the upload program. Several times we identify the Tx as known the GPIO-1 that means General Purpose Input/ Output Interface. When we do not use it as TX, we use it as a GPIO-1.

h) **Ground:** It is connected always with 5V to the ground of the circuit.

2.3.1.11 AHB Blocks

It has two types of slaves. One is APB block that is work in a decoder; another one is flash controller that is use in standard applications.

2.3.1.12 Software Information

It has accomplished with SRAM and ROM. It has some implementations. Those are including 802.11 b/g/n/I WLAN mac protocol and Wi-Fi with direct specification. It also implementation some of low-level protocols in ESP8266. These are:

- ✓ P2P Wi-Fi direction
- ✓ Frame encapsulation (802.11h/RFC 1042)
- ✓ Fragmentation and defragmentation
- ✓ Acknowledgement

2.3.1.12.1 Software Features

a) Integrated 802.11 b/g/n/d/e/k/r
b) Integrated 802.11n with 2.4GHz
c) Integrated P2P
d) 802.11h/RFC1042 frame encapsulation
e) Multiple queue management to fully utilize traffic prioritization which is defined by 802.11e standard
f) 802.11i features security

2.3.1.12.2 Power Management

ESP8266 followed by these ways:

a) **On:** This means power active where are chip listen, transmit and receive. It followed by 5-2 power consumption.

b) **Deep sleep:** It is only working in RTC and when chips are powered off. It works only when the power is 20µA.

c) **Light sleep mode:** It is working when RTC is operating and here power consumption is 0.8Ma.

d) **Modern sleep/ Wakeup:** It provides 1.5 mA power. It works when CPU is working.

e) **Off:** This situation cleared the all registers and chip pin is low. It power consumption is 0.5µA.

2.3.1.13 Wi-Fi Identifications

802.11 b/g/n WLAN MAC protocol and TCP/IP are implemented in ESP8266EX. The ESP8266 support two types of power management. These are:

a) **Wi-Fi MAC:** It provides low-level protocol such as:
   - Defragmentation
   - 2 x virtual Wi-Fi phase
   - RTS, CTS and Immediate block ACK

b) **Wi-Fi radio and baseband:** It includes:
   - 802.11b and 802.11g
   - 802.11n MCSO-7 in 20 MHz bandwidth
   - 802.11n 0.4 µs guard-interval
   - Antenna diversity
   - Up to 72.2 Mbps of data rate

2.3.1.14 Clock

It followed by two types of clock. One is High Frequency Clock that is provided from internal oscillator and external oscillator and their frequency is 24-52MHz. Another one is External Clock and which frequency is also 24-52MHz.

2.3.1.15 How does the ESP8266 work?

ESP is a wireless communication wi-fi module. It's used very easily to communicate to any local area network. So ESP8266 works either local area Wi-Fi network or from the internet which is complete after the forwarding port. The first version ESP8266 has GPIO pin which is performed to turn a LED or a relay on/off.

2.3.1.16 Use of ESP8266 to add the capability of an autonomous vehicle

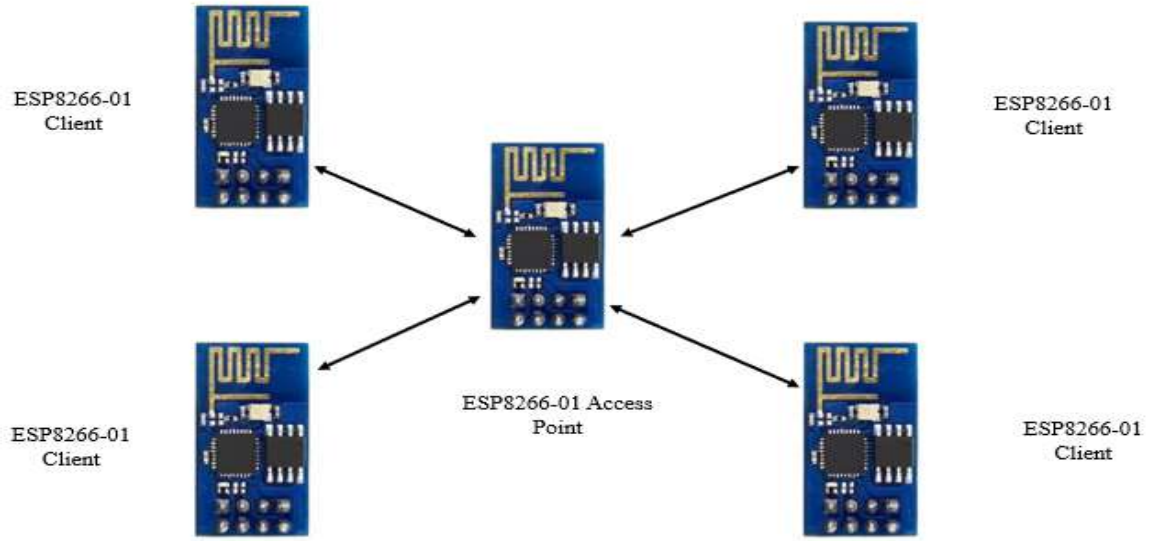

Figure 2. 5: Use of ESP8266 of an autonomous vehicle

For any autonomous vehicle esp8266 Wi-Fi module is essential module because it's a wireless communication module. One of the most important characteristics of this module is it's can connect one to one or many to many clients at a time. ESP8266 can work 3 different mode (as a client, as one access point and both client and access point).

An autonomous vehicle can use some esp8266 module, for if we used 5 modules (4 module used as a client and 1 is a access point). This module maintains DHCP protocol to transmit the messages between client and access point. For every client used only one IP 192.168.43.255.

After that successfully programmed all the ESP, initially all the client connected with access point and send messages to the access point. Access point receive the message and forward the messages the other client. For this process all the client can communicate to each other via access point esp8266.

2.3.1.17 Advantages of using ESP8266

Some advantages of using ESP8266:

- ✓ Inexpensive
- ✓ Do Something Different
- ✓ More compatible development environments
- ✓ Flexible Design
- ✓ Abundant Learning Resources
- ✓ Convenient Application Development

2.3.1.18 How to we use ESP8266 Wi-Fi module?

We have used ESP two types of our projects, such as Victim and rescue team. It is possible to exchange information easily. Below is a sample of how we use it:

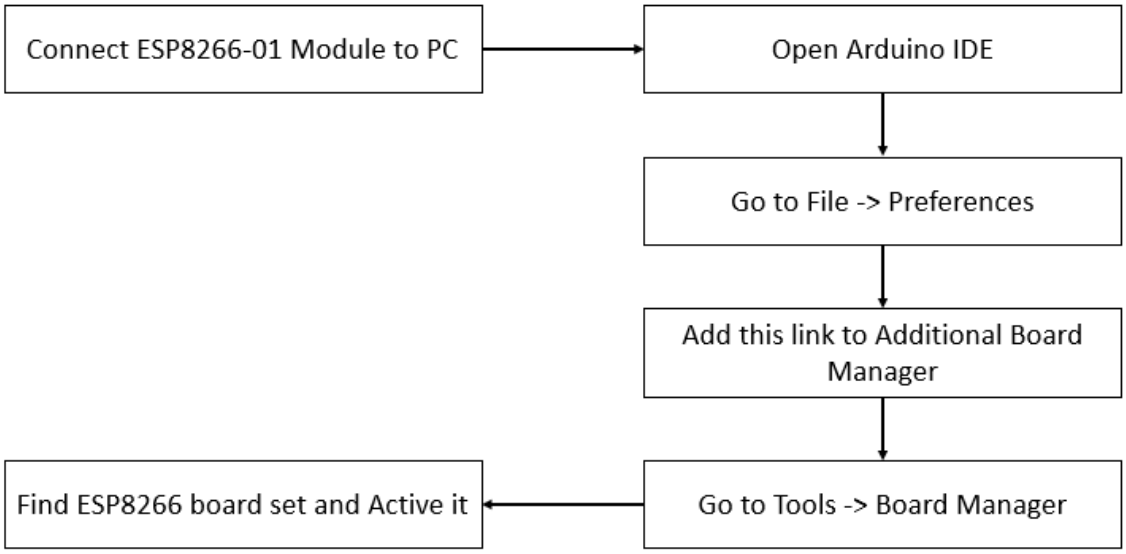

Figure 2. 6: Using of ESP8266

2.3.1.19 How to build an ESP communication?

ESP Communication is made in two ways. These are:

1. ESP-to-ESP communication
2. Many-to-many ESP communication

Below is a short brief description of how this communication is made:

1. **ESP-to-ESP communication:** ESP8266 is a microcontroller base Wi-Fi module. This module is a lowest cost so that it is easily used for any IoT based project or works. This communication build in UDP communication. Because UDP communication is easily to communicate to other devices at the same time. And benefits of UDP is, it provides cross platform communication. UDP connection is present here we can easily ESP8266 to ESP8266 connection established.

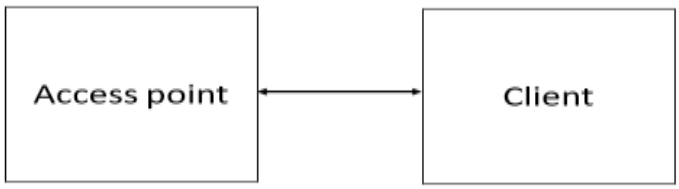

Figure 2. 7: In ESP8266 network for ESP to ESP communication build

In our project, we are firstly building one to one means ESP to ESP communication which are acts in client and access point. When the first communication was complete means builds, we went to second communication try to our second position works which is build in many to many ESP communication.

