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CHAPTER 01 – INTRODUCTION

1.1 BACKGROUND OF THE PROJECT

A fire suppression system is somewhat of a built arrangement of segments that are intended to stifle an accidental fire, ordinarily in a work yard or place yet in addition possibly in a vehicle also. Fire suppression system dependably comprise of no less than one segment intended to douse a fire through the use of an outer substance. Many fire suppression systems likewise comprise of flame recognition system or fire detecting system, and in addition flagging/signaling systems.

The recognition of a fire regularly consequently actuates the extinguishing segment of the framework; be that as it may, some fire concealment systems require manual enactment, but nowadays with the changing advanced technology world, things become less complicated and less human intervention. Therefore, this fire suppression system is mostly automatically activated which is easier and quicker.

1.2 PROBLEM IDENTIFICATION

A country like Sri Lanka which is a semi-developed country, the number of road accidents and vehicle accidents have increased within the last few years with increased number of vehicles and incredibly increased traffic. These are not only the reasons but drivers, reckless driving, system failing in vehicles etc.

Road signs, un organized disturbed roads, no proper safety systems in vehicles, these are few other reasons for accidents to occur in Sri Lanka and damages are also high where it is affected to equipment damages as well as human health and losing lives with great damages to vehicle where it ends up catching a fire or completely damaged.

Mainly because of no proper safety systems in vehicles or year of manufacture of the vehicle being too old and less advanced equipment’s are fitted, people tend to lose lives or being injured. On the other hand, the damages to the vehicle are high and to repair its costly.

1.3 AIM

In this project the main aim is to help prevent very critical, and life threat injuries, lessen downtime after a fire crisis, reducing insurance costs and to prevent or reduce repairs which could be very costly. To equip a fire suppression system to day to day passenger vehicles.

1.4 OBJECTIVE

- Developing a system which will be less costly and affordable enough to be fixed in any vehicle. Such as, currently available fire suppression systems in the market is expensive and limited to a specific set of vehicles (High end vehicles and presidential vehicle).
- Introduce a less complicated and an efficient fire suppression system for day to day vehicles
- To reduce damages to the vehicle and avoid injuries to the passengers in the vehicle by 25%.

1.5 SCOPE AND LIMITATION

This project focus on creating a simple universal system with less wiring which could be fitted into any vehicle including day today passenger vehicles, using heat sensors which can send signals to an electric control module. Through the signals, module act accordingly to send an electric signal to the nozzles, therefore, fire extinguishing agent will be sprayed as a foam onto the affected areas, where the fire has taken place. However, to carry the fire extinguishing agent, a tank with a motor pump is included in the system to provide required pressure. Through the research, this project also includes types of fire extinguishers which can be used in a fire suppression system.

This project also includes a circuit design which can be fixed into a prototype to test out its results, due to the limitation in installing it to an actual vehicle to test out its results. The fire suppression system is proposed based on an actual car measurement, such as passenger sedan vehicles, due to the limitation in access to other vehicles in the market. Another limitation is designing a prototype to a scale using temperature sensor buzzer and motor system to pump the liquid to the nozzles.

CHAPTER 02 – LITERATURE REVIEW

According to the research conducted, there are over 150,000 accidents annually related to car fire and at least 17 cars catch on fire, which kill at least 209 individuals injuring approximately 750 individuals every year alone in united states of America. There are many reasons which can possibly create a car fire. Such as; an error in design flaws which lead to Certain vehicles are more inclined to fire than others. In the event that the manufacturer does not get an issue, it could prompt a blast or fire. Manufacturer defects that may prompt fire which incorporate electrical issues, defective batteries or fuel tank leaks.

Car accidents are also another reason to cause fire. Car crash can result in flames. According to research from the NFPA demonstrates that while mishaps represented 4% of vehicle fires, they caused 60% of vehicle fire-related fatalities. Regardless of whether an accident will cause a fire relies upon what area of the vehicle is hit. For instance, if the gas tank is hit, it could cause a leak and followed by fire.

Another cause would be electrical issues in the system. The NFPA states that electrical and mechanical failures caused 66% of vehicles bursting into fire. This incorporates issues with; Batteries and Heating systems. Overheating engines leads on to the off chance that the engine gets excessively hot, it could result in fluids rising to hazardous temperatures and spilling out onto the engine or exhaust system. Overheated coolant or oils can rapidly ignite in these conditions.

According to the research conducted, type of vehicles to catch fire fast are mostly daily used passenger road vehicles such as SUVs, which is stated as 83%. Thus, 66% of fires occur in standard passenger vehicles such as regular cars.

Research also mentioned engine, fuel tank, running gear and wheel areas are one of the areas which is more prone to start or get caught in a fire. Second most fire prone areas are the operator and the passenger area of the vehicle.

2.1 FIRE EXTINGUISHING AGENTS

However, in terms of car type gas or fuel cars have a higher chance of catching fire than the hybrid or electric vehicles. According to the *The EV Safety Advatage* One of the *Clean Technicas* Reports mention that electric cars are the safest vehicle in terms of a fire compared to petrol or diesel cars.

When designing a vehicle fire suppression system, it is also necessary to give importance to the types of fire extinguishing agents that can be used to stop fire in a vehicle. These agents work in different way for instance when an application of a fire extinguishing agent, its separate heat and oxygen In area which has a fire. Fire extinguishing agents acts as an agent to remove elements which caused the fire during an incident. Most of the time these elements are known to be *The Triangle.* The fire triangle commonly consists of fuel, heat and oxygen. During an incident, when an agent is applied, the agent act as a component to cool-out the fuel to remove the heat and act as a brier between heat and oxygen to control the situation.

During this process, when the triangle is broken by the agent the fire stops. Most of the time these fire extinguishing agents has a long-lasting effect by reducing the chances for the fuel to act up. Commonly used fire extinguishing agents are; water, chemical foam, dry powder, Halon, or Carbon dioxide. However, due to the unfortunate situations some of above-mentioned fire extinguishing agents cannot act alone.

2.2 DRY CHEMICAL & WET CHEMICAL AGENTS

In the vehicle fire suppression systems, dry chemical also known as powder agent, is extensively been used. Dry chemical has the capability of knocking down a fire rapidly and one of the most effective agents in the fire suppression system. Dry Chemical contain of powder materials respectively constructed in a such way that it is known to be a water repellent with a capability of acting as a liquid due to expellant gas pressure.

Dry chemical is also known to be ABC Fire extinguisher, Multi-purpose fire extinguisher. Dry powder chemical can be used in fires such as;

- Fires which include flammable solids for an instance, paper, wood or textile. This is type of fire is also categorized into class A fire.
- Fire which include flammable liquids, petrol or diesel or paint which is categorized in to class B fire.
- Fires which include flammable gasses like Butane or methane is classified as class C fire
- Fire which is caused by electrical equipment up to 1000v

However, to comes with its own draw backs. Expertise mention that at times it has low post fire security reaction. According to research experts say that it has the possibility to reignite when powder settles. If a container is not sealed in proper manner, it'll infect the areas with moisture. Hence, it is mostly recommended to use Dry chemical and wet chemical together to control the situation. With the mix of wet chemical, it will make sure to cool down the affected areas and the dry chemical will make sure to put down the fire rapidly. Wet chemical act as a roadblock between oxygen and fuel to make sure that there is no re-ignition.

Dry Chemical agents come with different types. Such as;

- Mono Ammonium Phosphate, mostly used in class A, B and C fires
- Sodium Carbonate, mostly used in class B and C fires
- Potassium Bicarbonate, mostly used in class B and C fires

Wet chemical agent includes potassium acetate based, when discharged it spread as a mist which form a soapy like foam. The foam act to hold the heat and steam and block fire re-ignition.

2.3 TYPES OF NOZZLES

Nozzles which are been used in the fire suppression systems are mostly the ones that spray directly towards the fire in a hazarded situation. There are different types of Nozzles available in the market suitable for vehicle fire suppression system as mentioned below.

2.3.1 FULL CONE NOZZLE

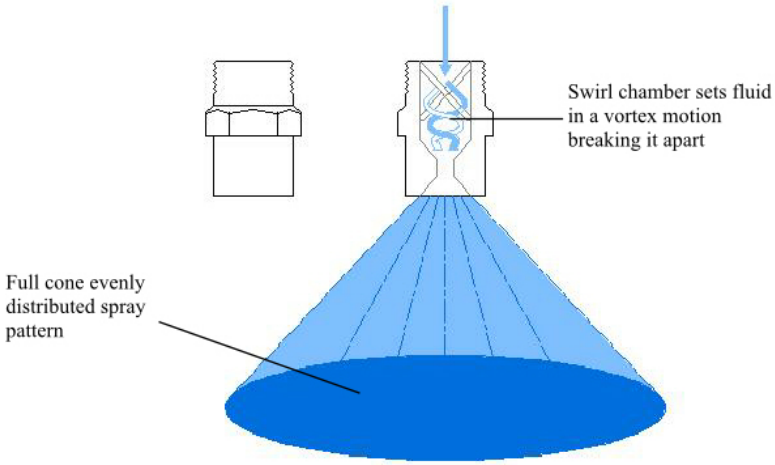

Figure: 1

2.3.2 HOLLOW CONE NOZZLE

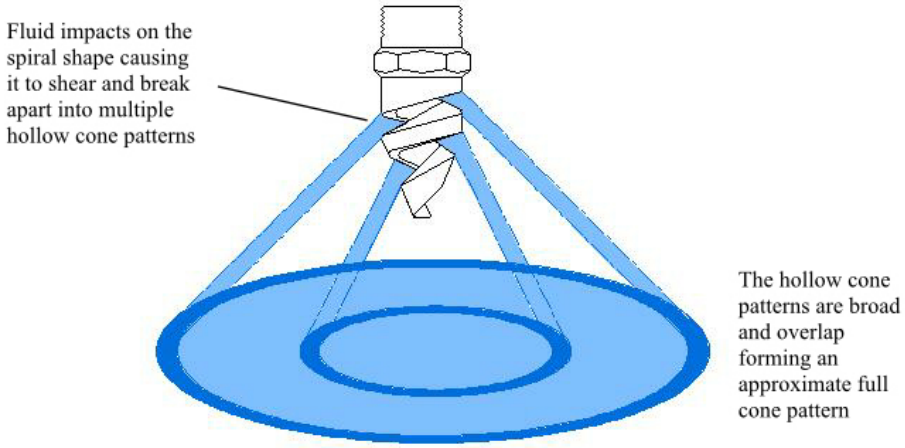

Figure: 2

2.3.3 FLAT SPRAY OR SOLID STREAM NOZZLE

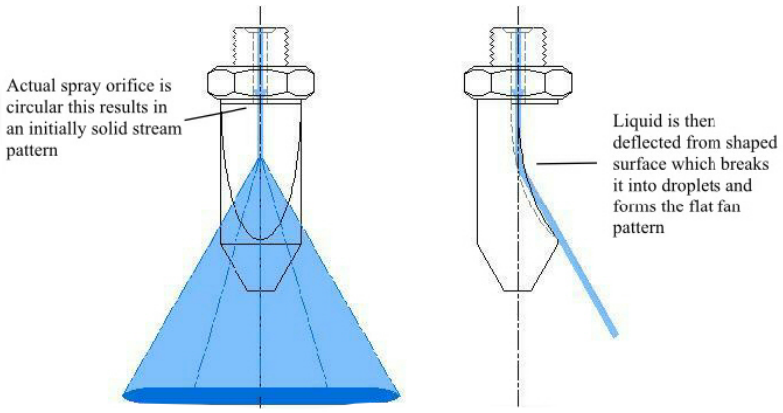

Figure: 3

This project is mainly focused on safety system and designing a fire suppression system to avoid damages to the vehicle and avoid injuries to passengers. This type of systems is already in use with vehicles and already there are existing fire suppression system technologies being used in this automobile engineering field. Few well-known companies use fire suppression system in high end or racing cars. By analyzing, will help towards finding the sub issues as indicated by the problem identification and help towards separating the sub issues with arrangements that as of now exist and the sub issues that should be comprehended. It doesn't always need to be an accident to catch a fire in vehicles.

