Palestine Polytechnic University

Collage of Engineering

Mechanical Engineering Department

Hebron – Palestine

Smart Automobile Air Conditioning And Ventilation System

Project Team:

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Submitted to the Collage of Engineering

In partial fulfillment of the requirements for the

Bachelor degree in Mechanical Engineering.

Supervisor Signature

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Palestine Polytechnic University

College of Engineering

Smart automobile air conditioning and ventilation system

Project Team

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Submitted to College of Engineering in partial fulfillment of the requirements for the Bachelor degree in Automotive Engineering

الإهداء

نهدي مشروعنا هذا إلى قدوتنا ومعلمنا وقائد أمتنا محمد صلى الله عليه وسلم

إلى من هم أكرم منا مكانة .. شهداء فلسطين

إلى من ضحوا بحريتهم من أجل حرية غيرهم .. الأسرى والمعتقلين

إلى كلمن ساهم في وصولنا لطريق النهاية .. إلى كل من علمنا شيئا جديدا

وغذى فكرنا بالعلم والمعرفة .. إلى كل من وقف بجانبنا وساعدنا في كل المصاعب

إلى دكاترتنا وأساتذتنا في الجامعة

إلى من رعونا بنور قلبهم..وحمونا بحكمتهم..وقدموا لنا حنانهم وقلبهم..إلى من سقونا وأطعمونا وربونا وأدبوناومنحونا الحب والحنان..إلى من فرشوا طريقنا بالورود..ورافقونا في الصعود..إلى من فتحوا أمامنا أبواب التفوق والنهوض وكسر قيود الظلام..إلى بسمة الأمل ونبع الحنان..إلى من هم بلسم روحنا..إلى ورود حياتنا

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إلى من كانو ملاذنا وملجئنا .. إلى من تذوقنا معهم أجمل اللحظات .. إلى من سنفتقدهم وأتمنى أن يفتقدونا

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إلى من نتمنى أن نذكرهم .. إذا ذكرونا .. إلى من نذكرهم ونسونا

الشكر

أشكر الله العلي القدير الذي أنعم علينا بنعمة العقل والدين القائل في محكم التنزيل

" وفوق كل ذي علم عليم "

وقال رسول الله (صلى الله عليه وسلم)

" من صنع إليكم معروفا فكافئوه، فإن لم تجدوا ما تكافئوه به فادعوا له حتى تروا أنكم كافأتموه "

نثني ثناءً حسنا وندين بالشكر الجزيل إلى مشرفنا

الدكتور محمد غازي القواسمة

الذي أنار لنا الطريق ولم يبخل علينا بتوجيهاته ونصائحه

وإلى معلمينا الذين لم يبخلوا علينا بعلمهم والذي لولا جهودهم لما وصلنا لما نحن عليه الآن

كما ونوجه شكر

لكل من ساهم بإنجاز عملنا هذا الذين لم يدخروا جهدا في تقديم المساعدة لنا من توفير المصادر والمراجع اللازمة وكل التقدير للذين منحونا كل التشجيع.

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ولم يترددوا في مد يد العون لنا سائلين الله عز وجل بأن يجمعنا بهم في جنات الخلد مع الرسل والصديقين والشهداء والأبرار حيث لا يوجد فرق.

Abstract

Due to the increase of traffic accidents resulting from the fatigue and drowsiness of drivers due to lack of oxygen level in the passenger compartment in addition to the increase of accidents of leaving children in the cars for long periods in a hot atmosphere, resulting in death suffocation due to lack of oxygen level or heatstroke due to high temperature inside the cabin may also result in their death. A system has been proposed to mitigate these accidents by providing warning systems and alarms operating in the case of lack of oxygen level from the safe limit in the cabin when there are passengers whether the vehicle is working or parked, the proposed system to operate the air conditioning and alarm systemautomatically if the vehicle is operating and open the windows if the vehicle is parked in order to reduce the occurrence of cases of suffocation or fatigue of passengers and drivers in vehicles.

نظراً لإزدياد حوادث السير الناجمة عن إرهاق ونعاس السائقين بسبب نقص مستوى الأكسجين في مقصورة الركاب بالإضافة إلى الإزدياد في حوادث ترك الأطفال في السيارات لفترات طويلة في أجواء حارة مما يؤدي إلى وفاتهم خنقاً بسبب النقص في مستوى الأكسجين أو إصابتهم بضربة شمس نتيجة الحرارة العالية داخل المقصورة التي قد تؤدي أيضاً إلى وفاتهم. فقد تم إقتراح نظام يعمل على التخفيف من الحوادث المذكورة من خلال توفير أنظمة تنبيه وإنذار تعمل في حالة نقص مستوى الأكسجين عن الحد الآمن في المقصورة عندما يتواجد بها ركاب سواءً كانت المركبة تعمل أو متوقفة بالإضافة إلى إمكانية النظام تشغيل نظام التكييف والتنبيه تلقائياً في حال كانت المركبة تعمل وفتح النوافذ في حال كانت متوقفة، وذلك للحد من حدوث حالات إختناق أو إرهاق للركاب والسائقين في المركبات.

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1. Introduction

1.1 Project Overview

As time spent in a car is increasing, a car accident caused by drowsy driving is also increasing year by year. Experts state that driver drowsiness is responsible for about 30% of severe traffic accidents [1]. Approximately 5 million auto crashes occur in the United States (U.S) each year, killing 34000 people, according to data from the U.S Department of Transportation (DOT).The U.S.DOT indicate that drowsy driving would seem to factor in 500000 crashes per year. Obviously, anything that could reduce the prevalence of drowsy driving could have a huge impact on the number of crashes and associated death [2].

