Palestine Polytechnic University

College of Engineering

Graduation Project

Car Suffocation Rescue System

Project Team

Abdalla Bannoura, Electrical Engineering

Ehab Hawash, Electrical Engineering

Project Supervisor

Eng. Ayman Wazwaz

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الشكر والإهداء

اليوم ومع نهاية مرحلتي الجامعية، أقفُ أمامكم مرفوعَ الرأس، فخوراً بما قدمتهُ، والتي كانت النهاية السعيدة التي سهرتُ من أجلها الليالي ووضعتها في مصبْ نظري وأقسمتُ بأنْ أخرجَ من هنا تاركاً بصمتي التي سيتذكرها الجميع.

الشكر والفضل لله على نعمة الصبر والقدرة على إنجاز هذا المشروع فلله الحمد على هذه النعم.

نتقدم بجزيل الشكر والتقدير إلى الدكتور المشرف "م. أيمن وزوز" على كل ما قدمه لنا من توجيهات ومعلومات قيمة ساهمت في إثراء موضوع دراستنا في جوانبها المختلفة.

كذلك نتقدم بجزيل الشكر لأعضاء لجنة المناقشة على وقتهم الثمين لمناقشة المشروع.

لا يسعني إلا أنْ أتقدم بجزيل الشكر إلى عائلتي وأصدقائي الذين كانوا من أكبر الداعمين لي في الضراء قبل السراء وزادتني عزيمة وقوة لإكمال هذا المشوار بالنجاح الباهر.

أهدي هذا البحث والنجاح إلى روح والدي الحبيب الذي عملت جاهداً ليبقى فخوراً بي الآن وإلى الأبد.

ABSTRACT

Cars are becoming an important means of transportation; many families have at least one car. However, due to the carelessness of drivers or parents, they often leave their children in the car for a long time and lock the door and windows, which leads to heat shock or suffocation death of children. Especially, the cases of suffocation death caused by children left in the car by the parents who take a lot of time until they get back, ignoring the risk they are taking against their children.

In order to avoid the risk of suffocation in the car for children, an automated rescue system based on microcontroller is designed. ESP32 is used as a processor, a GSM communication module, a camera for a taking picture from inside the car, and sensors for temperature and CO_2. When it detects that a person in the vehicle is locked and in a closed environment, the alarm information is sent to the emergency contact person such as parents or car owner via Telegram and the microcontroller send a signal to open ventilation channel which represents in opening windows.

أصبحت السيارات وسيلة نقل مهمة، معظم العائلات تمتلك سيارة على الاقل. ومع ذلك، وبسبب إهمال السائقين أو الوالدين، فإنهم غالبًا ما يتركون أطفالهم في السيارة لفترة طويلة ويغلقون الباب والنوافذ، مما يؤدي إلى صدمة شمسية أو موت الأطفال اختناقًا. على وجه الخصوص، حالات الوفاة بالاختناق التي تسبب بها الأطفال في السيارة من قبل الوالدين الذين يستغرقون الكثير من الوقت حتى يعودوا، متجاهلين المخاطر التي يتعرضون لها ضد أطفالهم.

من أجل تجنب خطر الاختناق في السيارة للأطفال، تم تصميم نظام إنقاذ آلي يعتمد على متحكم دقيق. يستخدم ESP32 كمعالج ووحدة اتصالات GSM وكاميرا لالتقاط صورة من داخل السيارة وأجهزة استشعار لدرجة الحرارة وثاني أكسيد الكربون. عندما يتم اكتشاف أن شخصًا محتجز في سيارة وفي بيئة مغلقة، يتم إرسال معلومات الإنذار إلى المسؤول مثل الأهل او مالك السيارة في حالات الطوارئ عبر Telegram ويقوم المتحكم الدقيق بإرسال إشارة لفتح قناة التهوية والتي تمثل في فتح النوافذ.

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Chapter 1

Introduction

1.1 Overview

This chapter is the introduction for the project, which describes the general idea of the project, it also contains the project motivation, project objectives, project scope and literature reviews.

1.2 Background

Having little kids in vehicles is a very responsible yet something to be cautious from. Children under the age of six years are legally obligated to be seated in baby seats while driving. Forgetting kids alone in cars is a relatively common phenomenon that spreads widely in the Palestinian society. As a result, the percentage of death and injury rates of children has risen.

There are several cases, in which people forget their children in their vehicles for long periods of time, not necessarily paying attention, whether any venting channel is available. People usually leave their child due to rushing in stores, to work or to make visits to places in which they underestimate, how long it takes until they get back, ignoring the risk they are taking against their children. [1]

1.3 Problem Statement

Leaving children alone sitting or sleeping in vehicles without any air ways or venting channel, nor taking into consideration, how long they are going to stay.

A closed vehicle under the sun may turn very quickly into an oven, as the temperature inside it reaches from 25 to 35 degrees in 3 minutes, and to 50 degrees in 6-8 minutes. [2]

1.4 Importance

The system is particularly created for the safety of children with no venting channel, who are left alone inside vehicles.

Creating a smart rescue system that reduces the cases of children suffocating in closed cars due to being left jailed inside for long periods of time, especially under certain circumstances, where it is too hot outside in severe heat waves or in bad weathers.

1.5 Project Objectives

1. Providing a ventilation cannel via opening the windows.
2. Trigging an alarm inside the car the alerts the people around the car.
3. Alerting parents that they had left their children in the car by notifying their smartphones via calling or text messages.
4. Creating a rescue system with acceptable and competitive cost.

1.6 Motivation

This project mainly aims to improve safety and rescue children who are left alone inside the car without any venting channels, in order to reduce the percentage of death and injury rates of children.

The motive is the increasing of death and injury rates of children how are locked down inside the cars.

1.7 Project Scope

1. Context:

   The project is an integrated system with vehicle components placed on the roof of the vehicle.

2. Input and output information:

   The input will be:

   1) Camera or motion detection.
   2) CO_2 percentage.
   3) Temperature percentage.

   The output will be:

   1) Open venting channels.
   2) Alerting the parents via call or text message.
   3) Triggering the alarm.

3. Functions:

   1) Automatically activating the rescue system when detecting a child on the car, via a camera installed on the roof of the car or via motion sensor.

   2) Proposing a smart system that detects temperature and CO2 percentage inside the car cabinet to save kids from suffocation.

   3) Opening one of the windows, after the sensors detects the rising on CO_2 percentage and temperature level, to prevent suffocation.

   4) Quick response by call or via text message, by a GSM modem SIM900 that sends an alert via call or message.

   5) Triggering the car alarm immediately once the system additionally detects high temperatures or CO2 percentages.

1.8 Literature Review

- A paper, published in international journal of scientific and technology research, by S. Shankar, V. G. Paratheep, G. Paranesh, P. Umesh and V. M. Vignesh, talked about air suffocation prevention inside a car cabin, by using MQ135 Sensor and Arduino, so if the carbon dioxide (CO_2) level within the car is up to the set point which is measured in this work using Arduino. This will send a flag control the window and opens the window. [3]

- Another paper was proposed by Neera Batra, Jasleen Kaur and N.K>Batra, suggest (Smart CO detector) an automatic car window opening system on detection of carbon monoxide, a MQ-7 gas sensor is used to detect CO gas and display it on LCD screen, if CO percentage reached the limit, an alarm automatically rings and, if necessary, the window of ventilation is activated immediately. Also, a notification Via GSM is sent to the owner's number registered with smart CO detect system. [4]

- A new paper in 2021 published in Indus University by Prof. Swapnil Solanki, used PIR sensor to detect the motion of the child, and a MQ135 sensor is used to detect carbon dioxide gas, the sensor detect this situation which are connected to the Arduino. It further gives the signal to the relay module which is directly connected to the fan and turns it on in order to provide the air circulation inside the car. [5]

- Research about mechatronic system to prevent death due to suffocation in a locked car by Mallikappa DN Dodderi, Rao Sukesh Raghavendra, Narayana Hegde, Navaneeth Rao and Mohammed Asif. The system starts only if the engine is turned off also, doors and windows are closed or centrally locked. System then checks if there is any movement inside the car. If any movement is detected alarm is triggered until owner comes and turns it off. If no movement is detected for about 30 minutes, it will automatically get deactivated. Hardware: Raspberry Pi, BTC PC380 webcam. Two cameras have been setup above right front and left back of window glass with 30 degrees downwards so that they will only focus on car seats. When the temperature is above 35 and a motion sensor detects any motion or a pressure sensing element sense for weight on the seat, the microcontroller gives command to servo motor and it rotates by a required amount to lower the window and allows cool air to enter the cabin. [6]

Our project shares some similarity with some of the aforementioned projects, like using temperature and gas sensor to detect the increase in temperature and CO_2 percentage inside the car cabin, but with different technology. Like using a camera for detection with the motion sensor and sending an alert to the parents via calling or texting using the GSM which provides quick and fast response time and accurate detection of an emergency situation.

1.9 Task

Table (1.1): The arranged tasks along first & second semester.

# Of Task	Task description
T1	Project selection
T2	Identify the idea of the project
T3	Collect references from websites
T4	Select an initial design
T5	Conducting the needed adjustments and calibration on the design
T6	Select the mechanical parts
T7	Writing the thesis chapters
T8	Prepare the 1st presentation (Introduction to project)
T9	Editing the thesis based on received committee revision
T10	Purchasing the sensors and microcontroller part
T11	Building project prototype
T12	Conducted the needed programming and coding
T13	Testing the smart system
T14	Calibration of testing prototype
T15	Completing the thesis structure
T16	Preparing the final presentation

1.10 Time Schedule

Table (1.2): Illustrates tasks in first semester and how long it takes weekly for each task.

Task /weak	1	2	3	4	5	6	7	8	9	10	11	12	13	14
T1														
T2														
T3														
T4														
T5														
T6														
T7														
T8														

Table (1.3): Illustrates tasks in second semester and how long it takes weekly for each task.

Task /weak	1	2	3	4	5	6	7	8	9	10	11	12	13	14
T9														
T10														
T11														
T12														
T13														
T14														
T15														
T16														

1.11 Cost Estimation

Table (1.4): shows the expected cost for the prototype ±15%.

#	Name of part	Quantity	Cost
1	Body project	1	200 $
2	ESP32	1	25 $
3	ESP32 Camera	1	30 $
4	Temperature sensor	1	10 $
5	CO2 sensor	1	10 $
6	Motion Sensor	1	15 $
8	GSM model (Sim900)	1	30 $
9	FTDI	1	8 $
10	5V Relay	1	10 $
11	PCB Board	1	10 $
Total cost			348 $

Chapter 2

Theoretical Background

2.1 Overview

2.2 Car system

2.3 Risks

2.4 Hardware

2.5 Software

Chapter 2

Theoretical Background

2.1 Overview

This chapter defines the car system, techniques used in the project, and the used parts like microcontroller, sensor and camera, also the reason for choosing it, also language of programing.

2.2 Car System

Locked cars with no venting channels or with leaving the air condition on are never safe, as the temperature rising in a locked car is very high, it like to be locked down in oven. Refer to article hot cars can hit deadly, oven-like temperatures in as little as one hour. [7]

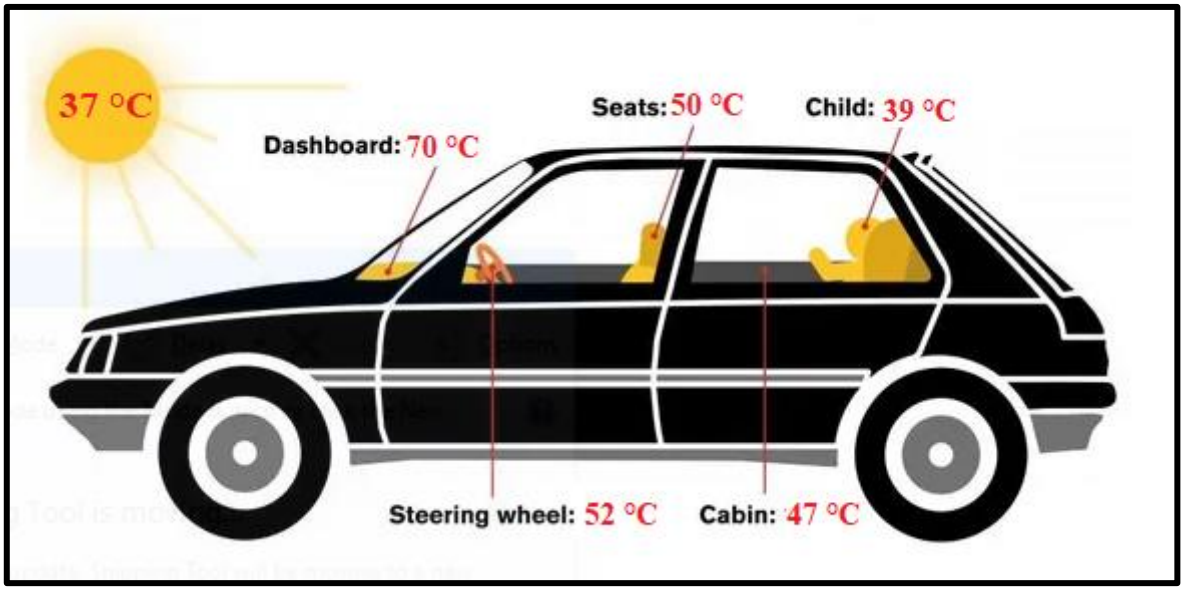

Figure 2.1: Vehicle Parked in The Sun For 60 Minutes

2.3 Risks

Lowering the window is the best way to keep the temperature in the safe range, also to let the air enter to the car cabin, so it helps the child who stuck inside to breath easily. Refer to A Mechatronic System to Prevent Death due to Suffocation in a Locked Car. [6]

