

Arab International University

Faculty of Informatics and Communication Engineering

Junior Project Report on

Swarm robots for fire detection

Submitted to

Department of Informatics Engineering

in partial fulfillment of the requirement for the Degree of Bachelor in

Informatics Engineering

Submitted by

Ahmad Al-Zein **Hazar Korabi** **Kawthar Fakhoury Idelpi**

Mohammad Horani **Lana Touma**

Under the Supervision of

Dr. Khaled Dekk-Al Bab **Eng. Louay Abo Al-Zahab**

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CERTIFICATE OF APPROVAL

The undersigned certify that they have read and recommended to the Department of Informatics Engineering for acceptance, a project report entitled Project Title In English Submitted by: Ahmad Al-Zein, Hazar Korabi, Kawthar Fakoury, Lana Touma, Mohammad Al-Horani….. in partial fulfilment for the degree of Bachelor of Engineering in Informatics.

Supervisor	**Head of Department**
Dr. Khaled Dekk Al-Bab	**Dr. Said Desouki**

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Students could invest time, mind and spirit in our university in order to reap the benefits of works and the time devoted in the coming years. We will be by our students in every step of their way.

To my father Michel Touma

My mother Rima Salloum

My friends Yara Chiniara, Toka Al-Khatib, Wassim Yousef,Dani Moussa, Laith ALoneni who have stuck by me and believed in me.

The gift of your support and acknowledgement is truly appreciated.

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Lana Touma

To my father Imad

My mother Rana

Who were so very patient and never lost faith in me even after I lost faith in myself due to my old university.

Who kept pushing me forward no matter what towards regaining my passion and a brighter future at my new university.

To My friends Hisham haffar, Amar Akkad, Mohannad Skkar, Louay Ghawagy and Jalal Sneter who have always been there for me and supported me.…

Thank you.

……

Mohammad Al-Horani

……

……

To my father Mohammad Fakhoury Idlbi

My mother Nada Al Shami

To my siblings Rania,Manal,Amani,Hasan and Anwar

Thank you for your constant support and for believing in me.

……

Kawthar Fakhoury

To my father Khaled Al-Zein

My mother Rania Imam Oughli

My sister Lana

I was only able to get this far thanks to you and your support. I know I can always count on you staying by my side and I'm ever thankful.

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Ahmad Al Zein

To my father MHD Mazen Korabi

My mother Faten Al-Halabi

Thank you for all you've done and are continuing to do for me. This success and every other one that may follow will always go out to you.

……

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Abstract

The dangers of fires are undeniable and often catastrophic, this is why firefighting is important, it is about risking your life to save another. It is a deadly career, and only a few people are usually willing to take the risk.

Firemen are in constant danger while risking their lives under dangerous circumstances. Our goal is to help them by making robot cars that are able to seek out a potential source of fire in the industrial environment and declare a fire threat before it rages out of control.

The Fire-Fighting robot is capable of detecting flames and moving towards them, it will know where to head thanks to the fixed ceiling camera which has a view from above of the entire environment that the robot will be scouting.

The camera will send the coordinates of the robot by recognizing the colors on its back and using a color detection algorithm to track it.

The camera will also find the coordinates of the fire and then send both coordinates to the server which will then order the robot car to head towards the fire.

The PID Algorithm and Arduino code work together to control the movement of the robot and make sure it is headed in the correct direction and reaches the fire before it rages out of control.

In this report we will go over the phases of our project, hardware and algorithms used, problems we ran into, and plans for the future in detail.

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Abbreviations

PID Proportional, Integral, and Derivative

CV Computer Vision

SP Set point

PV process variable

PWM Pulse Width Modulation

SOC System-on-a-chip

NodeMCU Node Micro Controller Unit……..

……..

Keywords

Robot, Swarm, Server,

Fixed camera,Pid,Tensorflow,

Python,OpenCv,Fire,Arduino,Firefighter, H-Bridge circuit. PWM, output pins, control pins,power supply, Ultrasonic sensor,voltage regulator,SONAR, HC-SR04, 7805 IC, NodeMCU.

Introduction

Fire is a classical element that has been an equalizer on Earth prior to the start of written history. It has many positive attributes but it can be extremely dangerous when outside of control. Structure, vehicle, aircraft ship fires and wildfires can wreak havoc and cause serious injury and/or death. Thankfully, brave men and women have dedicated their lives to protecting others from flames that can occur due to a myriad of reasons anywhere, at any time. Unfortunately, firefighters are only human and can succumb to injury or death as well.

With technology being as advanced as it is today, the idea of employing robots that are capable of travelling into areas unsafe for people through an array of sensors, visual camera, IR and more technology that transmits information for navigation to a remote operator didn't seen too far-fetched anymore.

Inspired by the recent forest fires in Syria which had a catastrophic effect on the crops and endangered both the lives and livelihoods of many farmers, we decided to try and create something that would help with a quicker discovery of the fires before they spread out of control.

In order to avoid the possibility of firemen arriving too late to the fire scene or not being able to access a certain rocky area, we've proposed creating a bunch of helper robots that will be able to get into those hard to access areas and recognize the fire threat in record time, thus potentially saving lives including the firemen's.

In this project we will be developing a swarm of robot cars that will move autonomously towards the fire and take appropriate actions.

Using things like color detecting algorithms to track the robot cars and a fixed ceiling camera that has a view of the entire environment along with PID control algorithms and Arduino to control the movement of the cars, we were able to achieve this goal.

We will be going into further detail about the technologies used and the steps taken in this report.

Chapter 1: Project Description

1.1 Background

The project objective is to help lessen the risk of fires and stop them from possibly spreading by sending a swarm of robots to scout the area and locate the fire before it gets out of hand and then notify the competent authorities.

1.2 Problem Statement

Wildfires threaten lives directly, and wildfire smoke can affect us all. They spread air pollution not only nearby, but thousands of miles away. We've noticed in the past year forests in Syria have fallen victim to the spread of wildfires and this has affected large areas of agricultural land. And there were many bumpy areas that the firefighters could not reach easily.

1.3Project Objective

The objective of the project is to create a swarm of fire-fighting robot cars. The robot helps to detect the exact direction of the fire source, it has the capability of sensing accurately with increased flexibility, Low cost in the long run, it is reliable and can easily access the bumpy areas that the firemen are usually unable to access, by using live footage from a camera we can efficiently detect the location of the fire.

1.4Project Scope

The Fire-Fighting robot is capable of detecting flames and moving towards them. The PID Algorithm and Arduino code work together to control the movement of the robot with obstacle avoidance. It can detect the flame more effectively in the buildings and fixed lighting conditions. The Fire-fighting robot cars can provide firefighters with enhanced situation awareness and more safety.