Maintaining vehicle parts and wiring system. Due to some research, two third of vehicle fires are caused because of electrical system failing or malfunction. One major component is the battery.

Thus, it could be because of fuel tank and fuel lines.

2.4 EXISTING FIRE SUPPRESSION SYSTEMS

Few existing fire suppression systems which is being used in automotive industry are as follows;

2.4.1 FIRE SUPPRESSION SYSTEM IN FORD CARS

In 2005 ford introduced a fire suppression system to the Crown Victoria Police Interceptor. This was to reduce rear impact crashes. To reduce the spread of fire, this system deploys chemical agents. This system is manually operated where there is a deployment switch located near the front sun visor at the front.

Figure: 4

This system comprises of two hardened steel compartments that hold the fire suppressant materials and gas generators that pressurizes and send the fire suppressant. There are two complex assemblies, each furnished with two deployable nozzles, which splash the fire suppressant down onto the ground. Also, there is a manifold, mounted high with two settled nozzles, which splashes the fire suppressant material up and to the body of the car. An electronic control module (situated under the back seat) contains a back-accident sensor, which is the systems processed computer. The system actuates in a rapid, high-vitality raise affect impact.

Ford Motor Co. announced on the 7th of August back in 2003, a step to protect police officers. This was to be achieved by adding a fire suppression system to the Crown Victoria Police interceptors, a four-door body Sedan also known as CVP1. This was to be offered as a factory option in the Sedan. The initiative was in order to minimize risks for police officers in fire related scenarios due to high speed, high energy rear impact crashes. This was achieved by utilizing a chemical suppression agent that contributed in lessening the spread of fire.

The fire suppression system of the Crown Victoria Police interceptor contains two stainless steel containers that hold the material for the fire suppressant and gas generators that pressurize and deploy the fire suppressant. In addition to this, there are two manifold assemblies. Each one has two deployable nozzles equipped with it in order to spray the fire suppressant down onto the ground. Furthermore, there is a manifold with two fixed nozzles mounted high that spray the fire suppressant chemical up and into the body. The system's processing computer is located under the rear seat is an electronic control module that contains a rear crash sensor. During a high speed, high energy rear impact collision, the system gets activated. Incase, vehicle electrical power is lost there is a large electrical capacitor that provides back up power.

Identifying this fire suppressant automobile model by Ford is easy. The suppression system logo on the rear windows or the manual activation switch between the sun visors is the indication. This allows the system to be used even though other fire conditions exist.

2.4.2 FIRE SUPPRESSION SYSTEM USED IN AUDI VEHICLES

It would show up the tad of "steam" hasn't prevented the German automaker from attempting to take the engine R8 pull out onto the Nuburgring as these shots taken by the WorldCar-Finns sees this end of the week would appear to affirm. As indicated by the Finnish fish-slappers, test pilots never again have anything to fear from the fire.

With the model expense evaluated at half million Euros, Audi's sports division, quattro GmbH, has now introduced an electronic fire suppression system as demonstrated by the white "E" which is a foam-based extinguisher with a sticker and two red buttons seen by the driver's side rear view mirror. If there should be an occurrence of a fire, the primary response is for the driver to escape the vehicle and if chance is insignificant, the fire suppression system can be activated from the outside of the vehicle by pressing the two red buttons

2.4.3 AMEREX FIRE SUPPRESSION SYSTEM

Amerex is one of the world's driving makers of firefighting hardware, and perceived inside the business for the excellent designing, assembling and nature of all the gear we make and introduce. Amerex can shield your gear from fire with an Industrial Factory mutual global Research center FM5320 affirmed fire suppression system exclusively.

Amerex FM5320 endorsed Vehicle Fire Suppression Systems are structured in light of the hardest workplaces including; mining, aggregates, waste management, mass transit, forestry and ports. The automatic systems suppress the fire in beginning, before it turns out to be completely settled and spreads into very combustible zones. Accordingly, harm is restricted and hardware down time is held to a base. Amerex system designed in a such way that the system warn the operator and it allow to suppress the fire while protecting the vehicle and passengers.

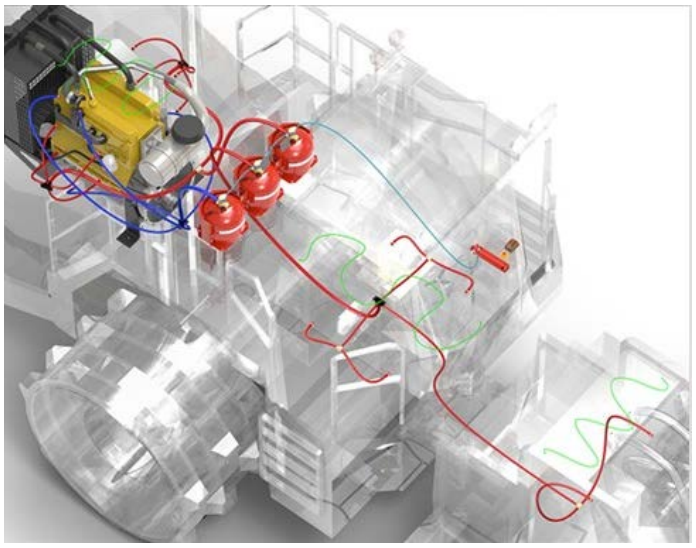

Figure: 5

CHAPTER 03 – METHODOLOGY

In a fire suppression system, key components are known as fire extinguishing agents and the fire detectors. However, the control module carries a bigger weight in the fire suppression system as it controls and dictate the system while it counterattacks the fire. Initially control module gather or receive information via the sensors and detectors in the system. Following, its decision-making process happens whether there is a fire. According to the statistics, control module command or provide necessary measures to protect vehicle from catching fire.

In a manual system fire suppression only provide the fire warning to the system which require the driver to stop the vehicle, engine shutdown and manually operate the fire suppression system followed with an evacuation. However, in the electric system it is far more complex than the manual system. It allows to electronically detect and monitor actuation, power, release and communication circuits along with the interface signal measures like either engine or fuel shutdown. It also isolates the main battery while stopping the engine fan while activating high decibel alarm leading to releasing a fire suppression agent.

Detection time is another critical factor in a fire suppression system. In all vehicle's engine fan is the component which is sued to cool air around the engine. To accomplish optimum coverage using suppression agent the fan has to be stopped before the discharge. According to a speed of rpm, for the fan to be stopped it takes at least of 10 seconds. The full detection of fire and deployment of fire suppression agent depend on the vehicle and the quality of the system. According to the source ***Ardent vehicle Fire Protection*** [3] predicted timings are as follows;

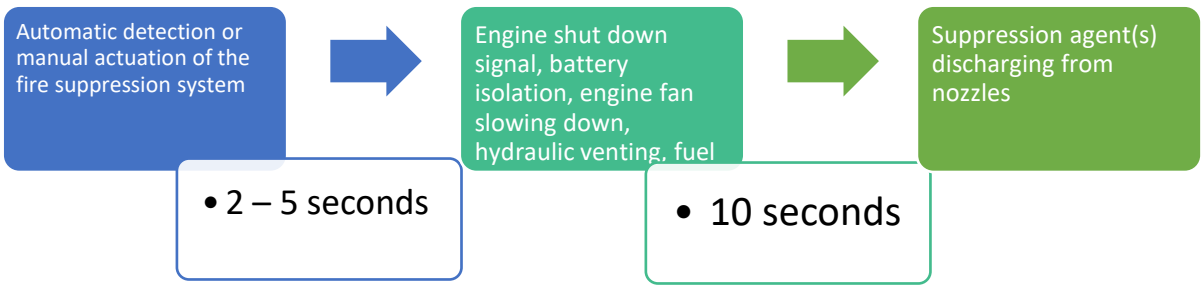

Figure: 6

Below mentioned are the three designs I have created for the proposed fire suppression system. These methods are one of the affordable ways of implementing a fire suppression system to any vehicle in the market. Based on the efficiency and the cost I will be choosing the optimum method to develop through the project completion.

3.1 FIRST CONCEPTUAL DESIGN: MANUAL PROCESS

A fire begins in the secured territory. Equipped operator ought to convey gear or the equipment to a total stop, set the brake, and switch off the engine

Passenger or the driver pulls the ring pin and strikes the plunger on the manual actuators. The weight from the actuator caused the fire suppression system to actuate.

Gas pressure the dry chemical extinguishing agent and impels it through distribution horse

Through the implanted nozzles, dry chemical extinguisher agent will be discharged or sprayed to the affected areas to suppress the fire.