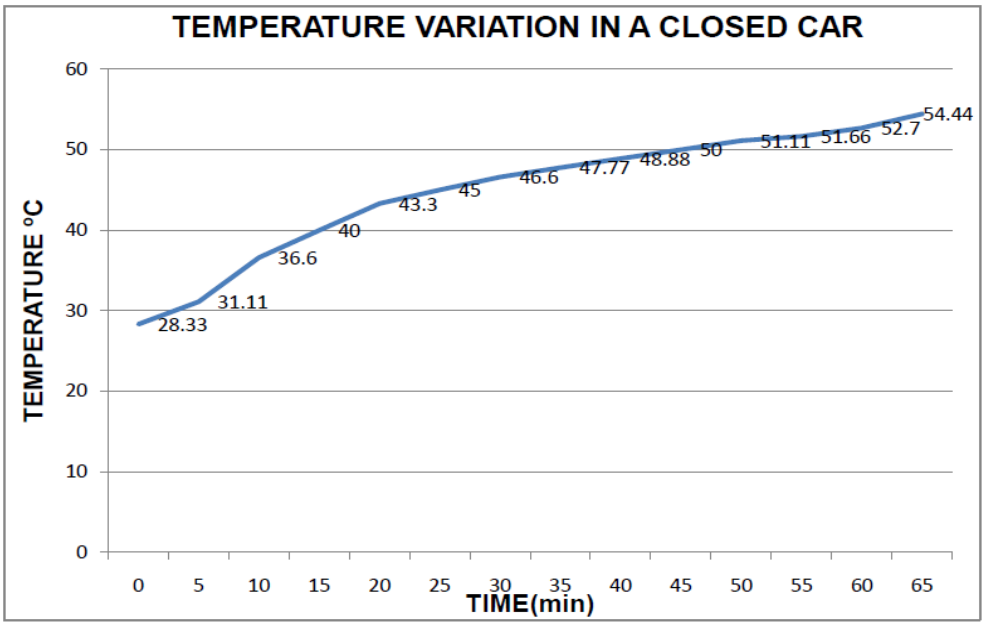

Figure 2.2: Temperature Variation in a Closed Car

Depicts that, when the car is closed, in the initial period, the temperature increases rapidly from the ambient temperature. With further passage of time, the temperature increases but at a slower rate. In 60 minutes, the temperature increased from 28 degree to 54 degree. This variation is thus harmful and fatal to the essential life.

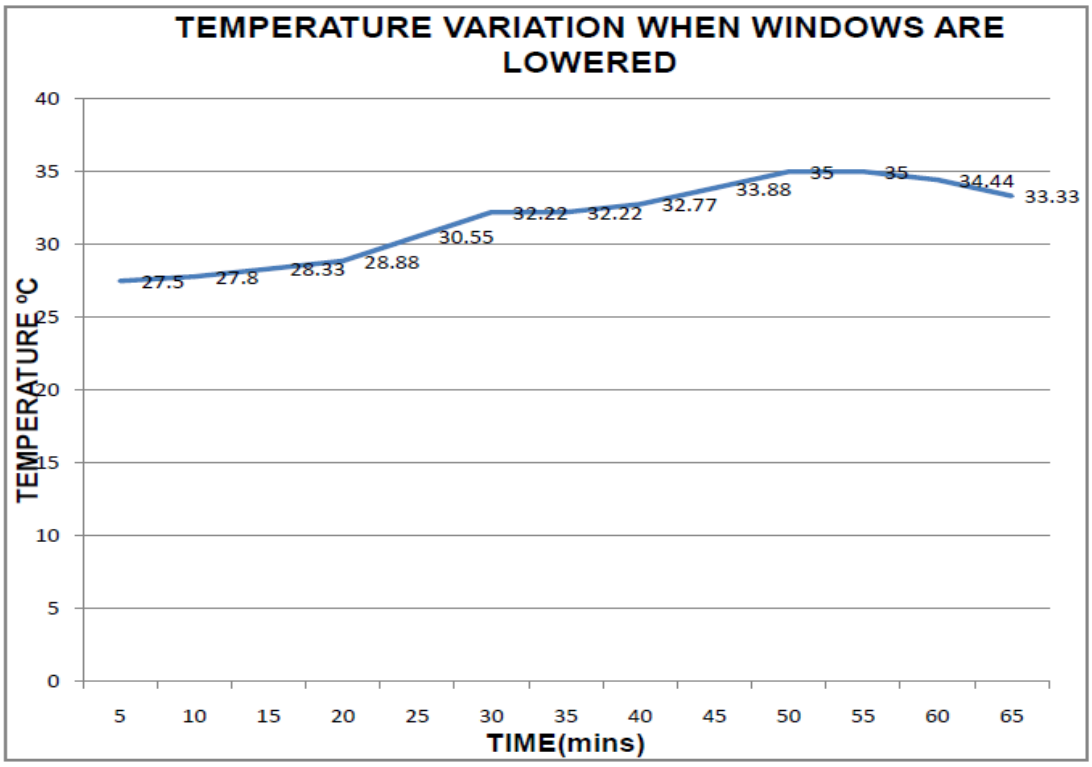

Figure 2.3: Temperature Variation When Windows are Lowered

Depicts that, with the windows lowered, the temperature increases at very low rate. In a period of 60 minutes, the temperature increased from 27.5 degree to 33.33 degree. This variation lies within the safe limit.

2.4 Hardware

The hardware components needed in this project.

2.4.1 ESP32 Microcontroller

ESP32 is a tool for making computers be able to sense and control more of the physical world than desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and development environment for writing software for the board.

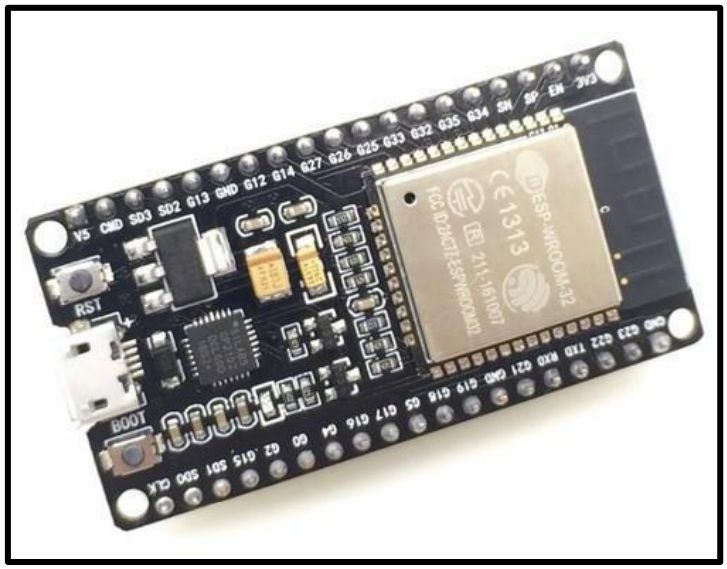

Figure 2.4: ESP32 Microcontroller

ESP32 is powerful, generic Wi-Fi + Bluetooth module that targets a wide variety of applications, ranging from low-power sensor networks to the most demanding tasks, such as voice encoding, music streaming and MP3 decoding.

ESP32 is highly-integrated with in-built antenna switches, power amplifier, low-noise receive amplifier, filters, and power management modules. ESP32 adds priceless functionality and versatility to your applications with minimal Printed Circuit Board (PCB) requirements. Also, it can perform as a complete standalone system, reducing communication stack overhead on the main application processor. Also, it can interface with other systems to provide Wi-Fi and Bluetooth. ESP32 is capable of functioning reliably in industrial environments, with an operating temperature ranging from –40°C to +125°C. [8]

The ESP32 can be programmed in more than one language like C, C++, and Python. The programming language used in this system is Arduino.

2.4.2 ESP Camera

The ESP32-CAM is a small size, (as shown in the figure 2.5), low power consumption camera module based on ESP32. It comes with an OV2640 camera and provides onboard card slot.

The ESP32-CAM module has fewer I/O pins than the previous ESP-32 module we looked at. Many of the GPIO pins are used internally for the camera and the microSD card port. Another thing missing from the ESP32-CAM module is a USB port. In order to program this device, you'll need to make use of an FTDI adapter.

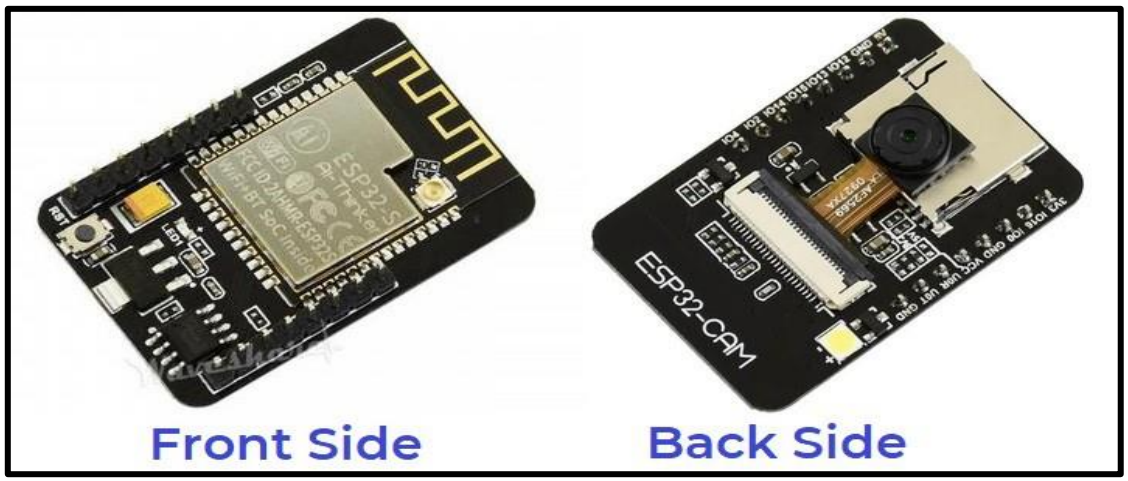

Figure 2.5: ESP32-Camera Module

The ESP32-CAM can be widely used in intelligent IoT applications such as wireless video monitoring, Wi-Fi image upload, QR identification, and so on. [9]

The ESP32-CAM suit for IOT applications such as:

- Facial detection.
- Wireless monitoring.
- Intelligent agriculture.
- QR wireless identification.

2.4.3 GSM Modem SIM900

GSM stands for Global System for Mobile Communications and is the global standard for mobile communications.