1.5Project Features

This project uses color detection through a fixed camera instead of sensors to locate both the fire and the robot coordinates.

The server, after receiving information from the camera, will be able to locate the fire.

The server will send the coordinates to the robot cars.

The robots will have different colors on top of them for ease of detection.

The robots will move autonomously towards the fire.

The robots will avoid colliding with each other.

The robot will have two wheels at rear side and two wheels at front side.

The wheels have the ability to stabilize the robot.

The robots are able to rotate until 360 degrees.

	Related work	**Comparison**
-Louay-Abo-Al-Dahab , Kinana al Rimawi, Mohammad Arafat.(2017). Multi agent robots.	-A swarm of self-driving robots heading towards a fixed target. Using a QR code on top of the robot in order to track its movements by scanning it and decoding a number on top of it to get the id of the car and a PID algorithm to help with the robots movement, the cars will autonomously head towards the target upon receiving the orders from the server.	1-This project used QR codes on top of the robot cars to find its coordinates and id. We used color detection and vectors in order to find its coordinates and id. 2-This project has the robots head towards a fixed target while ours has them head towards a fire source.
-Kirubakaran, S & Rithanyaa, S & Thanavarsheni, S & Vigneshkumar, E. (2021). Arduino based firefighting Robot.	-An Arduino UNO development board issued to control a firefighting robotic system. Made up of HC-SR04 sensors. A gas sensor (MQ2) for sensing hazardous smoke, a temperature sensor (LM35)for more precise temperature measurement, and a fire flame sensor (IR) for detecting and sensing the approaching fire are all mounted on a servo-motor for obstacle detection and free path navigation. In addition, for extinguishing the flames, it also makes use of a water tank and a spray gun mechanism. With the aid of a 12V pump, water is pumped from the main water tank to the water nozzle.	1- This project uses a gas sensor for sensing hazardous smoke and a fire flame sensor. We use no sensors and rely on the PID algorithm. 2-This project has a water pump to put out the fire. Our robot merely heads towards it as of now.

Chapter 2: Literature Review

Chapter 3: Hardware

The fixed camera:

Cameras are devices for recording visual images in the form of photographs, film, or video signals.

This camera will be hung from above and able to see the environment which contains both the fire and the robots, and take live footage and send it to the server.

The server:

In computing, a server is a piece of computer hardware or software (computer program) that provides functionality for other programs or devices, it may serve data to systems on a local area network (LAN) or a wide area network (WAN) over the Internet.

In this case, the server will receive the live footage from the fixed camera and preprocess the data using OpenCV-Python which is a huge open-source library for the computer vision, machine learning, and image processing and now it plays a major role in real-time operation which is very important in today's systems. By using it, one can process images and videos to identify objects, faces, or even handwriting of a human.

The server will calculate the coordinates and area of the fire and the coordinates of the robots and send that information to the robot cars.

The cars:

Each robot is a self-driving (autonomous) robo-car, capable of sensing its environment and moving safely with little or no human input.

The robots will receive information from the server allowing them to locate the fire and move towards it while avoiding obstacles.

In order to assemble the new robot friends, controlling DC motors is needed . One of the easiest and inexpensive way to control DC motors is to interface L298N Motor Driver **with Arduino.** It can control both speed and spinning direction of two DC motors.

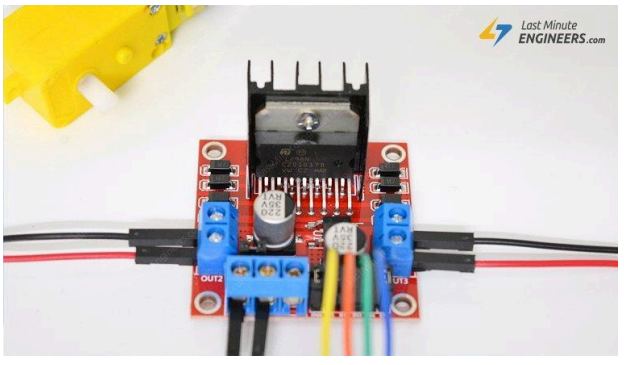


Figure 1

In order to have a complete control over DC motor, one must control its speed and rotation direction. This can be achieved by combining these two techniques.

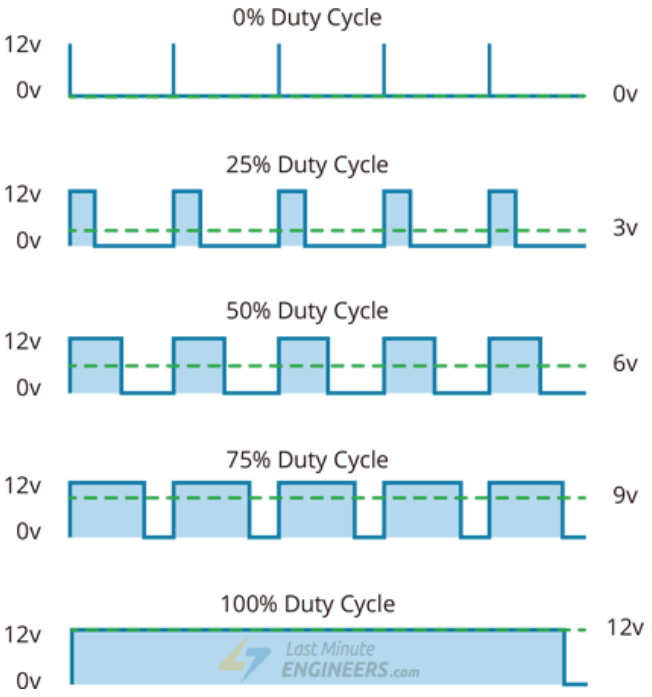
Car components:

1. PWM – For controlling speed 2. H-Bridge – For controlling rotation direction

>The speed of a DC motor can be controlled by varying its input voltage. A common technique for doing this is to use PWM (Pulse Width Modulation)

PWM is a technique where average value of the input voltage is adjusted by sending a series of ON-OFF pulses.

The average voltage is proportional to the width of the pulses known as Duty Cycle.



The higher the duty cycle, the greater the average voltage being applied to the dc motor(High Speed) and the lower the duty cycle, the less the average voltage being applied to the dc motor(Low Speed).

The image to the right illustrates PWM technique with various duty cycles and average voltages.