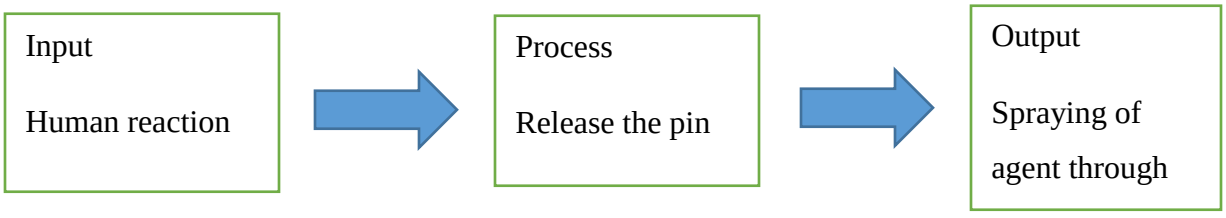

Figure: 7

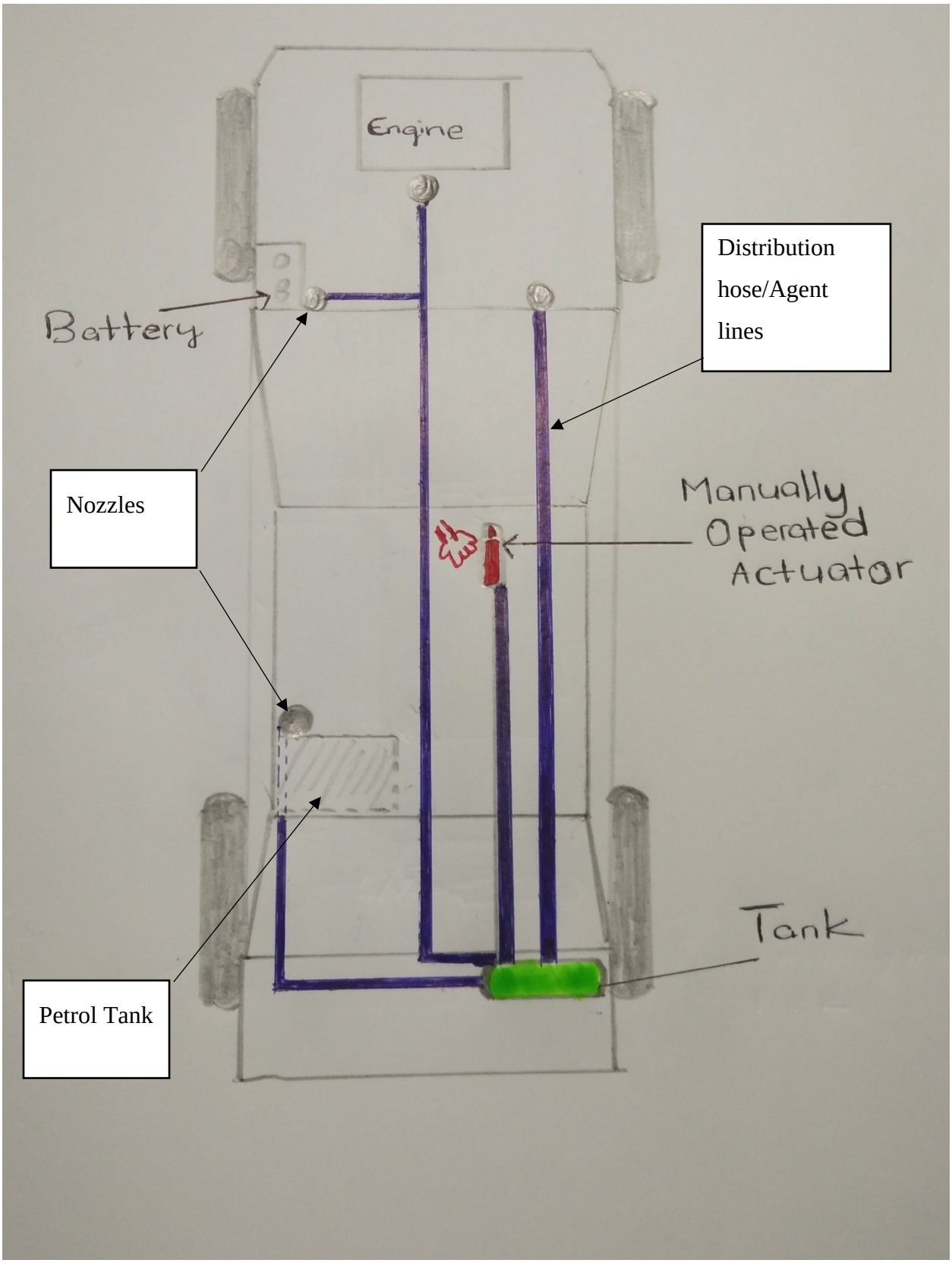
Engine
Battery
Distribution hose/Agent lines
Nozzles
Manually Operated Actuator
Tank
Petrol Tank

Figure: 8

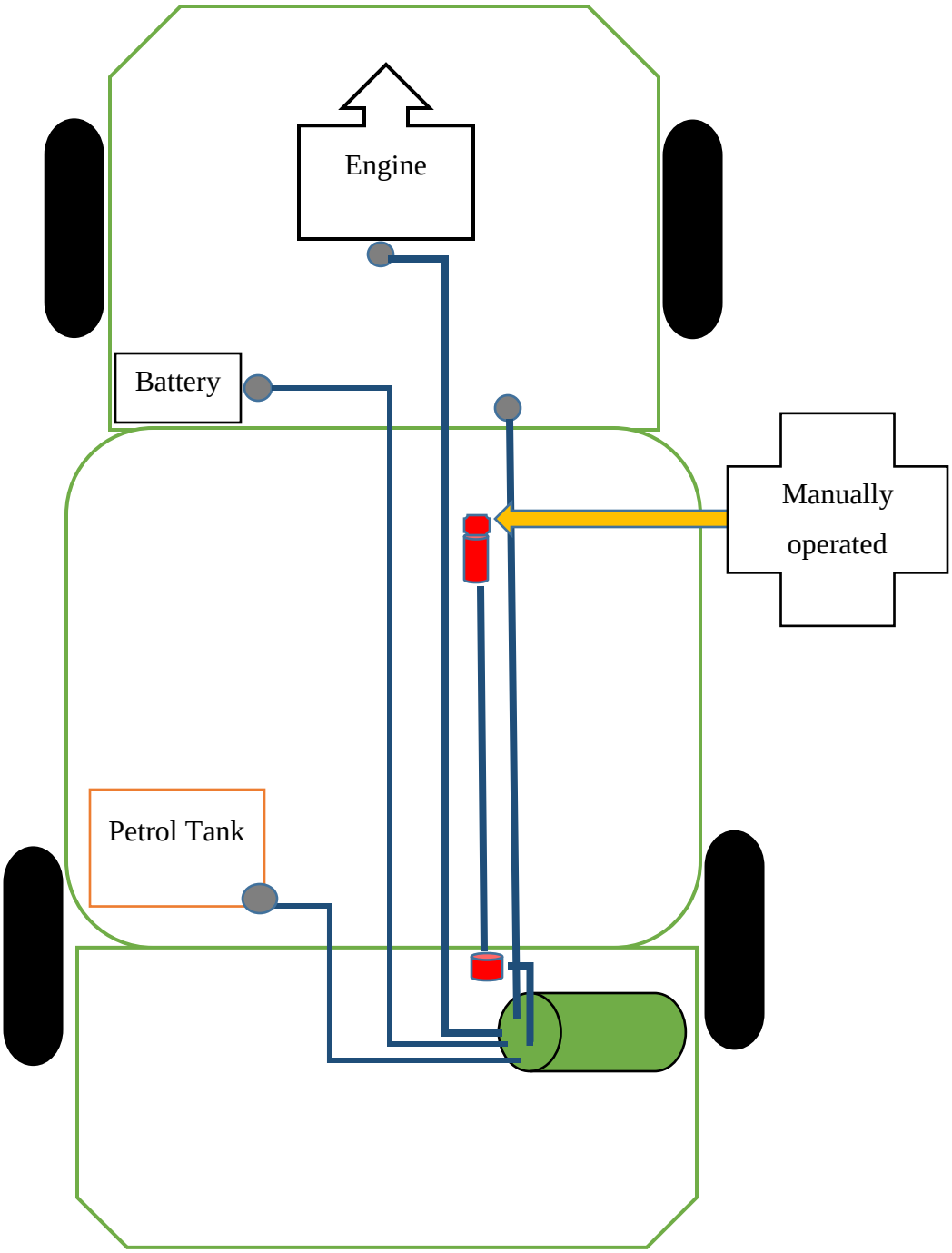

Figure: 9

3.2 SECOND CONCEPTUAL DESIGN: ELECTRONIC PROCESS

A fire begins in the secured area. Equipped operator ought to convey gear or the equipment to a total stop, set the brake, and switch off the engine

In this step, flame detectors/heat sensors send signals to the system control module to indicate that a fire has been started in the affected area

From there, the control module activates the fire suppression system while the module also time delay in shutting down the functions in the vehicle and activate the auxiliary vehicle elements accordingly along with the installation. After the installation, gas pressure the dry chemical extinguishing agent and impels it through distribution horse. After, through the implanted nozzles, amber liquid chemical extinguisher agent will be discharged or sprayed to the affected areas to suppress the fire.