SIM900 is a GSM modem, which can be integrated into a great number of IoT projects. You can use this shield to accomplish almost anything a normal cell phone can; SMS text messages, Make or receive phone calls, connecting to internet through GPRS, TCP/IP, and more! To top it off, the shield supports quad-band GSM/GPRS network, meaning it works pretty much anywhere in the world. [10]

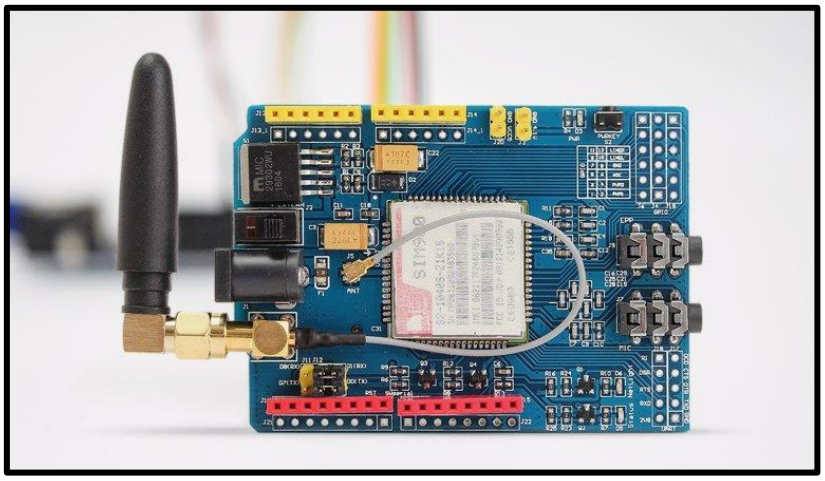

Figure 2.6: GSM Modem SIM900

2.4.4 Sensors

2.4.4.1 CO_2 Sensor (MQ135 Sensor)

The MQ-135 Gas sensors are used in air quality control equipment and are suitable for detecting or measuring of Alcohol, Benzene, Smoke, CO2. The MQ135 sensor module comes with a Digital Pin which makes this sensor to operate even without a microcontroller and that comes in handy when you are only trying to detect one particular gas. If you need to measure the gases in parts per million (PPM) the analog pin needs to be used. The analog pin is TTL driven and works on 5V and so can be used with most common microcontrollers like ESP32. [11]

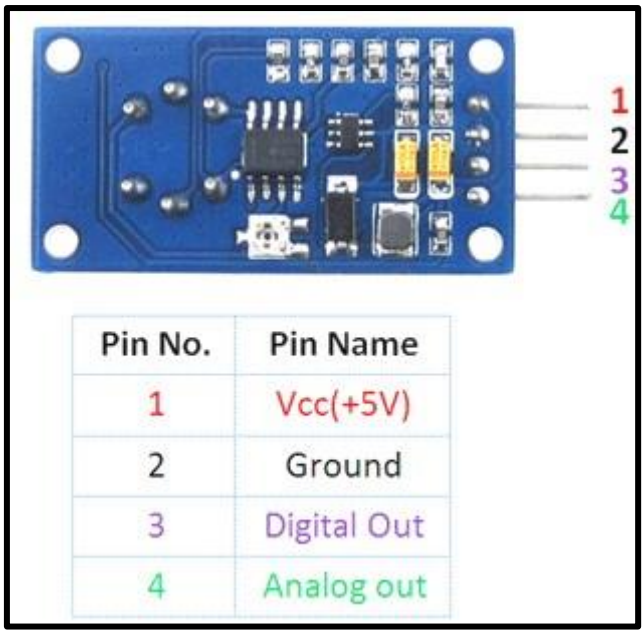

Figure 2.7: MQ135 Pinout

If indoor carbon dioxide levels get too high (around 40,000 ppm), your life may be in danger. At levels we are more likely to experience (1000-5000 ppm), the health effects are more subtle. Around 1000 ppm, a very common indoor level, you will start to experience fatigue, sleepiness, and may struggle to concentrate. [12]

The MQ135 sensor is used the detect the rising of CO2 levels inside the car cabin. And to keep anyone inside the car safe the limit of CO2 levels is going to be sit at 1000 PPM, because when it reaches this number after a period of time human will start to suffer from fatigues, and may start to Lose consciousness.

2.4.4.2 Temperature Sensor (DHT11)

DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital signal acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive type humidity measurement component and an NTC temperature measurement component, and connects to a high performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness. [13]

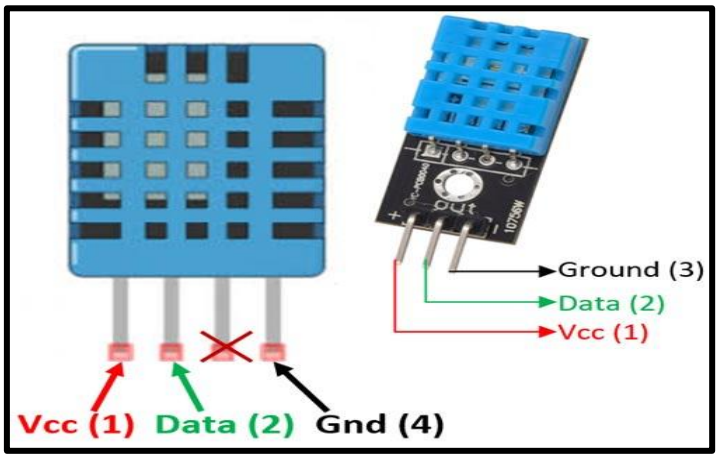

Figure 2.8: DHT11 Pinout

The DHT11 detects temperature from $0℃ - 50℃$ with accuracy equal $\mp 2℃$ which is acceptable for the project, it covers the needs. As the temperature increase the resistance of the DHT11 will decrease. The operating voltage of the DHT11 is 3.3V-5V. takes the power from the ESP32 pin 3.3V.

2.4.4.3 Motion Sensor (PIR Sensor)

PIR sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason, they are commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors. [14]

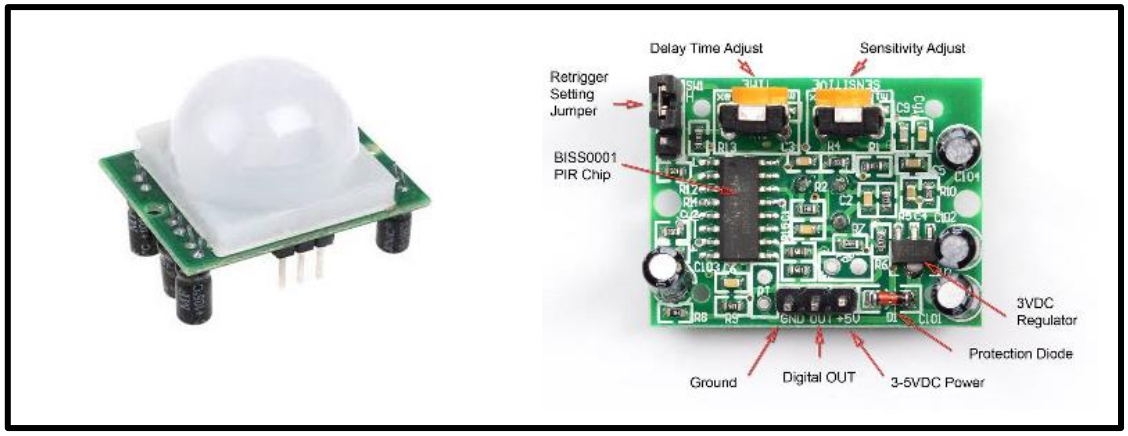

Figure 2.9: PIR Sensor Pinout

The PIR sensor detects the motion up to 6 meters, and gives 3.5V at the output when it detects a movement. And this output will set the camera to take photos inside the car and send them to the owner's phone.

The operating voltage is 3.3V, ESP23 is going to supply the sensor by 3.3V pin on it.

2.4.5 Actuators

2.4.5.1 Lowering Window

Lowering the window is the best way to keep the temperature in the safe range, also to let the air enter to the car cabin, so it helps the child how stuck inside to breath easily.

There is a relay that will take a signal from the microcontroller to open the window when the alarm starts, it will be lowered like 5-10 cm only.

The motor is going to be used in the project is DC Reversible Motor with operating voltage 12V.

2.4.5.2 Triggering Alarm

As the system starts and detects the existence of a child, also the sensors detect a rising on temperature or in CO_2 levels the alarm starts to warn the people around.

The Buzzer will work with 3.3V coming from the microcontroller pins.

Figure 2.10: Buzzer

2.5 Software

The programming language and libraries needed in this project.

2.5.1 Arduino Code

Arduino code is written in C++ with an addition of special methods and functions, which we'll mention later on. C++ is a human-readable programming language. When you create a 'sketch' (the name given to Arduino code files), it is processed and compiled to machine language.

The Arduino Integrated Development Environment (IDE) is the main text editing program used for Arduino programming. It is where you'll be typing up your code before uploading it to the board you want to program. Arduino code is referred to as sketches. [15]

The Arduino integrated development environment (IDE) has main features: [16]

- Sketch Editing Tools
- Libraries
- Serial Monitor
- Programmer Functions
- Sketches Management
- Auto Format
- User Preferences
- Fix Encoding & Reload
- Board Selection & Management
- Project Documentation

The main benefits of Arduino IDE can be seen in its ability to function as an on-premise application and as an online editor, direct sketching, board module options, and integrated libraries.

The software has hundreds of integrated libraries. These libraries were made and openly shared by the Arduino community. Users can take advantage of this for their own projects without involving third-party installations.

2.5.2 Needed Libraries

There are several libraries that will be added to support many tasks.

- Open CV Library.

OpenCV is a huge open-source library for computer vision, machine learning, and image processing. OpenCV supports a wide variety of programming languages like Arduino, C++, Java, etc. It can process images and videos to identify objects, faces, or even the handwriting of a human. When it is integrated with various libraries, such as NumPy which is a highly optimized library for numerical operations, then the number of weapons increases in your Arsenal i.e., whatever operations one can do in NumPy can be combined with OpenCV.[17]

Artificial Intelligence (AI) is the science and engineering of making intelligent machines, especially intelligent computer programs. Artificial Intelligence is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable.[18]

Machine Learning (ML) is a subset of Artificial Intelligence. ML is a science of designing and applying algorithms that are able to learn things from past cases. If some behavior exists in past, then you may predict if or it can happen again. Means if there are no past cases then there is no prediction.[18]

The ESP32 CAM Based Object Detection & Identification with OpenCV.

Chapter 3

System Design

3.1 Overview

3.2 Introduction

3.3 State Behavior

3.4 Hardware Interface Design

3.5 Software Interface Design

3.6 Project Prototype

3.7 Conclusion

Chapter 3

System Design

3.1 Overview

This chapter introduces the whole system, not only the subsystems and the components that define the system but also the relations between objects and the interfaces, furthermore it provides the control system diagram, data diagram and state diagram. Moreover, it shows the inner and outer interfaces between the blocks of the system.

3.2 Introduction

Before start explaining the system in details, Figure 3.1 show an overview of the system in general with the main component and the important subsystems are used.

- ESP32 the main brain of the system. That is going to lower the window and trigger alarm.
- ESP camera and motion sensor are used for detection.
- CO2 and Temperature sensor are used to read the percentage of CO2 and temperature continuously.
- GSM Modem is used to send warnings to the parents.

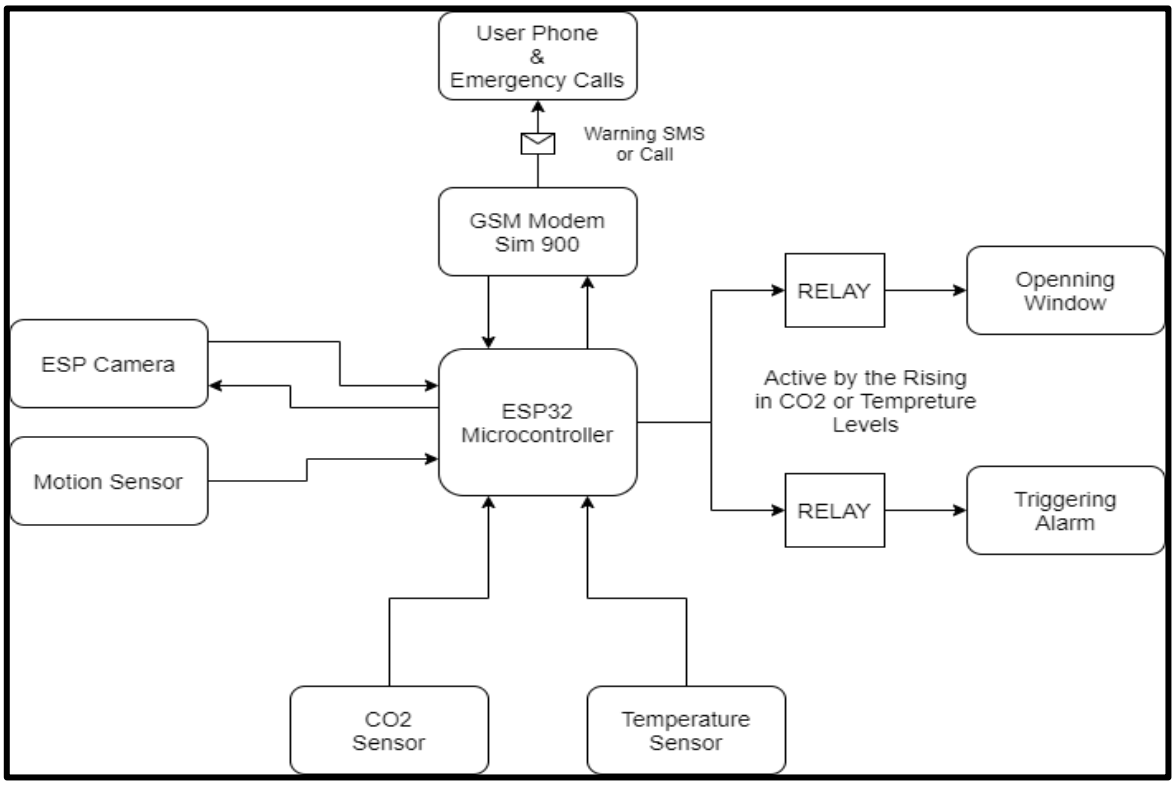

Figure 3.1: System block diagram.