Figure 2

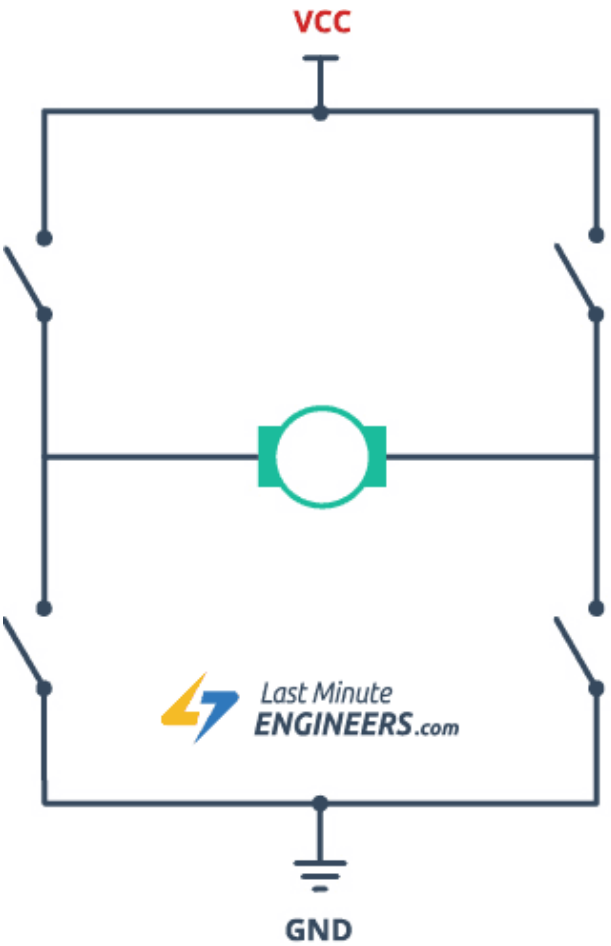
>The DC motor's spinning direction can be controlled by changing polarity of its input voltage. A common technique for doing this is to use an H-Bridge.

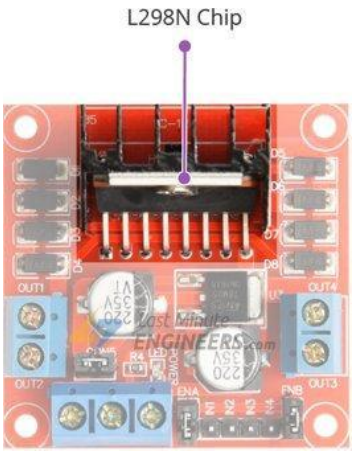
An **H-Bridge circuit** contains four switches with the motor at the center forming an H-like arrangement.

Closing two particular switches at the same time reverses the polarity of the voltage applied to the motor. This causes change in spinning direction of the motor.

To the right is an image that shows an H-bridge circuit working:

Figure 3





> L298N Motor Driver IC:

At the heart of the module is the big, black chip with chunky heat sink is an L298N.

The L298N is a dual-channel H-Bridge motor driver capable of driving a pair of DC motors. That means it can individually drive up to two motors making it ideal for building two-wheel robot platforms.

Figure 4

> Power Supply:

The L298N motor driver module is powered through 3-pin 3.5mm-pitch screw terminals. It consists of pins for motor power supply(Vs), ground and 5V logic power supply(Vss).

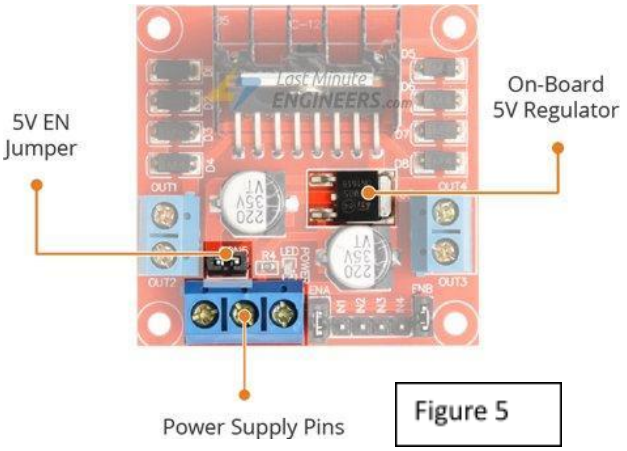


Figure 5

> Voltage Drop of L298N:

The voltage drop of the L298N motor driver is about 2V. This is due to the internal voltage drop in the switching transistors in the H-Bridge circuit.

So, if 12V are connected to the motor power supply terminal, the motors will receive voltage around 10V. This means that a 12V DC motor will never spin at its maximum speed.

To get maximum speed out of motor, the motor power supply should be bit higher voltage(2V) than motor's actual voltage requirement.

Considering the voltage drop of 2V, 5V motors are being used, 7V need to be provided at motor power supply terminal.

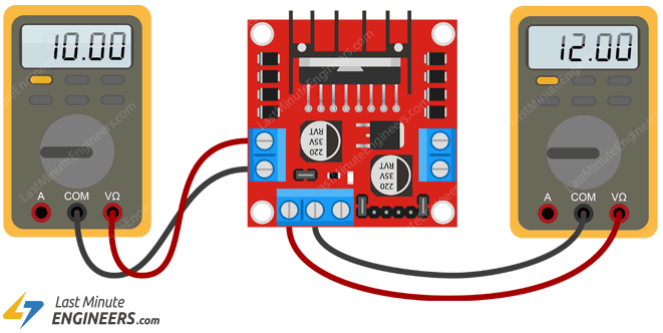
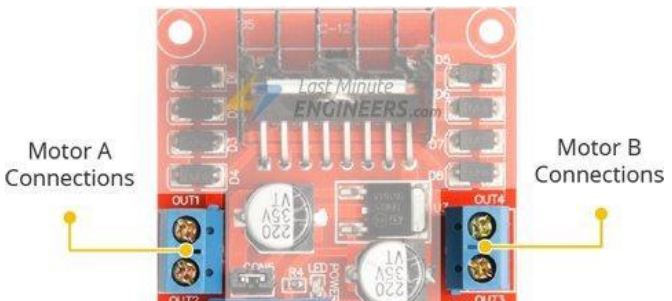


Figure 6



> Output Pins:

The L298N motor driver's output channels for the motor A and B are broken out to the edge of the module with two 3.5mm-pitch screw terminals.

Each channel on the module can deliver up to 2A to the DC motor. However, the amount of current supplied to the motor depends on system's power supply.

