الجامعة العربية الأمريكية
ARAB AMERICAN UNIVERSITY

Arab American University
Faculty of Engineering and Information Technology
Computer Systems Engineering
SENIOR PROJECT (II)

Small scale Fire extinguishing Robot

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2021-2022

Students Statement

We, the undersigned students, certify and confirm that the work submitted in this project report is entirely our own and has not been copied from any other source. Any material that has been used from other sources has been properly cited and acknowledged in the report.

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Submitted in partial fulfillment of the requirements of B.Sc. Degree in Computer Systems Engineering

5/07/22

Supervisor Certification

This to certify that the work presented in this senior year project manuscript was carried out under my supervision, which is entitled:

"Small scale fire extinguishing Robot"

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I hereby that the aforementioned students have successfully finished their senior year project and by submitting this report they have fulfilled in partial the requirements of B.Sc. Degree in Computer System Engineering.

I also, hereby that I have **read, reviewed and corrected the technical content** of this report and I believe that it is adequate in scope, quality and content and it is in alignment with the ABET requirements and the department guidelines.

Dr. Tarqe Zanoon,

ACKNOWLEDGMENT

We are grateful to God for the good health and luck that helped us to complete this project.

We would like to express our gratitude to everyone who helped us during the graduation project (Small scale Fire extinguishing Robot) starting with endless thanks to our supervisor Dr. Tareq Zanoon, who didn't keep any effort in encouraging us to do a great job, providing us with valuable information and advice to be better each time. Thanks for the continuous support and kind communication which had a great effect on us to feel interesting in what we are working on.

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Also, we would like to thank EIT College which was our community. It provides a special environment for its students to act as a big family in the way of our struggle to Seek knowledge. In the end, we want to thank the university which allowed us to be a part of this great family.

ABSTRACT

After reviewing many statistics about fires and their impact on human life and the loss that is caused in property, we have built a project that contains components and software that enable us to build a small-scale fire fighting robot that is suitable for turning off relatively small fires.

The robot can move to the fire location by remote control, then detect fire and spray water by itself, as well as provide manual control together with a camera to observe the surrounding environment. The design consists of an Arduino controller board, RF module(receiver and transmitter), a number of sensors to collect data, and taking the correct intervention by using the appropriate components to turn off the fire.

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NIFC	The National Interagency Fire Center
CHD	coronary heart disease
PC	Project Committee

1 CHAPTER 1: INTRODUCTION

Human life, as well as the environment that we hope to protect for the coming generation, is very important, one of many reasons that cases of fire are humans and global warming.

Fire is a chemical reaction in which a carbon-based material (fuel), mixes with oxygen, and is heated to a point where flammable vapors are produced. Any item that contains paper, wood, plastic, fabric, or flammable liquids is considered fuel and a fire can start when these vapors come into contact with a fuel source at a high enough temperature. The fire burns slowly at first and might last anywhere from a few minutes to several hours. In the initial period of fire, light to moderate amounts of smoke is produced. When the fire reaches the end of the early stage, visible flames appear, a trained individual with a portable fire extinguisher be an efficient first line of defense. These flames have the potential to ignite nearby combustible materials inside the room, putting the lives of those who'd be in the room in danger within three to five minutes. It becomes necessary to use powerful suppression methods, be it fire department hoses or automatic systems [1].

1.1 Problem Statement and Purpose

In our senior project, we will build a small scale fire extinguishing car that will help people and firefighters to turn off the fire, the importance of this system comes from that every 23 seconds, the fire department in the USA respond to fire somewhere [2], as well as 7,139,713 acres, are burned in January-December in the USA according to The National Interagency Fire Center (NIFC). (we have used USA statistics because of the lack of studies in Palestinian studies).

Fires are spread around the world cases lost in life and properties. as shown in a lot of studies almost 51,222 people have lost their lives in India, 2666 have lost their lives in Sudan and 1522 have lost their lives in Algeria in 2015, according to the International Association of Fire and Rescue Services [3], also the firefighters have a high opportunity to lose their life in different ways such as death or because of diseases and other risks that they are facing, as mentioned in the following studies that 32% firefighter has died on duty and 10% firefighter death during training [4] also 45% of a firefighter has suffered from coronary heart disease (CHD) that led them to death [5].

In addition to all, the most important cases that a small scale fire extinguishing car will be useful that we can use it to turn off the fire in small places that the humans cannot reach, as well as in dangerous places that life of the firefighters will be in danger so sacrificing in the robot to turn off the fire rather than losing a firefighter life.

To help to solve this problem we propose to build a controlled automatic fire detector and extinguisher robot which is an electromechanical device used to replace human labor or to perform specific functions [6]. Our car robot prototype is designed using Arduino based Microcontroller which can interact with its environment that will detect fire by using a flame sensor and wireless camera for automated and manual control, After the fire is detected a water pump on a servo motor to control its direction is used to turn off the fire, as well as we built a remote control to control the car and the water pump, all of this component help us to build a successful working small prototype system that suites to turn off the fire in small areas, but the concept of our project may be implemented in different sizes.

1.2 Project and Design Objectives

The main objective of this project is to help people and firefighters by building a small scale fire extinguishing car to turn off the fire in small places that the humans cannot reach.

Here are the most important objectives that the project aims to achieve:

1- build a hardware system that detects fire.
2- build a fire extinguishing system.
3- build a remote control car.

1.3 Intended Outcomes and Deliverables

After the completion of the implementation of our senior project we expect to have:

1- Car robot that helps detect fire accurately and turning off fires in small places.
2- Romot controls that can moves the car in different places.
3- Help firefighters accomplish their job.
4- Document to describe the projec

2 CHAPTER 2: BACKGROUND

2.1 OVERVIEW

In this chapter, we mention some systems that perform a similar task as our project, which is a fire-fighting car system with extra functions to detect fire in the surrounding environment. As we are going to show below there is an automated system that turns off the fire but needs human intervention, where another system is used to turn off the fire in a particular area, as we can see we can find different systems, using different components, but have the same purpose which is helping to turn off the fire.

2.2 RELATED WORK

2.2.1 FIRE EXTINGUISHING MATERIAL

The type of materials in portable extinguishers is determined by the type of fire and area of suppression. The types of fires are divided into 4 types, which are grouped according to the type of material that is burning.

- The first type is the fire that is caused by burning wood, cloths, and paper, this type is usually extinguished by water.
- The second type is fires that are caused by the burning of flammable liquids, oils, and grease. Dry chemicals, Carbon dioxide, and Multipurpose dry chemicals are fire extinguishing materials that can be used for extinguishing this type of fire.
- The third type of fire is those involving live electrical equipment.

  Carbon dioxide and Dry chemical materials are used to extinguish this type.

- The fourth type of fire involves flammable metals such as magnesium, potassium, and sodium.

Dry powders, coat the burning metal and provide a choke cover that can be used to extinguish this type of fire. [7]

2.2.2 FIREPROOF COVERING MATERIALS

Fireproof covering materials are used in buildings to prevent deformation and to protect people in buildings in the event of fires. It should feature high heat absorption capacity, small thermal conductivity, and long-term durability. This material uses a super absorbent polymer, Aquacover, consisting of heat sink packaging, ceramic wool, and aluminum glass cloth. Examples of these materials are steel that must be coated in a thermal insulator capable of absorbing heat not exceeding 350℃ [8].

Refractories are solid and heat-resistant materials that can withstand temperatures above 1000 degrees Fahrenheit, such as cement and bricks, and are often used in high-temperature places such as ovens [9].

2.2.3 IMPLEMENTATION OF CONTROLLED ROBOT FOR FIRE DETECTION AND EXTINGUISH TO CLOSED AREAS BASED ON ARDUINO

A group of engineers has built a controlled robot fire-extinguisher is used to extinguish the fire in the closed area by using a wireless camera and flame sensor to detect fire, and turn off the fire by sending a command from a mobile phone to Arduino to make the water pump work.