2. **Many to many ESP8266 communication:** ESP8266 is a wireless serial communication where this Wi-Fi module provide a self-contained with TCP/IP protocol. ESP works for several ESPs at the same time by using UDP connection.

   At the same time UDP communicate in many ESPs at same network so all ESPs send messages all Wi-Fi devices and all of network read the messages. Many to many ESP8266 communications has present a STA mode which is known as a client where the messages are came to different addresses and all ESPs ignore this address.

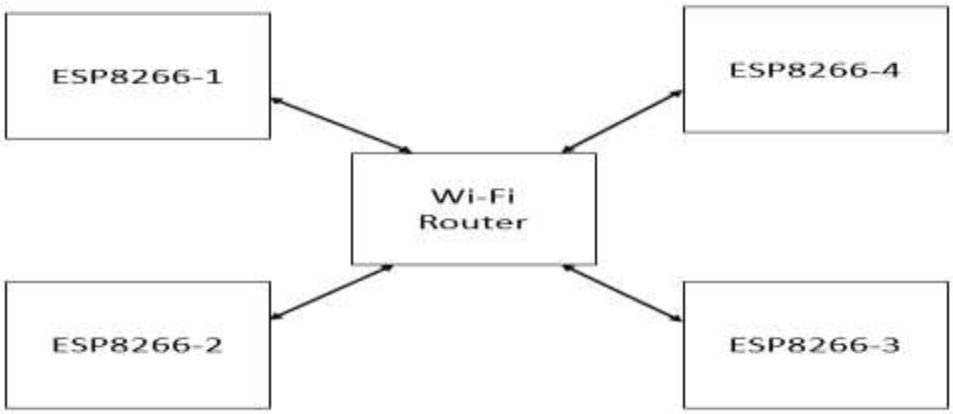

Figure 2. 8: In ESP8266 network many to many ESP communications

2.3.2 Autonomous Vehicles module

Our project's name is the Autonomous Vehicle Road Safety Information Exchange. Where we have made a one-way road safety information change through Autonomous Vehicle. To send Safety Information we have been creating many Autonomous Vehicle. Among these, we have used many automation velocity modules for making these Autonomous Vehicles.

- ✓ Arduino Uno
- ✓ IR sensor
- ✓ Relay module
- ✓ Jumper wires
- ✓ Battery
- ✓ Bread board

Autonomous Vehicle Modules Some Short Descriptions are discussed below:

2.3.2.1 Microcontroller

Microcontroller is a single chip of microcomputer where it has everything built in. Microcontroller is also a complete function of microcomputer because the micro controller comprises the circuit of micro-processor.

Micro controller has built in memory which it means, it supports ROM and RAM, necessarily Input/ Output circuits for a request. It has also less external hardware and reducing Printed Circuit Board (PCB) size and consequently are cheaper, compact, more reliable and less power system based on.

3 types microcontroller shown in figure-2.9:

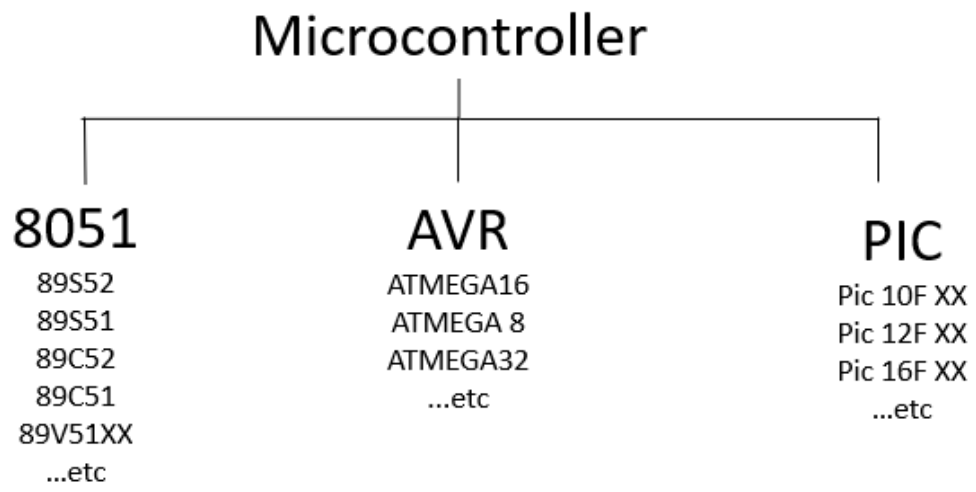

Figure 2. 9: 3types of microcontroller with examples

Now we will discuss the microcontroller board based on the ATmega328 and the name of which is Arduino Uno.

2.3.2.1 Introduction of Arduino Uno

Arduino Uno is a microcontroller board based on atmega328 which is developed by Arduino.cc. Arduino Uno devices are much cheaper and more flexible that are capable of doing many acts as like compared to their predecessors that happened to cover more space, turned out costly with the ability to perform at fewer act.

"Uno" means "One" which is came from in Italian and it's named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. In a series of USB Arduino boards the Uno is the latest, and the reference model for the Arduino platform; for a compare with previous versions.

It is used for two types of electronic circuits board. They are physical programmable circuit board which is using usually on microcontroller AND piece of code running on computer with USB connection which is using between the computer and Arduino.

It has 6 analog inputs, 14 digital input/output pins where 6 pins can be used as Pulse Width Modulation (PWM) outputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

Figure 2. 10: Arduino Uno

2.3.2.2 A short description of an Arduino

Microcontroller	ATmega328
Operating Voltage	5V
Supply Voltage (recommended)	7-12V
Maximum supply voltage (not recommended)	20V
Analog Input Pins	6
Digital I/O Pins	14 (of which 6 pins provide PWM output)
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328)
EEROM	1 KB (ATmega328)
Clock Speed	16 MHz

Table 6: Arduino information table

2.3.2.3 Memory Information

Arduino boards has 3 pools or types of memory which are used on AVR-based in the microcontroller. They are:

a) **Flash memory:** where is only stored the Arduino sketch.

b) EEROM: It is a memory space that their programmers can use to store long term information.

c) SRAM: SRAM is mean Static Random Access Memory. When it runs the sketch creates and manipulates variables.

Differences between them:

Flash Memory	EEROM	SRAM
Flash memory erased the entire device is erased, which can then be rewritten	EEROM contrast to one can erase a desired section or byte	SRAM is volatile type of used memory
Recently it is available in where the contents are divided into blocks and done with block by block erasure	Here is no byte erasure option available	SRAM is a static random access memory that retains data bits in memory as long as power is being supplied
It erases block or whole chip	It is erased by byte	SRAM is typically faster than DRAM because it doesn't have refresh cycles
It is less expensive	It is more expensive	Cost per bit is high
It contains large data	It contains smaller faster data	Here current to retain data is more important

Table 7: Differences between Flash memory and EEROM and SRAM

2.3.2.4 Information of Power

The Arduino Uno power source is selected automatically that it can be powered by either an external power supply or with the USB connection. External power which is non-USB that can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. A battery can be leads to be POWER connector with in the Ground and Vin pin.

This board can be operated from 6 to 20 volts for an external supply. If the 5V pin can provides less than five volts and however the board may be unstable or shaky when the board supplied with less than 7V. If using more than 12V, the voltage regulator may overheat and damage the board. So usually 7 to 12 volts are used. The power pins are given below:

a) VIN: It is an external power source used when the input voltage of the Arduino board (in contrast to the USB connection or 5 to 5 volts). You can use this supply voltage through this pin, or, if you provide voltage through the power jack, access it via this pin.

b) 5V: The regulator power supply is it. As it is used to power the microcontroller and other components on the board. It is come either from VIN through an on-board regulator, or to be supplied by USB or another regulated 5V supply.

c) **3V3:** A 3.3 volts supply which is provided by the on a regulator board. Most current draw is 50 mA.

d) **GND:** It is a Ground pins.

2.3.2.5 INPUT and OUTPUT

The Uno can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. Each pin has an internal pull-up resistor and they are operated at 5V. The most current per pin is 40Ma. Several pins are known as are given below the functions:

a) **PWM:** 3,5,6,9,10, and 11 are PWM pins. They are provided 8-bit PWM output with the analogWrite () Function.

b) **Serial:** 0 used to receive TTL data (RX) and 1 used to transmit TTL serial data (TX). These pins are communicated to the similar pins of the FTDI USB-to-TTL serial chip.

c) **External Interrupts:** 2 and 3 pins are configured to trigger an interrupt on a low value, a rising or a falling edge, or a change in value.

d) **SPI:** 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins are support SPI communication.

e) **BT Reset:** 7. This pin connected only the bluetooth module to a reset line

f) **LED:** 13. When the LED is on, the pin is HIGH and when the LED is off, the pin is off.

2.3.2.6 Analog pins

The Uno has 6 analog pins which are known as noted A0 to A5. Each input pins are provided 10 bit analog-to-digital conversion (ADC) using the analogRead() function. Most of the pins are used as inputs as digital pins but analog inputs 6 and 7 are not be used as a digital pin.

There are two couple of other pins present on a board. One is AREF which is known as reference voltage and its used in analogReference() function; another is Reset that is used in microcontroller for bring this line LOW to reset.

2.3.2.7 Communication of Arduino Uno

Arduino Uno is known as a microcontroller board base. It has some interface with both the Arduino boards and a computer. Arduino Uno is ATmega328 has provided a serial communication with support 5V that is using Rx and Tx pins. These pins are contained digital pins, where Rx assign in value 0 and Tx assign in value 1.