> Control Pins:

For each of the L298N's channels, there are two types of control pins which allow for controlling speed and spinning direction of the DC motors at the same time via **Direction control pins** & **Speed control pins.**

Figure 7

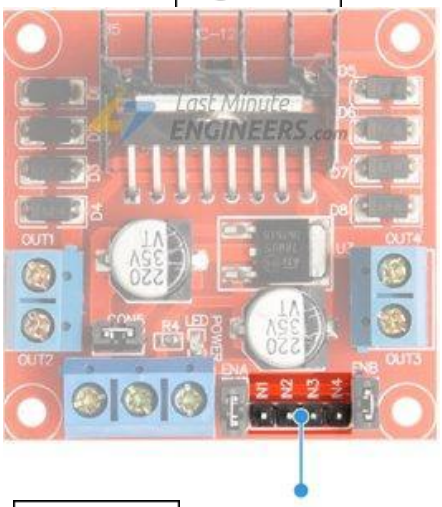


Figure 8 Direction Control Pins

>> Direction Control Pins:

Using the direction control pins, we can control whether the motor spins forward or backward. These pins actually control the switches of the H-Bridge circuit inside L298N IC.

The module has two direction control pins for each channel. The IN1 and IN2 pins control the spinning direction of the motor A while IN3 and IN4 control motor B.

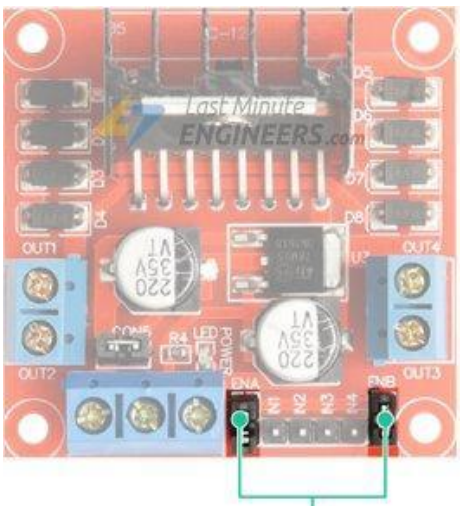
The spinning direction of a motor can be controlled by applying either a logic HIGH (5 Volts) or logic LOW(Ground) to these inputs. The below chart illustrates how this is done.

Input1	Input2	Spinning Direction
Low(0)	Low(0)	Motor OFF
High(1)	Low(0)	Forward
Low(0)	High(1)	Backward
High(1)	High(1)	Motor OFF

>> Speed Control Pins:

The speed control pins viz. ENA and ENB are used to turn the motors ON, OFF and control its speed.

Pulling these pins HIGH will make the motors spin, pulling it LOW will make them stop. But, with Pulse Width Modulation (PWM), we can actually control the speed of the motors.

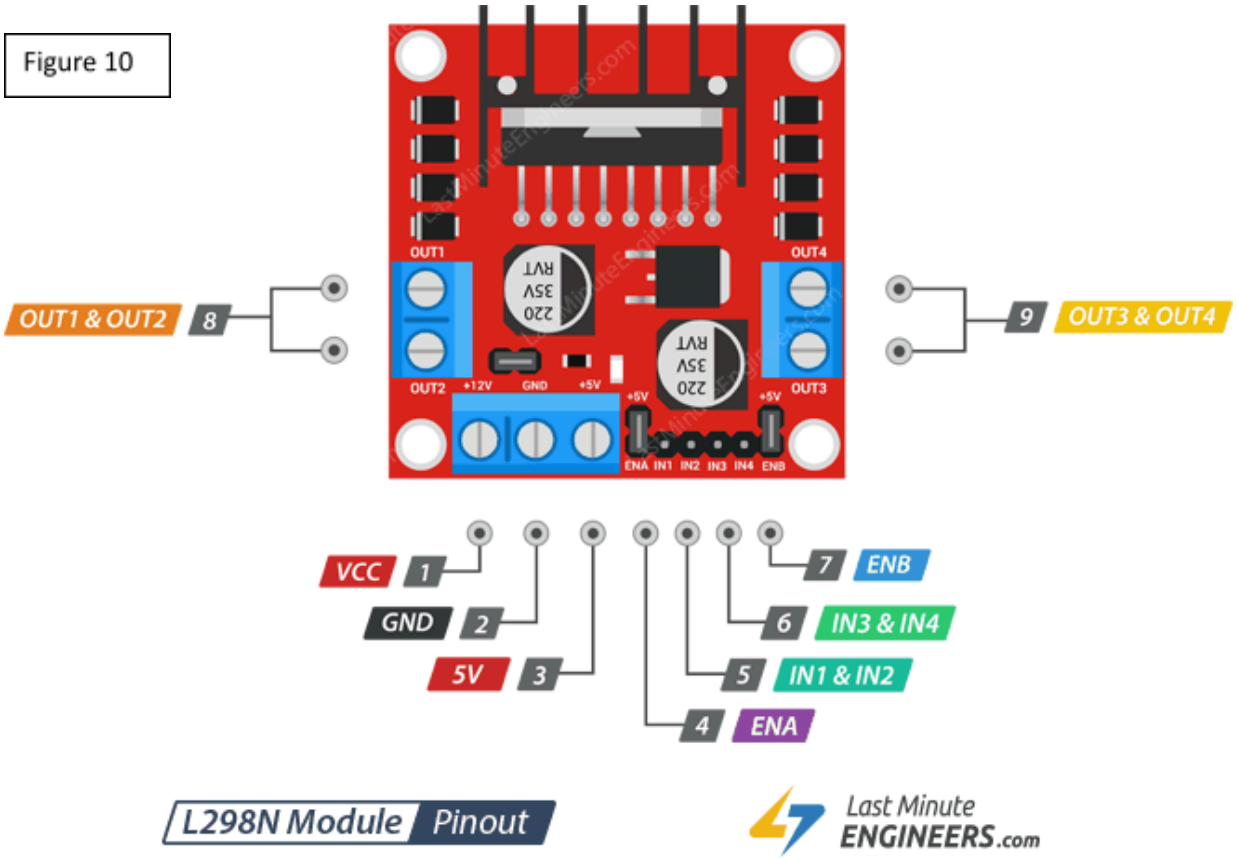


The module usually comes with a jumper on these pins. When this jumper is in place, the motor is enabled and spins at maximum speed. To control the speed of motors programmatically, removing the jumpers and connect them to PWM-enabled pins on Arduino is a must.

Figure 9

> L298N Motor Driver Module Pinout:

Figure 10



VCC pin supplies power for the motor. It can be anywhere between 5 to 35V. Remember, if the 5V-EN jumper is in place, you need to supply 2 extra volts than motor's actual voltage requirement, in order to get maximum speed out of your motor.

GND is a common ground pin.

5V pin supplies power for the switching logic circuitry inside L298N IC. If the 5V-EN jumper is in place, this pin acts as an output and can be used to power up your Arduino. If the 5V-EN jumper is removed, you need to connect it to the 5V pin on Arduino.

ENA pins are used to control speed of Motor A. Pulling this pin HIGH(Keeping the jumper in place) will make the Motor A spin, pulling it LOW will make the motor stop. Removing the jumper and connecting this pin to PWM input will let us control the speed of Motor A.