It has been used a lot of components such as a Four-wheel car prototype, DC Motor for Car Prototype to rotate a tire connected to it in a single axis, Flame Sensor This sensor used to detect and respond to the presence of a flame, RF wireless camera which is used to help to move the car and detect fire, DC water pump, Arduino which is a single-board microcontroller and a software suite for programming. The board must be connected to a specific component so it can interact with the surrounding environment like sensors, switches, and different types of actuators, and Bluetooth HC-06 which is used to exchange data within a short distance. [6]

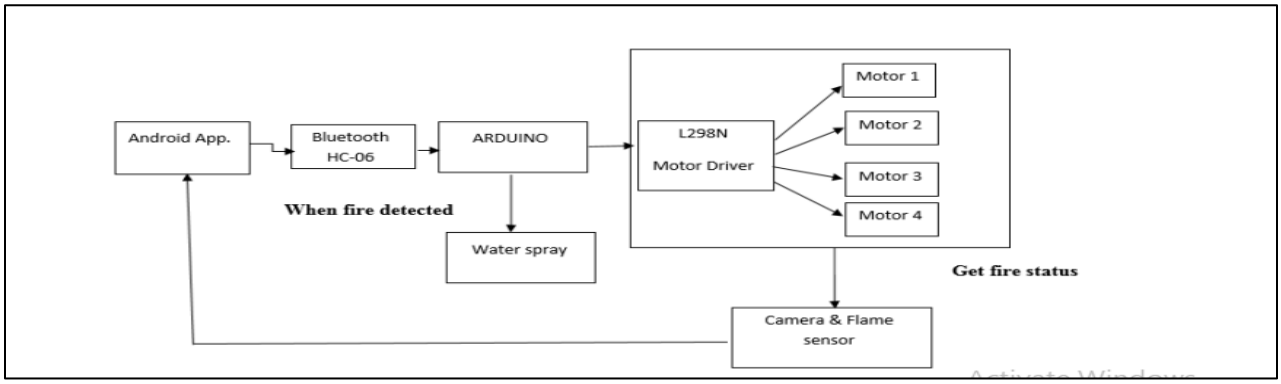

Figure 1: system1 Block diagram

2.2.4 DESIGNING AND BUILDING A NEW INTELLIGENT SYSTEM FOR FIRE ALARM AND EXTINGUISHING IN AUTOMOTIVES.

A system has been developed to detect and observes the first signs of fire in automotive by sensors detecting the external values, as it sensing fire components, it notifies the driver by calling him and turning on the fire alarm light, and activating the fire extinguisher and water flow pump to extinguish the fire.

This system uses smoke detectors sensors, flame detection sensors, heat detection sensors, gas detection sensors to detect fire, The microcontroller is responsible for processing the information coming from these sensors and then sending the necessary instructions to others. [10]

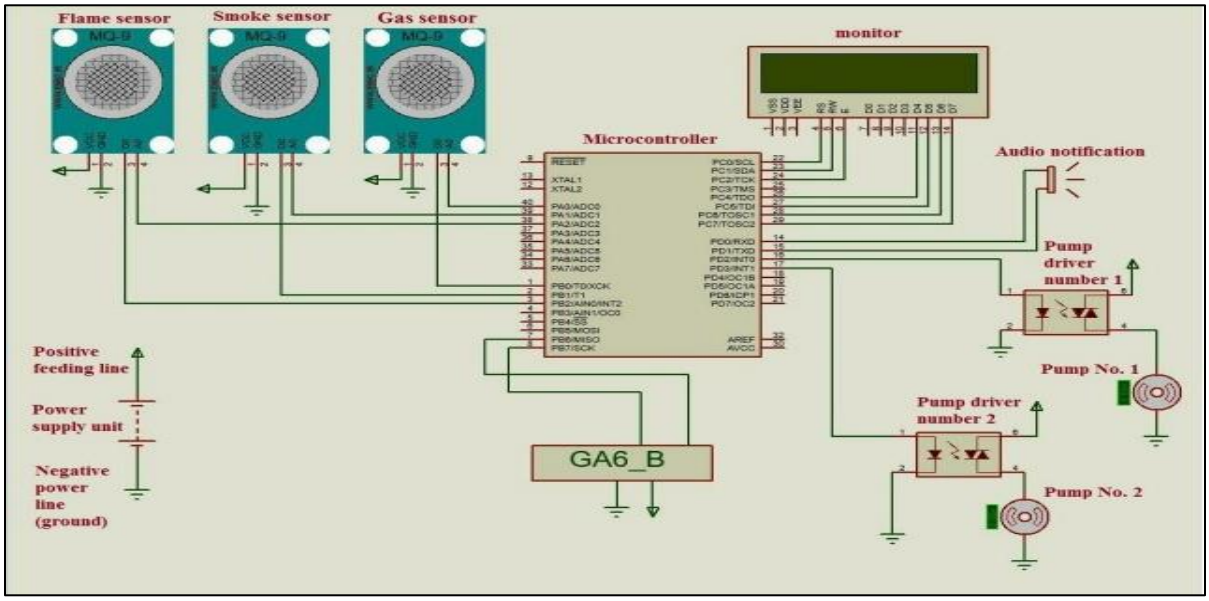

Figure 2: Schematic of the electrical circuit of an automotive fire extinguishing system

2.3 SUMMARY

By analyzing the above systems we have found that all the above systems have used different kinds of microcontrollers but the most suitable one for us is Arduino because of its speed of processing of the data, the design cost, and the number of sensors connected to the robot, as well that it is an open-source electronics platform based on easy-to-use hardware and software [11] the second important component is a flame sensor and the reason that we chose this sensor over another sensor of smoke or heat detector it can detect the flame faster and more accurately due to its mechanisms [1] the third one is a wireless camera because it doesn't require a local power source, Security, is Cost-effective, and its simple installation [12]. The last one is DC motors Which are ideally suited for robots because it is particularly convenient, as it has high torque and high efficiency [13] we have used three wheels in our project unlike the above projects which use four wheels.

We have built our project by taking advantage of each project of the above project and improving it, the first project has built a controlled fire detection system which helped build the controlled part in our project, and the second one which was an automated fire extinguisher which helps us building the automated part. as we can see our project has combined the above two projects in one project which is a controlled, automated fire detection system.

3 CHAPTER 3: METHODS AND MATERIALS

3.1 SYSTEM DESIGN AND COMPONENTS

3.1.1 SYSTEM HARDWARE DESIGN

The process of extinguishing the fire can be done in two ways the controlled- fire extinguishing system and the automated one. The system includes the main control module which is Arduino responsible for controlling all components in the other models, the flame detection module that locates the fire, and the fire extinguishing module responsible for the extinguishing process, The system also contains a remote control module, through which we can control the robot car remotely with the wireless camera on the car.

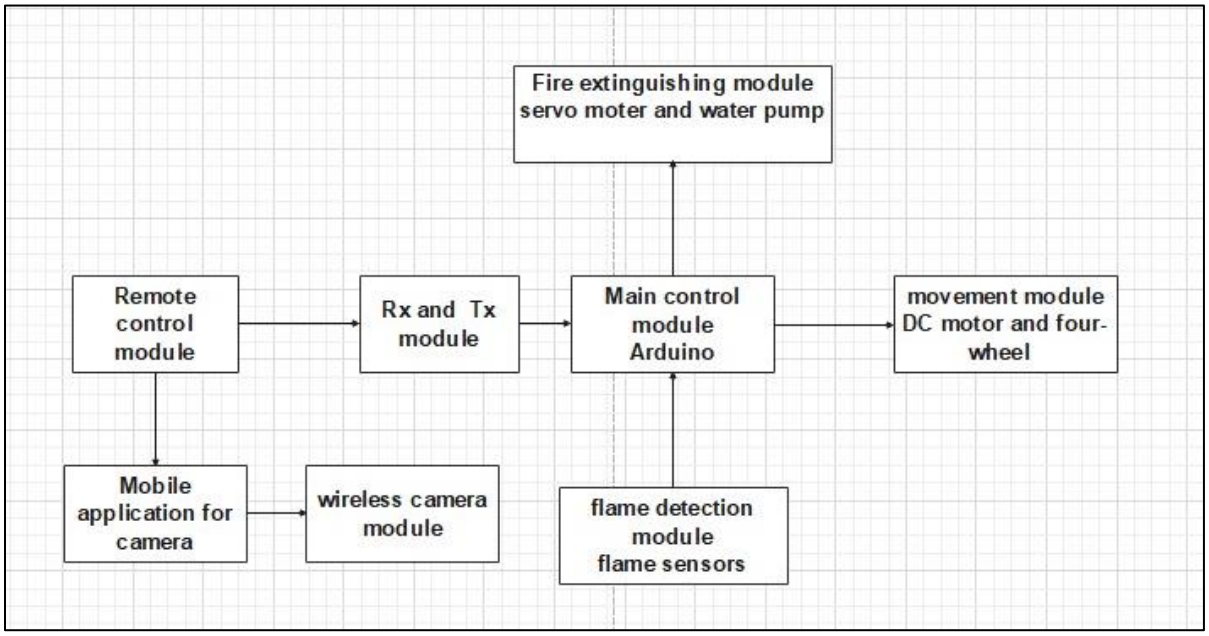

Figure 3: System Block Diagram

The system was designed as a remote control robot car. the robot car contains the main controller device of the whole system is a core part of the controlled firefighting car which is Arduino nano it can receive data from other components then process and analysis these data it sends corresponding instructions to control each module. The main controller is directly

connected to the flame detection module and is composed of three flame sensors on the front, right, and left of the robot car. The automated fire extinguishing module is mainly composed of a servo motor which is connected directly with Arduino, and a water pump connected by an H-Bridge with Arduino. The main controller is connected to the dc motor drive by a relay, and the dc motor directly drives the 3-wheel car.

The remote-controlled module contains a wireless camera that manually controls the movement of the robot car and the fire extinguisher module, this remote has a mobile application to control the wireless camera, that exists in the robot car. the wireless camera enables us to see the surrounding environment and the fire sites from a distance. Rx a Tx module connects the robot car to the remote control.