When Arduino provides a serial communication in an ATmega16U2 on the board its over USB and it on the computer take place such as a virtual communication port to software. Here doesn't need an external driver. When data is being transmitted through the USB to serial segment their Rx and Tx LED pins are on the board will be flash. And USB port connecting to the computer. Arduino software allows a serial monitor.

2.3.2.8 Communication protocols of Arduino

Arduino supports three types of communication protocols. They are shown in figure-2:

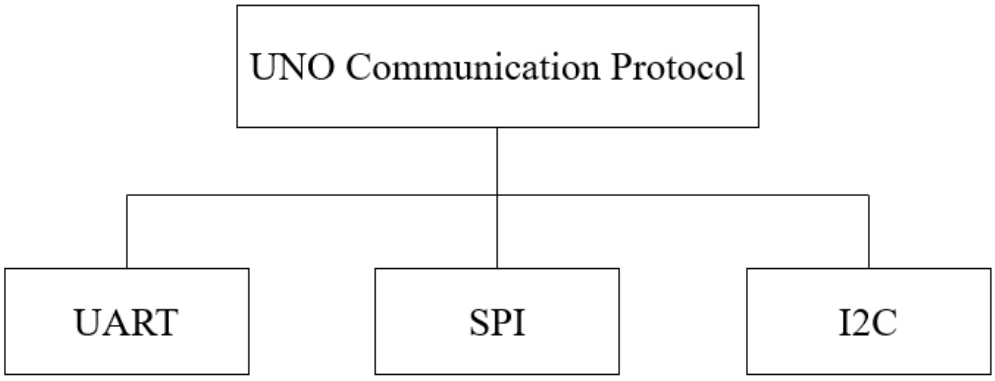

Figure 2.11: Arduino Uno Communication Protocol

a) UART: UART means Universal Asynchronous Receiver or Transmitter. UART is the first communication protocol that is provide a serial communication.

It performs communication with Tx and Rx; where Tx is transmission data and Rx is receiving data. This communication is very easier. Altogether the Tx and Rx used this communication form a serial port which a communication can occur. Mainly this serial communication used in hardware such as shown in figure-3:

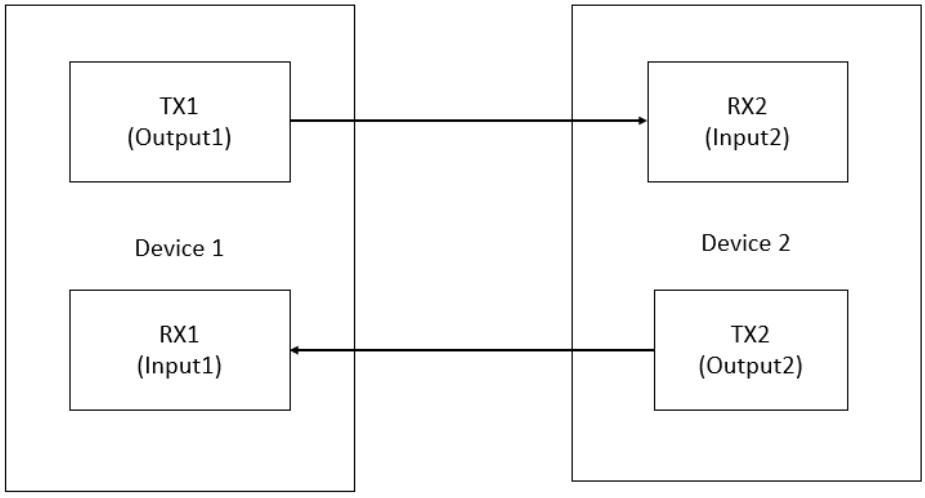

Figure 2. 12: UART diagram with hardware connection

b) SPI: SPI means Serial peripheral Interface. SPI is different from UART in the following keys:

- For implementation it used more than two lines
- Synchronous
- Following a master slave

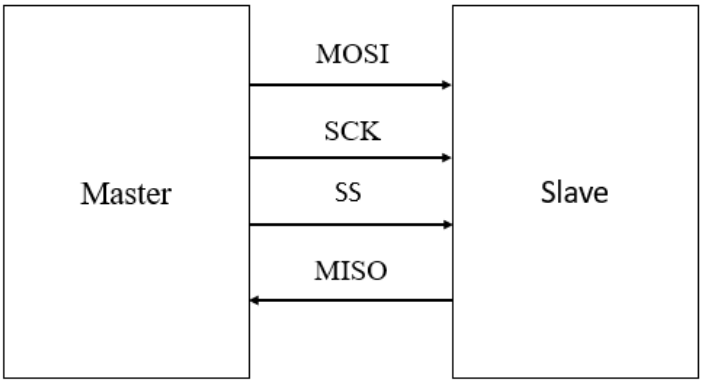

Figure 2. 13: SPI diagram with hardware connection

Here MOSI mean "Master Out Slave In", SCK is "Clock", SS is "Slave Select" and also MISO is mean "Master In Slave Out".

c) I2C: It is known as inter-integrated circuit. I2C has many drawbacks in other communication protocols; these are:

- ✓ It's able to connect with multiple masters to multiple slaves
- ✓ It provides higher speed for the communication
- ✓ Implementation some resistors and two wires

These communications are shown in figure-5:

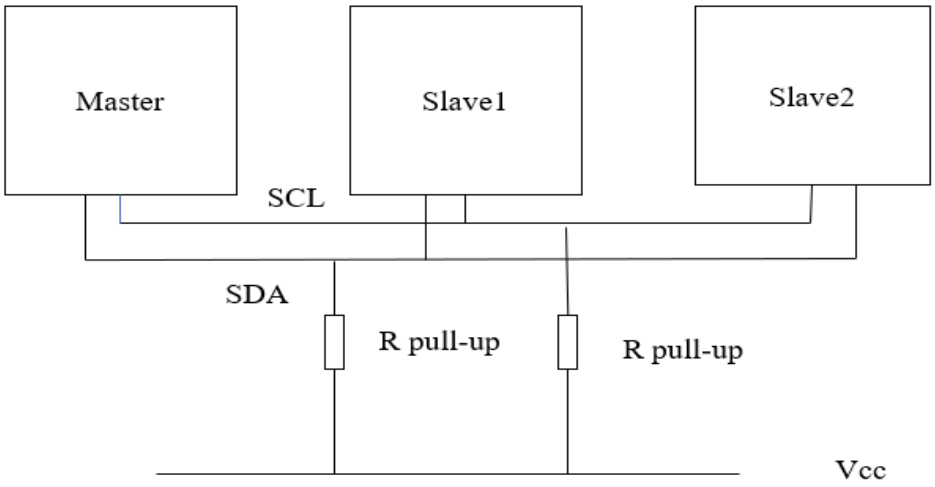

Figure 2. 14: I2C diagram with hardware connection

It has also two wire interfaces. One is SDA that is known a data line and another one is SCL that is known is clock line.

2.3.2.9 Programming of Arduino Uno

The Arduino Uno is programming by using the Arduino software. Where the "Arduino Uno comes from the Tools>board menu. Arduino software provides an application that is known as a cross-platform application which is called IDE written in Java. ATmega328 placed allow individual burner with a bootloader.

2.3.2.10Arduino Uno Software Reset

Arduino contain a reset button that is require a physical pressure before the code upload on the Arduino boards.

Arduino Uno is designed in a way. This way permits it to reset with the software running on a connected computer. Here a hardware flow control present that is known as DTR of the ATmega8U2 which is connected with the reset line of the ATmega328 through a 100 nano-farad capacitor.

When the DTR line is take to a low, this line long enough to reset the chip. When you need to a code upload Arduino software allows this strength with a pressing the upload button in the environment of Arduino. The Arduino Uno requires a footstep which is cut to disable the auto reset.

2.3.2.11 Physical Characteristic of Arduino Uno

Arduino Uno has 2.7 inches maximum length with the maximum width of 2.1 inches. The board attached with four screw holes, this attach contains with to a case or surface.

2.3.2.12 USB over-current protection for UNO

Arduino supports many resettable ports. This resettable port provides your computer's USB ports from over current and shorts. Mostly computers provide their own internal protection and their fuses supports an extra layer of protection.

2.3.2.13 How does Arduino work in Arduino environment?

An Arduino Uno is an AVR 8-bit microcontroller base board. It has also two wire interfaces. In ATmega328 has 14 digital I/O pins, 6 analog inputs, a USB connection, ICSP header and a reset button.

It supports to both a physical programmable circuit board and a piece of software or IDE which is run on your computer. And these are used to both write and upload computer code to the physical board.

2.3.2.14 Importance of Arduino

An Arduino is easy-to-use communicate with both hardware and software that is called an open source electronics base platform. An Arduino is also a prototyping software and its own software that is known as Arduino IDE.

2.3.2.15 Advantages of an Arduino

a) Easy to use communicate
b) It is an inexpensive
c) It provides a cross platform
d) Extensible software
e) Easy to understand
f) Simple and clear programming environment
g) Open source and extensible s/w

2.3.3 IR sensor (4-Way IR Infrared Tracking Sensor Module)

In our project to design Autonomous Vehicle, we need to achieve line-completion capability. To following line, we have used the Four Way IR Sensor in our project. This is very easy to following lines through the Four Way IR sensor. Following this line can be ensured that autonomous vehicles are functioning properly.