IN1 & IN2 pins are used to control spinning direction of Motor A. When one of them is HIGH and other is LOW, the Motor A will spin. If both the inputs are either HIGH or LOW the Motor A will stop.

IN3 & IN4 pins are used to control spinning direction of Motor B. When one of them is HIGH and other is LOW, the Motor B will spin. If both the inputs are either HIGH or LOW the Motor B will stop.

ENB pins are used to control speed of Motor B. Pulling this pin HIGH(Keeping the jumper in place) will make the Motor B spin, pulling it LOW will make the motor stop. Removing the jumper and connecting this pin to PWM input will let us control the speed of Motor B.

OUT1 & OUT2 pins are connected to Motor A.

OUT3 & OUT4 pins are connected to Motor B.

> Wiring L298N motor driver module with Arduino UNO:

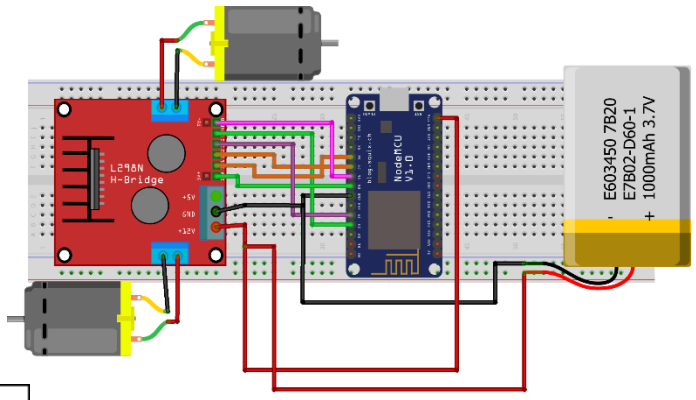
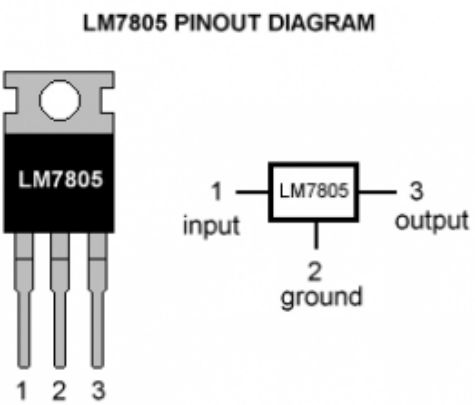


Figure 11

>Voltage Regulator:

Voltage sources in a circuit may have fluctuations resulting in not providing fixed voltage outputs. A voltage regulator IC maintains the output voltage at a constant value.



>7805 IC Rating

Input voltage range 7V- 35V

Current rating $I_{c=}$ 1A

Output voltage range $V_{Max=5.2V}$, $V_{Min=4.8V}$

Figure 12

>Pin Details of 7805 IC:

Pin No.	Pin	Function	Description

1	INPUT	Input voltage (7V-35V)	In this pin of the IC positive unregulated voltage is given in regulation.
2	GROUND	Ground (0V)	In this pin where the ground is given. This pin is neutral for equally the inpu and output.
3	OUTPUT	Regulated output; 5V (4.8V-5.2V)	The output of the regulated 5V volt is taken out at this pin of the IC regulator.

-There is a significant difference between the input voltage & the output voltage of the voltage regulator. This difference between the input and output voltage is released as heat. The greater the difference between the input and output voltage, more the heat generated.

If the regulator does not have a heat sink to dissipate this heat, it can get destroyed and malfunction. Hence, it is advisable to limit the voltage to a maximum of 2-3 volts above the output voltage.

> Scaling the output

The 7805's scaled output provides the input voltage (Vin) to the bandgap reference and the bandgap provides an error signal as the output. The 7805's bandgap circuit removes the feedback loop that exists inside a traditional bandgap reference. Instead, the entire chip becomes the feedback loop.

> lithium-ion battery:

A lithium-ion (Li-ion) battery is an advanced battery technology that uses lithium ions as a key component of its electrochemistry.



Figure 13

Compared to the other high-quality rechargeable battery technologies,

>>Li-ion batteries have a number of advantages:

They have one of the highest energy densities of any battery technology today (100-265 Wh/kg or 250-670 Wh/L).

In addition, Li-ion battery cells can deliver up to 3.6 Volts, 3 times higher than technologies such as Ni-Cd or Ni MH. This means that they can deliver large amounts of current for high-power applications.

Li-ion batteries are also comparatively low maintenance, and do not require scheduled cycling to maintain their battery life.

Li-ion batteries have no memory effect, a detrimental process where repeated partial discharge/charge cycles can cause a battery to 'remember' a lower capacity.

>NodeMCU:

The NodeMCU (***N***ode ***M***icro***C***ontroller ***U***nit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266.

It contains the crucial elements of a computer: CPU, RAM, networking (WiFi), and even a modern operating system.

The Arduino hardware is a microcontroller board with a USB connector, LED lights, and standard data pins. It also defines standard interfaces to interact with sensors or

other boards. But unlike NodeMCU, the Arduino board can have different types of CPU chips (typically an ARM or Intel x86 chip) with memory chips, and a variety of programming environments. There is an Arduino reference design for the ESP8266 chip as well. However, the flexibility of Arduino also means significant variations across different vendors. For example, most Arduino boards do not have WiFi capabilities, and some even have a serial data port instead of a USB port.

Pin Category	**Name**	**Description**
Power	Micro-USB, 3.3V, GND, Vin	**Micro-USB:** NodeMCU can be powered through the USB port **3.3V:** Regulated 3.3V can be supplied to this pin to power the board **GND:** Ground pins **Vin:** External Power Supply
Control Pins	**EN, RST**	The pin and the button resets the microcontroller
Analog Pin	A0	Used to measure analog voltage in the range of 0-3.3V
GPIO Pins	GPIO1 to GPIO16	NodeMCU has 16 general purpose input-output pins on its board
SPI Pins	SD1, CMD, SD0, CLK	NodeMCU has four pins available for SPI communication.
UART Pins	TXD0, RXD0, TXD2, RXD2	NodeMCU has two UART interfaces, UART0 (RXD0 & TXD0) and UA (RXD1 & TXD1). UART1 is used to upload the firmware/program.
I2C Pins		NodeMCU has I2C functionality support but due to the internal functiona of these pins, you have to find which pin is I2C.