The following design will show how the component is connected:

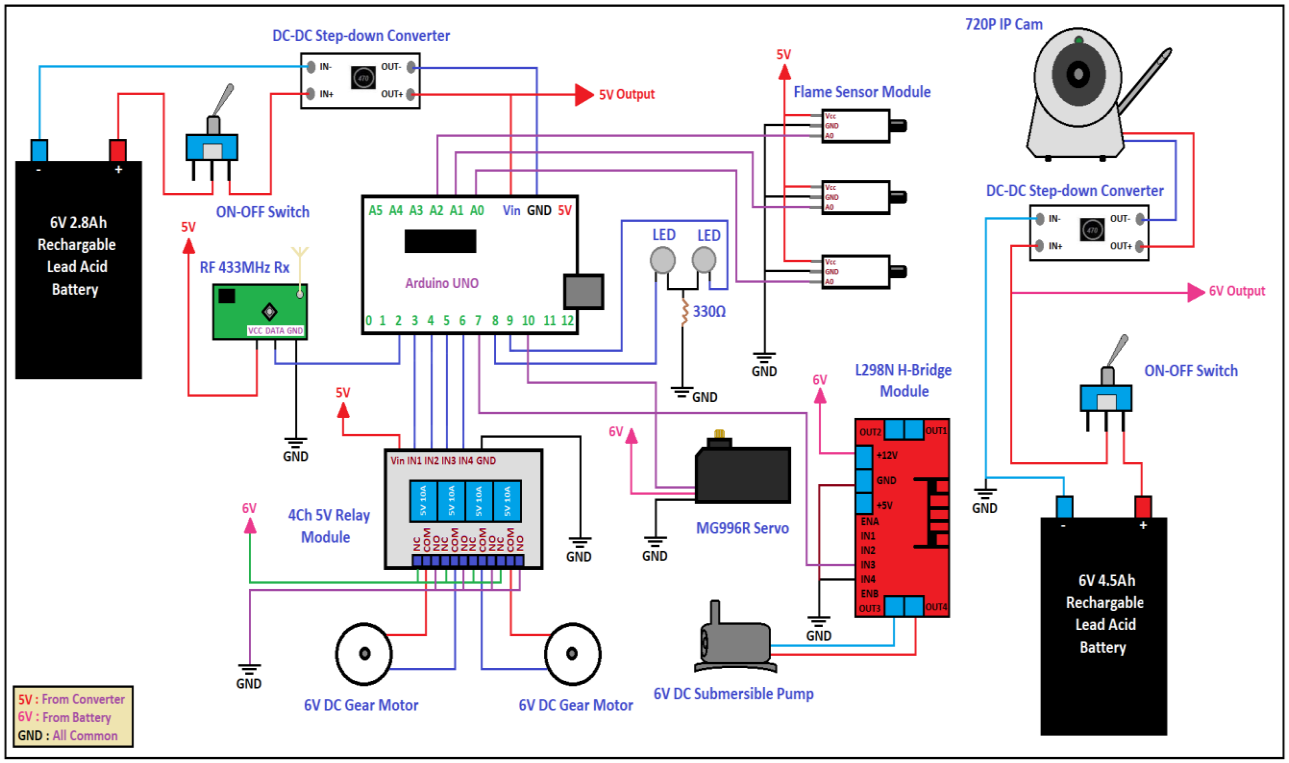

Figure 4: Connection diagram of robot car

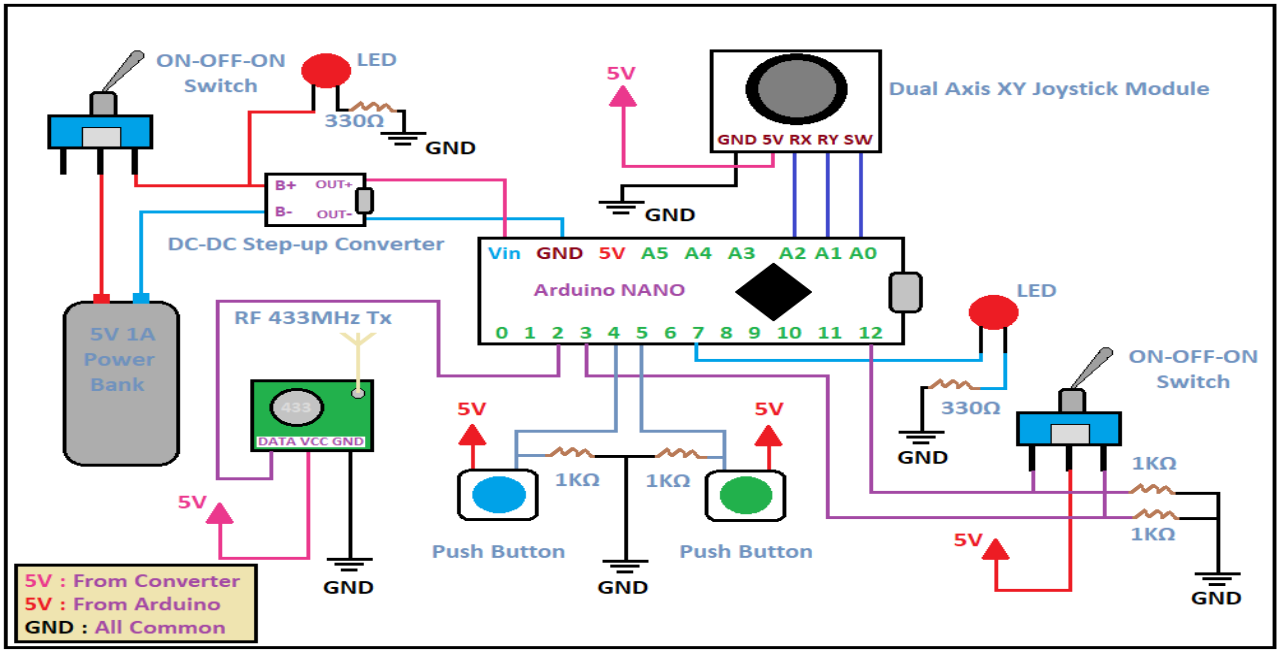

Figure 5: Connection diagram of hand controller

3.1.2 SYSTEM SOFTWARE DESIGN

After the hardware design is completed, the program needs to be written using C programming language then upload to Arduino. The system flow chart is shown in figure 20.

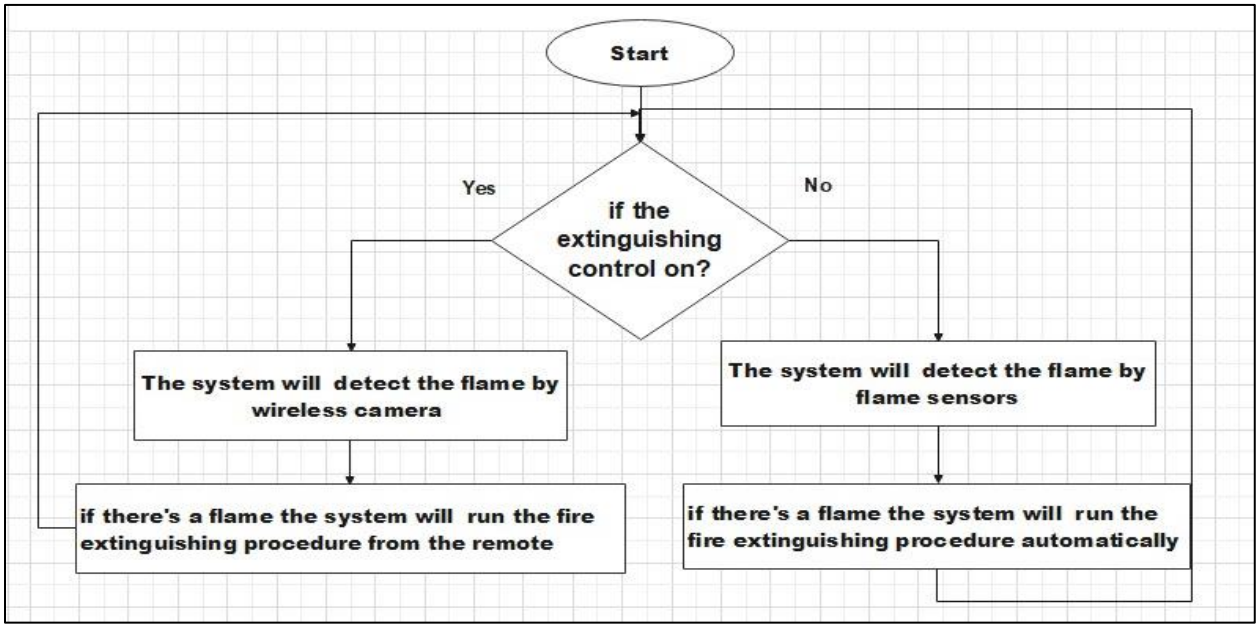

Figure 6: System flow chart

3.1.3 HARDWARE COMPONENTS

1) Arduino-Uno:

Description:

- Arduino Uno is a microcontroller board based on the ATmega328P.
- It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs,
- a USB connection,
- a reset button. [14]

Usage:

- We have used it to receive orders from the joystick and push buttons then analyze it and send it by a transmitter to the receiver on the car to control the car and the water pump.