3.3 State Behavior

This section will discuss each subsystem state behavior.

3.3.1 Data Flow

Data flow is the movement of data between the entity, the process and the data store. It portrays the interface between the components. [19]

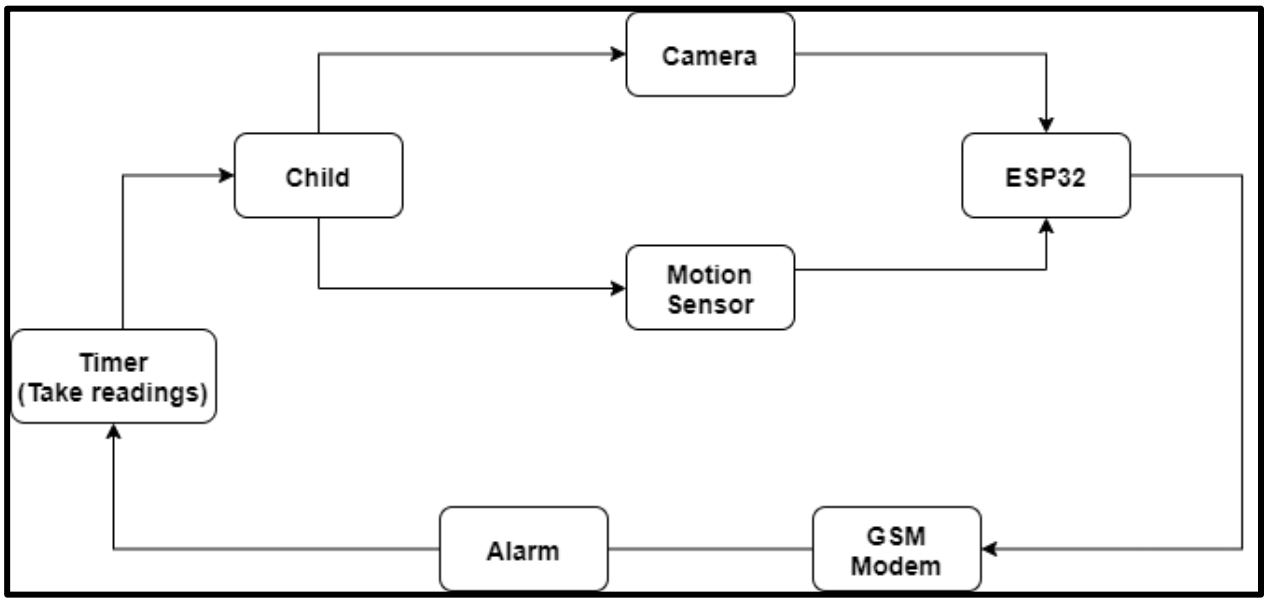

Figure 3.2: Data flow diagram for GSM modem

If a child is locked down in a closed car without any venting channel, he will pass in these stages.

First stage: as long as the child in the car, the ESP camera will detect him by using human detection to recognize him, but if the camera couldn't detect him because he is not in the range of it, the motion sensor will detect the child by his motion, then this will send a signal to the microcontroller to active the GSM modem that is going to make a call or send a massage for the parents or for rescue group like police or civil defense.

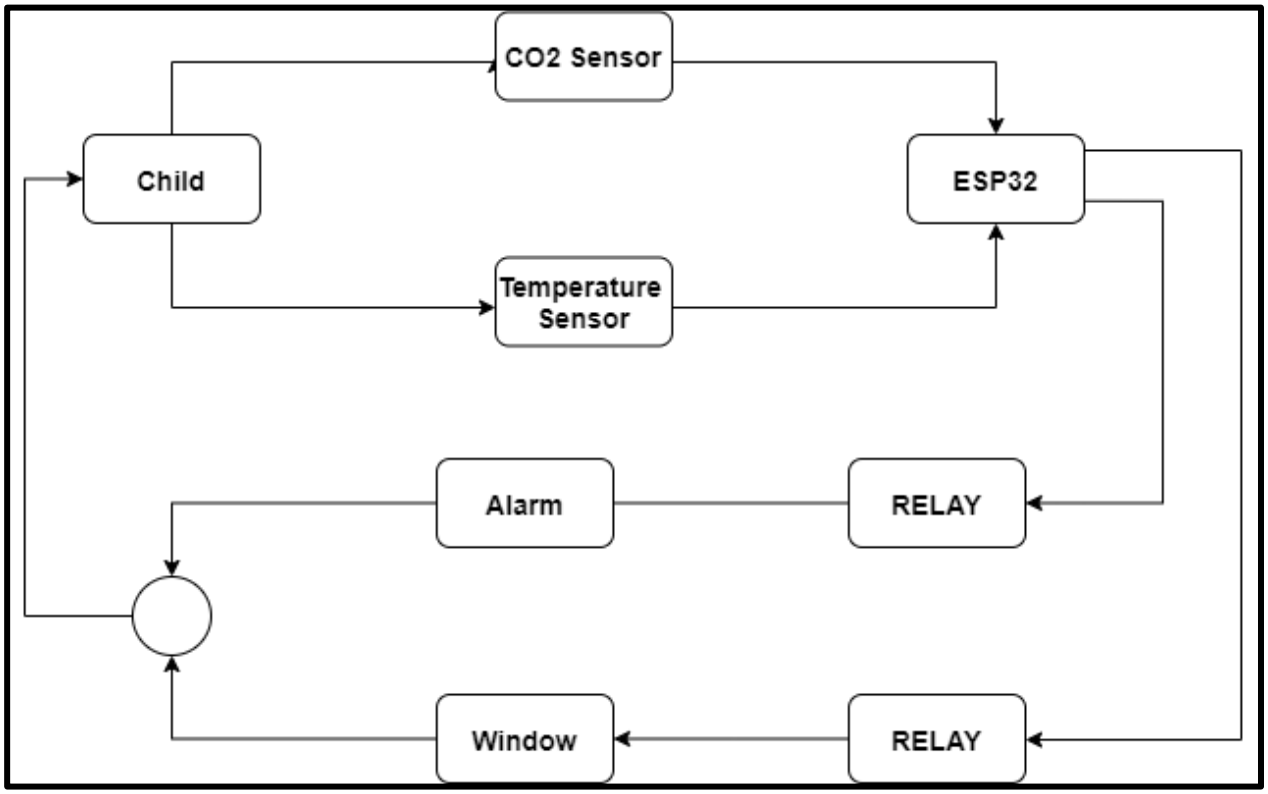

Figure 3.3: Data flow diagram to open window and alarm system

Sensors will sense if there is a child inside the car, although he is not moving or sleeping, if there is a child the microcontroller will send a signal to the windows in order to lower the window, in order to save the child from the Suffocation.

3.3.2 State Flow

State diagram for emergency calls or SMS.

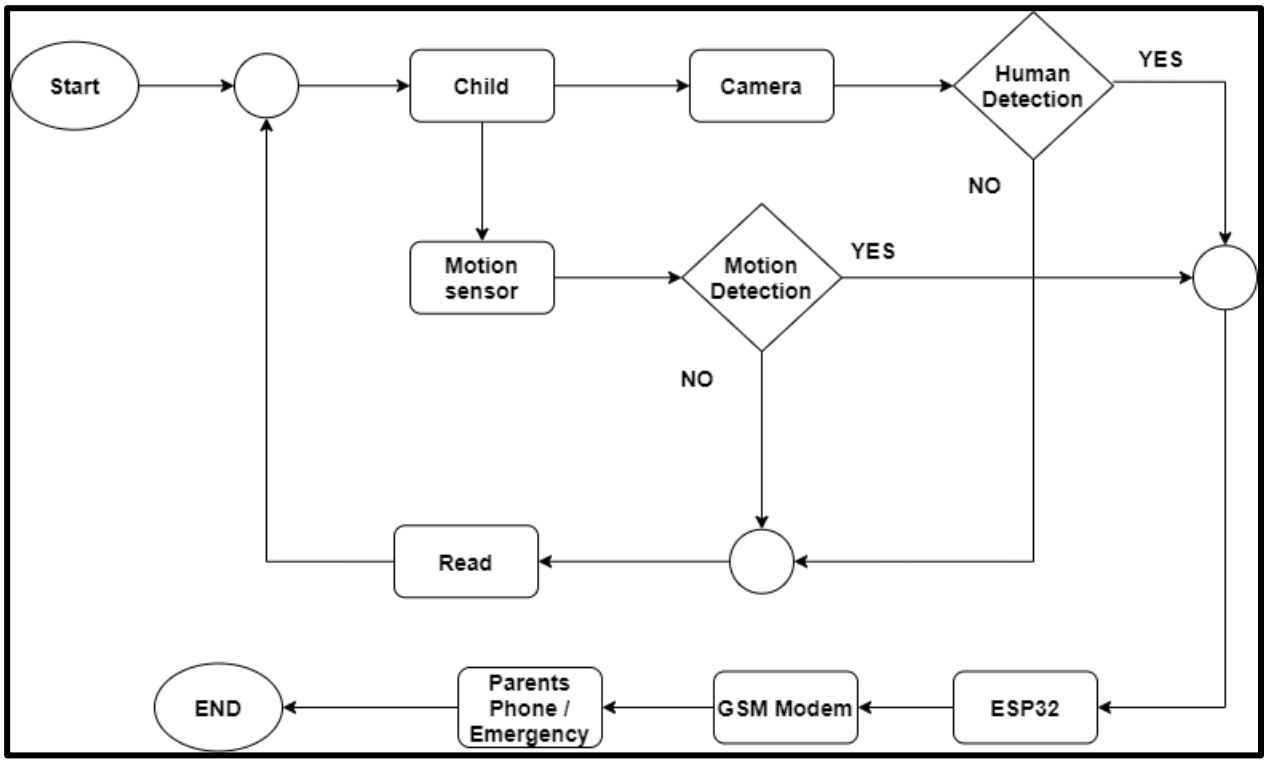

Figure 3.4: State flow diagram for GSM modem

If a child is locked down in a closed car without any venting channel, he will pass in these stages.

First stage: as long as the child in the car, the ESP camera will detect him by using human detection to recognize him, but if the camera couldn't detect him because he is not in its range the motion sensor will detect the child by his motion, then this will send a signal to the microcontroller to active the GSM modem that is going to make a call or send a massage for the parents or for rescue group like police or civil defense.

Figure 3.4 illustrates the examination if there is a child inside the car, so if this condition become true (Human or Motion detection) the camera or motion sensor will send a signal to microcontroller in order send a message or to call parents.

State diagram for lowering windows and triggering alarm.

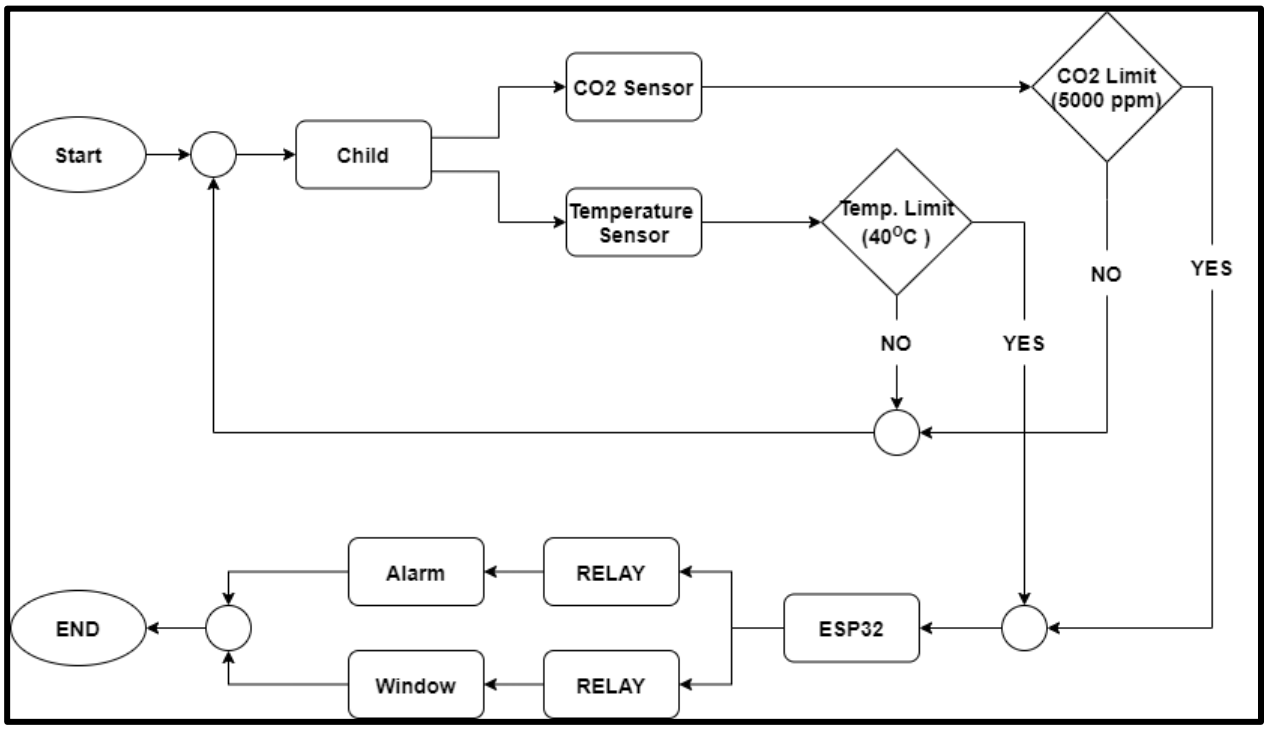

Figure 3.5: State flow diagram to open window and alarm system

The system will detect the variation in temperature and CO2 levels with the passage of time, if there is a high deference in Temperature and CO2 this is an indication that someone is there inside the car. Also, the system opens the window and triggers the alarm system after one of these parameters reaches the limit. in order to save the child from the Suffocation.