Oxygen (O_2) which is existed in closed or partially closed passenger compartments for automobile is less than oxygen outside. When doors and windows of the vehicle are locked, that absolutely prevents fresh air to enter passenger compartment and the presence of passengers inside reduces the amount of oxygen and increases the concentration of Carbon dioxide (CO_2); however, the driver is not able to ensure that the air quality and the thermal comfort condition inside the car cabin are safe enough for his/her and passengers health since the air particles in the environment are not detectable by human eyes. Human exhalation produces Carbon dioxide (CO_2) which is colorless, odorless and non-flammable gas. In enclosed environment with the poor ventilation system, such as a car cabin, the concentration level of CO_2 will increase significantly according to the number of the passengers.High level of CO_2 concentration than Oxygen (O_2) will not only cause negative effects to human health but also cause fatigue, drowsiness and slow reaction of actions to passengers and drivers. Accordingly, Drowsy driving is a main reason for many serious traffic accidents. When drivers are fatigued, their perception for the surrounding environment, their ability to judge the situation, and their ability to control the vehicle will decline in some different degrees, which resulting in accidents. In addition, The Heating, Ventilation and Air Conditioning (HVAC) system was introduced to the vehicle for better air circulation system inside the vehicle cabin and to ensure that the cabin temperature is maintained at an appropriate level,and using the Recirculation (RC) mode could minimize the particulate pollutant enter the cabin. Nonetheless, occupant exhalation gives rise to level of CO_2 as a result of prolonged using of (RC) ventilation setting and lack of the fresh air inside the cabin, this feature (RC) allows for buildup of Carbon dioxide (CO_2) in the cars cabin, which can cause drowsiness [3].

One of the major causes of lethal or serious injuries to children in non-traffic accidents with cars is founded on the unattended left behind of them in parked cars. About 700 children died in (U.S) between 1998 and 2016, because they were left alone inside parked cars. This has been reported by theUnited States (U.S) American Automobile Association organization (AAA), and unfortunately, these incidents also happens in various parts of the world. Once a car is turned off and parked, keeping its window glasses closed, that absolutely prevents fresh air to enter the passenger compartment. Moreover the presence of children inside reduces the amount of Oxygen. This condition may lead to suffocation and temperature inside the car increases rapidly even on a day with atmospheric temperature of about 21ºC. As the thermoregulatory system of the child is not well developed, this condition may lead to hyperthermia or heatstroke which can be fatal [4].

The proposed project relates generally to improvea method for reducing the accidents caused by drowsy drivers and left children in parked cars by using an alerting system to stimulate the driversand passengers attention if Carbon dioxide or temperature exceeds the safe limit. In addition to monitoring and controlling the temperature and the concentration of Carbon dioxide inside passenger compartment whether the car working or parked.

1.2 Objective

The objective of this project is to build a system to increase alertness to driver and passengers in automotive vehicles and make them more alert and feel better by improving the percentage of Oxygen indoors in order to reduce the number of accidents caused by drowsy drivers. Moreover, the lack of needed Oxygen amount could lead to suffocation and adverse effects especially when car is parked in the hot sun.

1.3 Project choice and justification

Importance of monitoring drowsiness during driving has been paid more and more attention. The development of the system that can monitor drivers arousal level and warn drivers of a risk of falling asleep and causing a traffic accident is essential for the assurance of safety during driving. In addition, children are at risk of hyperthermia (heat stroke) and suffocation because they are left in parked cars is an underestimated risk which can lead to serious injuries or even to death. The National Highway Traffic Safety Administration(NHTSA)initiated a research which shows that hyperthermia is the second leading cause of death for children in non traffic fatalities in the United States.

1.4 Task table

The project has been divided into several tasks as shown in the following table:

Table 1.1: Tasks description

Task ID	Task Description
T1	Project selection
T2	Collection references from library
T3	Collection references from website
T4	Selecting the project scope and the operation model
T5	Selecting the major parameters
T6	Study and analysis of information on the project
T7	The collection of information that have been studied
T8	Write the project and preparing the 1st semester presentation

1.5 Time table

The time spent on each task is shown in the following table:

Table 1.2: Time table

Week / Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
T1																														
T2																														
T3																														
T4																														
T5																														

T6									■	■	■	■	■	■	■	■														
T7											■	■	■	■	■	■	■	■												
T8							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

1.6 Estimated costof proposed project

The following table shows the components and their quantity used in the project, in addition to the financial cost of each piece and the total cost of the project:

Table 1.3: Estimated cost table

NO	Component	Quantity	Price (NIS)	Total (NIS)
1.	Fan	1	30	30
2.	Battery	1	50	50
3.	prototype structure	1	400	400
4.	Thermal sensor	1	190	190
5.	Temperature and humidity sensor	1	35	35
6.	Microcontroller (Arduino)	1	80	80
7.	CO_2 sensor	1	350	350
8.	Window motor	1	150	150
9.	Window glass	2	50	100
10.	alarm light	1	5	5
11.	buzzer	1	10	10
12.	Total amount			1400

Chapter two

2. Drowsy drivers and children left in vehicles

2.1 Drowsy drivers.

2.2 Effects of CO_2 exposure.

2.3 Children left in vehicles.

2.4 Previous studies.

2.5 Field of application.

2.6 Temperature and humidity.

2.7 Vehicle air conditioning system.

Chapter two

Drowsy driver and children left in vehicles

2.1 Drowsy drivers

The amount of time that drivers spend within cars has been increasing due to complex city life, traffic congestion, and particular occupational requirements. Moreover, car accidents caused by drowsy driving also increased. Consequently, drowsiness cannot be avoided and to find out the possibility for reducing drowsiness while driving due to the amount of Oxygen, driver drowsiness resulting from the passage of time when different Oxygen concentrations are supplied has been examined through subjective evaluations and reaction times using driving simulator for 10 male subjects. The results revealed the drowsiness was highest in the low rate (18%) Oxygen condition, while in the high rate (30%), it decreased to a certain extent. The feeling of sleepiness also showed the tendency to decrease somewhat in the case of the driving time having passed over one hour in the high-rate conditions. In the case of supplying a high-rate of Oxygen, the feeling of drowsiness is lowered to some extent and the reaction time is shortened. It was suggested that the driver's drowsiness can be reduced according to the amount of Oxygen [1].

In summertime and hot days the A/C have a feature called recirculation. This feature would use on a good hot days to help cool vehicle faster, what it does is helps cool the air inside the vehicle instead of pulling the hot air from outside vehicle and prevent the outside odors from entering inside the passenger compartment. The problem is that the use of the air recirculation mode, while increasing passenger comfort, also allows for the buildup of Carbon dioxide (CO_2) in the cars cabin, which can cause drowsiness.

The more people in the vehicle with the windows rolled up and the A/C or heater on max, the more Carbon dioxide. On long trips under these conditions you may have noticed that you begin to get sleepy, and that you feel refreshed when you open the windows. That’s the Outdoor Air (OA) at work, displacing the CO_2 that you have been breathing out, it would be nice if we could keep the windows open all the time, but the outside temperature, noise, and a significant decrease in fuel economy due to increased drag usually keep them shut.