>NodeMCU Development Board Pinout Configuration:

>NodeMCU ESP8266 Specifications & Features:

- Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106

- Operating Voltage: 3.3V
- Input Voltage: 7-12V
- Digital I/O Pins (DIO): 16
- Analog Input Pins (ADC): 1
- UARTs: 1
- SPIs: 1
- I2Cs: 1
- Flash Memory: 4 MB
- SRAM: 64 KB
- Clock Speed: 80 MHz
- USB-TTL based on CP2102 is included onboard, Enabling Plug n Play
- PCB Antenna
- Small Sized module to fit smartly inside your IOT projects.

>>The NodeMCU offers a variety of development environments, including compatibility with the Arduino IDE.

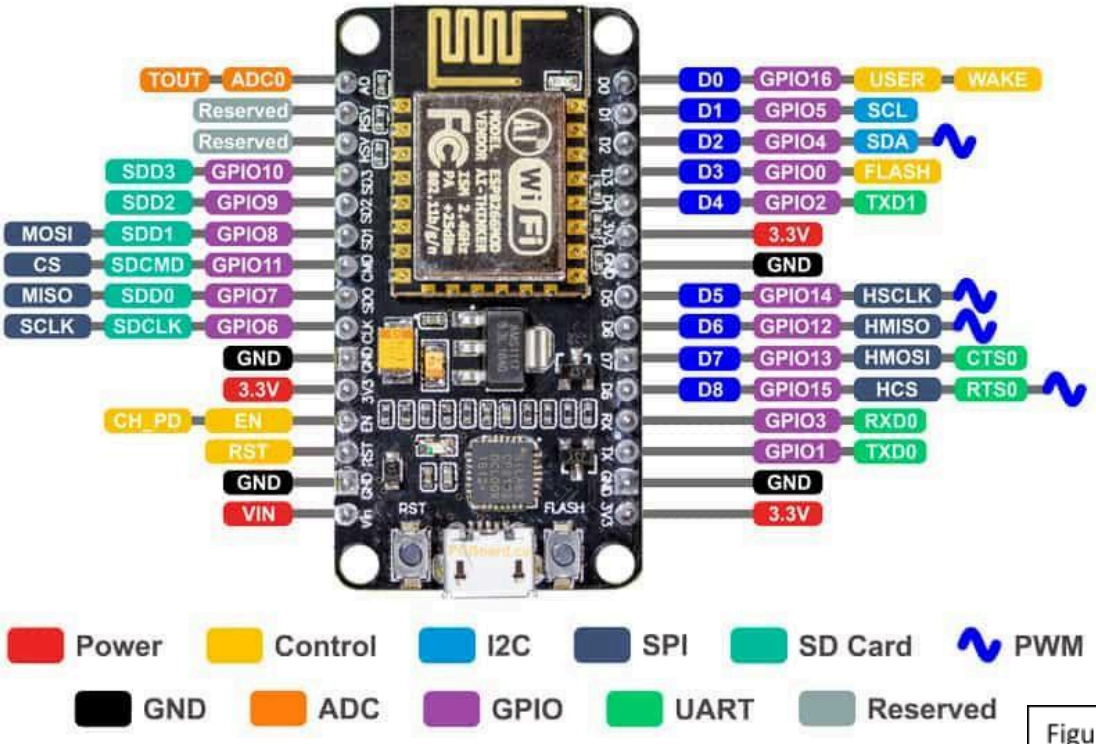


Figure14

The motors:

This Mini Electric Motor is a general purpose motor, work with batteries or solar cells perfectly Great replacement for the rusty or damaged DC gear motor on the machine. Used for electronic fans, electronic machine, toys, cars, robots, Arduino projects, etc with EMC, it has strong anti-interference ability and causes no interference to micro-controller



Figure 15

The wires:

A jump wire (also known as jumper, jumper wire, jumper cable, DuPont wire or cable) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.
Individual jump wires are fitted by inserting their "end connectors" into the slots provided in a breadboard, the header connector of a circuit board, or a piece of test equipment.



Figure 16

Chapter 4: System Analysis

4.1 Fire detection

Data Sets

Several data sets were merged together including pictures that either contain fires or don't.

The neural network

The previous data sets were used to train a **CNN** to be able to detect whether there is a fire or not in a given environment using Tensorflow and Keras both frameworks provide high-level APIs for building and training models with ease.

Results

The first time the network was trained, the accuracy wasn't the best, It was about 50% and the problem of overfitting occurred.

The second time the network was trained, the overfitting was fixed by expanding the data set and retraining which paid off in giving us an accuracy of 75%.

Eventually, after changing the variables in each layer of the network and continuously training it, the accuracy increased to 98%.



Figure 17

4.2 Tracking the robot:

Next step is to track the robot through the fixed camera in order to gain it's coordinates and orientation in real time and send them to the server.

To tackle this problem many different approaches were tried:

First solution: The first method that was tried was by using color detection and shape recognition with the help of Python's OpenCV library. The idea was to place 2 circles of different sizes on top of each car, using color recognition we would track the cars that have unique colors on top of them, and the ceiling cam, and the size difference would let us know which circle was at the front and which was at the back of the robot.

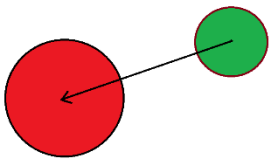


Figure 18

As for the angles, using the vector from the smaller to the bigger circle and the mid-points of each circle we were able to write an algorithm that would calculate them by figuring out the distance between each circle and comparing them to find which two circles belong on the same car.

Dist=√x^2+y^2

Then by calculating two variables : **verctorpfcarx** (by subtracting the y coordinates of all points form the x coordinates) and **vectorofcary** (by subtracting the x coordinates of all points form the y coordinates), thus the angle of the car would be given by: **arctan(vectorofcarx/vectorofcary).**

The issue we ran into has to do with the Quadrants of a Trigonometric Circle, as our previous rule doesn't work in every quadrant, we had to define a new function (fix angle) that would work on **translating to the first quadrant** using the **trigonometric laws.**

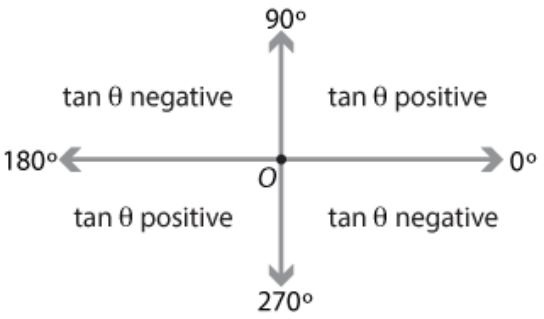


Figure 19

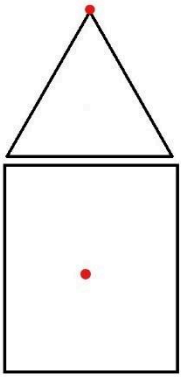
We ran into issues regarding the circle detection in real time with the first solution, due to the poor quality of the webcam and a delay in frame processing, in order to confirm this a different shape would be tried.