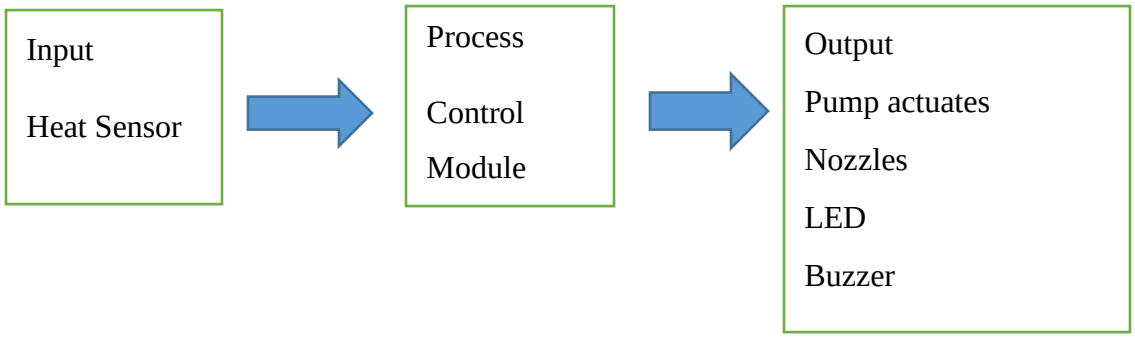

Figure: 10

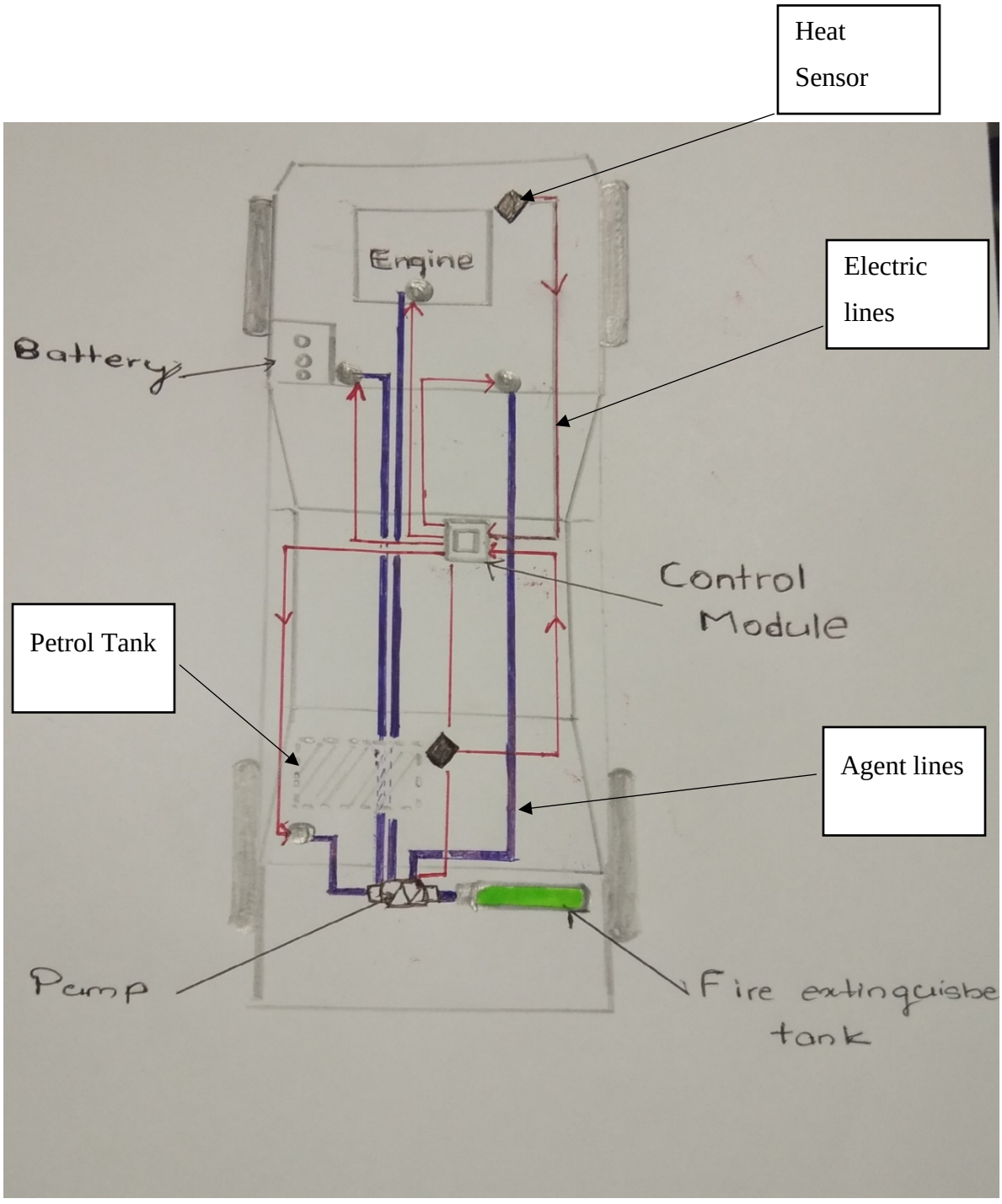
Heat Sensor
Engine
Electric lines
Battery
Control Module
Petrol Tank
Agent lines
Pump
Fire extinguisher tank

Figure: 11

3.3 THIRD CONCEPTUAL DESIGN

In the event of major front accident or an impact, the system safeguards the resulting refrigerant-air mixture in the engine compartment is separated from hot engine components which includes latter are also cooled. This is made possible using a gas generator filled with argon. By inserting argon gas parallel to hot areas will result in displacement of oxygen, possible ignition of the refrigerant can be prevented.

In the below displayed diagram numbers represent below components;

1. Gas lance with fan nozzle
2. Gas line
3. Argon gas generator
4. Electric line
5. Airbag control unit

During a hazard situation, crash bar sensors transfer signals to SRS Control unit in the vehicle thus, in this system there is another control unit built inside to activate the fire suppression system when needed. During a fire, SRS control unit send signals to the argon gas generator via the electric line. System is made in a such way that it can collect data related to any situation based on the damage and make a rapid decision to prevent any further damages to the vehicle such as fire. As the last step argon gas is released to exhaust manifold and the catalytic converter through the gas lance with fan nozzle.

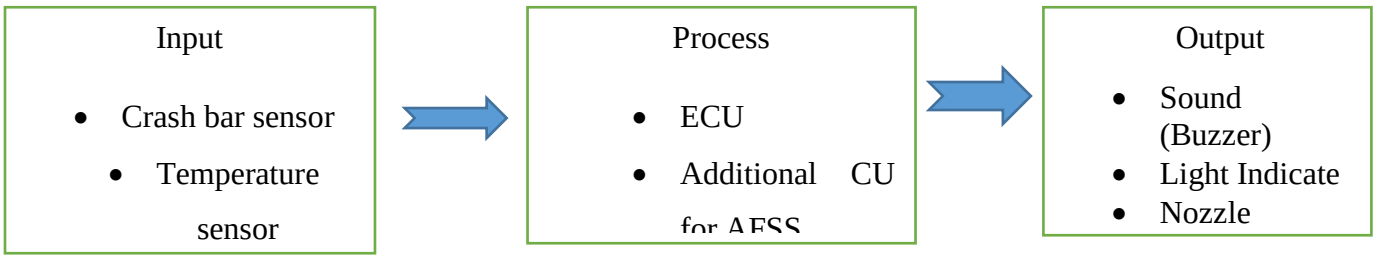

Figure: 12

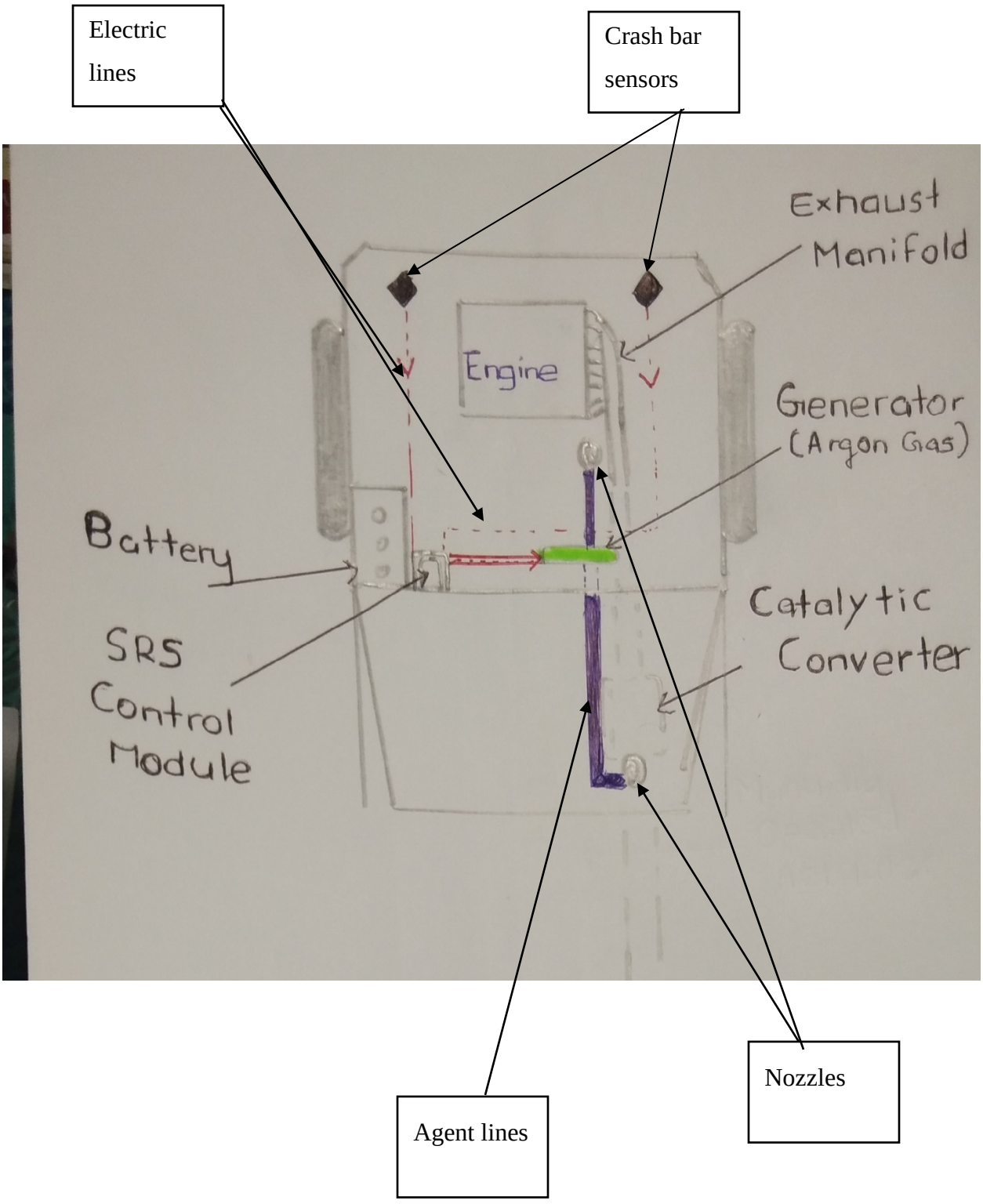
Electric lines
Crash bar sensors
Exhaust Manifold
Engine
Generator (Argon Gas)
Battery
SRS Control Module
Catalytic Converter
Nozzles
Agent lines

Figure: 13

3.4 DESIGN SELECTION USING WEIGHTED OBJECTIVE METHOD

By using few criteria to compare these three designs and few criteria selected is

- Cost
- Response time
- Efficiency
- Effectiveness of the extinguisher agent
- Tank capacity

Objectives of this criteria is considered as;

1. Cost – the cost required to manufacture this kit and store it in the vehicle
2. Response time – the time taken by the system and the nozzle to response to situation and shut the fire
3. Efficiency – number of valves used, area the nozzle covers by spraying
4. Effectiveness of the agent- How good the chemical is capability of re ignition harmful
5. Tank capacity – selecting a size of the tank for storage of the agent

Weighted Score =score ×comparison criteria weight

Design 01

Score	Weighted score
2	30
2	30
3	15
1	10
2	10
Total	95

Figure:15

Design 02

Score	Weighted score
3	45
2	30
3	15
2	20
4	20
Total	130

Figure: 16

Design 03

Score	Weighted Score
1	15
4	60
3	15
3	30
1	5
Total	125

Figure: 17

3.5 OPTIMUM DESIGN SELECTION FOR ACTIVE FIRE SUPPRESSION SYSTEM

First design is the most affordable solution for the fire suppression system however, it's a manually operated system which will not deliver results as expected. Thus, third design is shown its capability to be outstanding however, it's too costly to develop and maintain due its components which are been used. One of the expensive components are the argon gas which is been used. Secondly, the generator which is been used. Therefore, considering all the above, second design is chosen as the optimum design, due to efficiency, affordability, and less complexity. When selecting the suitable design, weighted objective method is taken into a consideration. At is showcase in *figure: 15* Weighted Score =score ×comparison criteria weight.