There is a certain amount of (OA) is designed into modern vehicles. However, tests has shown that this amount is not adequate to keep CO_2 levels below 1000 ppm. The amount of (OA) is designed to keep CO_2 below 2500 ppm for one person in the vehicle [5].

2.2 Effects of CO_2 exposure

The Wisconsin Department of Health Services website provides the following information regarding the effects of CO_2 concentrations:

250-350 ppm: the background, or normal, outdoor air level. (The global average is currently at approximately 390 ppm and rising)

350-1000 ppm: Typical level found in occupied spaces with good air exchange.

1000-2000 ppm: level associated with complaints of drowsiness and poor air.

2000-5000 ppm: level associated with headaches, sleepiness, and stagnant, stale, stuffy air, poor concentration, loss of attention, increased heart rate and slight nausea may also be present.

>5000 ppm: exposure may lead to serious Oxygen deprivation resulting in permanent brain damage, coma and even death.

In a study to measure Carbon dioxide in the cabin of a truck with the windows closed, the air conditioner on maximumand the engine idling, the indoor air quality monitor measured the CO_2 levels were increasing. They kept going up until they peaked at around 2400 ppm. After the levels seemed to stabilize, the AC knob turned from max AC (recirculating air) to normal AC, which opened the (OA) intake. The CO_2 levels dropped dramatically. Figure 2.1 shows the graph of measured data [5].

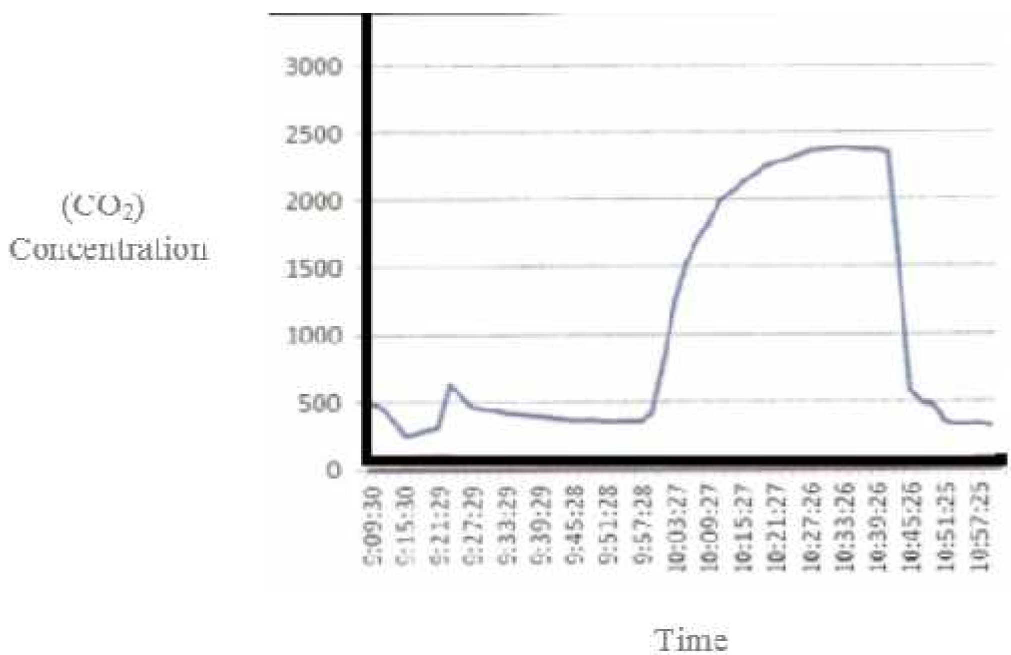


Figure 2.1: CO_2 Level

2.3 Children left in vehicles

Forgetting Kids in the car. This situation can end up with serious health risks, even death due to lack of Oxygen. Kids are more likely to be trapped in the car, especially for children between the ages of one and five years who do not have the ability to exit or open windows and doors.

Injury to children as the result of being left in a vehicle have a number of scenarios, where it is possible that the parents have forgotten or intentionally left their children in the vehicle. In addition, children forgetting in commercial passenger vehicle after falling asleep, were the driver did not notice them, and who entered a parked vehicle to play in it, and did not succeed in getting out.

What really happens when children are forgotten in locked cars?

The child starts to suffocate due to the consumption of Oxygen inside the cabin,and if the outside temperature is very hot and humid the child will lose consciousness.Suffocation and heat stroke (hyperthermia) are the biggest dangers, can damage the brain and other body organs. It can even lead to death. It doesn't take long for suffocate a child's and body temperature to become too high very fast when left in a car because the temperature inside a car can increase 20 degrees (Celsius) in just 10 minutes and 40 degrees in an hour. It doesn't have to feel hot outside to be dangerous inside a car. Deaths have happened when it's just above 21 degrees (Celsius) outside. Leaving the windows open slightly does not prevent the temperature from rising to a dangerous level. Figure 2.2is a study showing the number of children who died as a result of heat stroke in the period between 1998 and 2017 [6].