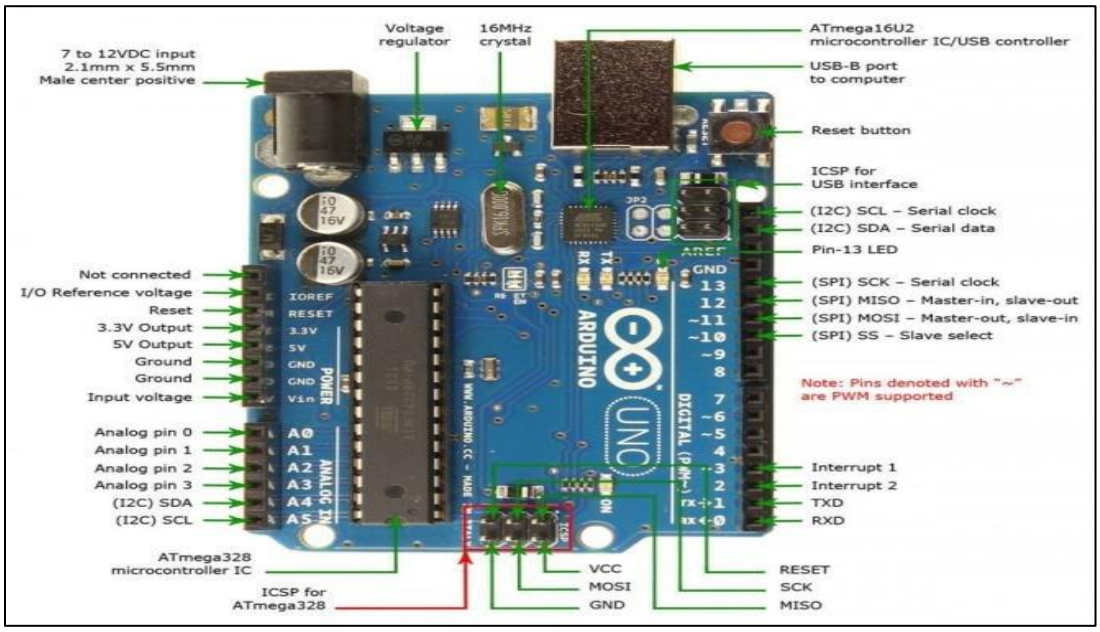

Figure 7: Arduino Uno

2) Arduino Nano:

Description:

- Arduino Nano is a microcontroller board based on the ATmega328P.
- It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 8 analog inputs
- a USB connection
- a reset button. [15]

Usage:

- We have used it to receive orders from a different kind of sensor then analyze the order to detect fire and control the car and the water pump (it work as the main brain for the car).

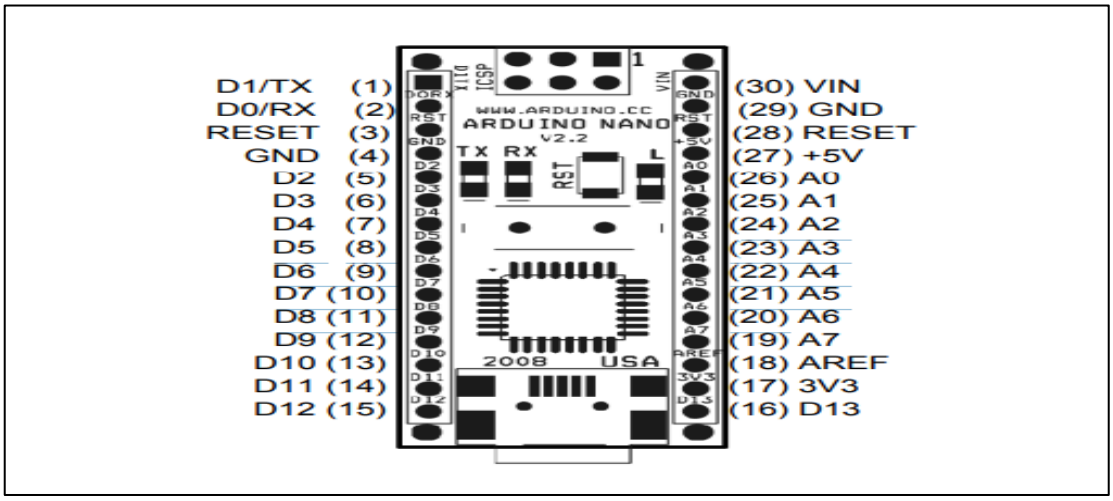

Figure 8: Arduino Nano

3) 5v four-channel relay:

Description:

- The four-channel relay module contains four 5V relays and the associated switching and isolating components, which makes interfacing with a microcontroller or sensor easy with minimum components and connections. [16]

Usage:

- The interface between low current and high current to control the direction of the dc motors.

Pin Number	Pin Name	Description
1	GND	Ground reference for the module
2	IN1	Input to activate relay 1
3	IN2	Input to activate relay 2
4	IN3	Input to activate relay 3
5	IN4	Input to activate relay 4
6	V_{CC}	Power supply for the relay module
7	V_{CC}	Power supply selection jumper
8	JD-V_{CC}	Alternate power pin for the relay module

Figure 9: 4 Channel Relay Module Description

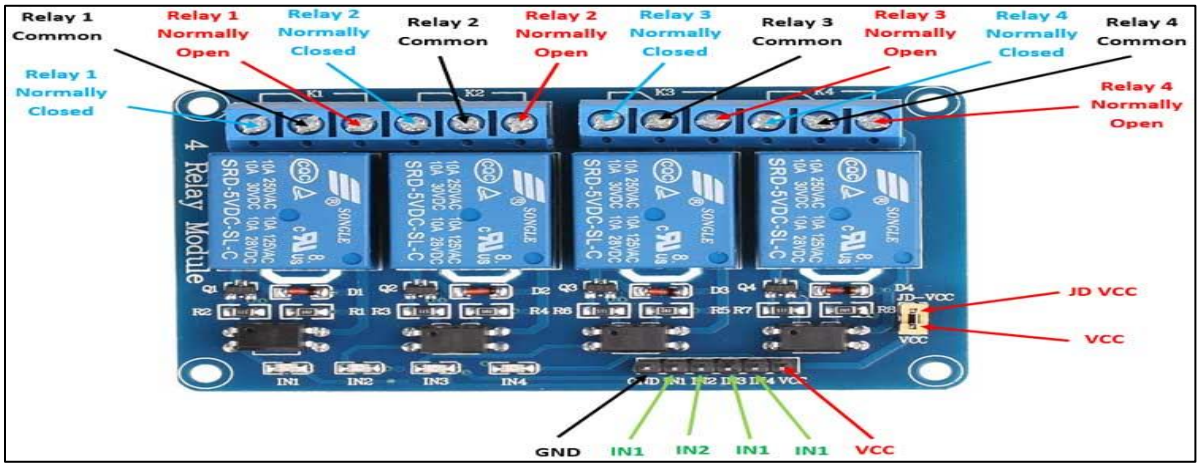

Figure 10: 4 Channel Relay Module

4) Servo metal gear high torque connection:

Description:

- The MG996R is a metal gear servo motor with a maximum stall torque of 11 kg/cm. Like other RC servos, the motor rotates from 0 to 180 degrees based on the duty cycle of the PWM wave supplied to its signal pin. [17].

Usage:

- we use it to control the angle of the pipe that sprays the water.

Wire Number	Wire Colour	Description
1	Brown	Ground wire connected to the ground of system
2	Red	Powers the motor typically +5V is used
3	Orange	PWM signal is given in through this wire to drive the motor

Figure 11: Wire Configuration

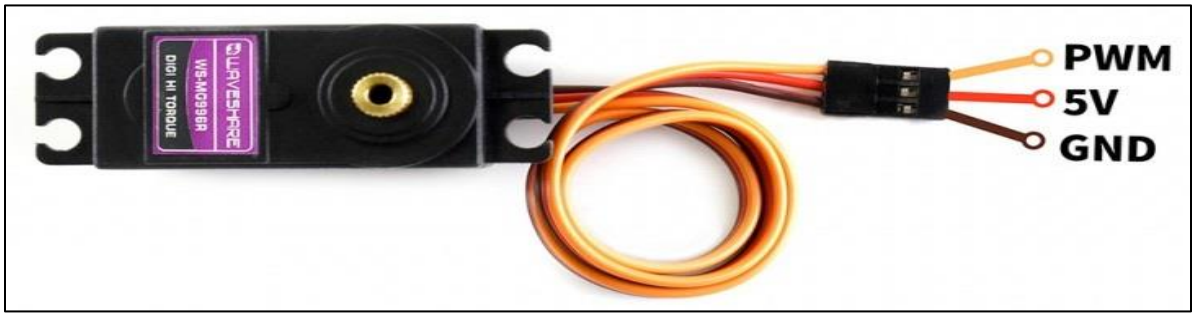

Figure 12: Servo Motor

5) Acid Battery:

Description:

- Rechargeable sealed lead-acid battery.
- Voltage: **6**V.
- its pattery life almost 1 hour. [18]

Usage:

- It is used as a car Robot power supply.