Figure 3.5 illustrates the examination if there is a child inside the car, so if this condition become true (Temperature or CO2 reaches the limit) the Temperature or CO2 sensor will send a signal to microcontroller in order to open the window.

3.4 Hardware Interface Design

3.4.1 ESP32

It’s the main brain of the system all the operations take order and command from ESP32 based on the data received from the sensors and the camera.

3.4.2 Main Functions

The project is a smart rescue system inside the vehicle that can be divided into subsystems as following:

- Camera detection.

  In this subsystem the ESP camera is going to detect the existence of any human inside the car by the motion detection with the PIR sensor, then a message will receive to the parent’s phones that there is a child inside the car, so the microcontroller will send a signal to the GSM modem to alerts the parents via calling or texting. Also, the camera will send the photo to the telegram.

- Motion Detection.

  Sensor will sense if any motion happened inside the car cabin, and the existence of any creature, then if there is any motion the sensor will be activated and the microcontroller will send a signal to the GSM modem to alert the parents, also to the windows of the vehicle in order to open a ventilation channel to save the child from the Suffocation.

- Activating alarm system and lowering windows.

  In this subsystem the microcontroller (ESP32) will send a signal not only to trigger the alarm system but also to the windows motor to lower the windows as a result to open a ventilation channel, when the CO2 or temperature level reaches the limit, it will active the sensor to send a signal to the microcontroller to trigger the alarm system and to lower the windows.

The main parts on the hardware were described earlier. Now, it is important to focus on the interfacing where all components are connected together to work as a system.

The figure below represents the system interfacing design.

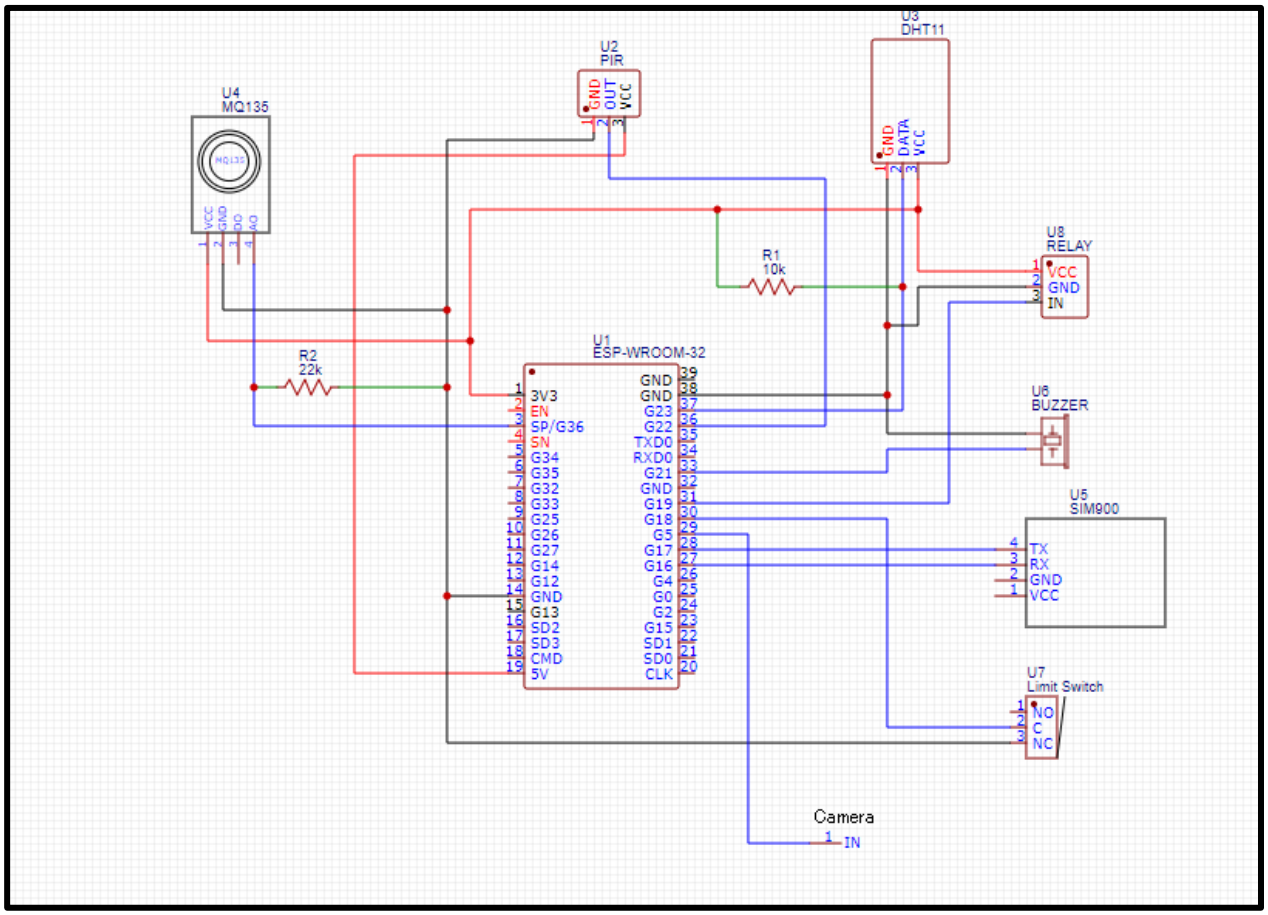

Figure 3.7: System interfacing design

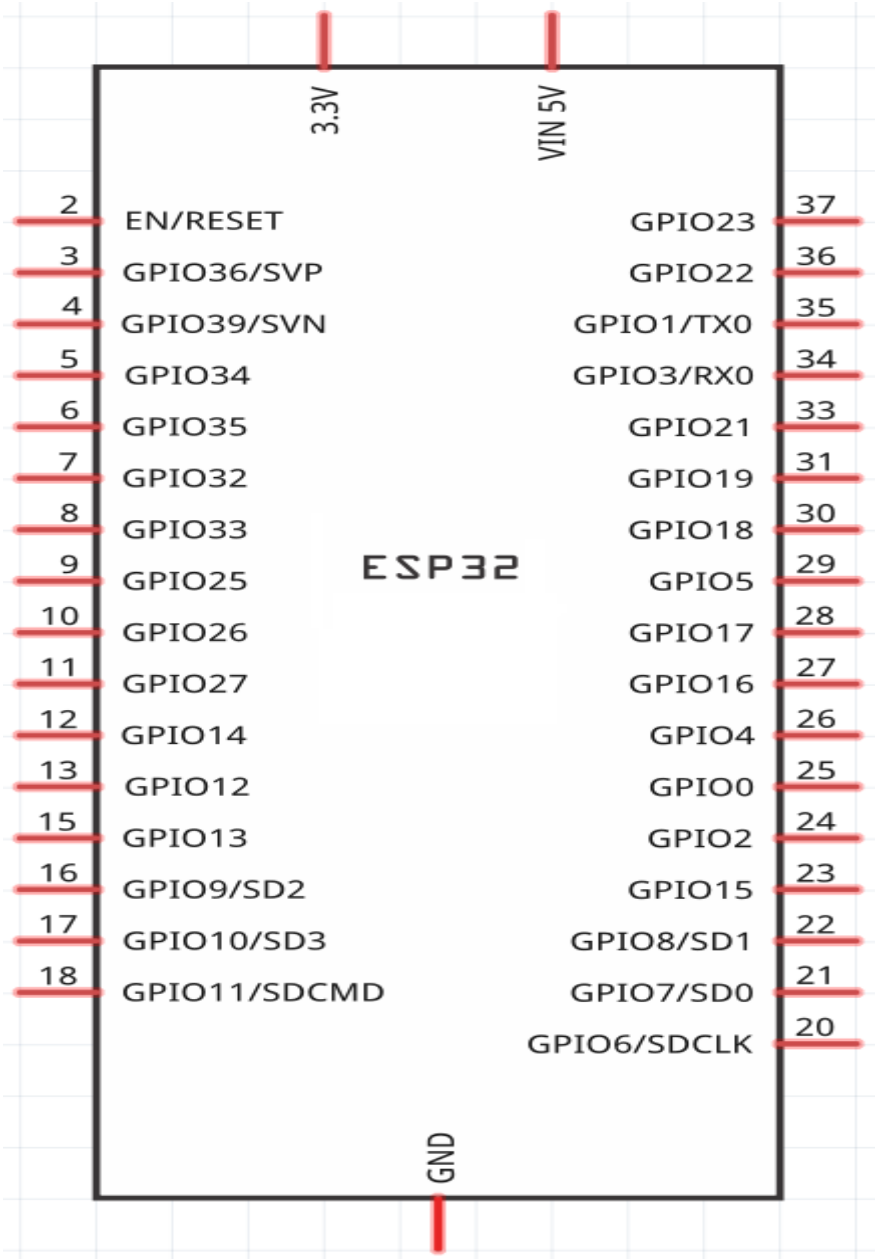

Figure 3.8: ESP32 microcontroller

This figure represents the scheme of ESP32 microcontroller will be used to control input/output signals, it is a simple explanation of the microcontroller pins.

3.5 Software Interface Design

3.5.1 Object Interfacing

software interfacing in this system is represented it three components, parent's mobile phone, microcontroller (ESP32) and ESP camera.

Parent's mobile phone is connected from one side, and from the other side with GSM modem, which it doesn't need software.

The other component is ESP32, it will be connected directly with GSM modem and the sensors in the car, so it needs a software to control all the data coming in and directs the commands go out for the actuators.

3.5.2 Camera detection technology.

A facial detection system is a computer application for automatically identifying or verifying objects from a digital image or a video frame form a video source. One of the ways to do this is by comparing selected facial features from the image and a facial database.

The ESP32 CAM Based Object Detection & Identification with OpenCV. OpenCV is an open-sourced image processing library that is very widely used not just in industry but also in the field of research and development.

3.6 Project Prototype

The system will be installed in a small car prototype, as shown below in the figure 3.9.

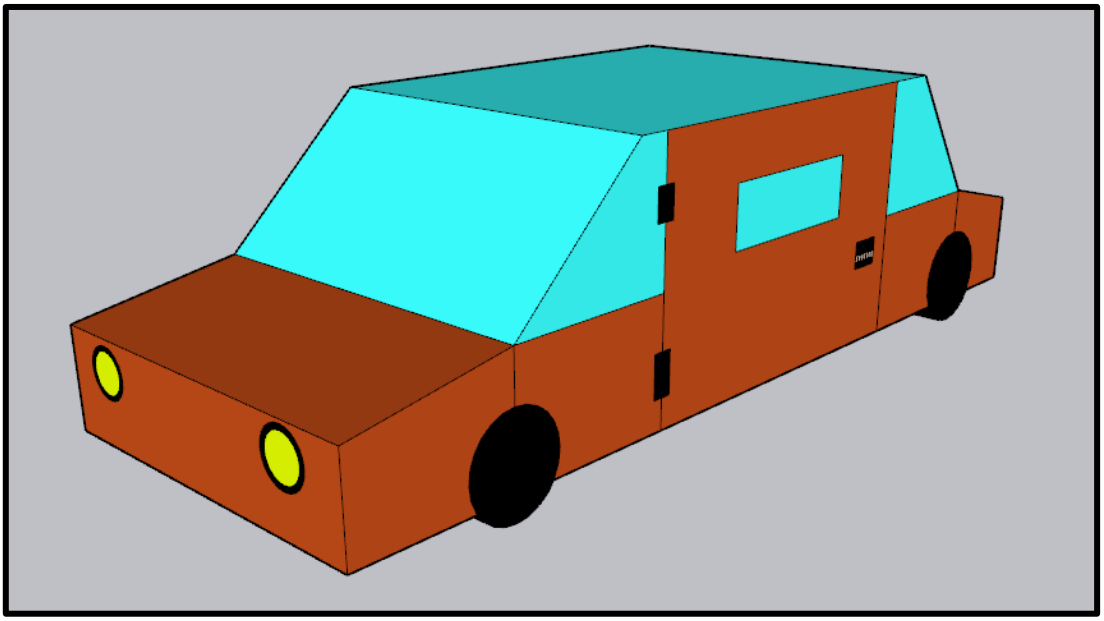

Figure 3.9: Car prototype

This prototype will contain a battery, motor for window, relays, dc-to-dc converter and the smart system.