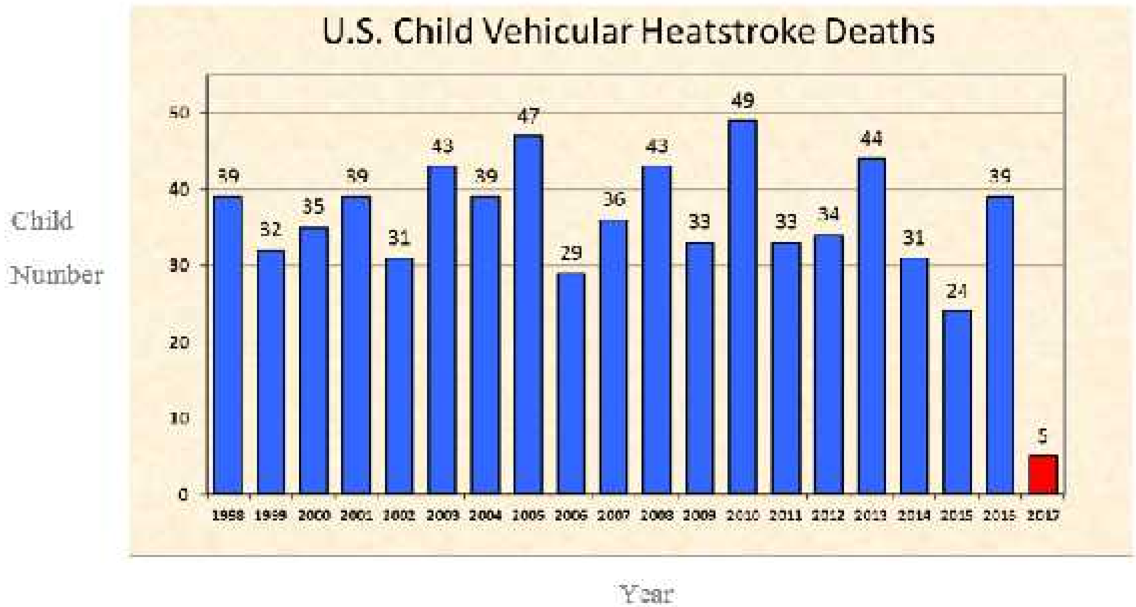


Figure 2.2: child heatstroke deaths

2.4 Previous studies

- Palestine Polytechnic University project named Design and implementation a security system to protect children in the car from suffocation by ventilation system and utilize on solar energy. The project design a safety system to protect children from being suffocated inside vehicles through new ventilation system works on solar power, the system also serves to cool the vehicle while it is parked under sunlight before driving.But the result was difficult to overcome the start current which required inverter has a high power, leading to increased costs. In addition, the project works if the car is parked only in case it is better to work even if the car is working with the possibility to connect the system with the driver through the mobile phone to alert him when running the system.

- Mercedes-Benz applied an Attention Assist system which has safety driving function to warn a driver depending on driver's fatigue to E-Class in 2009. This system recognizes a driver's individual driving pattern and characteristics profile and detects changes from recognized pattern. If it measures the driver is tired, it recommends the driver to rest through visual and auditory warning [1].

- Child Minder Smart Clip Systemis a child restraint based warning system. Designed exclusively for children in child restraints, the Child Minder Smart Clip System replaces the child restraint's chest clip. The receiver alarm unit is placed on an automotive key ring. The system alerts the caregiver with an alarm six seconds after the parent/caregiver has moved more than 15 feet from the child in the child restraint [7].

The proposed project is designed to measure the oxygen, temperature and humidity to detect driver drowsiness and limit it as well as the ability to detect the presence of children left or trapped inside parked vehicles by a set of sensors connected to an electronic circuit (microcontroller) that gives orders to the system to operate automatically.

2.5 Field of application

The proposed system works on most types of vehicles, which is necessary in every car, where it should be imposed on all family cars and school buses, to prevent accidents resulting from drowsiness of the driver or forgetting children inside cars, and should be used in all countries, especially countries with high temperature in the summer or other seasons.

2.6 Temperature and humidity

The average person requires a comfort zone of approximately 21ºC to 26ºC, with a relative humidity of 45 to 50 %. In this temperature and humidity range, we feel most comfortable, as the temperature of anything goes above or below this range we think of it as **HOT** or **COLD.** The control of temperature means the control of comfort and Air conditioning (A\C) system is a method of controlling heat [8].

2.7 Vehicle Air Conditioning System

The air conditioning in a vehicle must cool the passenger compartment and draw moisture out of the fresh air supply. As such it provides an assurance of pleasant passenger compartment temperatures even in strong sunlight and condensation free windows when humidity levels are high.

The most important components of vehicle air conditioning systems are the compressor, the capacitor, the dryer, the expansion valve and the evaporator. The individual components are interconnected via hose lines to form an enclosed system known as the refrigerant circuit. The refrigerant circulates in the refrigerant circuit. It is driven by the compressor.

The refrigerant circuit is divided into two sides:

- The part between the compressor and the expansion valve is called the high-pressure side.
- The area between the expansion valve and the compressor is the low-pressure side.

The four major functions of air condition system is [8]:

- ❖ Cool the air.
- ❖ Circulate the air.
- ❖ Purify the air.
- ❖ Dehumidify the air.

Chapter three

3. Smart air conditioning and ventilation system

3.1 Function of system.

3.2 System components.

3.2.1 Microcontroller (Arduino).

3.2.2 Sensors of temperature (DHT22).

3.2.3Sensor of CO_2.

3.2.4 Thermal sensor (D6T).

3.2.5 Alerting system.

3.2.6 Motors of glass windows.

Chapter Three

Smart air conditioning and ventilation system

3.1 Function of system

The proposed system aims to protect human life and preserve their safety. The system collects the required information from inside the vehicle passenger compartment and works automatically based on this information as follows:

1- Determine the concentration of Carbon dioxide,temperature and presence a child inside vehicle passenger compartment.

2- Determine if the vehicle is switched on or off (parked).

Vehicle switched on:

If the concentration of Carbon dioxide exceeds 1000 ppm or temperature is not suitable more than 26ºC or both, the proposed system gives orders to the alarm system to start work and operate the air conditioning system, to reduce the temperature and raise the proportion of Oxygen inside the cabin to the extent required to keep the driver active and does not feel sleepy. The alarm system operates automatically and stops automatically, as it stops working only if the amount of CO_2 and temperature are appropriateand if the amount of CO_2 does not decrease to the required or safe limit, the system automatically opens the windows of the vehicle to avoid drowsy driver.

Vehicle switched off (parked):

The system checks and ensures the presence of a person inside the cabin by thermal sensors (pyroelctric detector) that detect the presence of humans through the heat waves of humans body where the human body releases heat waves that sensors recognizes. If a person is founded inside the compartment in case the concentration of CO2 exceeds 2000 ppm or the temperature more than 30ºC or both condition existed inside, the system in the first stage activate the alarm system for a period of time. In the second stage the system opens the windows of the car, In order to protect and preserve the life of the person inside the cabin.