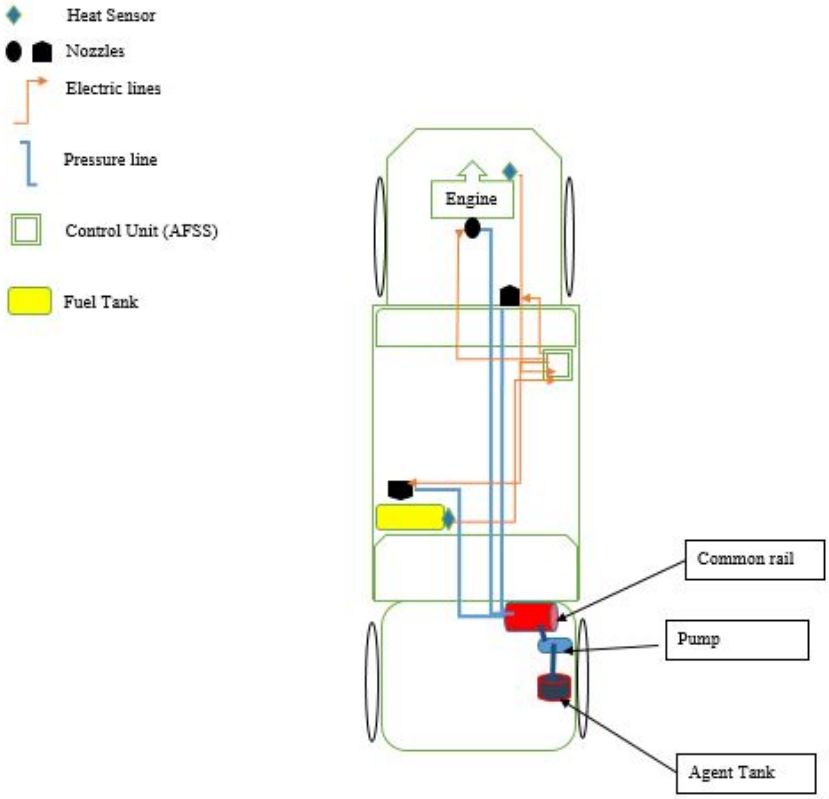

Figure: 18

3.6 FLOW CHART

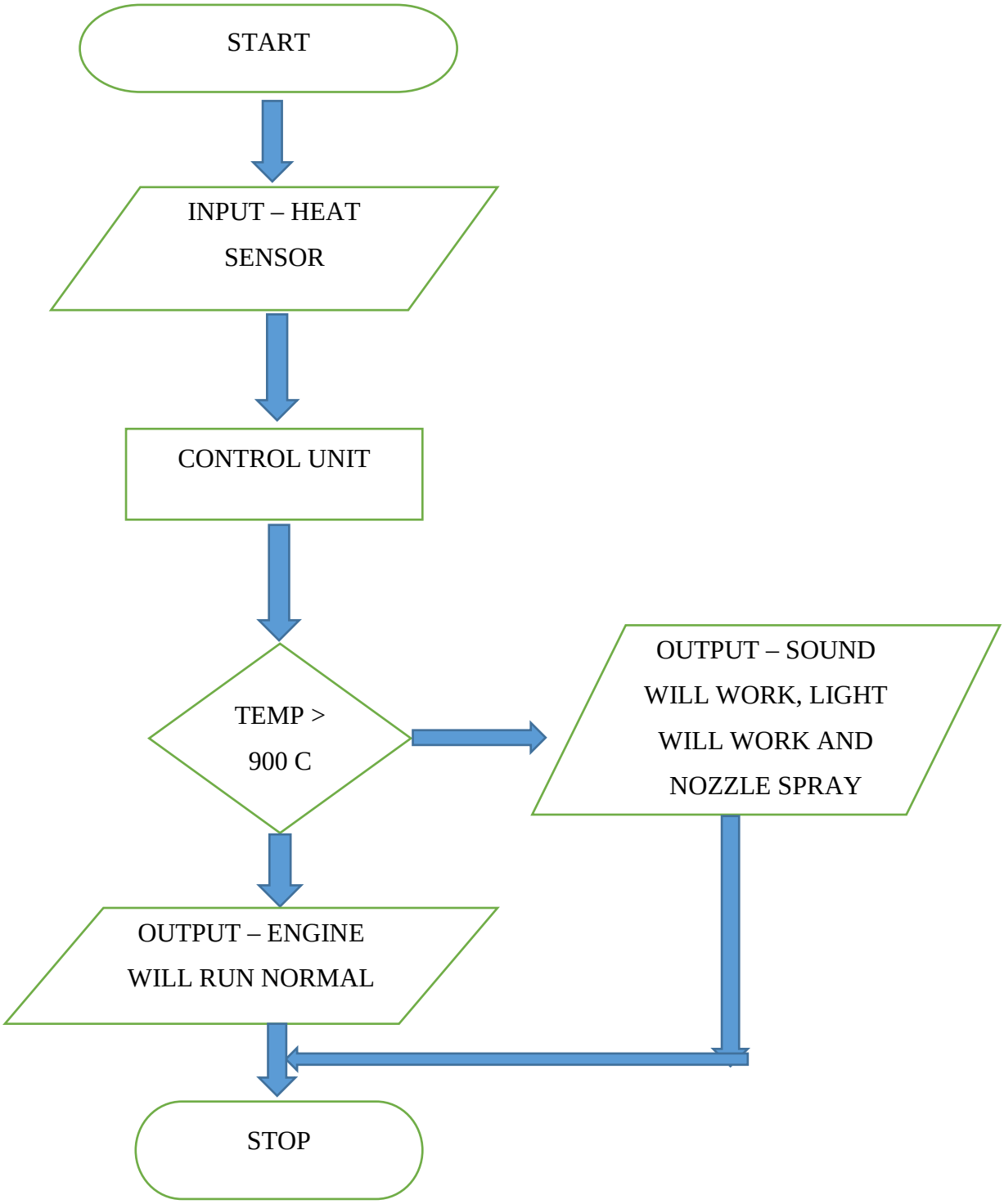

Figure: 19

CHAPTER 04 - DESIGN AND IMPLEMENTATION

Below design illustrate the positioning of the fire extinguisher agent. For the protection and the convenience, it will be placed at the boot of the vehicle. To ensure the fire suppression system can deliver expected efficiency, extinguisher agent is placed on side while placing it upright.

There onwards, fire extinguisher lines are being measured and fitted as required to the body of the vehicle and the end is fixed to the nozzles. Nozzles are being placed strategically to cover areas which more prone to catching a fire. Another end of the fire extinguisher agent line is fixed to the injector in 3ft, 6ft and 9ft in lengths.

Nozzles are full cone style which spray as a vortex covering the full area. Nozzles are mounted by a metal nut to the vehicle body. When setting up the lines and nozzles its necessary to make sure the its proper and not crushed as the system is activating as a circuit.

When a collision takes place or due to other un expectable reasons if the vehicles catches a fire, according to the given readings to the temperature sensors, if the smoke or fire exceeds that limit the heating sensors will read and sends a signal via an electric line which is given to Active fire suppression system control module, and the control module send out a signal to the injectors/nozzles to activate and spray the agent to the areas where fire is taking place or where the nozzles are located and also the CU will be sending another signal to the motor pump to make sure it stays pressurized which agent is supplied to the pump by fire extinguisher gas tank.

4.1 MAIN COMPONENTS IN THIS SYSTEM

4.1.1 HEAT DETECTING SENSOR

Heat detecting sensors are generally utilized in vehicle fire suppression systems. There are few types of heat detectors used in these systems depending on vehicle specifications most suited detectors are selected. Few types of heat detectors are as follows;

- Point/spot heat detector,
- Linear heat detector,
- Linear pressure heat detector (detects loss in pressure)
- Pneumatic heat detector (rise in pressure).

For the selected design linear heat detectors will be used as this is a simple system which can fitted into any vehicle The most widely recognized sort of linear detector utilized in vehicle fire suppression is a linear detecting cable that utilizes two spring steel conductors, isolated by a heat sensitive separator/insulator. At a foreordained temperature, the protection dissolves. This enables the conductors to come into contact, bringing about an adjustment in flag handed-off back to the control module. To defeat the issues of various temperature detecting prerequisites, spot heat identifiers or thermal switches can be put in territories requiring explicit point location. These would then be able to be interlinked with linear detection cables.

Electronically observed frameworks that utilizes linear heat detecting cables essentially diminish the opportunity of false release in examination with pneumatic loss of weight/pressure frameworks, as they can separate the electric signal coming about because of an expansion in temperature shape the one brought about by harm to the link. They additionally impart any harm to the framework, giving expanded unwavering quality.

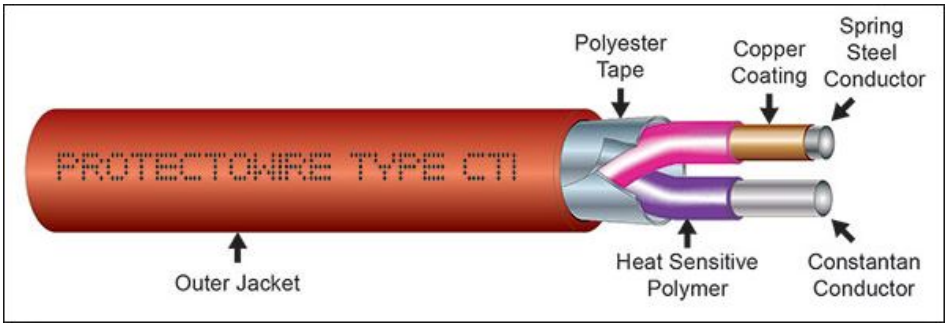

Figure: 20

4.1.2 CONTROL MODULE

The control module is known as the model CV-01, which include an independent display panel which is fixed to the dashboard in the vehicle. Control unit is stored in a different closed area with an individual connection box where the other materials are connected to. The design of the control unit is an adjustable solution that can cater in delivering a much secured and stable solution architecture. The control unit consist of buzzer and a pushbutton. Panel showcase the current status and allow the driver to monitor.

4.1.3 NOZZLE

The nozzle which is been used in the system is a direct spray into the affected areas which provide the cooling effect to the area via the fire suppression system. Nozzle include a secured cap to protect the nozzle from dust entering to the system. During the installation, nozzle is directly fixed to the pipeline.

4.1.4 CALCULATION

In order to find the pressure within the container, velocity at nozzle, flow rate at nozzle, container volume to sort the size of the tank to store, number of nozzles (injectors) are considered in the calculation. Calculation is done based on the source in references [22].

Pressure inside the tank

175 -250 pounds per square inch

$200 \text{ pounds per square inch } = 1378.95 \text{ kpa}$

$$P = P_1 + {}^{1}/_{2}\,\rho v^2$$

$$1378.95 = 101.325 + {}^{1}/_{2} * 1072.44 * v^2$$

$$\frac{(P - P_1) * 2}{\rho} = v^2$$

$$\frac{(1378.95 - 101.325) * 2}{1072.44} = v^2$$

$$v = 1.5435\ ms^{-1}$$

Assuming nozzle area 2 cm^2, flow rate

$$2 * 10^{-4} * 1.54\ m^3 s^{-1} = 3.08 * 10^{-4} m^3 s^{-1}$$

It discharges at 15 secs on contain.

$$flowrate * discharge\ time = volume$$

$0.000308 * 15 = 0.00462\ m^3$

When testing in a real vehicle, will be applying 4 nozzles in the vehicle system.