3.6.1 Battery

A 12V-DC battery will be placed inside in the front of the car. which is going to supply the window motor, buzzer, and the ESP32 with power.

3.6.2 Design of Power Window

The analysis for the motor that will be used to open and close the window.

- **Objective of design of power motor window:** To move glass with load of 12kg, within 15sec with dc power supply.

  1. Travelling time = 15sec.
  2. Direction = up & down.

- **Calculation for weight of glass:**

$Weight\ of\ product\ =\ Total\ load\ that\ motor\ has\ to\ carry$

$Density\ of\ glass\ =\ 2.5\ gm/cm^3\ =0.0000025\ kg/mm^3$

$Volume\ from\ the\ model = 1.57\ *\ 10^6\ mm^3$

$Weight\ of\ product\ = Volume\ X\ Density\ = 1.57\ *\ 10^6\ *0.0000025\ = 3.92\ kg$
$\approx\ 4\ kg$

$The\ weight\ of\ glass\ with\ considering\ friction.$

$Types\ of\ friction: Sliding\ friction\ Coefficient\ of\ friction\ for\ glass\ = 0.05$

$Additional\ weight\ due\ to\ friction$
$= weight\ of\ product\ *\ coefficient\ of\ friction\ =\ 0.05\ *\ 4$
$=\ 0.2\ kg$

$Additional\ weight\ due\ to\ human\ being\ approximately\ = 3.5kg$

$So\ total\ weight\ that\ motor\ has\ to\ lift\ during\ uplifting\ of\ glass\ is$
$= weight\ of\ glass\ +\ friction\ load$
$+\ weight\ due\ to\ human\ being\ =\ 4 + 0.2 + 3.5\ = 7.7\ kg\ \approx 8.0\ kg$

$With\ factor\ of\ safety, we\ will\ consider\ total\ weight\ Factor\ of\ safety = 1.5$

$So\ load\ with\ factor\ of\ safety = 1.5 * 8\ =\ 12\ kg$

- **Motor selection procedure**

$$Torque = force * diameter\ of\ pulley/2$$

$$Diameter\ of\ pulley = 60\ mm$$

$$Torque = \frac{12 * 10 * 60}{2} = 3.6\ N.m$$

$$So\ required\ Torque = 3.6\ N.m$$

$$Power = Tourqe * Speed$$

$$Power = 3.6 * \frac{2 * \pi * 50}{60} = 18.84\ Watts$$

$$So\ required\ Power = 18.84\ Watts$$

We have to select reversible motor with following specifications.

Company name: Makermotor.

Type: DC Reversible motor.

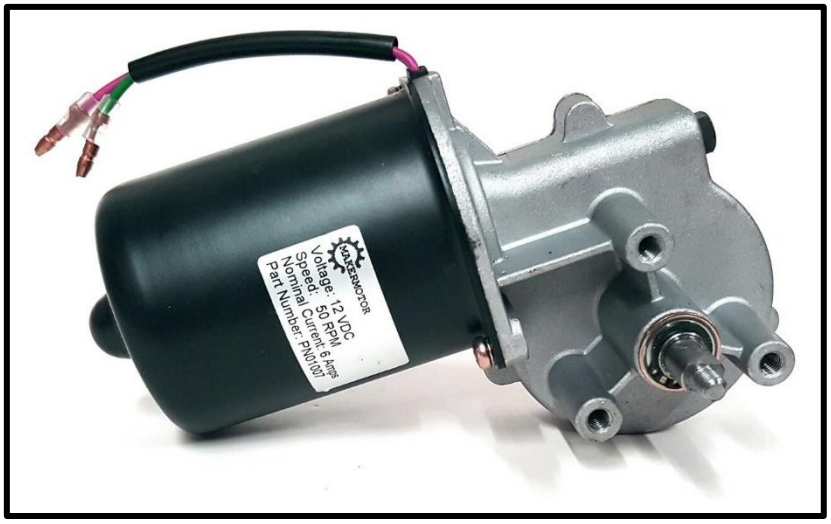

Figure 3.10: DC Reversible motor

The motor is with the following electrical specifications:[20]

1. Rated Voltage: 13.5 VDC**.**
2. Rated Speed: 50 RPM**.**
3. Rated Load: 60 Watts**.**
4. Rated Torque: 6 N-m**.**

3.6.3 Relays

There is going to be one relay for the window motor, it is a 5V-DC relay because the ESP32 generates 5V to their coils, when they are activated, they will allow the 12V coming from the battery to pass to lower the window.

Figure 3.11: 5V relay

3.6.4 DC-to-DC Converter

The converter will be used to converts the 12V coming from the battery to 5V to supply the ESP32, ESP cam, GSM modem and Sensor that used in the system.

Figure 3.12: dc to dc converter

3.7 Conclusion

The system design is represented as a whole system, also a detailed block diagram for the project, details about the components, modules, and the detection system, furthermore a drawing for control, data, state diagrams, also showing the interfaces between the blocks of the system, moreover it shows the car prototype.

Chapter 4

System Implementation

4.1 Introduction

4.2 Hardware System Implementation

4.3 Installing and Preparing Software System

4.4 Software Implementation

4.5 Summary

Chapter 4

System Implementation

4.1 Introduction

During the implementation stage, every single component has been tested individually and the results have been recorded. This chapter will focus on the testing stage of the project systematically, and finally a summary for the testing scenarios.

4.2 Hardware System Implementation

This section talks about each component implementation.

4.2.1 Electrical System Implementation

The figure below shows the hardware component before they are connected together. ESP23, which is the microcontroller and main component, is used to control signal came from sensors. The signal should be arrived for the window in the car. wires and GSM serve as connectors. GSM modem used to send calls and messages to the smart phone.

Figure 4.1: Electrical Subsystem Component

4.2.2 Sensors

In this system there are three sensors. First sensor is a motion detector which is installed in the car roof to detect any motion inside the car then sends a signal to the camera through the microcontroller to take a photo and send it to the parents.

Second sensor is the temperature sensor that is used to read the temperature inside the car cabin.

Third sensor is the CO_2 sensor that is used to read the carbon dioxide levels inside the car cabin.

The last two sensor determine whether to lower the window or not regarding to the increase in temperature and carbon dioxide levels in the car cabin.

Figure 4.2: Used Sensors in the Project

The monitor and detection system used in the project is ESP32 Cam. It is used to take photos when the motion sensor detects a motion inside the car cabin, also it send a message for the parents via internet to the parents or the car owner using Telegram Application.

Figure 4.3: Used Camera in the Project

4.2.3 Actuators

In this system, there are two actuators buzzer and window motor.

- **Buzzer**

The alarm system used is this project is a buzzer to warn the people around the car that there is danger near them or something is wrong.

Figure 4.4: Used Buzzer in the Project

- **DC Reversable Motor**

The figure below shows the DC motor that is used to boost and lower the window, which is installed in the car door and operated with 12V DC.

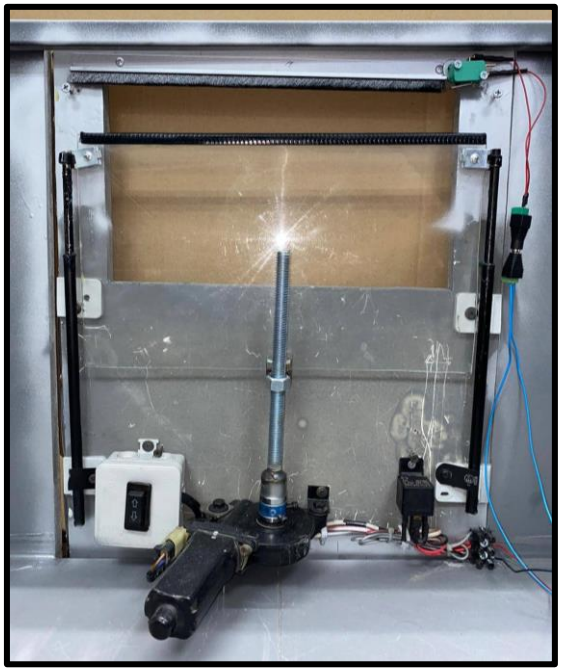

Figure 4.5: Used Motor in the Project

4.3 Installing and Preparing Software System

- Server Application

The system has two sides, the first sides that uses Wi-Fi to connect the Camera to the server so it can take photos and send them via Wi-Fi to the Telegram application after taking a signal from the motion sensor. Also, you can send commands to the camera bot on telegram to monitor the environment inside the car cabin.

Also, there is transmitter and receiver side for the GSM modem so it could receive a signal from the micro controller and send a calls message to a smart phone by using TX and RX pins on the ESP32.

In addition, the result if there is a child inside the car the camera takes a photo of him and sends it to the smart phone of the parents and call them via there smart phones.

4.4 Software Implementation

This section represents the software implementation.

- Arduino software

First of all, including the libraries that is going to be used in the program. These libraries include the DHT library, MQ library and software serial library all and other libraries that will serve to build the program. Figure 4.6 illustrates the libraries that has been used.

```
// Include Libraries
#include "dht.h"
#include <SoftwareSerial.h>
#include <MQUnifiedsensor.h>
```

Figure 4.6: The Used Libraries

Then, defining the pins that are going to use in the ESP32 as digital or analog input/output. As shown in the figure below.

```
// PIN Definition
int pirPin = 22;                // Choose the input pin (for PIR sensor)
#define dht_apin 23             // DHT PIN
#define RXD2 16                 // GSM RX
#define TXD2 17                 // GSM TX
#define Campin   5              // CAM 32 RX

#define placa "ESP-32"
#define Voltage_Resolution 3.3
#define pin 36                  // MQ135 Pin
#define type "MQ-135"
#define ADC_Bit_Resolution 12
#define RatioMQ135CleanAir 3.6
const int Buzzpin = 21;          // Buzzer Output pin 21
const int Relaypin = 19;         // Relay Output pin 19
const int Switchpin = 18;        // limit switch pin 18
```

Figure 4.7: The Defined Pins

In this part of the code, it shows how the GSM modem receives and sends commands, and the GSM respond to send a call to the smart phone.

```
void GSM_emergencyCall() {

  Serial.println("Make an Emergency Call");
  // REPLACE THE X's WITH THE NUMER YOU WANT TO DIAL
  // USE INTERNATIONAL FORMAT CODE FOR MOBILE NUMBERS
  Serial2.println("ATD + +970595852418;\r");
  delay(100);
  Serial2.println();

 // In this example, the call only last 10 seconds
 // You can edit the phone call duration in the delay time
  delay(10000);
  // AT command to hang up
  Serial2.println("ATH"); // hang up
}
```

Figure 4.8: GSM Code

4.5 Summary

This chapter explained the structure and the installation process of each subsystem.

Chapter 5

Testing

5.1 Overview

5.2 Car Model Description

5.3 Subsystem Testing

5.4 Overall Testing Scenarios

5.5 Achievements

5.6 System Response

5.7 Challenges

5.8 Conclusion and Recommendations

Chapter 5

Testing

5.1 Overview

This chapter describes the project achievements, the challenges and the problems that faced the team during the implementation stage with their suggested solutions, and the conclusion from this project.

5.2 Car Model Description

Here is the car that was designed for the project testing, this model was designed to simulate the real car model in terms of opening and closing windows in addition to simulate the car alarm also.

Figure 5.1: Real Car Model

Also, her is the circuit that wan installed on the car roof from inside, and the camera in the front side.

Figure 5.2: System Circuit

5.3 Subsystems testing

- DHT11 sensor testing.

The DHT11 is a temperature and humidity sensor that is used to compare between the temperature inside the car and the temperature set point.