Figure 13: Acid Battery

6) IR flams sensor module:

Description:

- A flame sensor module that consists of a flame sensor (IR receiver), resistor, capacitor, potentiometer, and comparator LM393 is an integrated circuit.
- It can detect infrared light with a wavelength ranging from 700nm to 1000nm. The far-infrared flame probe converts the light detected in the form of infrared light into current changes.
- Sensitivity is adjusted through the onboard variable resistor with a detection angle of 60 degrees.
- Working voltage is between 3.3v and 5.2v DC, with a digital output to indicate the [19]

Usage:

- presence of a signal. Sensing is conditioned by an LM393 comparator.
  It is used to detect the location of the fire in the surrounding environment

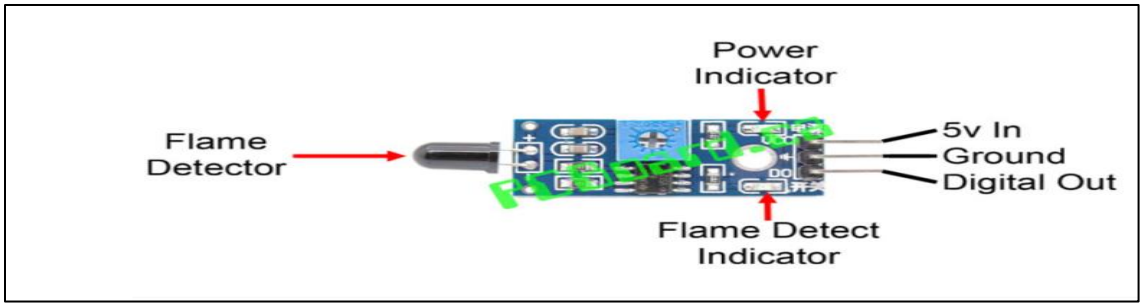

Figure 14 : IR flams sensor module

7) DC Mini Submersible Water Pump:

Description:

- Micro dc 3-6v micro submersible pump mini water pump for pump water at high pressure, which can take up to 120 liters per hour with very low current consumption of 220ma.
- It is a low-cost, small-size submersible pump motor that can be operated from a 2.5 ~ 6V power supply, and its Flow rate: is 80-120L/H. [20]

Usage:

- we use it as the main extinguisher of fire that we detect.

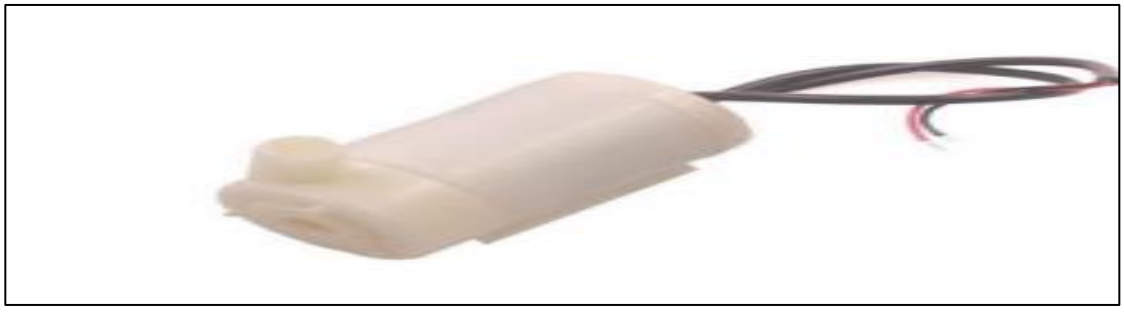

Figure 15: Mini Submersible Water Pump

8) Wireless IP camera 720p:

Description:

- Wireless IP Camera with 1 Antenna Wireless IP camera easy to achieve real-time remote viewing.
- The remote control of the Wireless IP Camera is a mobile phone, it is easy to install and supports multi-user viewing. [21]

Usage:

- we use it to explore the surrounding environment and to detect and watch the fire.

Figure 16: Wireless IP camera

9) 5MM LED:

Description:

- An LED is a two-lead semiconductor light source, which emits lights when activated. When an appropriate voltage is applied to the LED terminal, then the electrons are able to recombine with the electron holes within the device and release energy in the form of photons.
- The color of the LED is determined by the energy bandgap of the semiconductor. [22]

Usage:

- to show the mod of the device (automated or controlled).

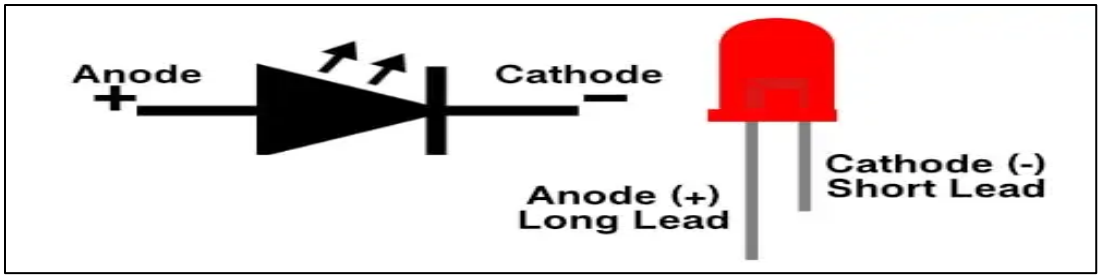

Figure 17: 5MM LED

10) Dual Axis XY Joystick Module:

Description:

- Joystick Module has two independent Potentiometer, one for each axis X for left and right position and Y for an up and down position.
- It is compatible to interface with Arduino, and its operating voltage is 5v.

Usage:

- We used it to control the movement of the car(left, right, forward, backward), by connecting it with Arduino. [23]

Table 1:Pin Configuration of Joystick Module

Pin Number	Pin Name	Description
1	Gnd	Ground terminal of Module
2	+5v	Positive supply terminal of Module
3	VRx	Voltage Proportional to X axis
4	VRy	Voltage Proportional to Y axis
5	SW	Switch

Figure 18: Dual Axis XY Joystick Module

11) ON-OFF 3 Pin Latching Toggle Switch:

Description:

- Single Pole Double Throw (SPDT) is can be used for controlling a process and changing the parameters of it. The switch can handle up to 3A at 230VAC and 6A at 125VAC. [24]

Usage:

- we use to change from moods (automated, off, controlled)

Figure 19: ON-OFF Switch

12) Plastic gear motor with wheel for car:

Description:

- The gear motor has a huge voltage range and a double-sided shaft which makes it perfect for model construction and prototyping.
- it can be operated from a 3 -6V power supply. [25]

Usage:

- we use it to move the robot.

Figure 20: Gear motor with wheel

13) RF Transmitter Module:

Description:

- Frequency: 433.92 MHz
- Voltage: 3-6V. [26]

Usage:

- We use it to transmit the instruction from romote control to the car.

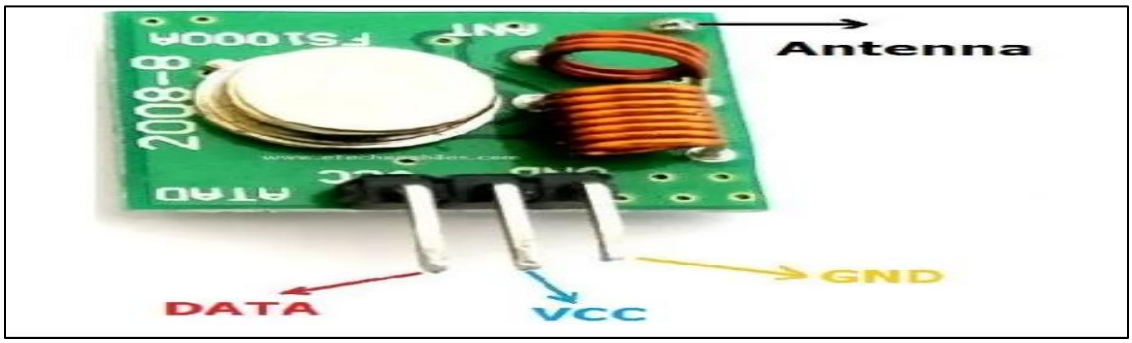

Figure 21: Transmitter

14) RF Receiver Module:

Description:

- Receiver frequency: 433 MHz
- Operating voltage: 5V.
- Max distance: 100 Meters. [27]

Usage:

- We use it to receive the instruction from romote control.