Figure 2. 15: IR sensor (4-Way IR Infrared Tracking Sensor Module)

2.3.3.1 Specifications of 4-Way IR sensor

There are many specifications of IR sensor, among them the Important:

- ✓ 4-Way IR Infrared Sensor offers DC voltage range ranging from 3.3Volts to 5 volts
- ✓ It also provides more than 1A current
- ✓ Output signal sends through Time to Leave (TTL)
- ✓ It can determine 4-Way IR Infrared Sensor temperature, this range is -10°C -+50°C
- ✓ It has also mounting hole with M3 screws
- ✓ It can measure the distance from six centimeters to one millimeter

- ✓ It has 2 boards where one is central control board that size is 42mm X 38mm X 12mm (length x width x height) and another one is small board that size is 25mm X 12mm X 12mm (length x width x height)

2.3.3.2 Module specifications

4-Way IR sensor has two types module. These are:

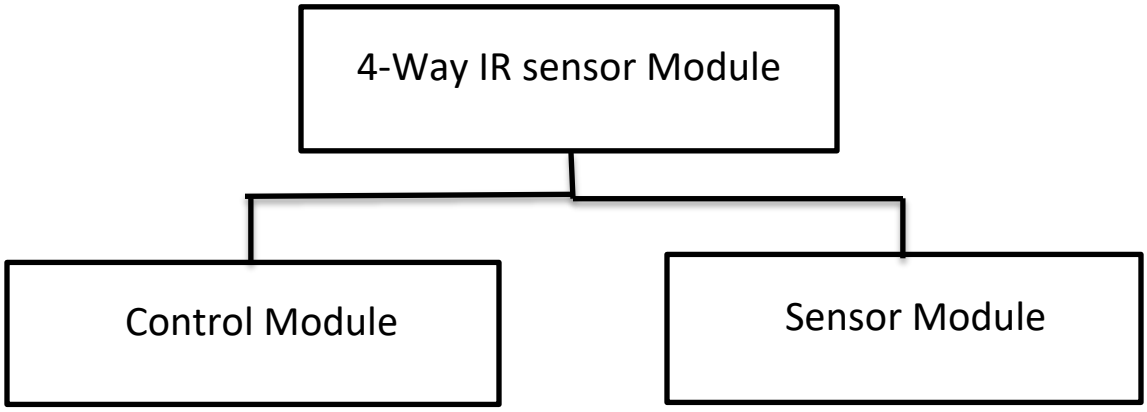

Figure 2. 16: IR sensor module

1. **Control module**: Control module has six pins again. They are VCC that is provide DC voltage through 3.3 volts to 5 volts, Ground pin, OUT1, OUT2, OUT3 and OUT4 where OUT1 to OUT4 pins are provides either high or low output.
2. **Sensor module:** sensor module has 3 types of connection mode. They are VCC to VCC, Input to Output and Ground to Ground.

2.3.3.3 Applications of IR sensor

The IR sensor has some applications. These are:

- ✓ Autonomous vehicles line following which is called tracking
- ✓ Other automated vehicles duplication applications can be used
- ✓ Autonomous cars are used to make barriers

2.3.4 Relay module

In our project used 2 channel relay modules for the general working purpose. Here we are use three 2 channel relay modules.

Figure 2. 17: 2-Way Relay Module

Relay module is a low level 5volts and a standard interface which is controlled by microcontroller. Relay module always works on 5volts logically. Here in this relay module, each channel provides current 15-20 mA. Relay modules offer many high voltage currents, it works DC30V 10A or AC250V 10A.

2.3.4.1 Features of relay module

- ✓ PCB size is 50mm x 45mm (length x width)
- ✓ Logical signal works 5volts
- ✓ When the relay is on, the two indents the LEDs
- ✓ These are proven too high current relay
- ✓ It also supports Opto isolation coupler which is provide safety high voltage
- ✓ Relay module support faster and shorter response time

2.3.4.2 Pin descriptions

In 2 Way relay module, it has 4 pins. These are:

a) VCC which is provide 5volts DC current
b) IN1: It is input number one which is provide low or high output
c) IN2: It is also input number two which is also provide low or high output
d) GND: It is ground point

2.3.5 Bread Board

It is a small piece of electronics device, which is discovered Ronald J Portugal in 1970. Here is no soldering is used so that it's also called "Solder less" breadboard. In bread broad, here is two types of working space present where one is durable and another one is reusable.

It is a plastic type of electronics board which has power rails with two-hole columns and terminal strips with 5-hole rows. It has also a center which is divided to two terminal strips. So that it's also called a prototype electronic board.

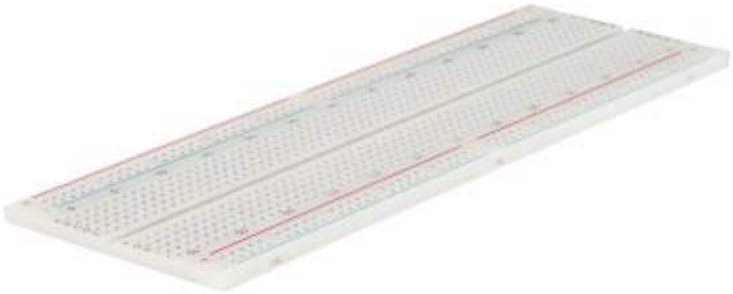

Figure 2. 18: Bread Board

2.3.5.1 Features of Bread board

- ✓ Bread Board size is 167.3 x 57.15 x 8.4 mm (length x width x height)
- ✓ Plate size 183 x 95 x 0.8 mm (length x width x height)
- ✓ Minimum temperature -25°C and maximum temperature 84°C
- ✓ Solder less bread board, ABS plastic board
- ✓ Supports 36volts current and 2Amps power
- ✓ Support 2 types tie point. One is terminal strips and another one is distribution strips

2.3.5.2 Importance of bread board

Any circuits diagram can be very well represented through the bread board. Circuit diagrams can be identified through the breadboard very neatly and beautifully. It is very easy to understand how a connection to the circuit is with another connection. For those reasons bread board is most important any circuit diagram design.

2.3.6 Jumper Wires

Jumper wires is a small size of an electronic wires that is easily connected to the bread board or Arduino Uno where it's need. Here is two type pins present without soldering. Jumper wires has different color. But their work is same.

Figure 2. 19: Jumper wires

2.3.6.1 Types of jumper wire

Three types of jumper wires. They are:

a) Male to male
b) Female to female
c) Male to female

The difference between the three types of jumper wires is their difference in end points to end points.

2.4 Software Used

We used arduino-1.8.7-windows software to process our full project. The stages of arduino-1.8.7-windows configuration is given below:

2.4.1 Step-1:

a) ESP8266 firmware upgrade: Download arduino-1.8.7-windows and install it. Open Arduino and select COM port number the select firmware file then set COM port number and download it.

b) Connection: Connect Arduino board pin with the esp8266 pin TX-TX, RX-RX, RESET-RESET, VCC-VCC, GND-GND, GPO-0 to GND, CH_EN –VCC.

c) Download the firmware:

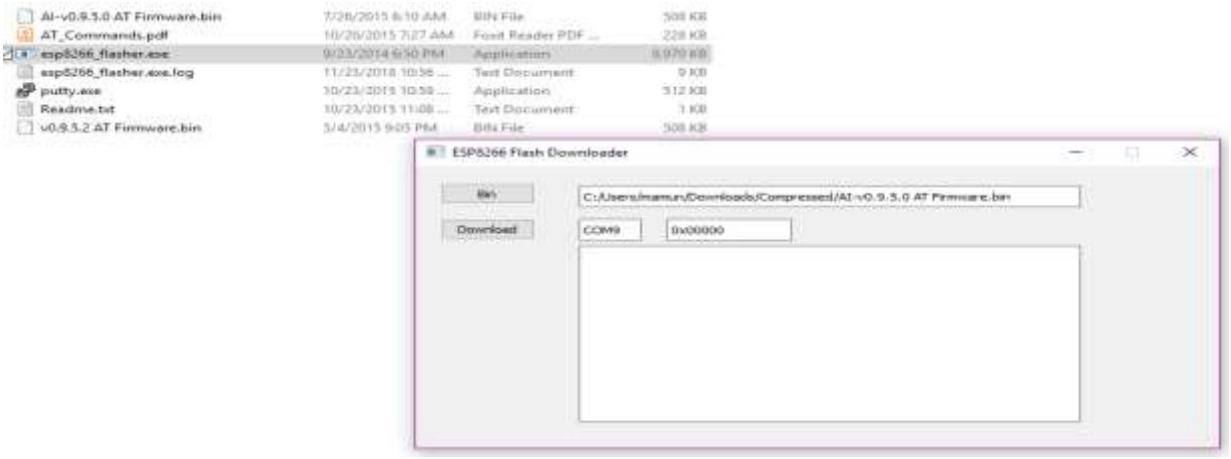

Figure 2. 20: Download the firmware

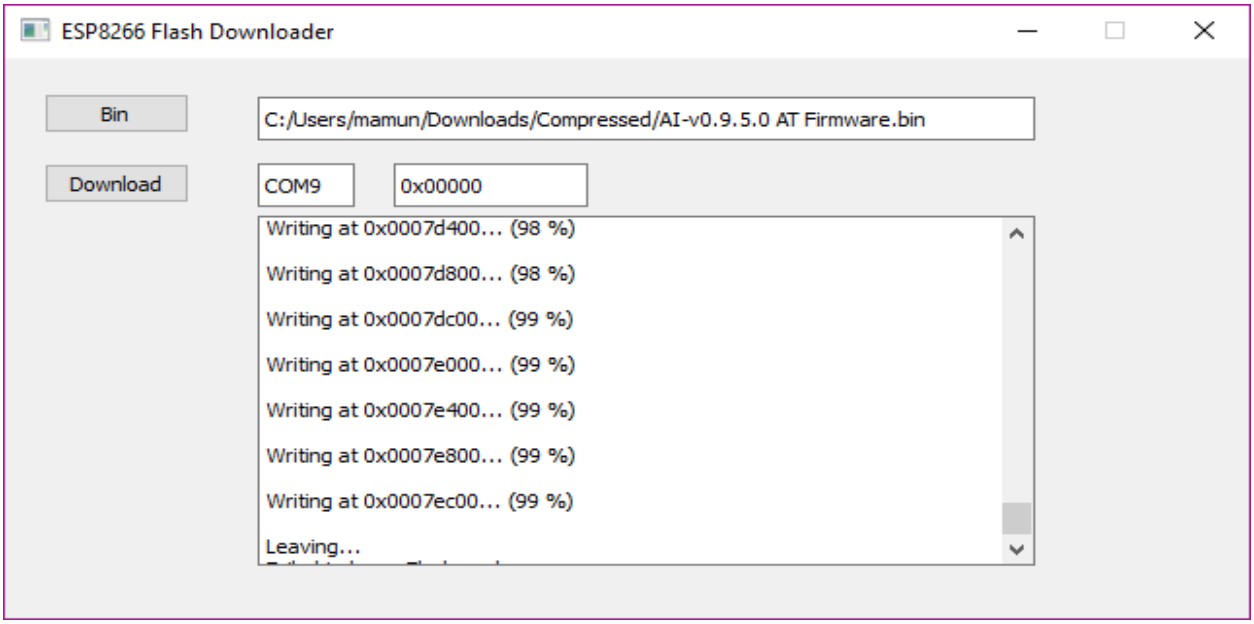

Figure 2. 21: Install the firmware

2.4.2 Step-2:

a) Select the esp8266 board packed:

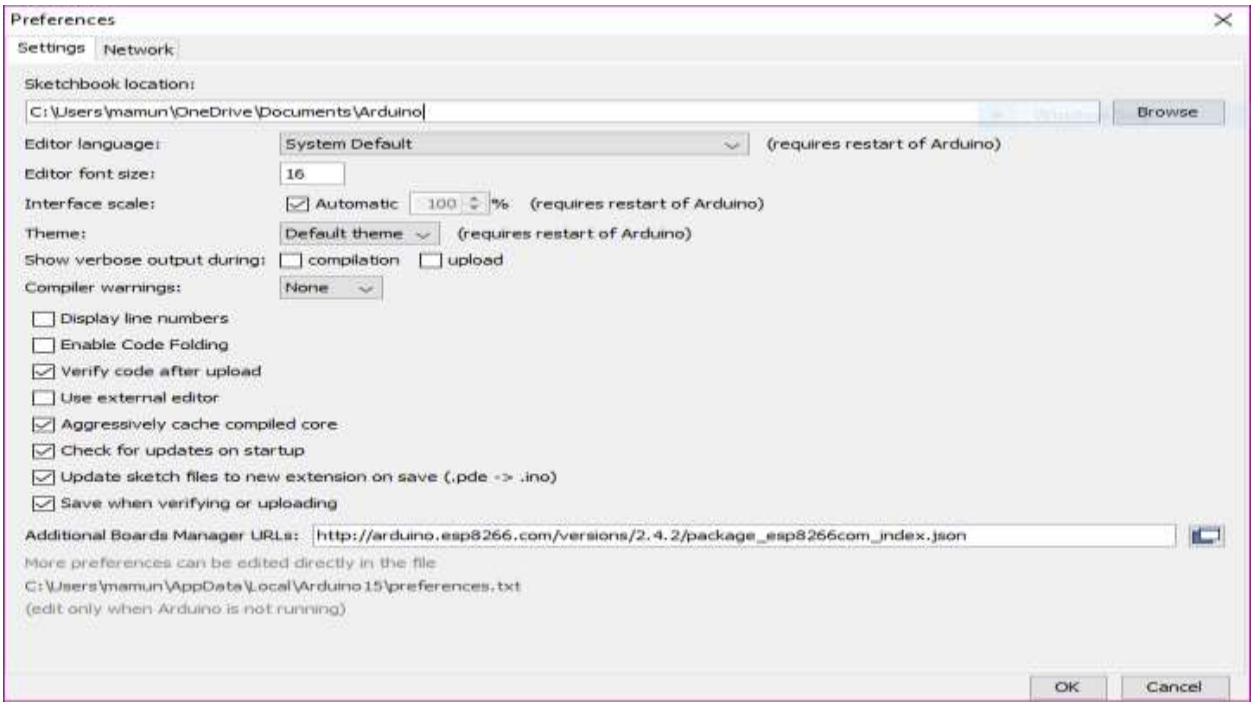

Figure 2. 22: Select the esp8266 board packed

b) Install ESP8266 Board Package:

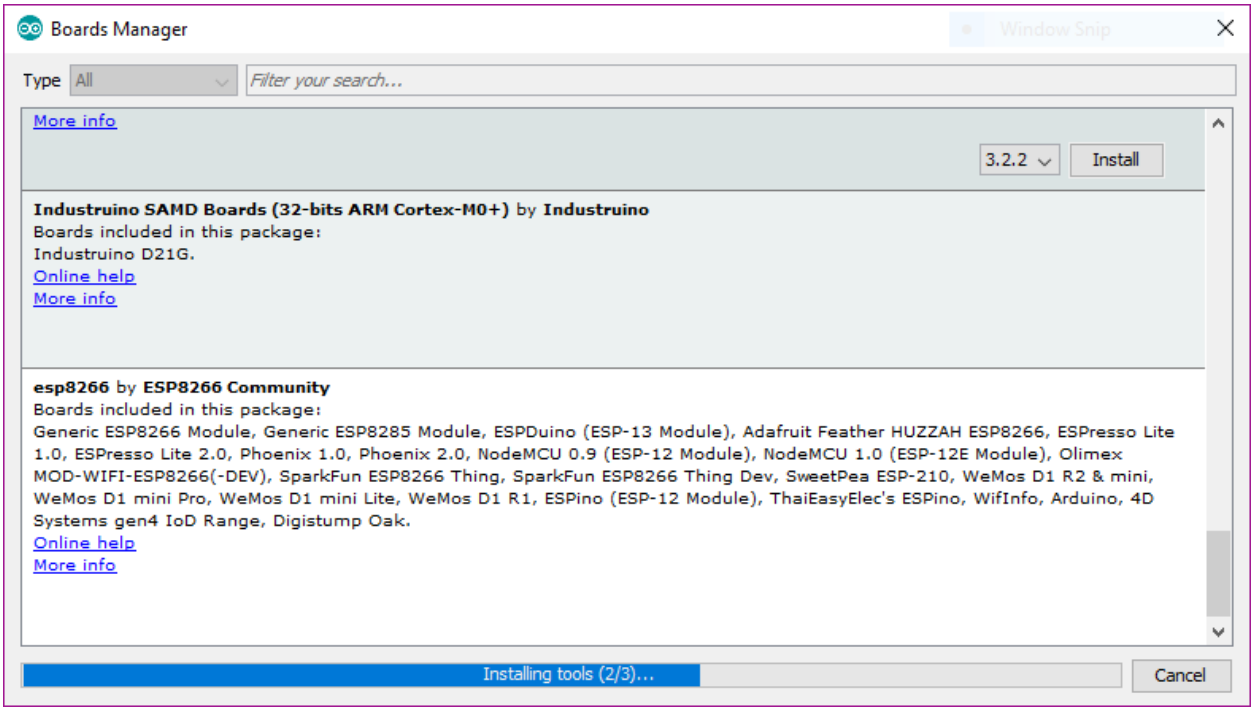

Figure 2. 23: Install ESP8266 Board Package

2.4.3 Step-3: Select the esp8266 board to upload program:

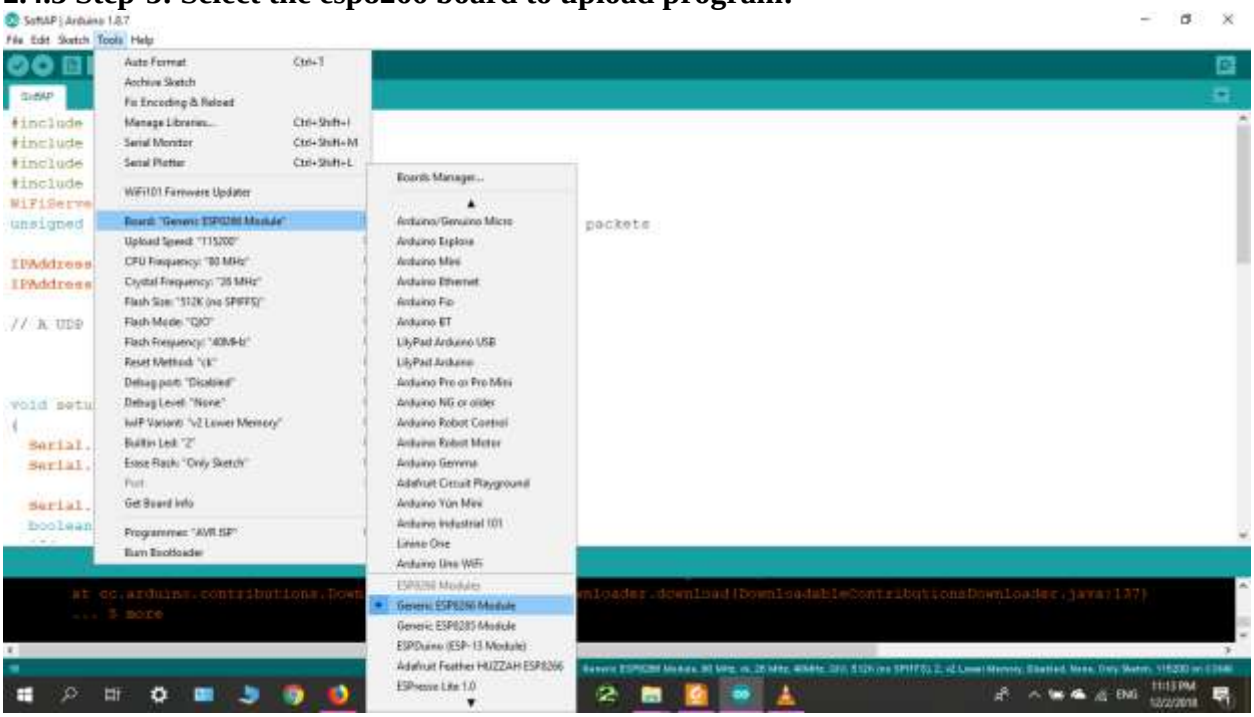

Figure 2. 24: Select the esp8266 board to upload program

Chapter 3

Project Description and Implementation

3.1 Circuit Diagram:

In the circuit diagram of the system all the process is control by Arduino Uno. Every Arduino contain an ATmega32 microcontroller. All the program of Arduino control and store by the atmega32 microcontroller. In the atmega32 microcontroller there is 8-bit microchip and 32kb ISP flash memory. The Arduino operate at 5 volts power supply.

The analog pin A1 and A2 are connected with the output pin of IR sensor. It operates at 3.5 volt. The IR sensor has some diodes. IR transmits infrared lights. When the infrared ray fell on to the white surface it reflected back and catch it by photodiodes which generates some voltage change and sent it to the Arduino throw the A1 and A2 analog pin.

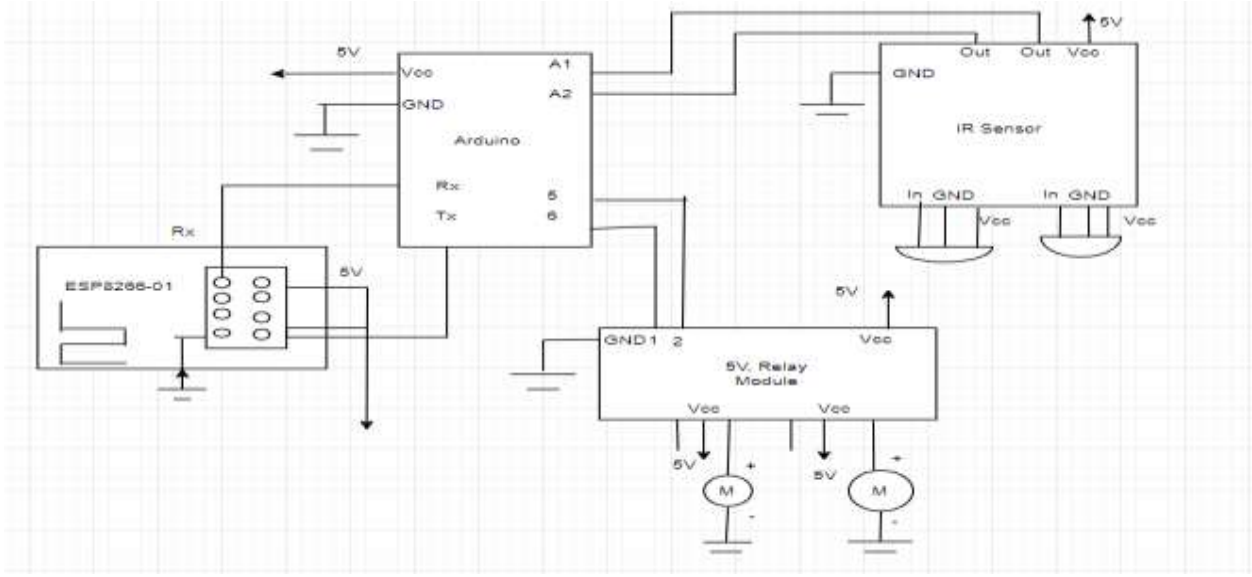

Figure 3. 1: Circuit Diagram of our project

The 5 volts 2 channel relay module operate at 5 volts current supply and it work as a switch to control the motor of the automated vehicles as the signal of IR sensor. The relay is connected with the PWM pin of Arduino. The positive pin of the motor is connected with the input pin of relay module and negative pin is connected with the ground.

The esp8266 is used only for continuous communication and it operates at 3.5 volt. The TX/RX pin of the esp8266 is connected with the TX/RX pin of the Arduino. TX is for transmit serial data and RX is for receive serial data. GPO 0 pin is connected with the ground pin when program is lode on it and after that disconnect GPO 0 from ground. CH_EN pin is connected with the VCC pin and reset pin is connected with the reset pin of Arduino. The esp8266 has own program storage capability.

3.2 Use Case diagram of our project:

In our project Client driving vehicle, when he faces any accident, he will generate a signal. Through ESP8266 wi-fi module. Nearest Access point will accept the signal through ESP8266 Wi-Fi module. And will send it to nearest rescue team. Rescue team will rescue the victim(client).

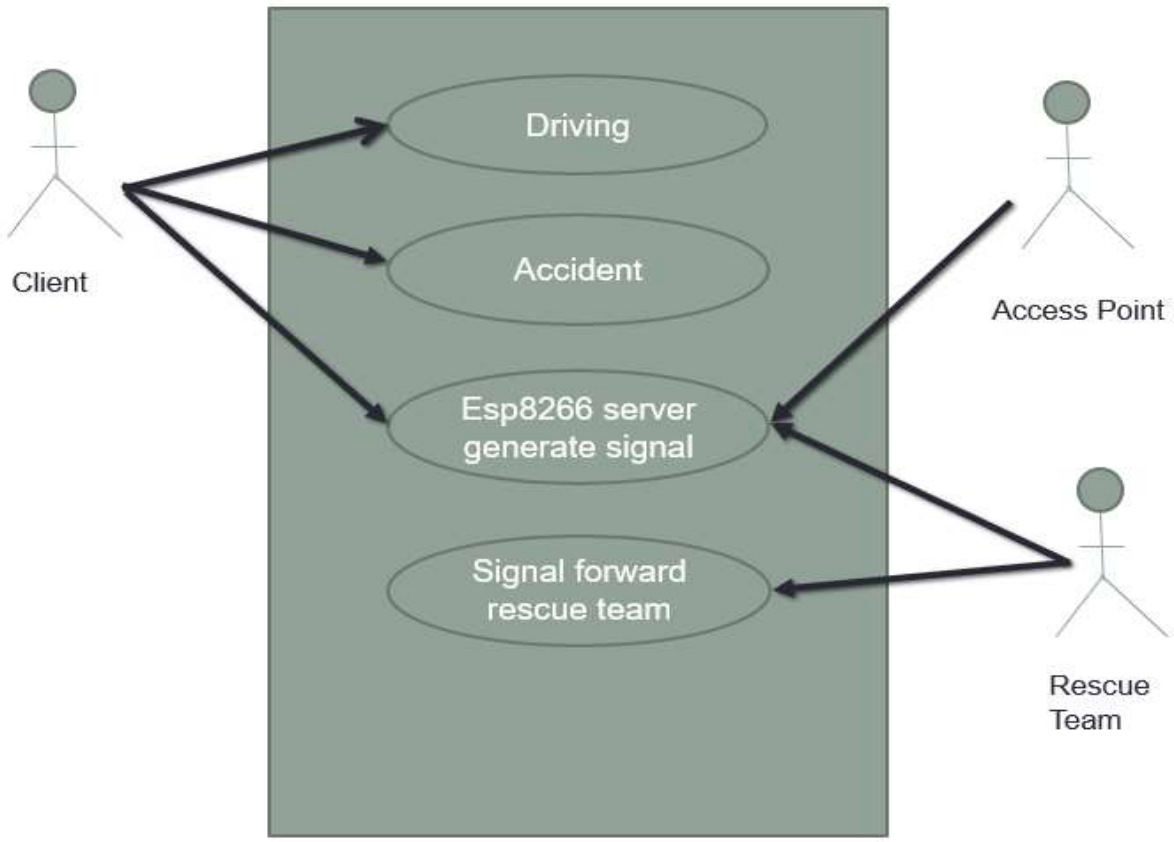

Figure 3. 2: Use Case Diagram of our project

3.2.1 Advantages of using Use case diagram

Some of advantages of using use case diagram in this project are given below:

a) Easy to understand overall project idea and mechanism.
b) Easy to make plan and implement the activity of 'Client, Server and Access point'.
c) It helps to avoid same activity, documentation and information exchange between Client, Server and Access point.

3.2.2 Disadvantages of using Use case diagram

Some of disadvantages of using this diagram in this project are given below:

a) Can't add every details of project's object
b) For some project use case are very difficult to understand and implement

3.3 Implementation

The full project is completed throw several phases. First of all, we built up an access point then built an automated vehicle and a rescue team center.