3.2 System components

There are a set of components connected together to achieve the purpose of the project as shown in figure 3.1 :

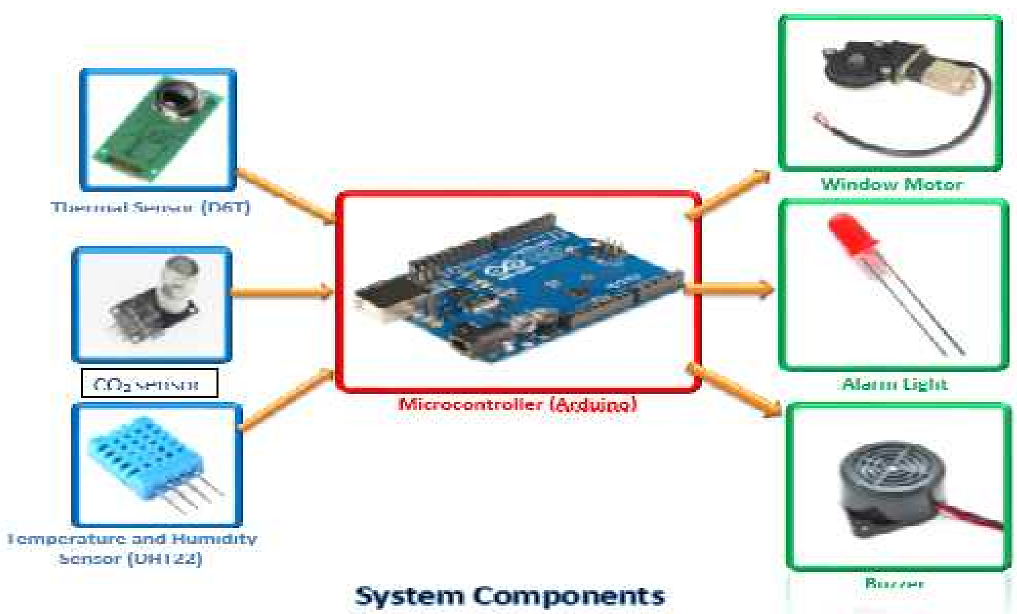


Figure 3.1: System components

3.2.1 Microcontroller (Arduino)

Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino provides an open-source and easy-to-use programming tool, for writing code and uploading it to your board. It is often referred to as the Arduino IDE (Integrated Development Environment) as shown in figure 3.2:

Figure 3.2: Microcontroller (Arduino)

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simplyconnect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

3.2.2 Sensor of temperature

The DHT22 is a basic, low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). It’s fairly simple to use, but requires careful timing to grab data. The only real downside of this sensor is you can only get new data from it once every 2 seconds.

Simply connect the first pin on the left to 3-5V power, the second pin to your data input pin and the right most pin to ground.

This sensor is more precise than other sensors, more accurate and works in a bigger range of temperature/humidity as shown in figure 3.3:

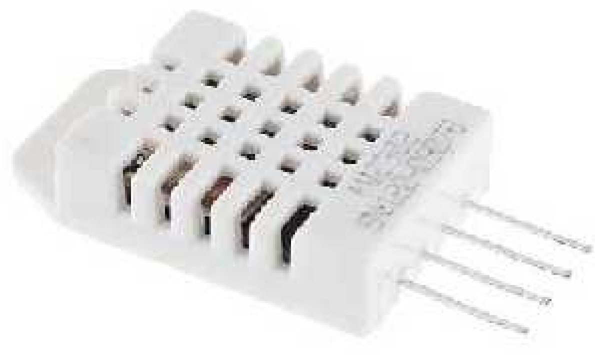


Figure 3.3: sensor of temperature

3.2.3 Sensor of CO_2

This sensor module has an MG-811 on-board as the sensor component. There is an on-board signal conditioning circuit for amplifying output signal and an on-board heating circuit for heating the sensor. It could be used in air quality control, ferment process, in-door air monitoring application as shown in figure 3.4:

Figure 3.4: CO_2 sensor

3.2.4 Thermal sensors (D6T)

The D6T series sensors are made up of a cap with silicon lens, MEMS thermopile sensor chips, and dedicated analog circuit and a logic circuit for converting to a digital temperature value on a single board through one connector. This project uses Omron D6T-8L-06 series.

It is as small as (14x18) mm size and a very sensitive infrared temperature sensor. Instead of measuring temperature on a single point, it can detect it in an array of pixels as shown in figure 3.5:

Figure 3.5: Thermal sensor

3.2.5 Alerting system:

If Temperature and Carbon dioxide level increase to the dangerous level, we need to activate alarm system to make the driver or the passengers in the vehicle aware of this situation.

The alarm system consists of two parts:

The first part is an optical alert system as shown in figure 3.6:

Figure 3.6: Light alarm

The second part is an audio alert system as shown in figure 3.7:

Figure 3.7: Buzzer alarm

3.2.6 Motors of glass windows.

In this project the power window will be used to open when the Oxygen level is become low and Carbon dioxide become high, and close it when the Oxygen and Carbon dioxide are at the natural level, so the window motor (actuator) contact with arduino to do this job as shown in figure 3.8:

Figure 3.8: window motor

Chapter four

4. The project design

4.1 Introduction.

4.2 Project prototype design.

4.3 How the system works.

4.3.1 Algorithm of the system.

4.3.2 Work strategy of the system.

4.4 Software design.

4.4.1 Temperature and humidity sensor software.

4.4.2 Carbon dioxide sensor software.

4.4.3 Thermal sensor software.

4.4.4 Microcontroller Software.

4.5 Modeling CO_2 concentration in vehicle cabin.

4.6 Conclusion.

4.7 Recommendation.

Chapter four

The project design

4.1 Introduction

The proposed project is a way to protect the drivers from the risk of drowsy and the children from risk of left them in vehicles, where the project will be a prototype in the form of a cabin simulates the passenger compartment in automotive vehicles to test the project performance and its effectiveness under circumstances similar to those conditions that occur to the driver causing him to sleep while driving and the conditions that the children are exposed when they are left alone in a closed car.

4.2 Project prototype design

The prototype is a way to try to design a new product or to modify an existing product in order to test the project if it is applicable or not, and whether it meets the purpose for which it is designed or not, before starting its production process or adapting it to a real model.

The 3D design programs are used for pre-project design which is before the project construction is made, so that an approximate or projected image of the project is available, such as SolidWorks program. The SolidWorks program is a solid modelling software that allows you to design product in 3 dimensions as shown in figures 4.1, 4.2, and 4.3.

The following Figures shows a three-dimensional design of the prototype, which is like a passenger cabin using the SolidWorks program. Where the Figure 4.1 shows the front projection of the prototype, Figure 4.2 shows the rear side projection of the prototype, and Figure 4.3 shows the rear projection of the prototype which is the control room of the prototype.