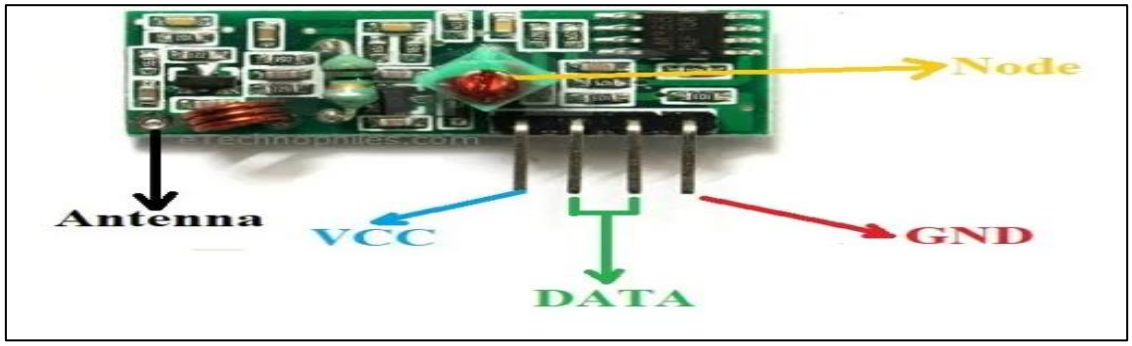

Figure 22: Receiver

15) L298N Motor Driver Module :

Description:

- Consists of an L298 motor driver IC and a 78M05 5V regulator.
- can control up to 4 DC motors.
- Maximum Power: 25W.
- Motor Supply Voltage: 46V.
- Motor Supply Current: 2A. [28]

Usage:

We use it to drive the stepper motor.

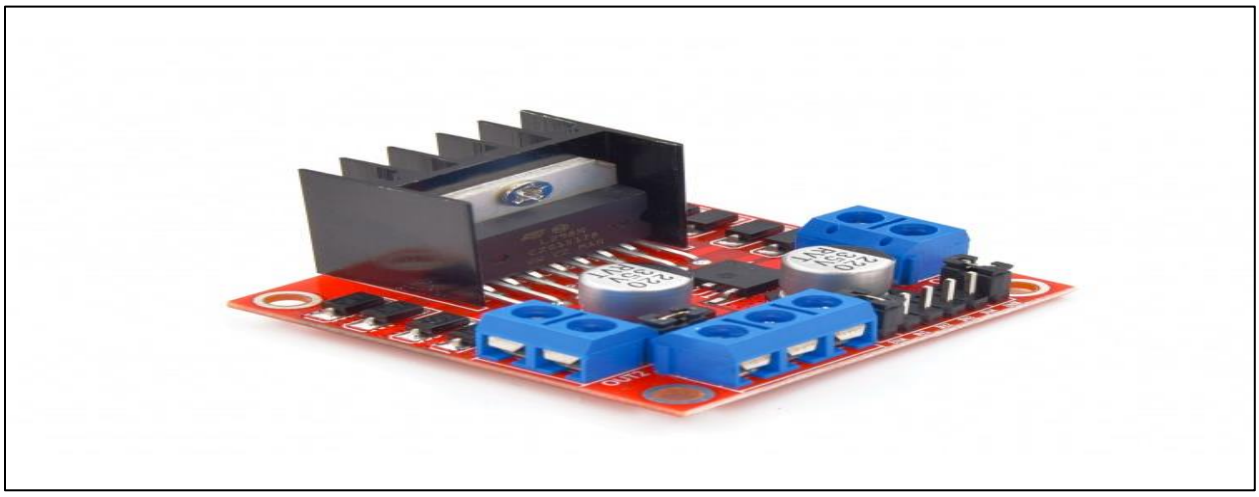

Figure 23: L298N Motor Driver Module

3.2 Design Specifications, Standards, and Constraints

3.2.1 DESIGN SPECIFICATIONS

3.2.1.1 Functional requirements

- The system must be able to move in all directions by the dc motor and controlled by joystick.
- The system must be able to detect the direction of fire in two ways, either automatically (by a flame sensor) or by a camera.
- The system must be able to turn off the fire.
- The system must takes less than 3 seconds to detect the fire .
- The system must takes less than 5 seconds to start turn pump in case the fire was opposite to the sensor.

3.2.1.2 Non-functional requirements

- Usability: The remote control should be easy to use and understandable to the user.
- Performance: The response time will be short of 4 seconds.
- Reliability: It can perform its intended functions and operations in a system's environment without breaking down.
- Affordability: The price of the device should be reasonable and affordable.

3.2.2 THE CONSTRAINT

Our system is a small prototyped system that is designed for a small area, with a small water pump that matches its size which is between 45cm, also we have a flame sensor that detects the flame or light of a wavelength in the range of 760 nm to 1100 nm [29], the servo motor that we have used has a limitation on the angle only from (0-180). the wireless camera that can turn around and detect the surrounding environment at (0-360) degrees. The robot has a battery life

that almost works for one hour, that can carry 400ml of water, the expected weight of the robot is around 4Kg, the quality of the video 720p that the camera will show.

3.3 DESIGN ALTERNATIVES

- We can change the wheels to a design that can climb stairs.
- Use a bigger rating dc motor instead of what we have used which is small rating dc motors.
- We have used a flam sensor to detect the fire, not heat or smoke sensors because they are more effective and reliable.
- We can use more flam sensors on different sides to accurately know the direction of the fire then the process of spry water will be more accurate.

3.4 SYSTEM ANALYSIS AND OPTIMIZATION

The two main functions of extinguishing the fire are controlled and automated, the first step is to drive the car by using the designed remote control, especially the joystick to deliver it to the nearest place to the fire then we can turn off the fire by using the two mentioned ways above. the automated way will use three flame sensors each one is on a different side [right, lift, front] to detect infrared light with a wavelength ranging from 700nm to 1000nm. and sends their values to the Arduino then the Arduino will decide in which direction the water should be sprayed after that the Arduino sends the instruction to the servo motor which moves into the suitable direction wait for a very short time then send the signal to turn the water pump on.

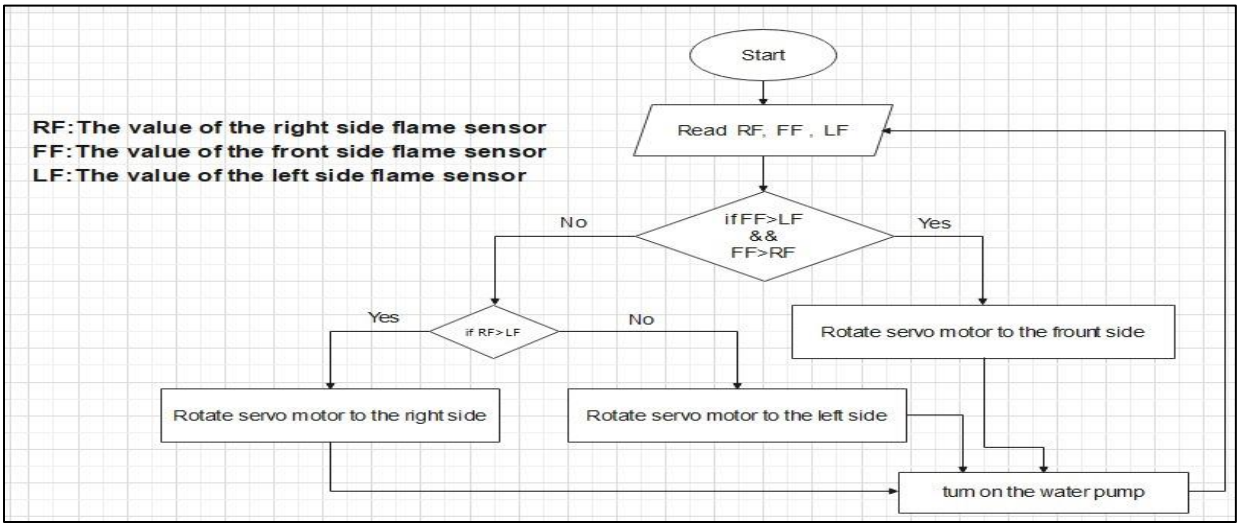

Figure 24: : System automated flow chart

At the moment that we turn off the automated part the controlled part of fire extinguishing will be on, by using the wireless camera that we installed in the front of the car and we can control it by using a mobile application to observe the surrounding environment. two push-buttons to control the servo motor one to turn it to the right and the other one to the left, and an on-off switch to turn on the water pump.