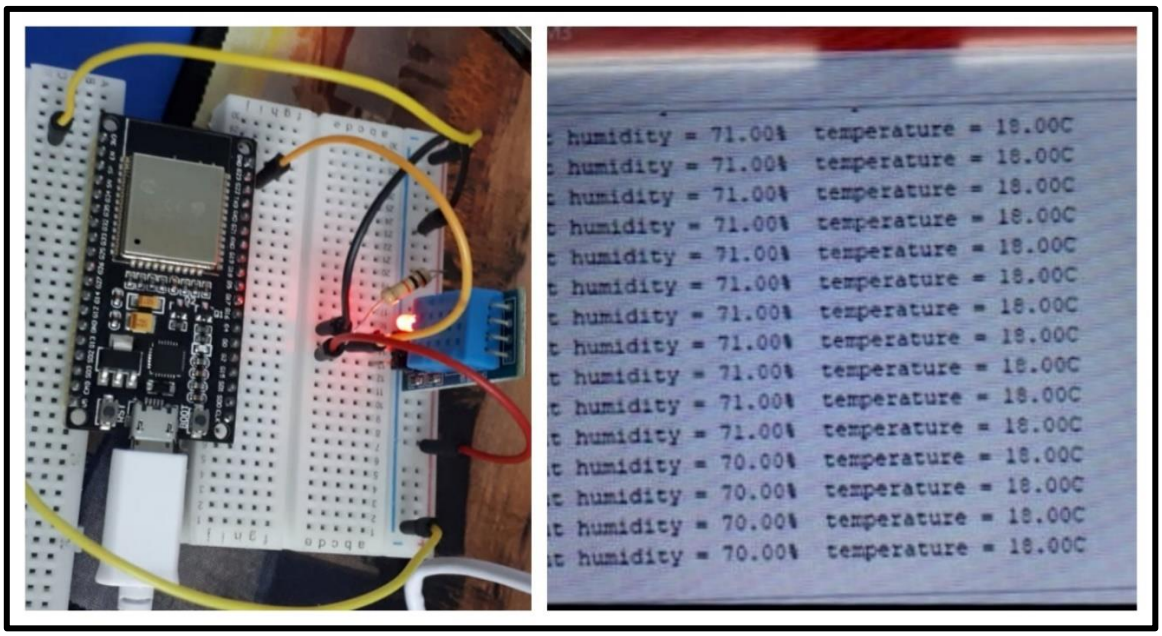

Figure 5.3: DHT Testing

- PIR sensor testing.

The PIR is a motion sensor that is used to detect any movement inside the car cabin to send a signal to the ESP cam and take a photo.

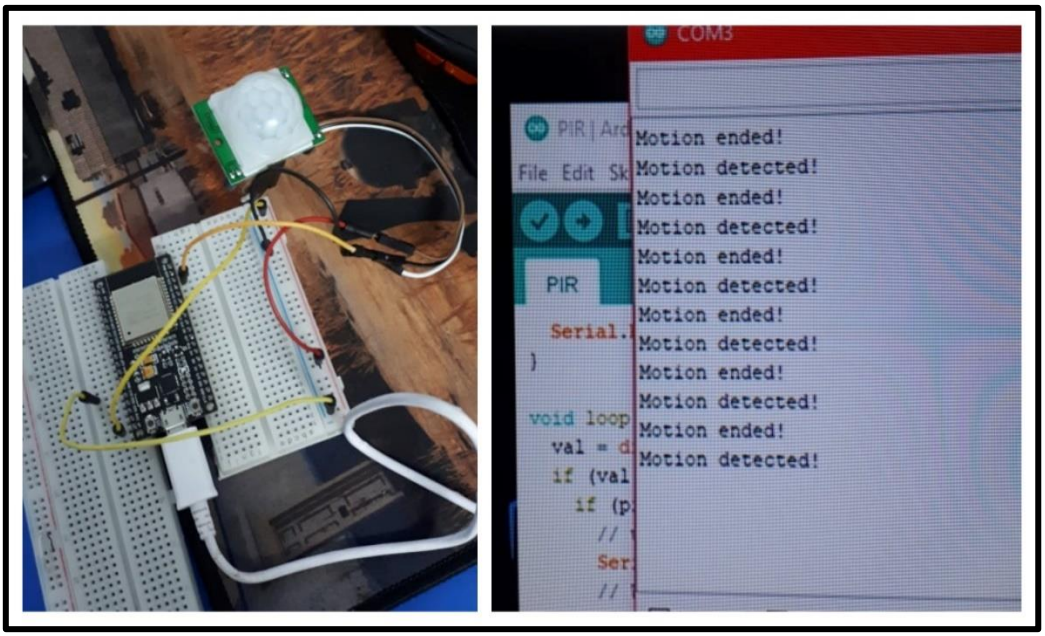

Figure 5.4: PIR Testing

- MQ135 sensor testing.

The MQ135 is gas sensor that is used to compare between the carbon dioxide level inside the car cabin and the set point.

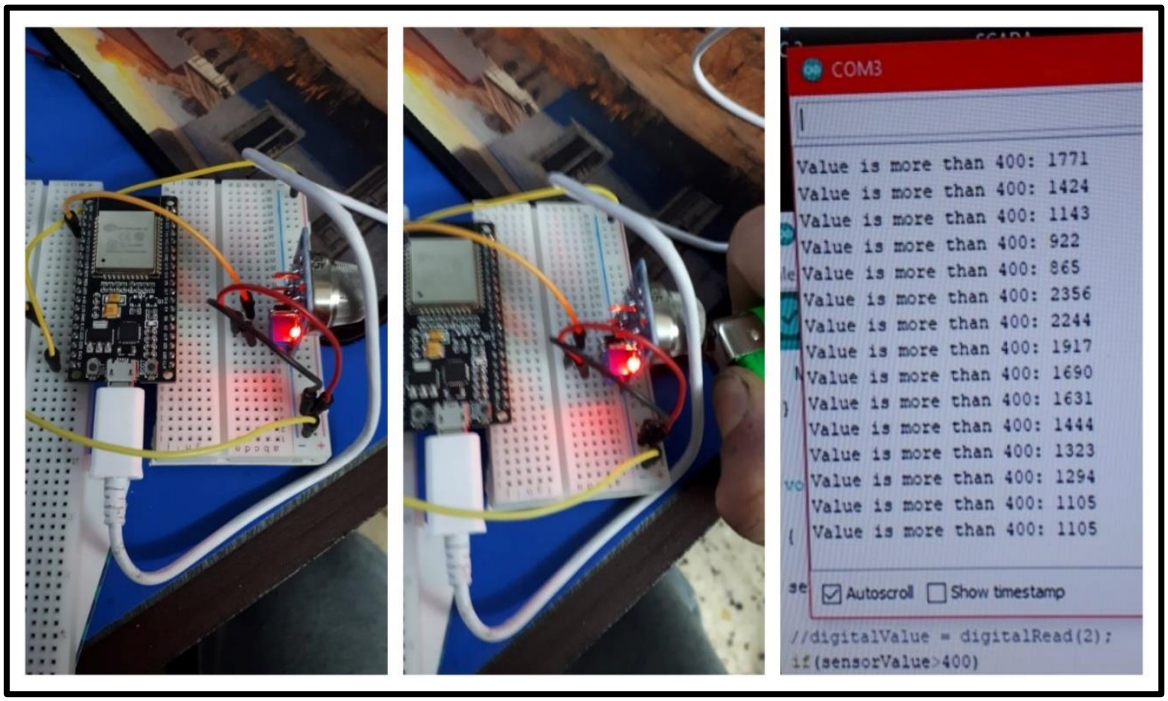

Figure 5.5: MQ Testing

- GSM modem testing.

The GSM modem is used to make alert calls to warn the parents that their child is stuck inside the car.

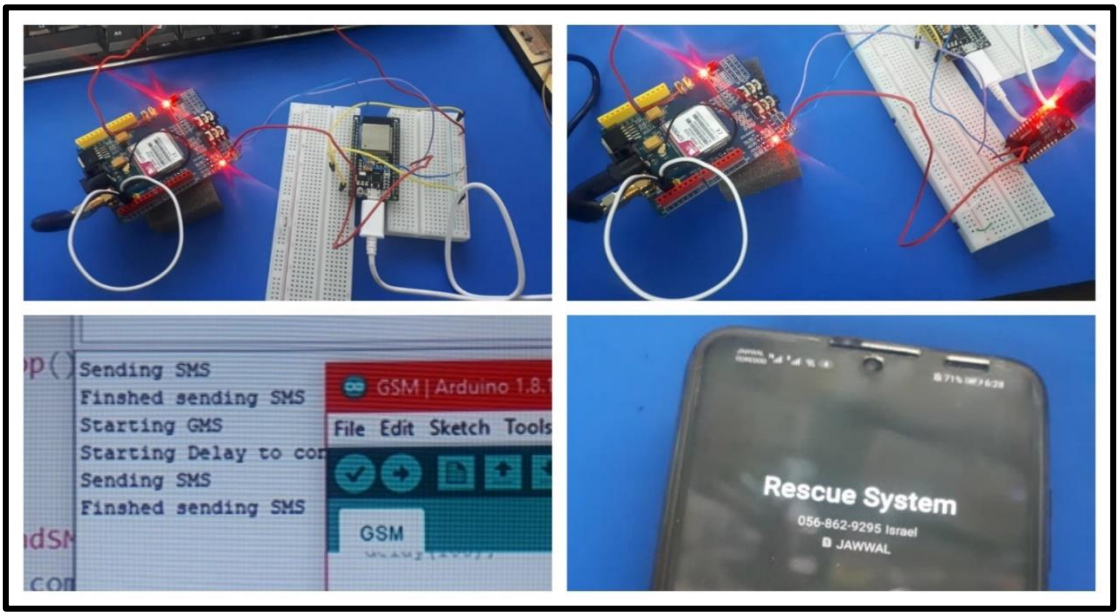

Figure 5.6: GSM Testing

- Testing sensors with Buzzer and GSM Modem.

This part represents the testing of all sensors either the buzzer and the GSM modem, after the is an increase in temperature or carbon dioxide the buzzer goes on and after 10 seconds the GSM starts calling the parent's smart phone.

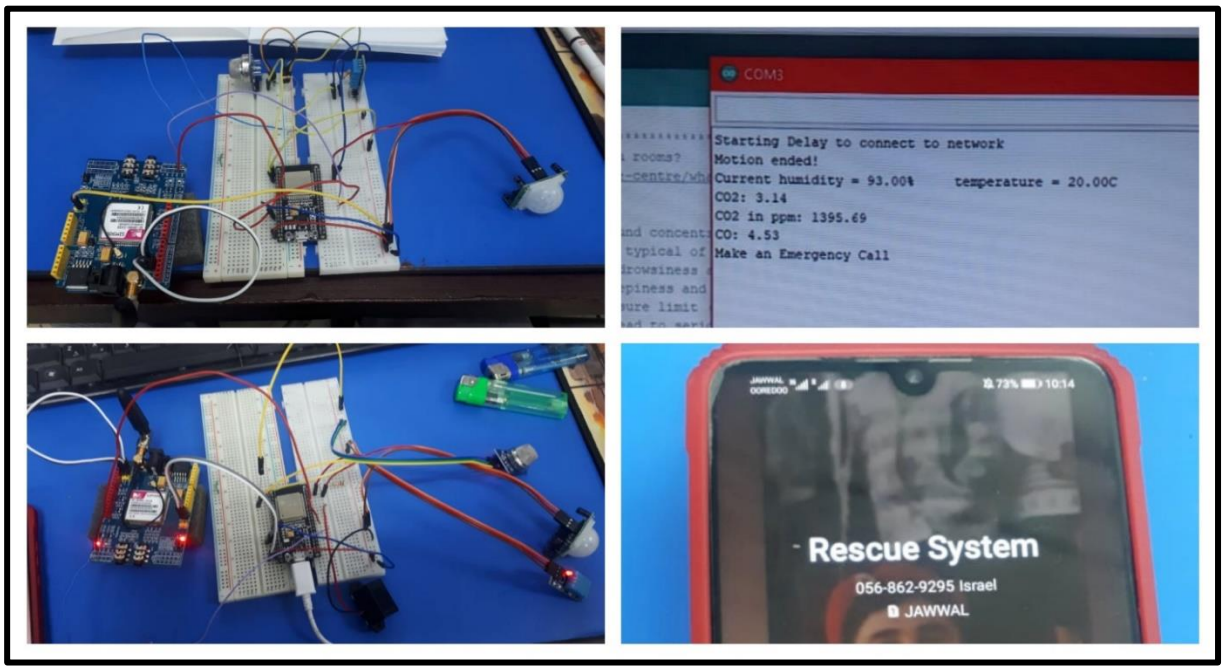

Figure 5.7: Sensors, Buzzer & GSM Testing

- ESP32-Cam Testing.

This part represents sitting the Wi-Fi server for the camera, the camera here is used to take photos inside the car when there is a motion.