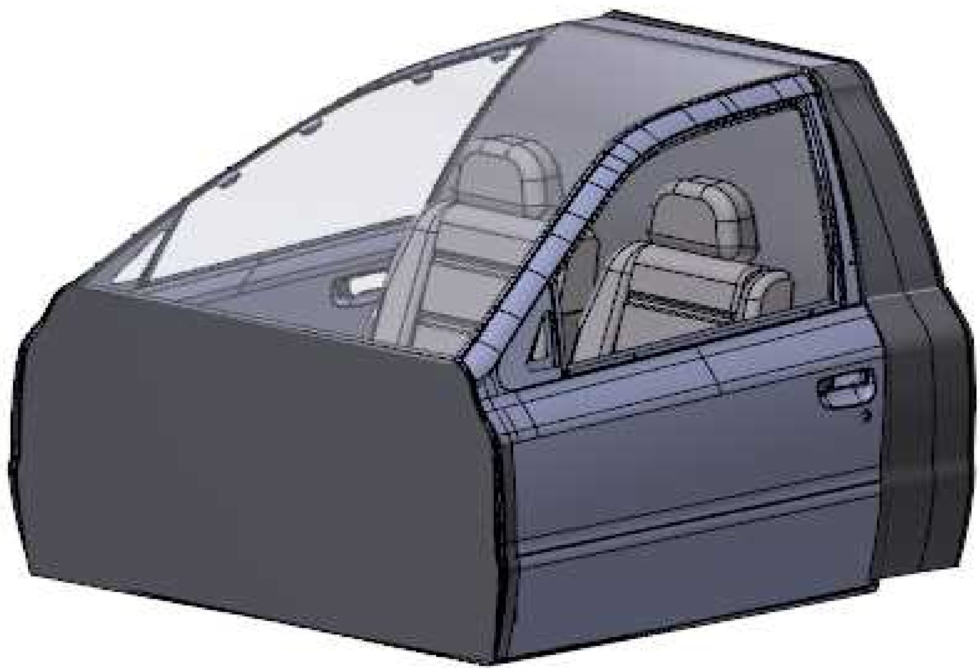


Figure 4.1: Prototype front side

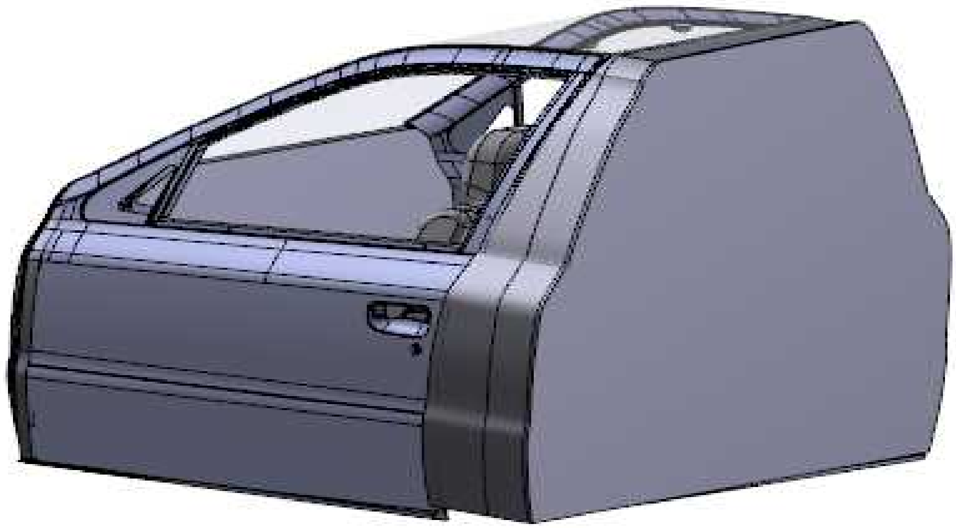


Figure 4.2: Prototype rear side

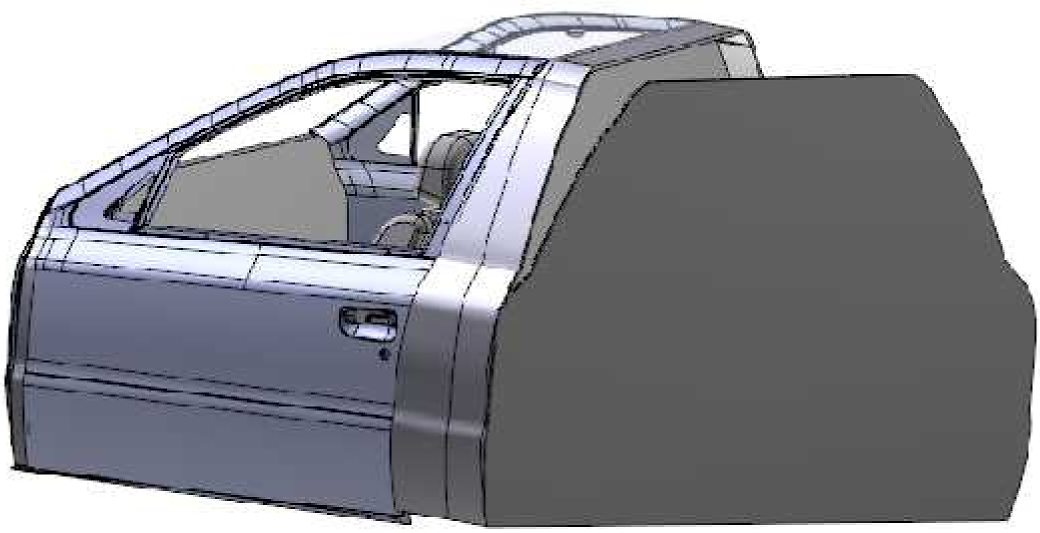


Figure 4.3: prototype rear side

4.3 How the system works

The project is a closed monitor and control system, where themonitoring system is done through a set of sensors inside the prototype cabin that measure, temperature, Carbon dioxide ratio and sensing of passengers presence.

The system is controlled by collecting information from the sensors continuously and periodically, where it is analyzed and compared with the values given to the system so as not to be exceeded, and if it exceeded, the system do several procedures such as turn on alarm system, Air Conditioning system and opening window to ensure that atmosphere insidethe cabin is suitable for the comfort of the driver and passengers.