Figure 20

Second solution:

Since the problem was supposedly with the shape detection, it was decided that an easier shape to manage and find the vector from was the following:



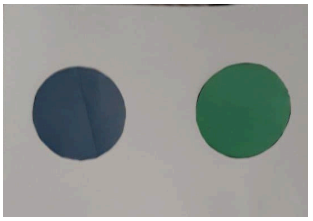
An amalgamation of a triangle and a rectangle, the idea was to grab the contours and the vector would go from the midpoint of the rectangle to the head of the triangle for ease and speed of detection.

This did not however work much better and the delay issue remained, which lead to the conclusion that the camera would only take 30 frames per second and the car would be moving in at least 60fps which caused damage to the photo.

Figure 21

After much consideration we reached the third and final solution.

Third solution:

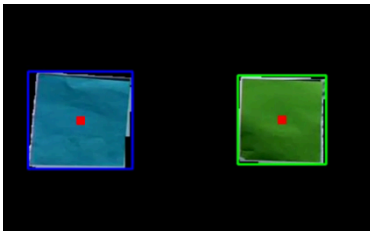


Color detection, it was decided that colors would be enough and shape detection wouldn't be necessary, two different colors would be placed on top of each car and upon detecting the color's contour we'd be able to return 3 main things:

-The coordinates of the midpoint of the contour.

-Which car we're working with.

-Which side that particular color is on (front or back of car?)



This was the most efficient method by far and upon merging the color detection code with the angle code explained in solution #1 the robot was successfully tracked in real time.

Figure 22

The previous info would later be sent to the server.

4.3 Controlling the robot:

This part will be done using an Arduino code and a **PID algorithm**.

The term PID stands for proportional integral derivative and it is one kind of device used to control different process variables like pressure, flow, temperature, and speed in industrial applications. In this controller, a control loop feedback device is used to regulate all the process variables.

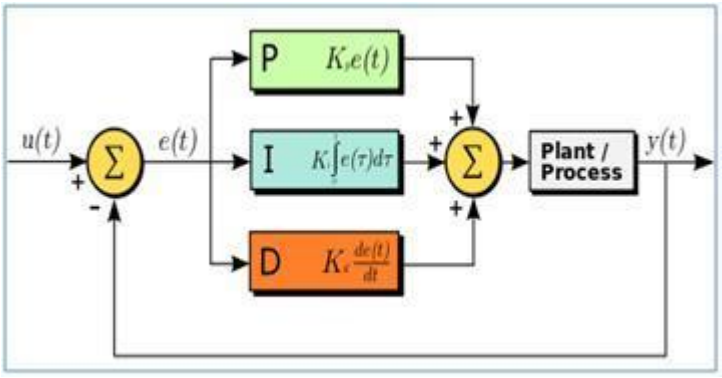


Figure 23

To implement a PID controller in a code or an Arduino sketch, five parameters must be known: proportional, integral and derivative constants, input value and set point value, the integral part didn't need to be used in our case.

To determine the error the following equation was used:

Error = setpoint – input;

The derivative of the error is the rate of change of the error:

rateError = (error - lastError)/elapsedTime;

Finally, the computed output is:

output = Kp * error + Ki * cumError + Kd * rateError;

Here, the **Kp, Ki** and **Kd** are the predetermined constants.

Finally, the variables must be noted for the next iteration:

lastError = error;

previousTime = currentTime;

4.4 Final results

-By merging the server, color detection and orientation codes together the final result was an autonomous robot capable of heading towards a designated target (the fire in our case) with the help of a fire detecting neural network.

The Arduino/PID code would be given to the robot car and once that's done the robot would be disconnected from the pc and a hotspot would be established to connect the car remotely to the server.

Once we run the code the camera would track the robot car from above using the colors on top of it and the server would take in the acquired info such as the robot coordinates and orientation and the needed orientation in order to head towards the fire and send an order to the robot which will then direct itself and move forward towards the fire.

The figure to the right shows a robot with 2 colors (yellow and orange) on top of it successfully moving towards the green circle which represents the fire target.

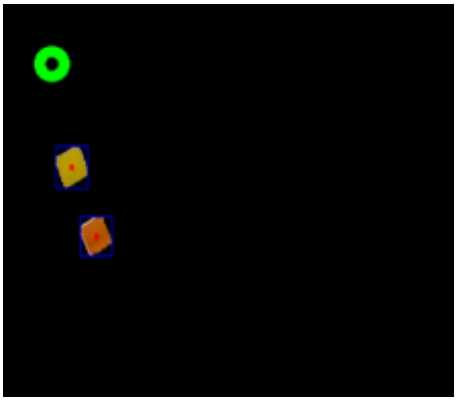


Figure 24

4.5 block diagram:

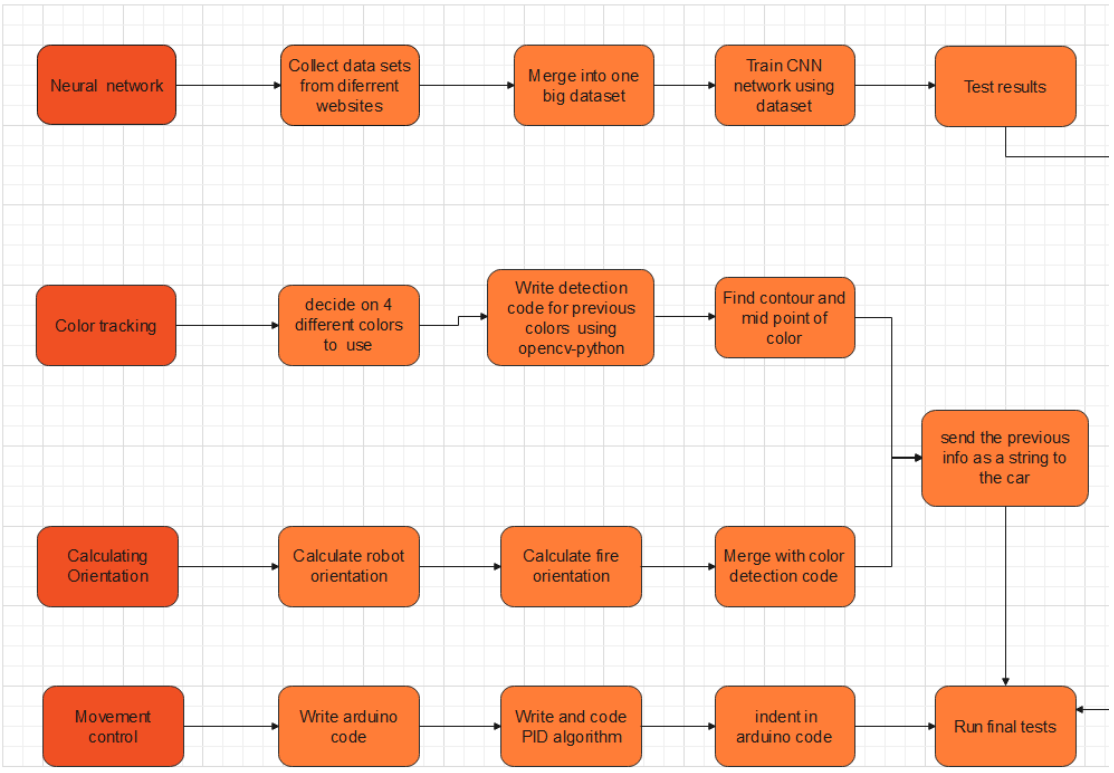


Figure 25

Conclusion and Future Vision

In conclusion, this project was inspired by Syria's recent forest fires, our robots were designed to help lessen the risks of fire and make firefighter's jobs a little easier, by being able to quickly recognize the fire threat before it spreads and autonomously head towards it with the help of a fixed ceiling camera that would be able to track them and send their location and the fire's location to a remote server and a perfected PID algorithm to make sure it stays on the right track.

The project is nowhere near perfect yet and still needs a lot of work in order to be ready to be implemented in the real world, however, we believe our idea has lots of potential and could save lives if implemented correctly.

Our hope for the future is to implement this idea on drones instead of robot cars.

Our future vision would probably look like this:

- Drones would be perfect for scouting the large forest area from above. They would roam around the area from above scouting for any potential fires and be able to stop them from spreading.

- The drones would have heat sensors to help with the fire detection alongside the neural network, they would have high accuracy and fast processing.

- The drones would be equipped with special water dispensers in order to help put out the fire.

- Finally, they would be able to send an alert along with the exact location of the fires to the nearest fire station.

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6- OpenCV documentation.

نبذة مختصرة

أخطار الحرائق لا يمكن إنكارها وغالبًا ما تكون كارثية، وهذا هو سبب أهمية مكافحة الحرائق، فهي تتعلق بالمخاطرة بحياتك لإنقاذ شخص آخر. إنها مهنة مميتة، وقليل من الناس فقط هم على استعداد لتحمل المخاطرة..

يتعرض رجال الإطفاء لخطر دائم بينما يخاطرون بحياتهم في ظل ظروف خطيرة. هدفنا هو مساعدتهم من خلال صنع سيارات آلية قادرة على البحث عن مصدر محتمل للنيران في البيئة الصناعية وإعلان خطر الحريق قبل أن يخرج عن نطاق السيطرة..

إن روبوت مكافحة الحرائق قادر على اكتشاف اللهب والتحرك نحوها، وسيعرف إلى أين يتجه بفضل كاميرا السقف الثابتة التي تتمتع بإطلالة من أعلى على البيئة بأكملها التي سيستكشفها الروبوت..

سترسل الكاميرا إحداثيات الروبوت عن طريق التعرف على الألوان الموجودة على ظهره واستخدام خوارزمية الكشف عن الألوان لتتبع الروبوت..

ستعثر الكاميرا أيضًا على إحداثيات الحريق ثم ترسل كلا الإحداثيين إلى الخادم الذي سيأمر بعد ذلك سيارة الروبوت بالتوجه نحو النار..

تعمل خوارزمية التحكم مع كود الاوردوينو للتحكم في حركة الروبوت والتأكد من أنه يتجه في الاتجاه الصحيح ويصل إلى النار قبل أن يخرج عن نطاق السيطرة..

في هذا التقرير سوف ننقل مراحل مشروعنا ، والأجهزة والخوارزميات المستخدمة ، والمشاكل التي واجهناها و خططنا للمستقبل بالتفصيل..

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الجامعة العربية الدولية AIU جامعة سورية خاصة أُحدثت عام 2005، خططها الدراسية والوثائق الصادرة عنها معتمدة ومصدقة من قبل وزارة التعليم العالي في الجمهورية العربية السورية.

تعمل الجامعة على تحقيق الأهداف الآتية:

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- الإسهام في البحوث العلمية النظرية والتطبيقية التي تخدم أغراض التنمية الوطنية، ويتم العمل على حث الأساتذة والعاملين الأكاديميين على البحث العلمي والمشاركة في المؤتمرات والندوات التي تنظم الأبحاث.
- تحقيق الشراكة مع الجامعات العربية والأجنبية المرموقة بهدف التطوير والتحديث المستمرين للعمل الأكاديمي والقيام ببحوث علمية مشتركة.
- استقطاب الكفاءات الأكاديمية والبحثية المتميزة عن طريق توفير البيئة المناسبة لعملها.

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- المختبرات العلمية الحديثة، ومختبر للمكتبات الإلكترونية.
- المحفزات المادية والمعنوية للطلبة.
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- التوجيه والإرشاد الأكاديمي والتربوي.
- مجموعة كبيرة من اتفاقيات التعاون العلمي مع جامعات محلية وإقليمية ودولية ذات سمعة مرموقة.
- اتفاقيات ومذكرات تفاهم متعددة مع العديد من مؤسسات المجتمع المدني.
- الحرم الجامعي اللائق والمزود بكافة المرافق العلمية والرياضية والترفيهية، والذي نشجعك على زيارته والتعرف على مزاياه.
- الأنشطة والأندية الطلابية بمختلف أنواعها: الرياضية والثقافية والعلمية والاجتماعية.

في الجامعة العربية الدولية سنوات الحياة الجامعية هي وقت للاستثمار في مستقبل الطالب. فالمعارف والخبرات التي يحصلها في قاعة المحاضرات والمختبرات ستساعده في تطوير ذاته، وستمنحه أسباب النجاح في التخصص الذي اختاره، والنشاط الطلابي الذي يمارسه سيساعده في توسيع أفقه، وفعاليات التدريب والأندية والرياضة ستمكنه من تطوير مواهبه، ولربما تساعده في اكتشاف مواهب جديدة.
ليستثمر وقته وذهنه وروحه في جامعتنا كي يجني فوائد عمله والوقت الذي كرسه في السنين القادمة. ونحن سوف نكون بجانب طلبتنا في كل خطوة على دربهم.



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قسم الهندسة المعلوماتية

تقديم

احمد الزين **هزار قربي**

كوثر فاخوري **لانا توما**

محمد الحوراني

بإشراف

الدكتور خالد دك الباب **المهندس لؤي أبو الدهب**

أغسطس 2021