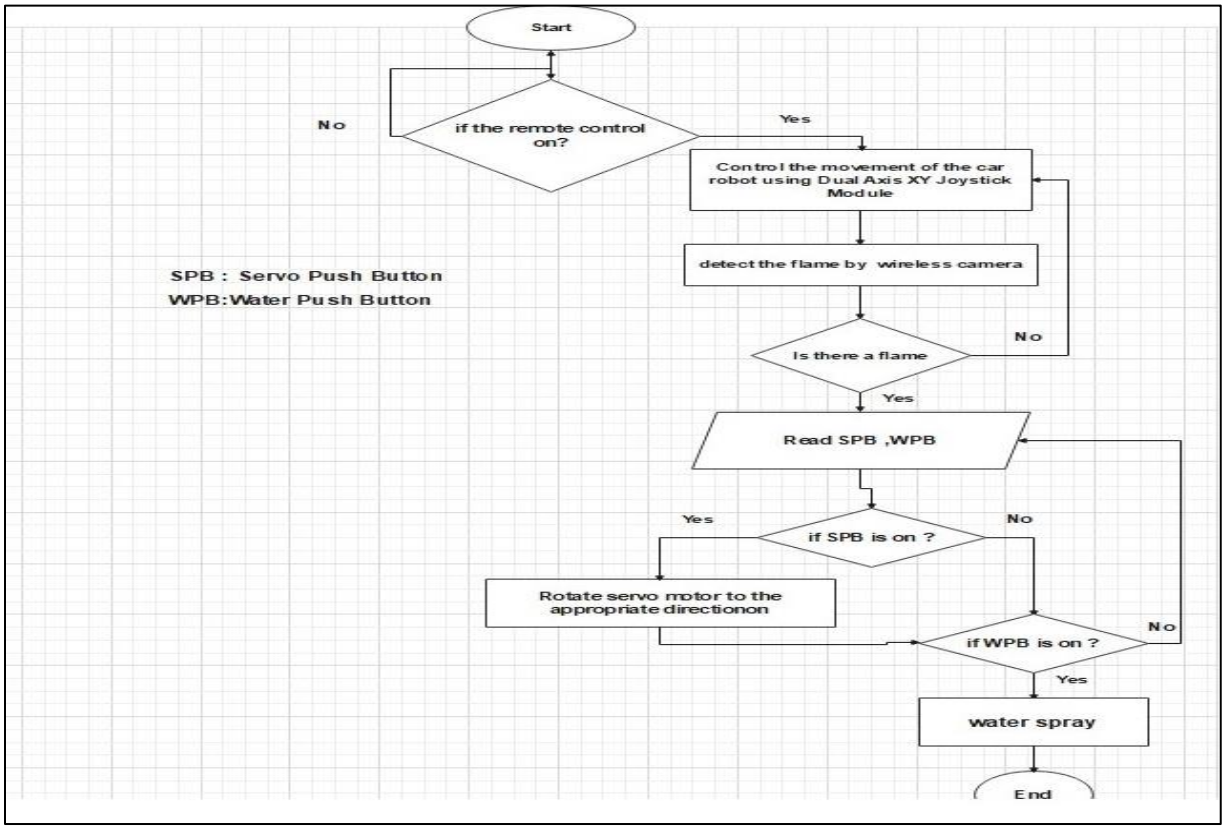

Figure 25: System controlled flow chart

3.5 SIMULATION AND/OR EXPERIMENTAL TEST

No simulation was used.

4 CHAPTER 4: RESULTS AND DISCUSSIONS

4.1 RESULTS

After completing the implementation and operation of both the robot and the remote control and establishing a wireless connection between them, we conducted experiments to measure the process of fire detection. And the result was that the robot was able to detect fire accurately by flame sensors or a wireless camera, remote control can move the robot in different directions.

Experiment 1

In the first experiment, a fixed distance between the car and the fire with changing the directions, and calculating the time needed to determine the direction of the fire. The results were according to a table 2 Experiment 1.

Table 2: Experiment 1

The direction of fire	Time to detect fire [sec]	Time to turn pump [sec]	Distance [cm]
Front	2.37	4.52	15
Left	1.39	3.61	15
Right	0.73	2.77	15
Front	2.4	4.9	15
Right	1	3.5	15

Figure 26: Detect fire in left direction

Figure 27: Detect fire in right direction

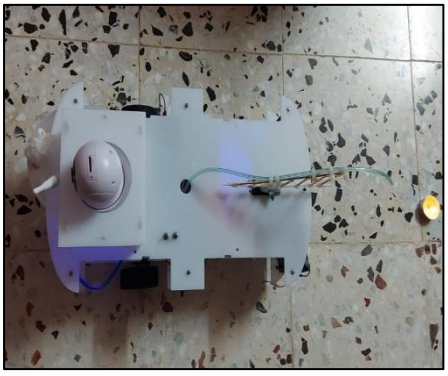

Figure 28: Detect fire in front direction

conclusion

We conclude from the first experiment that the robot car takes less than 3 seconds to detect the fire and less than 5 seconds to start turn pump in case the fire was opposite to the sensor.

4.1.1 EXPERIMENT 2

In the second experiment, a fixed direction of the fire with changing the distance between the car and the fire, and calculating the time needed to determine the direction of the fire.The results were as shown in Table 3 Experiment 2.

Table 3: Experiment 2

The direction of fire	Time to detect fire [sec]	Time to turn pump [sec]	Distance [cm]
Front	2.4	5.19	15
Front	2	4	30
Front	1.44	3.11	20

conclusion

We conclude from the second experiment that the distance does not significantly affect the time of fire detection or the time to turn on the pump.

4.1.2 EXPERIMENT 3

The third experiment was measuring the ability of people to control the car through the remote control, where we trained three people for an hour, then test them on a square path with a circumference of 9 meters and the results were as shown in the Table 4 Experiment 3.

Table 4: Experiment 3

Name	Time to finish the task [sec]	comment	Trainer opinion
Naema	42	She got out of the path 3 times	I need more time to train
Marah	31	She got out of the path once	It is easy to use
Noor	39	She got out of the path twice	It is understandable

Also, we were able to detect fire with the camera that can rotate from 0 to 360 degree and extinguishing process is done by using the remote control.

Conclusion

We conclude from the third experiment that the needed time for training varies from person to person, but the average duration was an hour.

4.2 DISCUSSIONS

According to the above experiments, we have achieved the following: the robot can automatically detect and extinguish the fire with good accuracy and time, the remote control sends commands to the robot to walk in all directions forward, backward, right and left, the remote control also drives the servo motor and directs it to the fire to be extinguished, sends the necessary command to operate the water pump, finally as long as the fire is on the fire extinguishing process continue its work.

5 CHAPTER 5: PROJECT MANAGEMENT

5.1 TASKS, SCHEDULE AND MILESTONES

In senior 1, we wanted to do two things, the first is to choose the idea of our senior project, and the second thing is to define and explain the approach to implement the idea. We divided these things into several tasks, among which we determined what the problem that project will be solved, what are Objectives and whats are the outcomes of this project, description of the project, standards, constraints, and the components that will be used.

In senior 2, we implemented and operated the car robot and the remote control. we conducted experiments to test them and recorded the results.