$4 * 0.00462 = 0.01848\ m^3$

18.48 $liters$ (a suitable tank which can contain 18 liters of the agent)

CHAPTER 05 - TESTING AND SIMULATION ANALYSIS

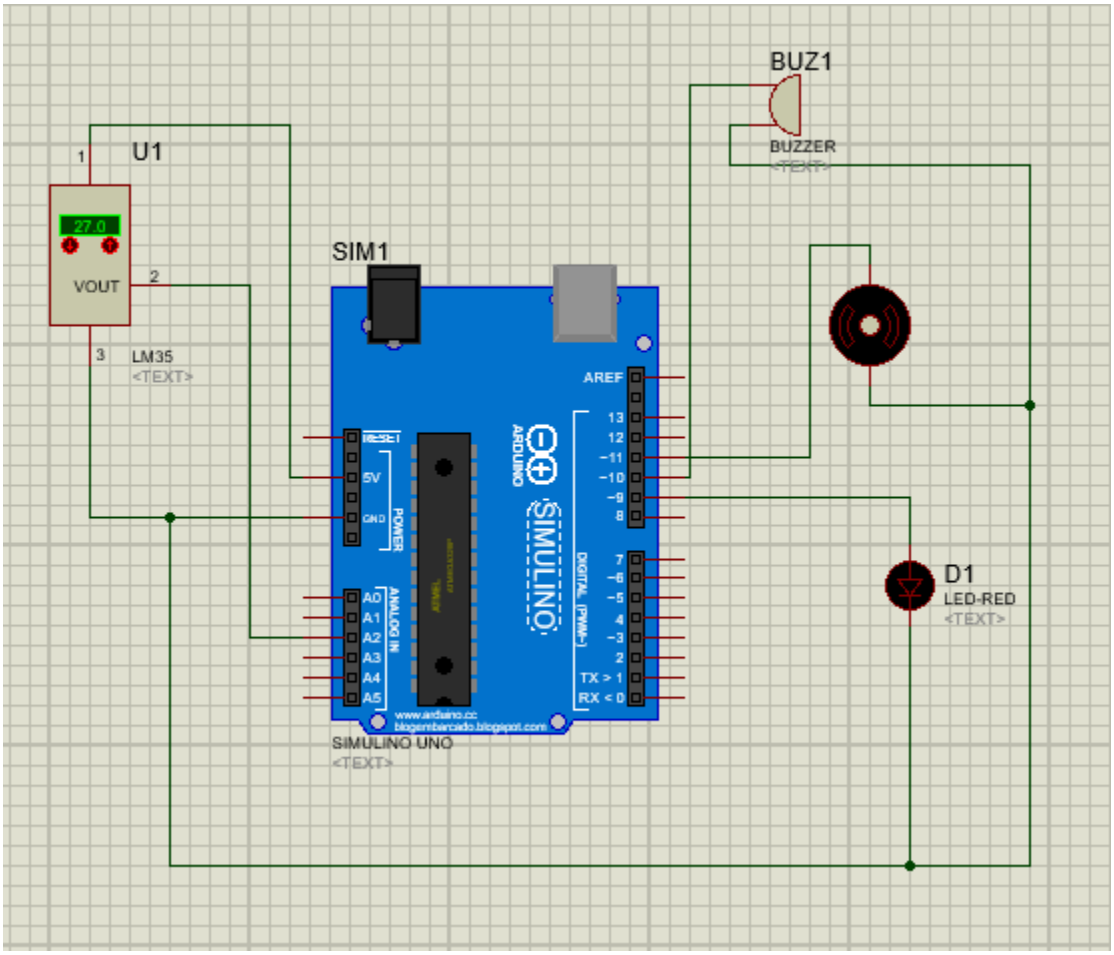

Figure: 21

A circuit diagram of the input and output of this device is shown from the above figure.

Assumption; the measurement of this prototype is in a scale of 1: 6 Celsius.

5.1 Implementing the functions of prototype with real world automotive

Prototype - Consist of LED lights which is shown in the prototype as a warning indication

Real Automobile - Will indicate on the instrument cluster

Prototype - Buzzer will produce a sound

Real Automobile - A buzzer will be fixed at the back of the drive mirror and it will buzz when the system activates

Prototype - Motor connected to tubes which the agent will flow towards the nozzles

Real Automobile - The motor pump will compress the liquid send through agent hoses to the nozzle

5.2 Function of the prototype with temperature

Prototype - System activates at 150 Celsius

Real Automobile – System will activate around 850 Celsius

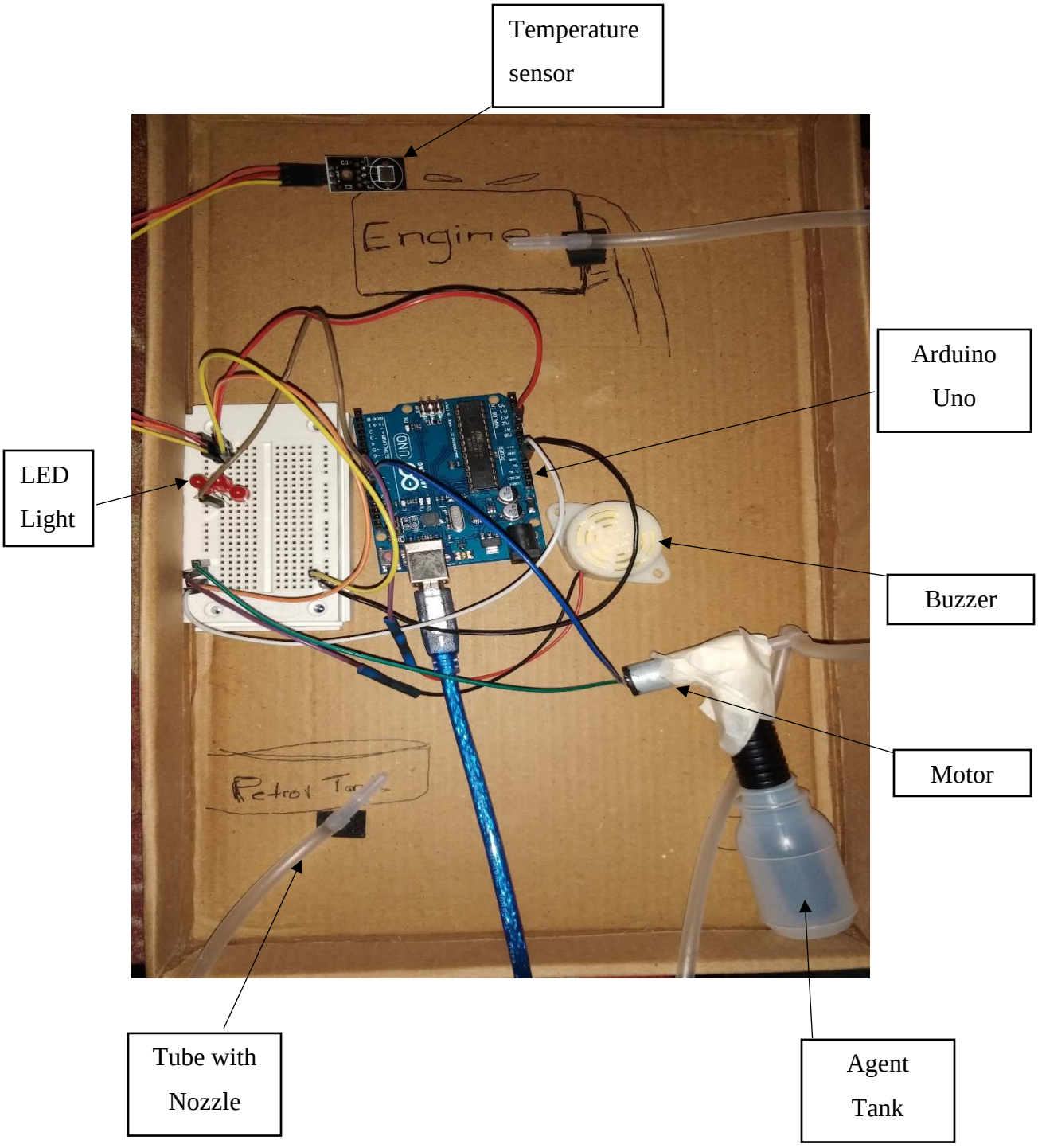
Temperature sensor
Engine
Arduino Uno
LED Light
Buzzer
Motor
Tube with Nozzle
Agent Tank

Figure: 22

5.3Testing result of temperature Sensor in Prototype

In the prototype the temperature sensor’s maximum value is 150 Celsius and once it reaches the limited value, it will send a signal through an electric wire to the processor (Arduino board).