3.3.1 Access Point:

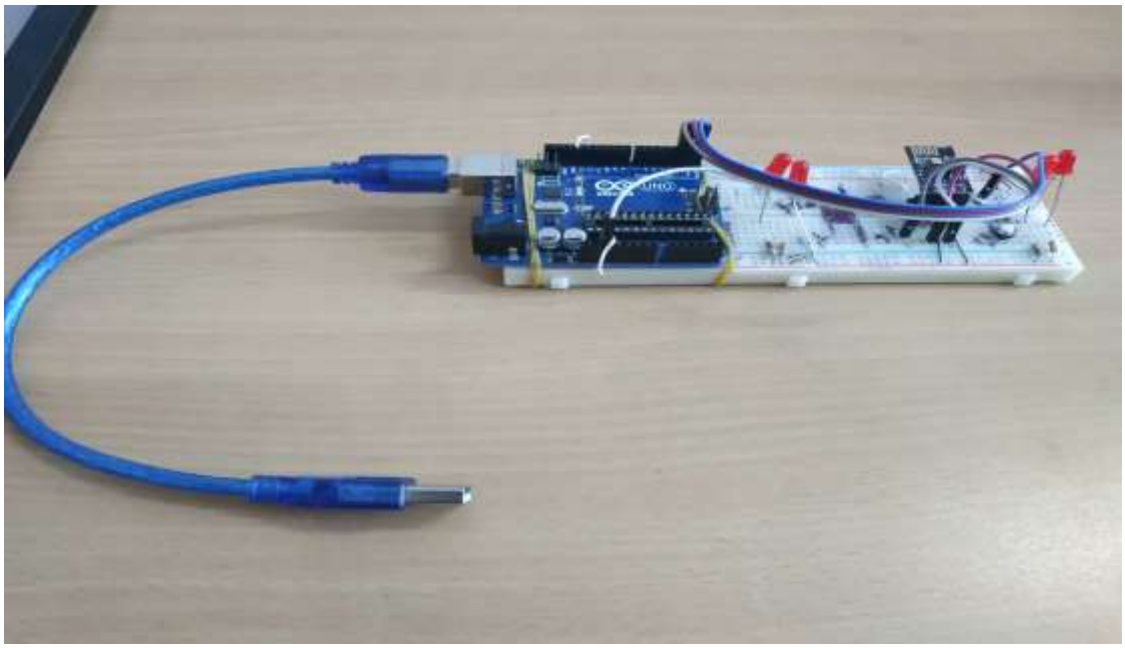

Figure 3. 3: Access point in our project

The access point creates a wireless local area network. We set SSID and password in it and statically set geolocation into it to identify the location. All the nearest road side unit (RSU)/automated vehicles connected with the access point.

When a vehicle occurs an accident, it sends the accident information to the nearest RSU. The RSU connect to the access point (AP) which it belongs. The AP send the information to the nearest rescue team to help the accident car as soon as possible. The rescue team informed about the location of the accident from the AP because in the accident information the AP send it location information with it. Then the rescue team rescue the accident car.

3.3.2 Automated vehicle/Rescue team:

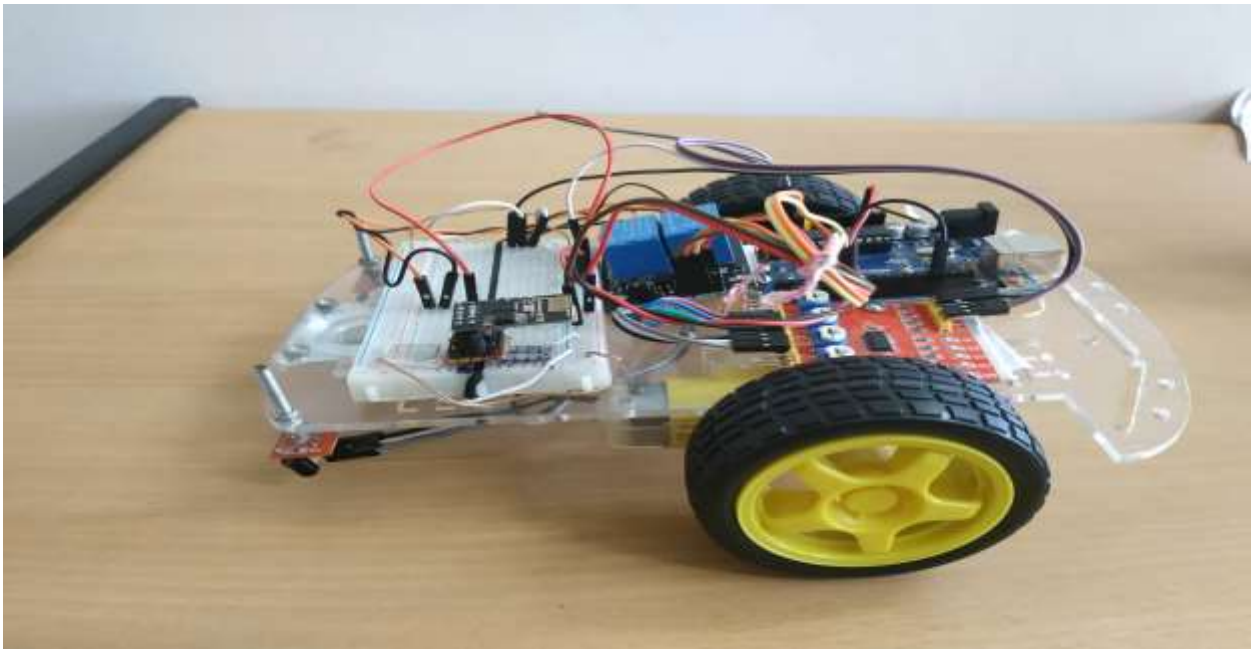

Figure 3. 4: Automated vehicle/Rescue team

The task of automated vehicles and rescue team is about similar. The automated vehicles operate automatically and follow the line. It has a communication unit (esp8266) which all time communicate with the nearest RSU and exchange information. When it falls in an accident, it sends the information to the nearest RSU to rescue it.

The rescue team also contain esp8266 and communicate with the RSU and operate with respect the signal of RSU.

3.3.3 Initial Stage:

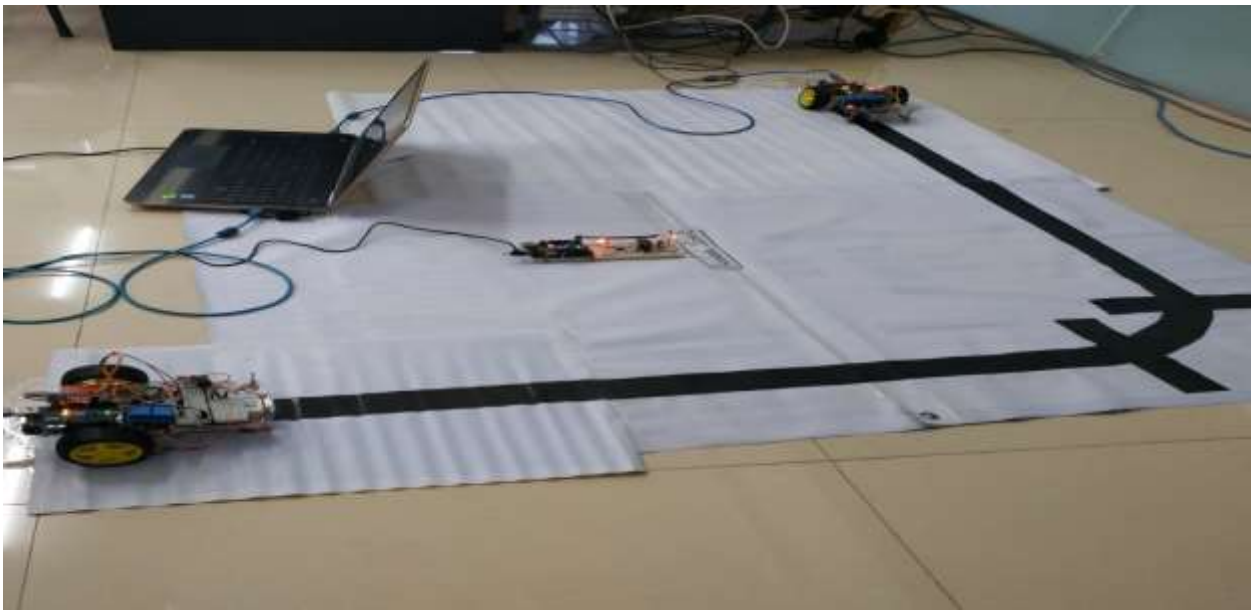

Figure 3. 5: Initial state of our project

In this stage the victim vehicles and rescue team are connect with the access point and exchange information.