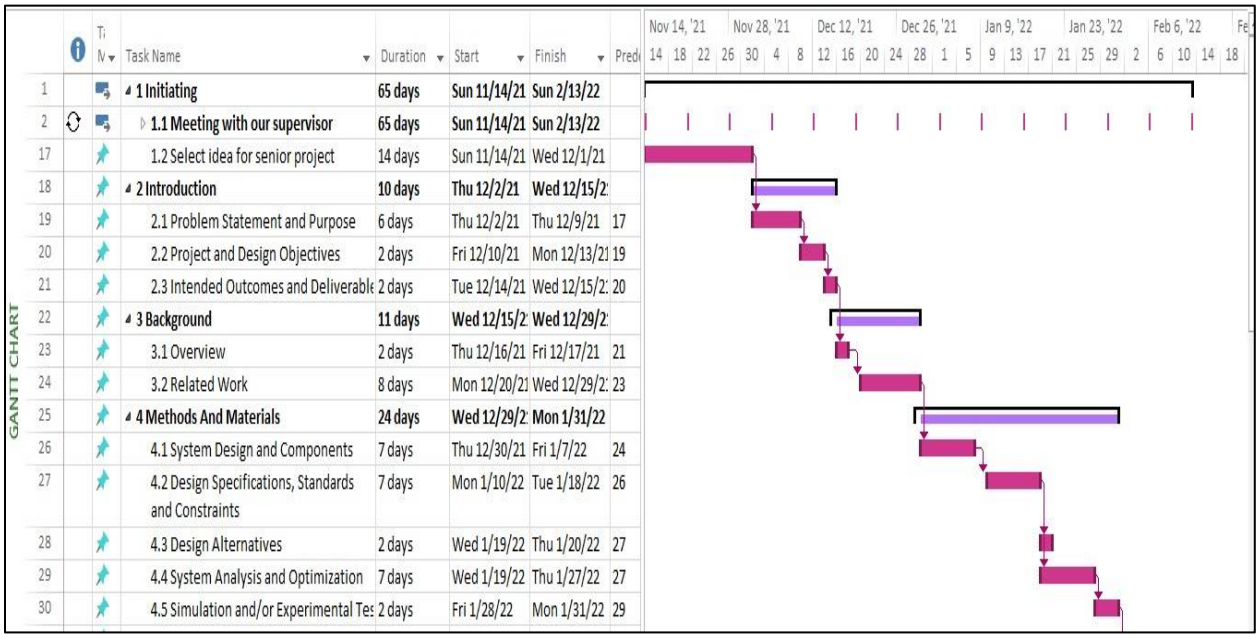

Figure 29: project schedule 1

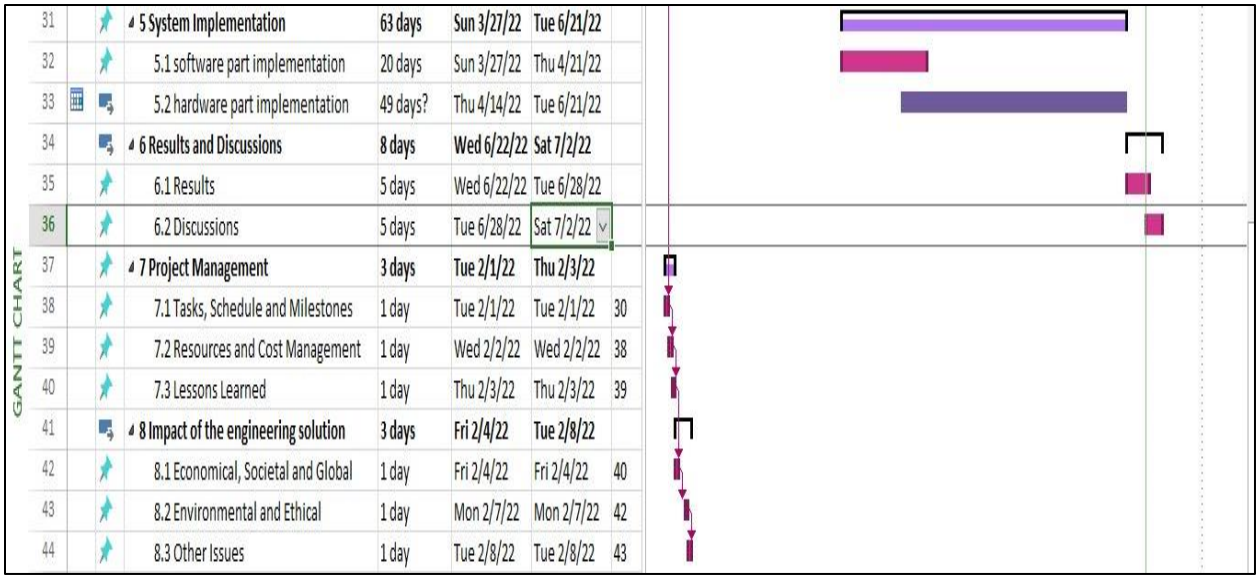

Figure 30: project schedule 2

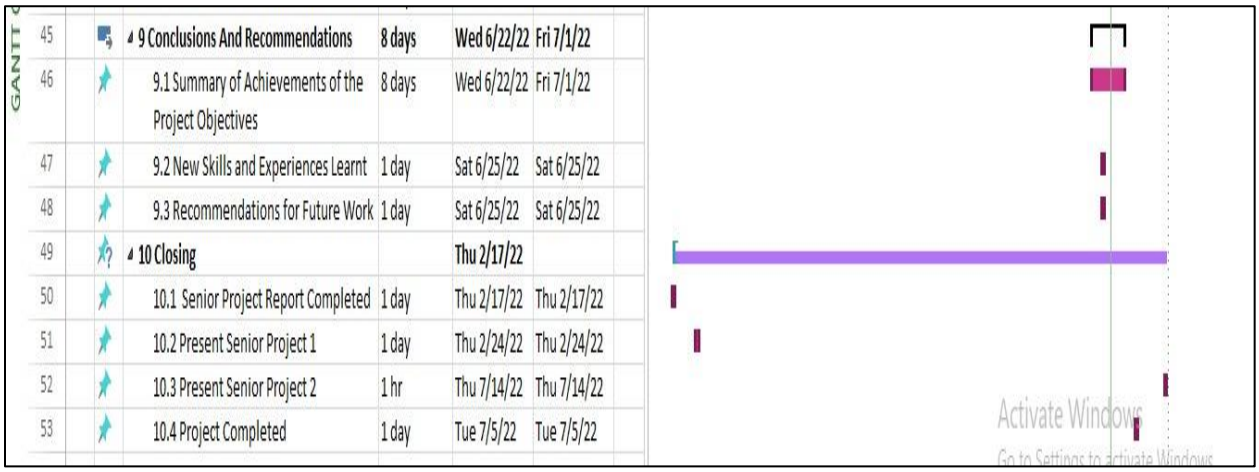

Figure 31: project schedule 3

5.2 Resources and Cost Management

What we will show in table 2 whether it is the price of the pieces or the total price, is the approximate price and not the exact price, because it is possible to change some pieces if they are not available in Palestine, or we order them from outside Palestine and this requires additional costs. The total price will be higher because there are costs that are added when the project is implemented.

Table 5: Total cost of senior project items

Item	# Unit	Unit Cost	Subtotals	Comments
Arduino Uno – R3 with cable	1	40₪	40₪	
Arduino nano 328P with cable	1	40₪	40₪	
5V 4-channel Relay Module Low	1	35₪	35₪	
L298N Dual H-Bridge Motor Drive Module Board	1	25₪	25₪	
MG996 Metal Gear High Torque Servo	1	50₪	50₪	
6V 4.5Ah Lead Acid Battery	1	35₪	35₪	
IR flame sensor module	3	22₪	66₪	
RF TX & RX KIT 315/433MHZ	1	30₪	30₪	
Mini Submersible Water Pump DC 3-6V 120L/H	1	20₪	20₪	
Micro USB Lithium Battery Charging Board 5V 1A	1	15₪	15₪	
Micro USB cable	1	5₪	5₪	
Electronics Soldering Wire	3	1₪	3₪	
Wireless IP camera 720P	1	130₪	130₪	
DC-DC 2A adjustable step-down module	1	20₪	20₪	
7×9cm DIY Prototype PCB	1	5₪	5₪	
9×15cm DIY Prototype PCB	1	8₪	8₪	
2 Pin Screw Terminal Block Connector	4	2₪	8₪	
40 Pin Single Row Female Header	2	5₪	10₪	
5MM LED	15	0.333₪	5₪	
Resistor	7	0.3₪	2₪	
Dual-axis XY Joystick Module	1	5₪	5₪	
ON-OFF 3 Pin Latching Toggle Switch	2	3₪	6₪	
Push Button Momentary Switch 12×12×7.3mm	2	2₪	4₪	
Round Push Button Cap for 12×12×7.3mm Switch	2	1₪	2₪	
Plastic Gear Motor With Wheel For Car	4	25₪	100₪	
Battary Clip	2	0.5₪	1₪	
silicon Tube	14	0.5₪	7₪	
Jumper wires 20cm	-	30₪	30₪	

Power Bank	1	45₪	45₪	
Screw,Female Brass Standoff,Others	-	70₪	70₪	
CNC cutting ,Robot Body Design	-	150₪	150₪	
Total senior project estimate		821₪	972₪	

6 CHAPTER 6: IMPACT OF THE ENGINEERING SOLUTION

6.1 ECONOMICAL, SOCIETAL, AND GLOBAL

6.1.1 ECONOMICS (COST) IMPACT:

The total cost of the project will exceed 822₪ that is used for the material without the cost of building the system, the exact cost is 972₪.

6.1.2 SOCIAL IMPACT OF THE PRODUCT:

The positive impact of our project on humans is that the system that we have built is a prototype that we can build in different sizes and we can use this system to go to places that are dangerous for humans to go which will help for sure saving the people.

6.2 ENVIRONMENTAL AND ETHICAL

Environmental impact of the product:

1. The robot will help minimize the loss of life as well as property.
2. The car will help reduce the danger whether it was on the firefighter or on the people who are facing the fire.

7 CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

7.1 SUMMARY OF ACHIEVEMENTS OF THE PROJECT OBJECTIVES

After implementing the project practically and testing the results that appeared helped us measure the achievement of goals. A system that work successfully hardware and software has been built which is capabale of being used in everyday life if more professionals are selected instead of the elements used in the project. The system can be easily used in closed parking lots, stores, supermarkets, shops.

7.2 NEW SKILLS AND EXPERIENCES LEARNT

- The skills that we have gained :

1. Report writing skills.
2. The skills of dealing with the hardware component.
3. scheduling tasks and time management skills.
4. Team working skills.

- The Experience learned:

1. Connecting hardware components.
2. Programming Arduino.
3. Dealing with different types of the hardware component.
4. Problem-solving.

7.3 Recommendations for Future Work

Our planned upcoming work on this project will be using a climb stairs wheel instead of a normal one that will enable the robot to move between floors, using more than only three sensors, this will give us more accurate results in automated fire extinguishing process, built an alert system that will give an awarning when the battery has almost died, using a fireproof material to cover the car robot, use dry powder to extiguish the fire instead of water due to its light weight and finally use batteries that last longer.

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