4.3.1 Algorithm of the system

This algorithm of the system describes the system operations and it will be translated into software codes in the software design section.

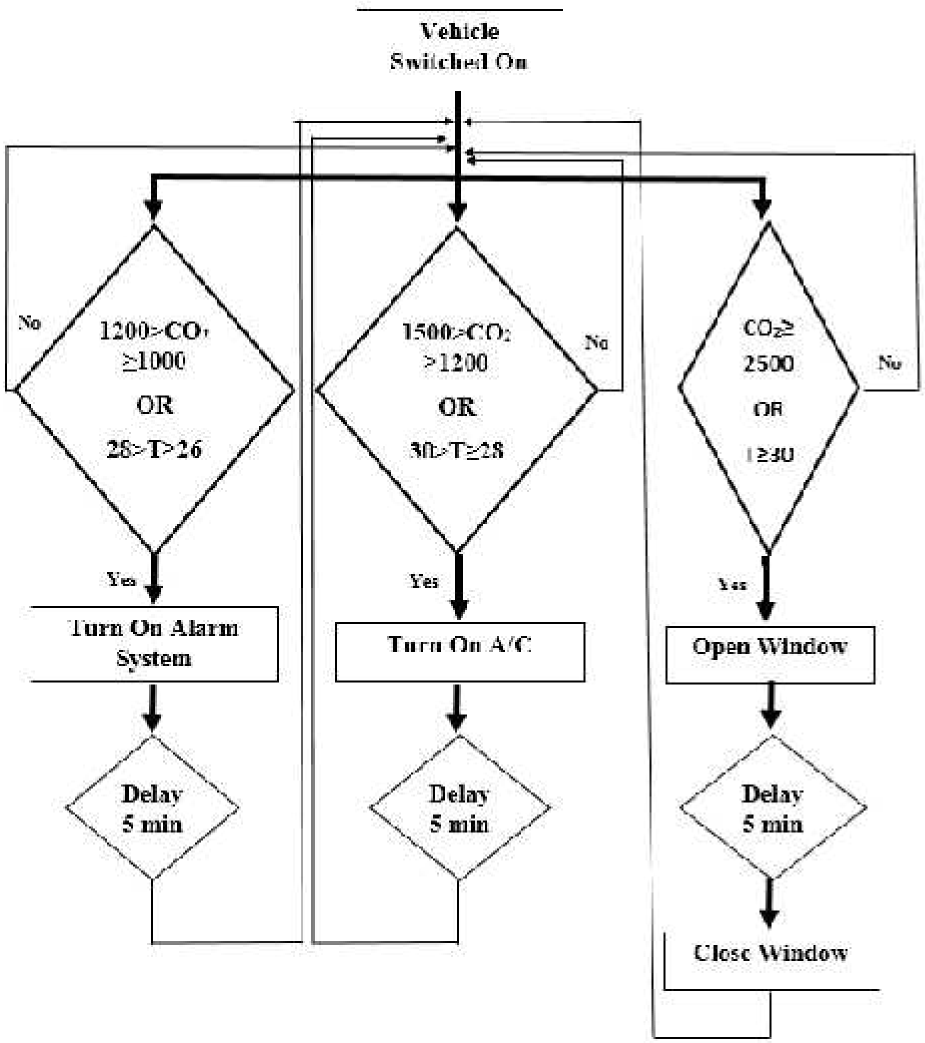
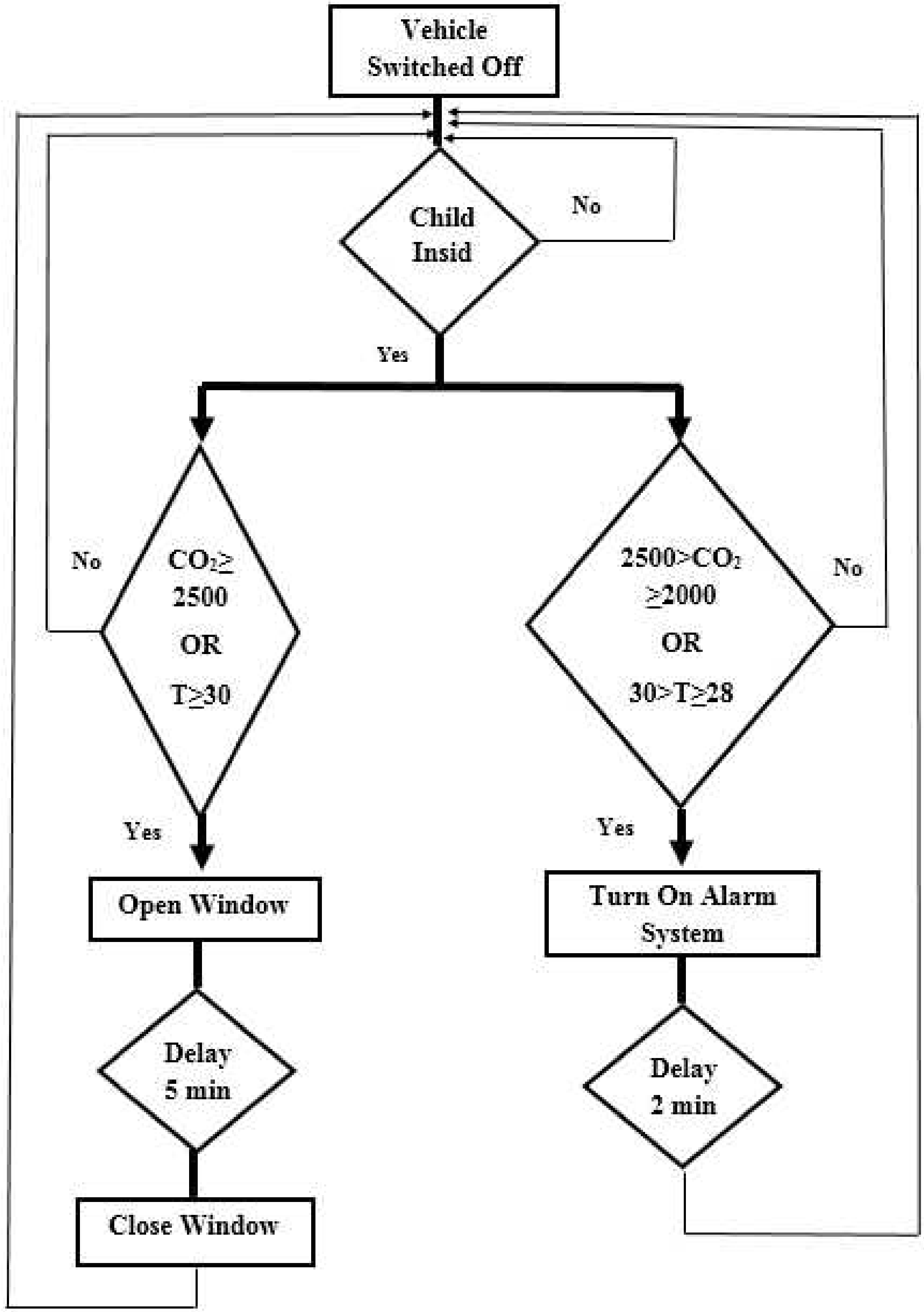