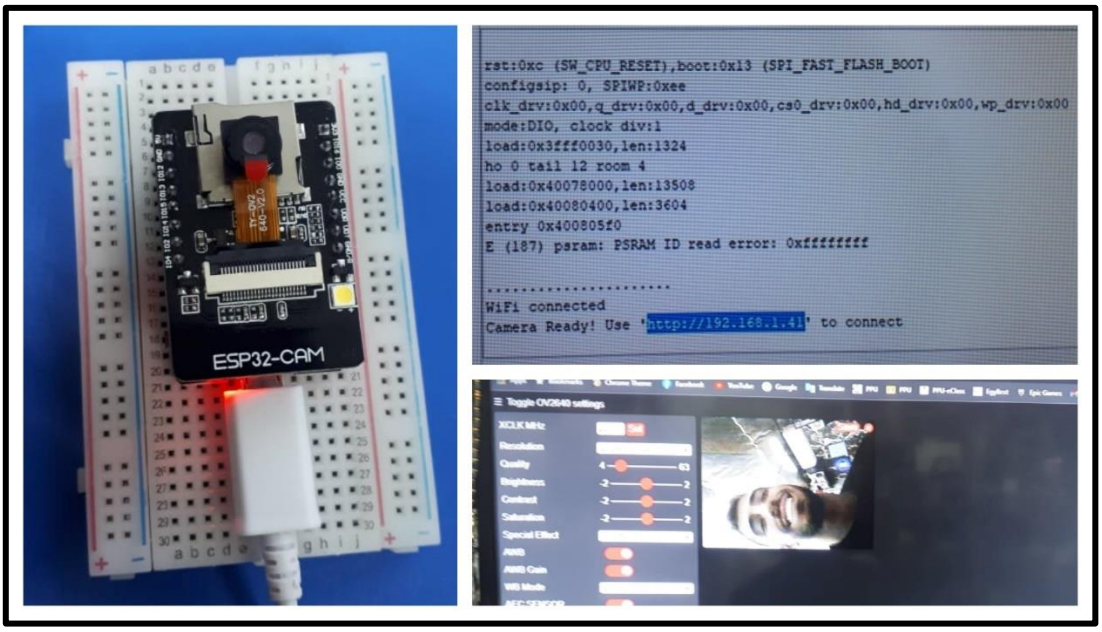

Figure 5.8: Camera Testing

Also, you can just send a command to the Telegram bot to take a photo any time you want. So, you can monitor the environment of the car cabin any time you want besides that you can toggle a flash from the camera as shown on the figure below.

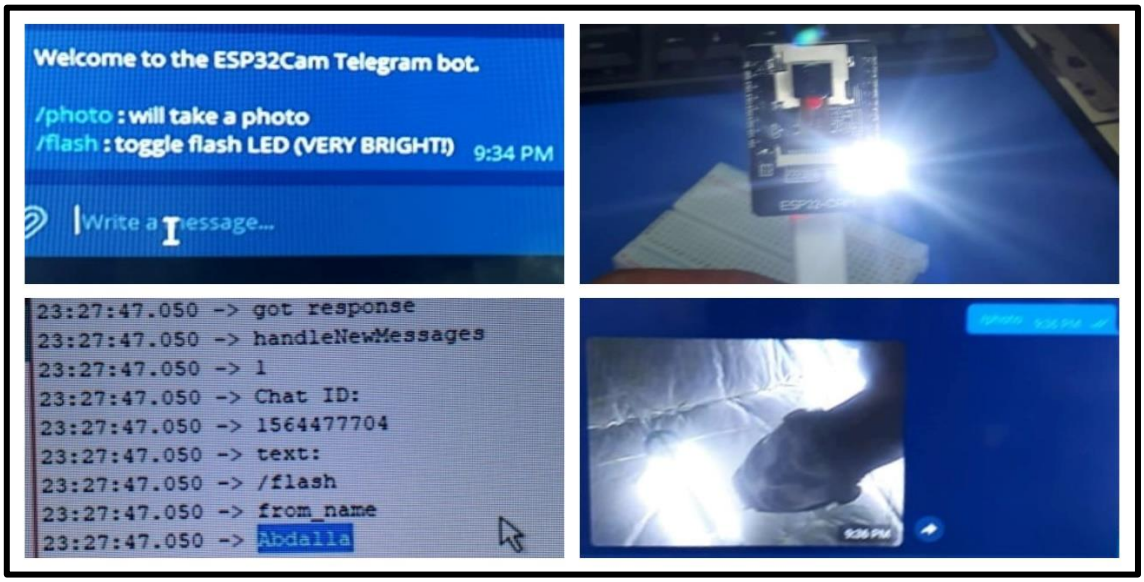

Figure 5.9: Camera Commands

- Creating the Telegram Bot.

The Telegram Tot is used to receive a photo from the ESP32-Cam and display it in the chat. also, you can use the bot to monitor the car cabin any time you want by sending a command (/photo) to the Bot or you can toggle a flash light that exists in the camera board by sending a command (/flash) to the Bot.

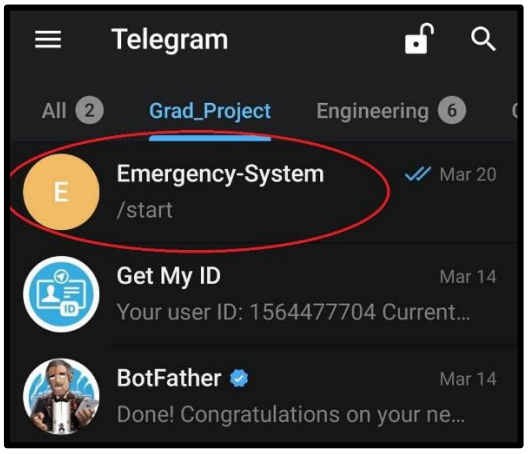

Figure 5.10: Telegram Bot

- Steps of creating Telegram Bot

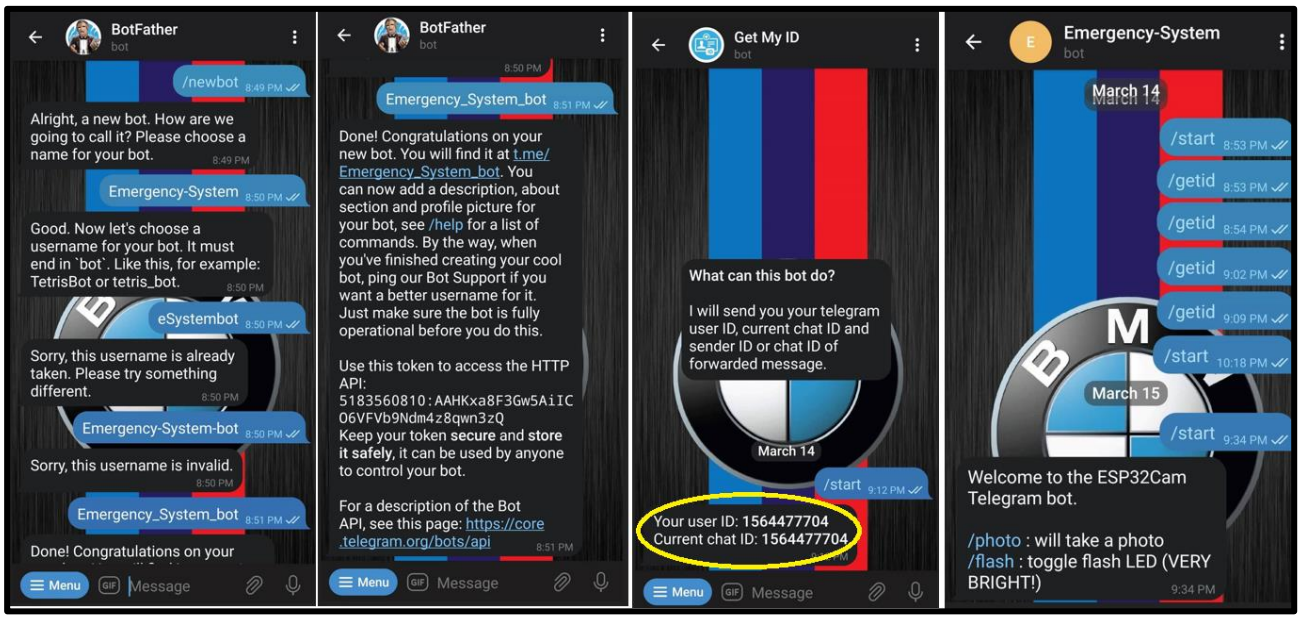

Figure 5.11: Steps of creating Telegram Bot

5.4 Overall Testing Scenarios

Here are the scenarios that the system had been through, first one is increasing the temperature by using a heat fan, as shown below.

Figure 5.12: Temperature Test

As the temperature increase above the 25℃ the system starts to take photos and send them to the user Telegram then it starts making the emergency call to the user smart phone to warn him. Also, the relay switch goes on and lower the window to make a venting channel for the child how is stuck inside the locked car, besides that a buzzer starts to warn the people around.

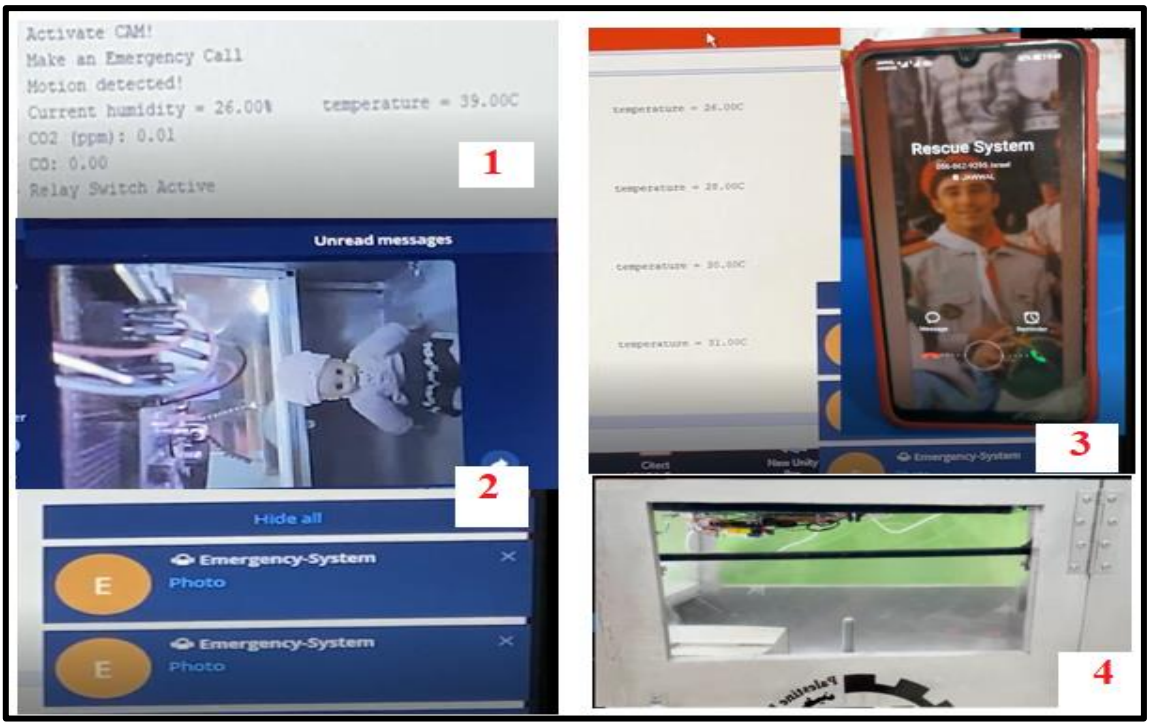

Figure 5.13: Notification Process

The second testing scenario was using a candle to raise the CO_2 levels which leads to the same notification process in figure 5.13.

Figure 5.14: CO_2 Test

5.5 Achievements

This program is able to provide the children stuck in the car with a ventilation channel through lowering the window, by checking the environment of the car cabin using three sensors that works together, also there is alert system in the program to pay parents attention through their smart phones by calling them and sending them photos from inside the car cabin.

- Using the smart phone to monitor the car cabin.
- Designing a graphical user interface needed for the project.
- Using the AI thinker and the machine learning in the program.
- Programmed a Wi-Fi device to send and receive data depends on the system needs.
- Construct the ESP32 to deal with different kind on inputs, and give outputs response to those inputs.

5.6 System Response

The system is working perfectly with acceptable performance, some times there is a little delay when the camera sends the photo to Telegram because of the internet problems, but it is accepted, also the GSM takes a little bit of delay sometimes when sending a call to the smart phone, the reading of the sensor is good, and the system works correctly.

5.7 Challenges

This section will describe the main challenges that faced the team during the implementation stage.

- The programming environment and language.

Choosing the suitable environment was the first challenge that faced the team during the implementation stage, at first the team used Micro-Python language but it didn't suit the program because there were difficulties bringing the libraries to work on it.so the team picked the Arduino environment at the end.

5.8 Conclusion and Recommendations

During this period, there were many experiences the team gained, the results and the conclusions will be discussed.

- Working with team is very important to achieve a shared goal in effective way, also gives power and meaning to the project, and during the work a, many solutions will be given so this helps the team to face their problems also solve it, each one has his own idea and the suggested solutions was made from these ideas.
- Suggested additions in the future:
    - Turning on the air condition.
    - Lowering the window using the smart phone.
    - Making an application for the smart phone to check the temperature and carbon dioxide level.

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