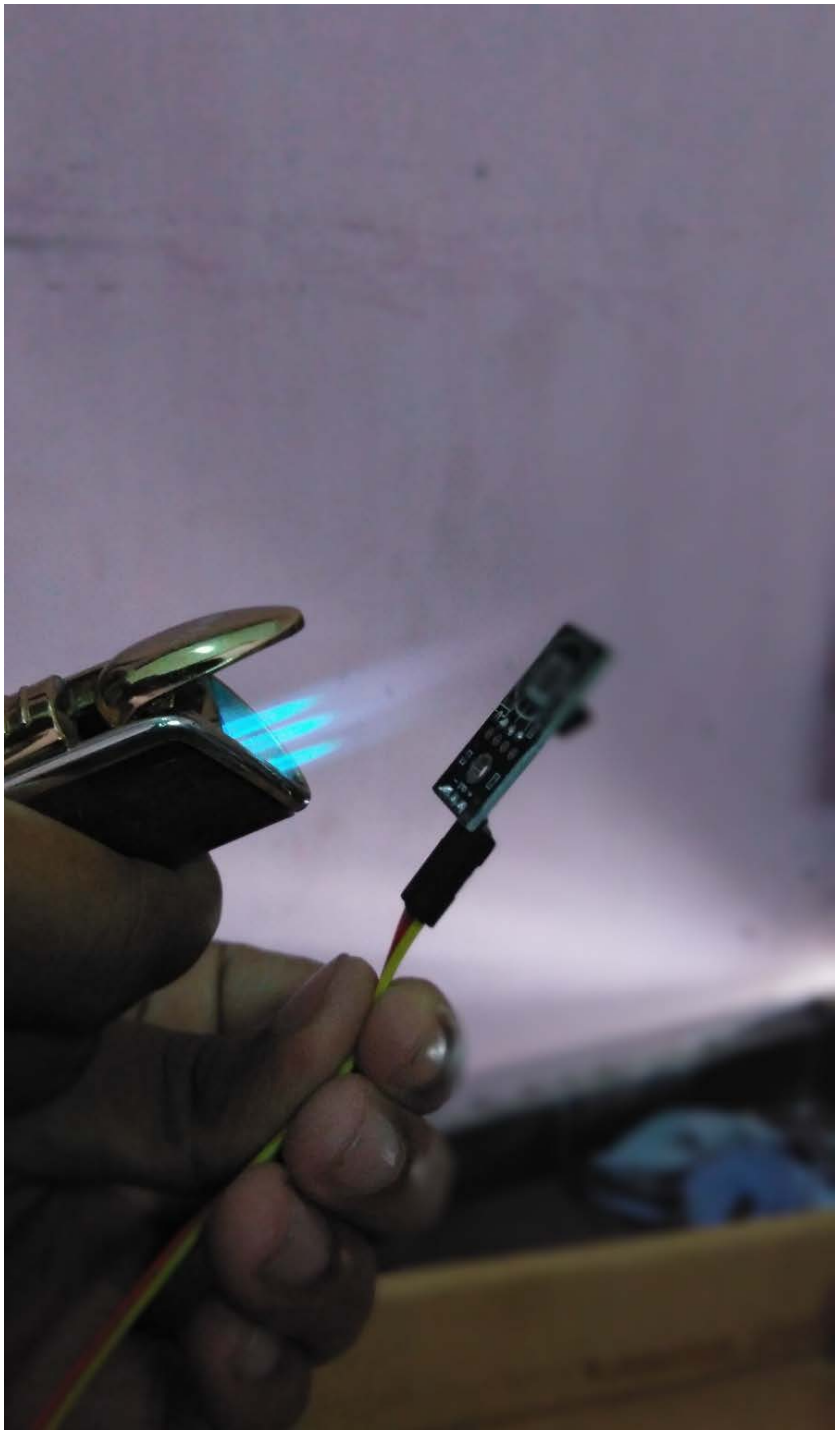

Figure: 23

5.4 Testing of the motor

When the temperature sensor sends the data to the processor (Arduino board), it will send a signal through an electric line and activate the motor pumping the agent from the tank sending to the nozzles via tubes.

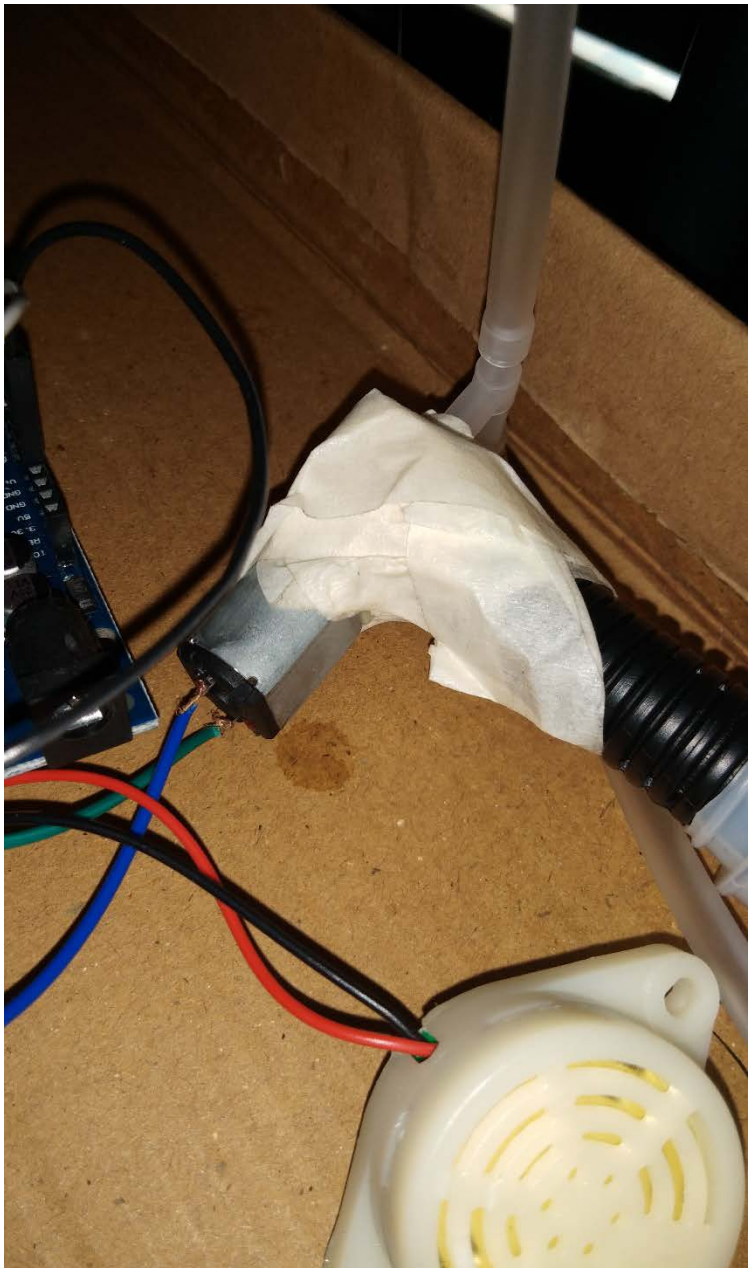

Figure: 24

5.5 Testing the LED lights

After the detection of the heat from the temperature, sensor and processor receive signals. Via the system the signals later will indicate warning by the LED bulbs.

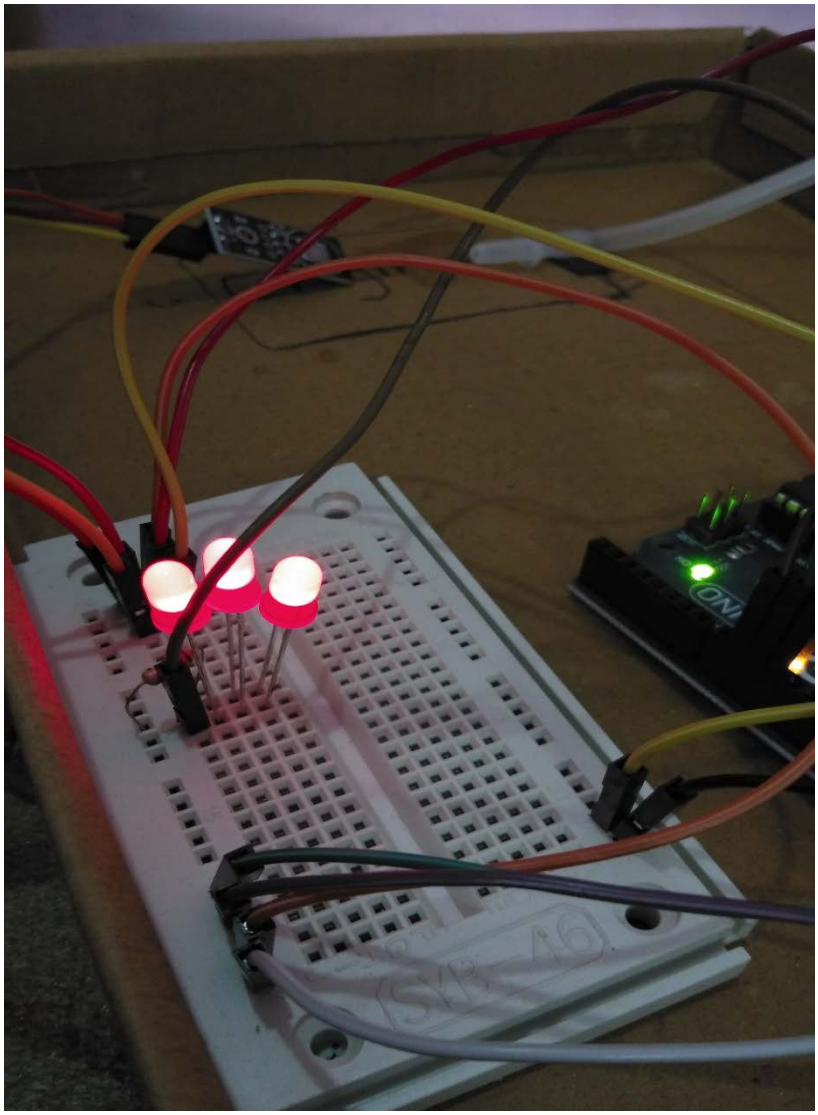

Figure: 25

5.6 Testing of Buzzer

After sending signals through the processor the buzzer will be receiving a signal to produce a sound.

Figure: 26

CHAPTER 06 - CONCLUSION AND FURTHER DEVELOPMENT

6.1 CONCLUSION

In Conclusion, active fire suppression system is identified as one of the major components which any vehicle should have installed. However, majority of the vehicles do not have a active fire suppression system. Available technologies are developed for heavy or racing cars in the market which is knows to be expensive. In the journey of creating an active fire suppression system, its necessity was proven through the conducted research. Currently many automobile manufacturers such as Audi is investing half a million US dollars to build active fire suppression systems for the supper cars thus, it is still concluded as an expensive system to be fixed in a general passenger vehicle.

Main objective of this project is to create an affordable active fire suppression system which can be installed to any passenger vehicle such sedans. In order to do so, a prototype was created to shows case functionalities of the system using materials such as; LM35 Heat sensor, Arduino Uno board, buzzer, LED bulbs, motor etc.

6.2 FURTHER DEVELOPMENT

Active fire suppression system is identified as a crucial function in the automobile industry. Based on the number of fire explosions in vehicles compels the automobile manufacturers to start investing in such technologies. For an instance, one of the most famous accidents was Hollywood actor Paul Walker’s fire accident which brought him an unfortunate death.

During further developments of this project, the system will be tested on an actual passenger vehicle to further develop the system. With the evolution of technology, this system will also be developed to a mobile app with further advancements. Current system does not guard the entire vehicle however, during the further developments, the system will be expanded to cover all the fire prone areas in a vehicle.

Current system only includes one type fire extinguishing agent however, with the development covering all the areas, different fire extinguishers will be used for the suitable situation with

multiple tanks. Fire detection system is to be improved in to a various area which will lead the system to be a fully fledge active fire suppression system at a affordable price range.