3.3.4 Accident Stage:

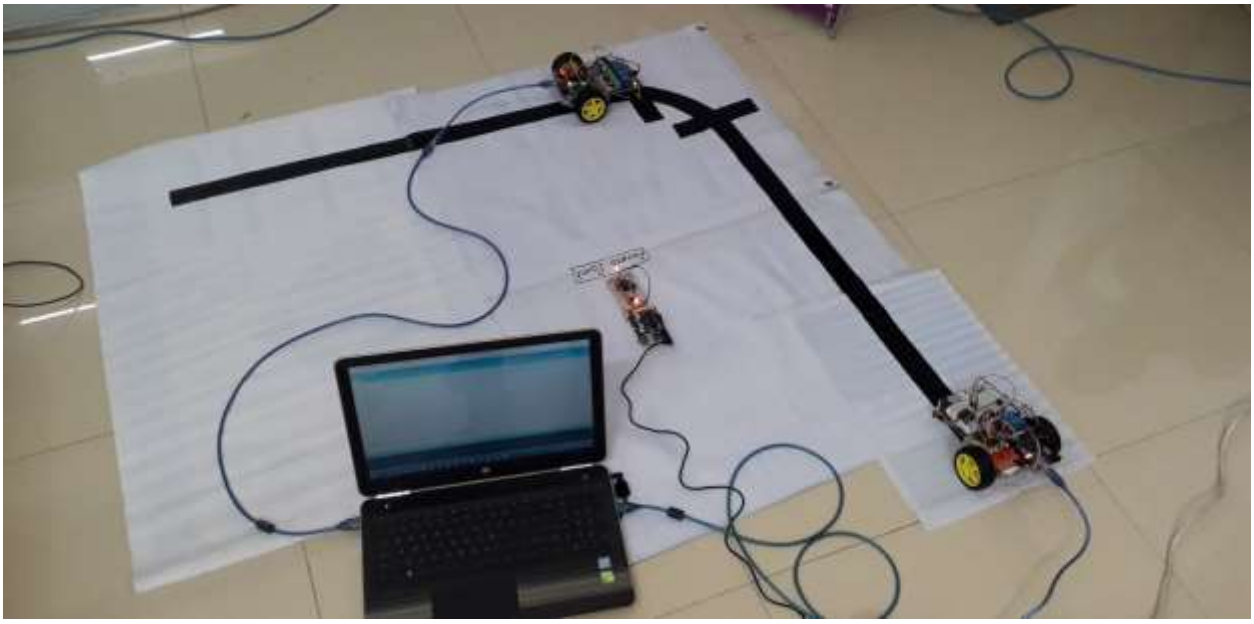

Figure 3. 6: Accident State of our project

Here the victim vehicles occur an accident and send the information to the AP. The AP forward the information of accident with its location to the rescue team to rescue team.

3.3.5 Rescue Stage:

Figure 3. 7: Rescue state of our project

In the stage of rescue the rescue team get the information of accident and the location of accident. After that the rescue team rescue the victim vehicles.

3.4 How to we are implementation the proposed system?

This section we are described the access point and rescue team works.

3.4.1 ARDUINO CODE:

Access Point Code:

```
#include <ESP8266WiFi.h>

WiFiServer server(80);
IPAddress IP (192,168,4,15);
IPAddress mask = (255, 255, 255, 255);
byte ledPin = 2;
```

```
void setup()
 {

        Serial.begin(9600);
        WiFi.mode(WIFI_AP);
        WiFi.softAP("CSE-400", "cse");
        WiFi.softAPConfig(IP, IP, mask);
        server.begin();

        pinMode(ledPin, OUTPUT);
        Serial.println();
        Serial.println("Accesspoint");
        Serial.println("Server started.");
        Serial.print("IP: ");
        Serial.println(WiFi.softAPIP());
        Serial.print("MAC:");
        Serial.println(WiFi.softAPmacAddress());
}

void loop()
 {

        WiFiClient client = server.available();
        if (!client) {return;}
        String request = client.readStringUntil('\r');
        Serial.println("From the station: " + request);
        client.flush();
        Serial.println(client.println(request + "Location: United City, Madani Avenue, Badda,
Dhaka 1212 " + "\r"));

}
```

Client Code:

```
#include <ESP8266WiFi.h>
#define GPIO2

byte ledPin = 2;

char ssid [] = "CSE-400"; // SSID of your AP
char pass [] = "cse"; // password of your AP
IPAddress server (192,168,4,15); // IP address of the AP

WiFiClient client;
boolean configMode = false;
```

```
void setup()
{
	Serial.begin(9600);
	pinMode (2, OUTPUT);
	WiFi.mode(WIFI_STA);

	WiFi.begin(ssid, pass); // connects to the Wi-Fi AP

	Serial.println();
	Serial.println("Connection to the AP");

	while (WiFi.status()! =WL_CONNECTED)
	{
		Serial.print(".");
		Delay (500);
	}
	Serial.println();
	Serial.println("Connected");
	Serial.println("Station_001");
	Serial.print("LocalIP:");
	Serial.println(WiFi.localIP());
	Serial.println("MAC:" + WiFi.macAddress());
	Serial.print("Gateway:");
	Serial.println(WiFi.gatewayIP());
	Serial.print("AP MAC:");
	Serial.println(WiFi.BSSIDstr());
	pinMode(ledPin, OUTPUT);
}

void loop ()
{
	client.connect(server, 80);
	configMode = (digitalRead(2) == HIGH);
	if (configMode)
	{
		Serial.println(client.print("My car is in denger.Your  \r")); // Client_001
		String answer = client.readStringUntil('\r');
		Serial.println("From the AP:" + answer);
		client.flush();
	}
	else {
	 }
	client.stop();
	delay (2000);
}
```

Automated Vehicles Code:

```
int leftInput = A1;
int rightInput = A2;
int leftMotor = 7;
int rightMotor = 8;
int leftValue = 0;
int rightValue = 0;
int led1=2;
void setup ()
{
	pinMode (leftMotor, OUTPUT);
	pinMode (rightMotor, OUTPUT);
	pinMode (led1, OUTPUT);

	Serial.begin(9600);
}
void loop ()
{
	leftValue = analogRead (leftInput);
	rightValue= analogRead (rightInput);

	Serial.print("Left Sensor: ");
	Serial.println(leftValue);

	Serial.print("Right Sensor: ");
	Serial.println(rightValue);

	if (leftValue < 155 && rightValue < 155)
	{
		digitalWrite (leftMotor, HIGH);
		digitalWrite (rightMotor, HIGH);
		digitalWrite (led1, LOW);
	}
	if (leftValue > 155 && rightValue < 155)
	{
		digitalWrite (leftMotor, LOW);
		digitalWrite (rightMotor, HIGH);
		digitalWrite (led1, LOW);
	}
```

```
        if (leftValue < 155 && rightValue > 155)
        {
                digitalWrite (rightMotor, LOW);
                digitalWrite (leftMotor, HIGH);
                digitalWrite (led1, LOW);
        }
        if (leftValue > 155 && rightValue > 155)

        {
                digitalWrite (rightMotor, LOW);
                digitalWrite (leftMotor, LOW);
                digitalWrite (led1, HIGH);
        }

        delay (1000);
}
```

Chapter 4

Limitations, Problems faced and Future Works

4.1 Limitations

4.1.1 Only geolocation is used:

This system can identify the geolocation of the access point only. The location of AP is set inside it.

4.1.2Required a large amount of esp8266 Wi-Fi module for RSU:

To prepare a complete there required a large amount of esp8266 for each AP, RSU and for each vehicle.

4.1.3 Not experimented for large area:

We design this system for a large area but we only experimented the system only a small range area. This system is not experimented for a large area.

4.1.4 Exact location can’t identify:

This system can’t identify the exact location of the victim car. It get the information of location about AP.

4.1.5 This is a real-life scenario using a toy domain:

We use the automated vehicles as a toy domain for a real-life scenario.

4.2 Problem we faced

4.2.1 Lack of prior experience:

A little amount of prior experience would be so much helpful.

4.2.2 ESP8266 is not bread board friendly:

The esp8266 module we used for communication is not bread board friendly. For this problem we have made a header to set it on the bread board.

4.2.3 Communication among h/w and s/w:

Set up and collaboration hardware and software are much difficult because some time the hardware are corrupted. Sometime the hardware is destroying for high current flow.

4.3 Future Works

4.3.1 Design the system to identify the exact location of client (car):

In future we will try to design the system so that it can identify the exact location of the victim car.

4.3.2 Improve capability like avoid traffic jam:

As the automated vehicles is used for the toy domain. In future we will design the system so that it can avoid traffic jam like in the first or last car of a signal inform the previous car to avoid the road or traffic jam.

4.3.3 Improve capability for fully automated driver less vehicles:

With the modern technology we will develop the system in fully automated driver less vehicles.

4.3.4 Design the system for inter vehicles communication throw RSU:

In our system it can communicate only with the RSU or AP. In future we will develop the system to communicate among vehicles to vehicles for quick communication.

4.4 Expenses

1. Per-kilometer for RSU is about 1250 Taka
2. Per autonomous vehicles only for communication cost is 700 Taka

Chapter 5

Conclusions

In this project we have studied and implemented an automated vehicle with road safety information exchange using an Arduino Uno and esp8266. The Arduino Uno is used to upload program in esp8266 in the vehicles and the TX/RX pin is used to data transfer and received.

The esp8266 is used as the main communication module. All the vehicles (Victim & Rescue team) continuously connected with the RSU/AP. When the client (victim car) faces any problems, it informs the nearest RSU then the RSU informed it to the AP. The AP then forward the information to the nearest rescue team to help the victim car. In this way we develop our full system. The system transfer information to the proper authority so quickly and the authority will be able to take action very quickly which will reduce the percentages of road accidental death.

The project is also our starting to robotics and IOT. I have learned a lot about the various use of different sensor Arduino and esp8266. The programming and interfacing of microcontroller has been mastered during the implementation.

In future we will develop this system for advance use of safety information exchange among client to client with modern technology. We will add modern sensor like ultrasonic sensor, face recognition sensor in the vehicles to make it automated so that it can operate without driver and able to avoid traffic jam. By using this system, we can easily reduce the accidental death, save our time and money.

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