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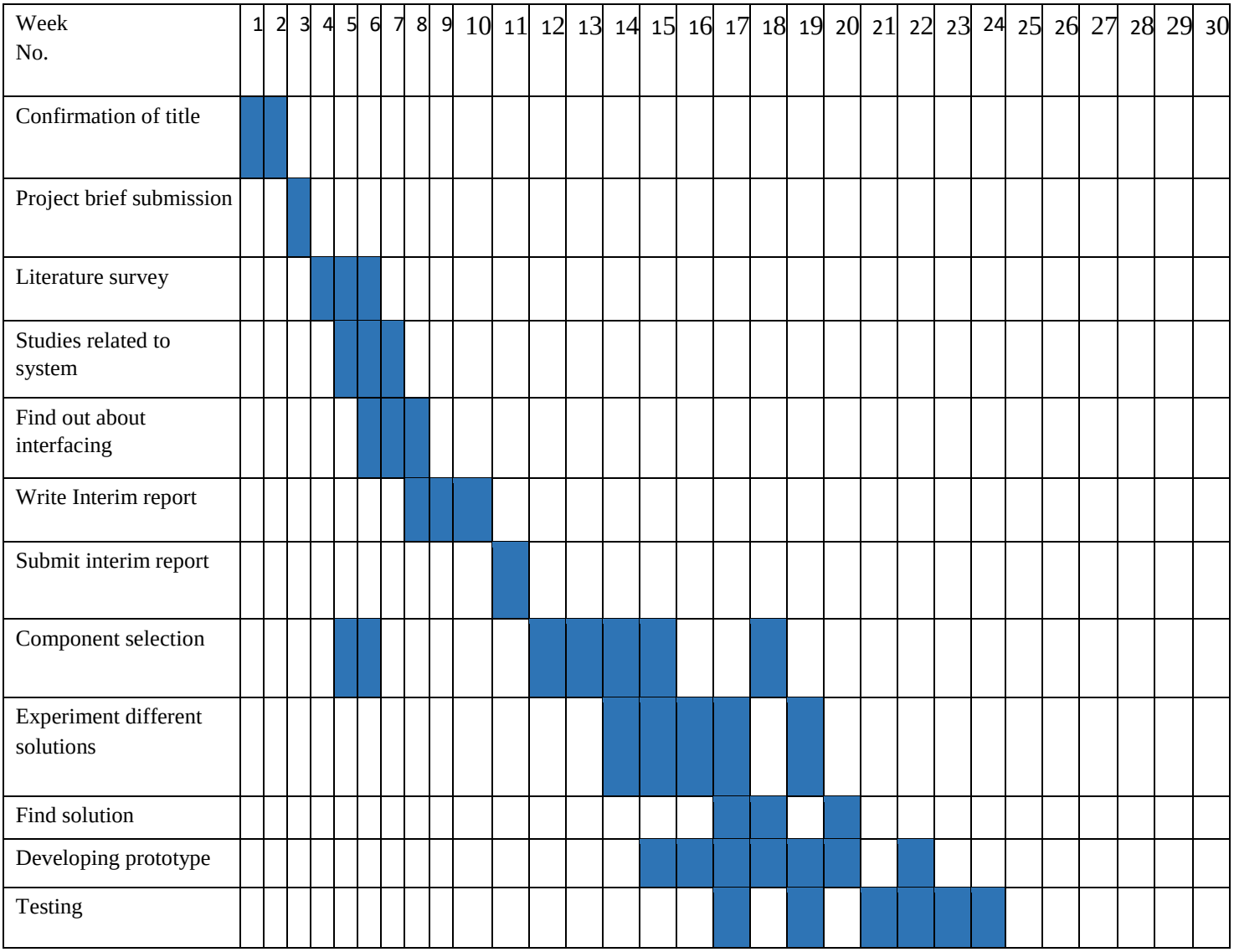
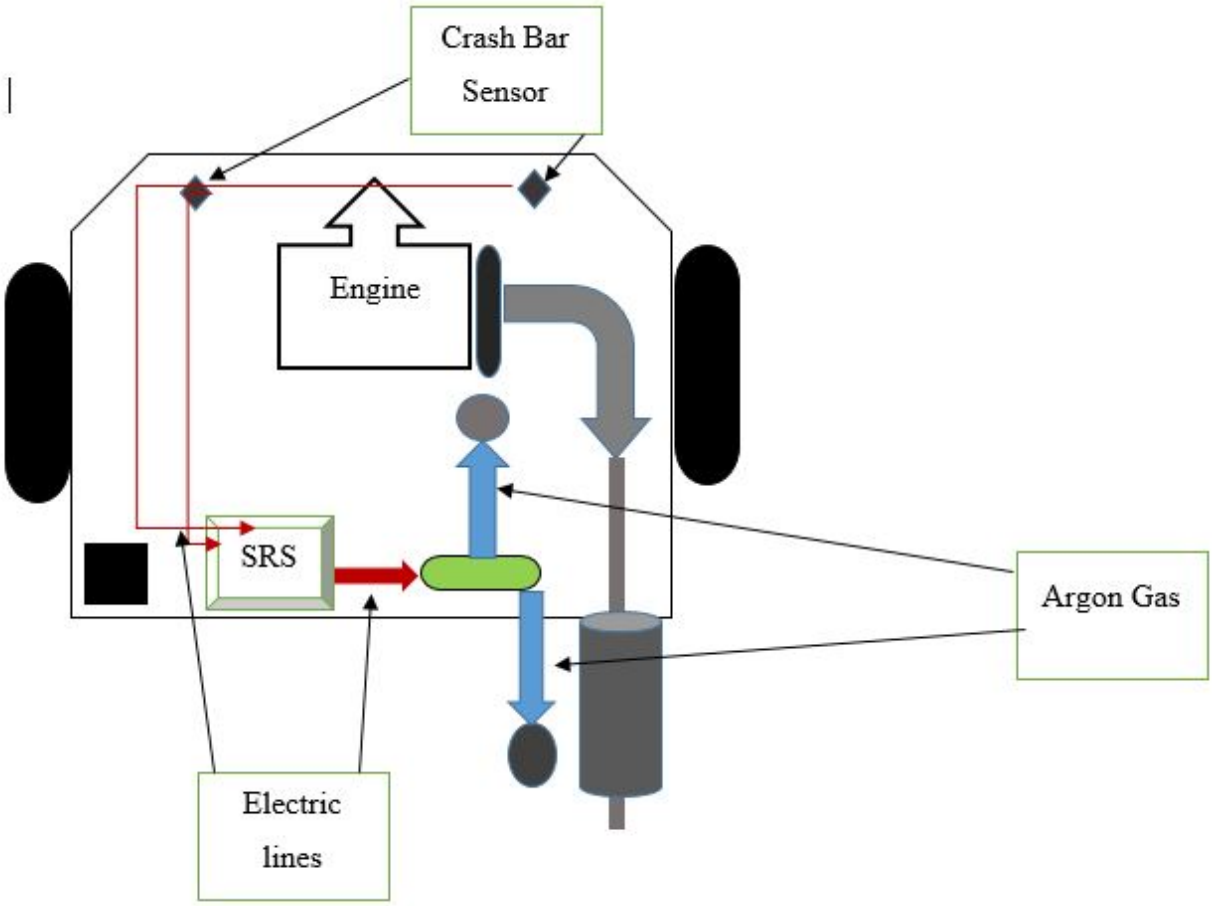
APPENDIX

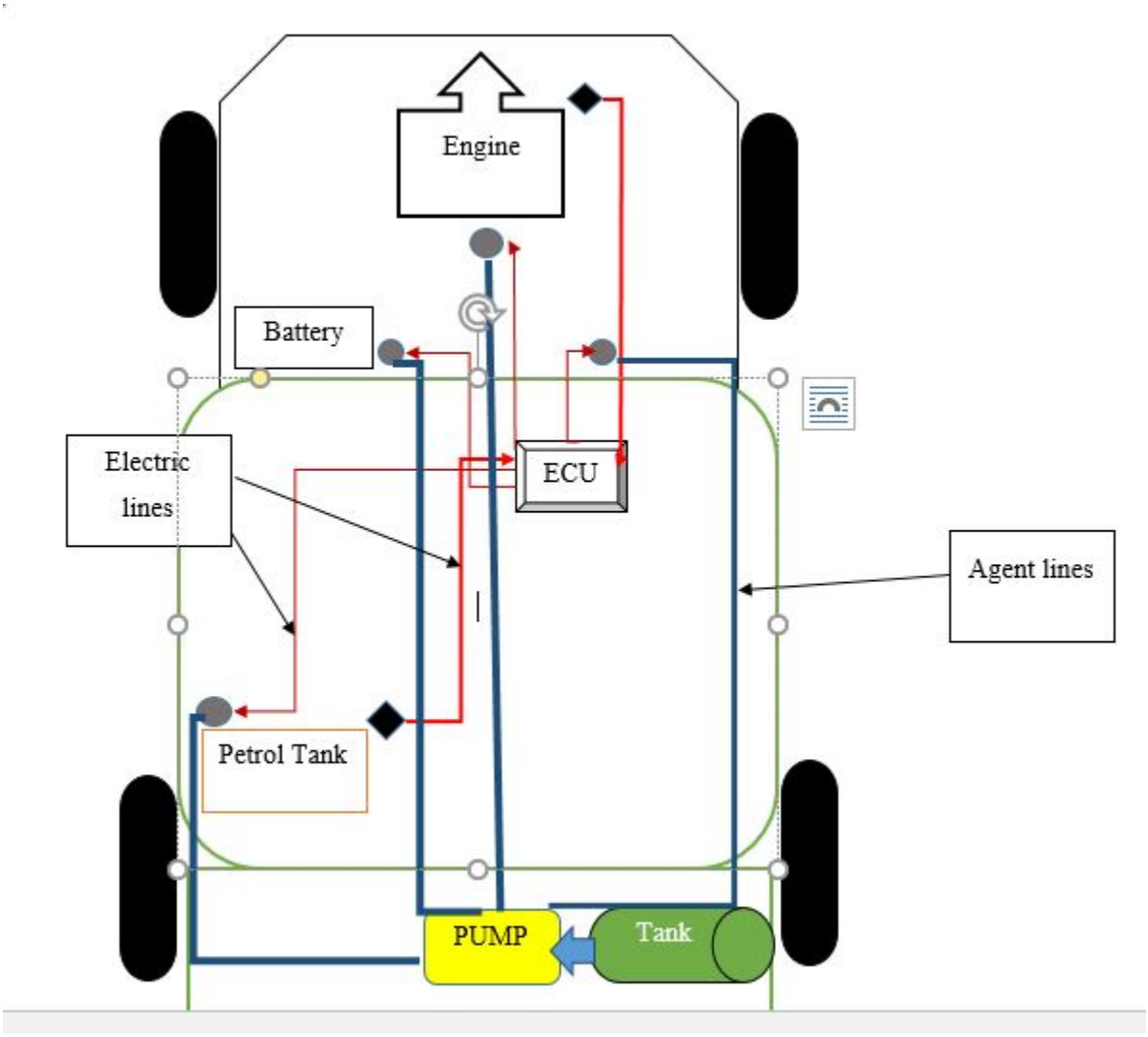
APPENDIX 1



APPENDIX 2



APPENDIX 3


Engine
Battery
Electric lines
ECU
Agent lines
Petrol Tank
PUMP
Tank

APPENDIX 4

```
const int hot = 120; //set hot parameter

void setup() {
  pinMode(A1, INPUT); //sensor
  pinMode(11, OUTPUT); //motor
  pinMode(10, OUTPUT); //led
  pinMode(9, OUTPUT); //buzzer
  Serial.begin(9600);
}
void loop() {
  int sensor = analogRead(A1);
  float voltage = (sensor / 1024.0) * 5000;
  float mv = (voltage)/10;
  float tempF = (mv * 9)/5 + 32;
  Serial.print("temp: ");
  Serial.print(tempF);

  if (tempF >= hot) { //hot
    digitalWrite(11, HIGH);
    digitalWrite(10, HIGH);
    digitalWrite(9, HIGH);
    Serial.println(" It's Hot.");
  }
  delay(500);
}
```