Figure 4.4: Algorithm of the system



Vehicle Switched Off
Child Insid
No
Yes
No
CO2≥ 2500 OR T≥30
2500>CO2 ≥2000 OR 30>T≥28
No
Yes
Yes
Open Window
Turn On Alarm System
Delay 5 min
Delay 2 min
Close Window

4.3.2Work strategy of the system

Thesensors send analog data to the microcontroller, these data expressed the physical case of the system. Where the microcontroller checks the physical situation inside the cabin and take the decision based on the value of the given data, then send commands to the alarm system, A/C system and the window motor as needed.

The prototype is designed from an insulated cabin similar to the passenger compartment in automotive vehicle Contains inside it the Sensors, Alarm system, Display screen, Window motor, and Fan were it has been used as an alternative to the air conditioning system, In addition to designing an external room as a control unit of the system contains inside it the Arduino, Battery 12 V, Switch ON/OFF, Breadboard, Relays and Wires as shown in figure (4.5).

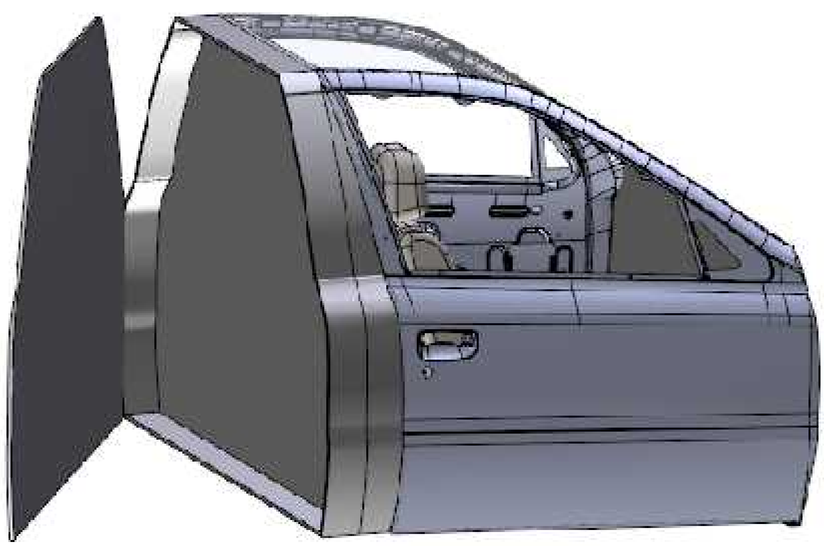


Figure 4.5: Prototype cabin and control unit

4.4 Software design

4.4.1 Temperature and humidity sensor software

```
#include <DHT.h>;

//Constants
#define DHTPIN 7     // what pin we're connected to
#define DHTTYPE DHT22   // DHT 22  (AM2302)
DHT dht(DHTPIN, DHTTYPE); //// Initialize DHT sensor for normal 16mhz
Arduino


//Variables
int chk;
float hum;  //Stores humidity value
float temp; //Stores temperature value

void setup()
{
  Serial.begin(9600);
  dht.begin();
}

void loop()
{
    delay(2000);
    //Read data and store it to variables hum and temp
    hum = dht.readHumidity();
    temp= dht.readTemperature();
    //Print temp and humidity values to serial monitor
    Serial.print("Humidity: ");
    Serial.print(hum);
    Serial.print(" %, Temp: ");
    Serial.print(temp);
    Serial.println(" Celsius");
    delay(10000); //Delay 2 sec.
}
```

Figure 4.6: Temperature and humidity sensor software

4.4.2 Carbon dioxide sensor software

```
const int AOUTpin=0;//the AOUT pin of the CO sensor goes into analog
pin A0 of the arduino
const int DOUTpin=8;//the DOUT pin of the CO sensor goes into digital
pin D8 of the arduino
const int ledPin=13;//the anode of the LED connects to digital pin
D13 of the arduino

int limit;
int value;

void setup() {
        Serial.begin(9600);//sets the baud rate
        pinMode(DOUTpin, INPUT);//sets the pin as an input to the
arduino
        pinMode(ledPin, OUTPUT);//sets the pin as an output of the
arduino
}

void loop()
{
        value= analogRead(AOUTpin);//reads the analaog value from the
CO sensor's AOUT pin
        limit= digitalRead(DOUTpin);//reads the digital value from
the CO sensor's DOUT pin
        Serial.print("CO value: ");
        Serial.println(value);//prints the CO value
        Serial.print("Limit: ");
        Serial.println(limit);//prints the limit reached as either
LOW or HIGH (above or underneath)
        delay(100);
        if (limit == HIGH){
                digitalWrite(ledPin, HIGH);//if limit has been
reached, LED turns on as status indicator
        }
        else{
                digitalWrite(ledPin, LOW);//if threshold not reached,
LED remains off
        }
}
```

Figure 4.7: Carbon dioxide sensor software

4.4.3 Thermal sensor software

```
const int pirPin = 8; // This is the D8 pin that we are going to use


unsigned long motionDelay = 1000; // Motion Delay Timer
unsigned long motionTimer; // Motion Trigger Timer
boolean inMotion = false; // Motion sensor need to be read or not flag
()void setup
}
:put your setup code here, to run once //
pinMode(pirPin, INPUT); // Prepare the pin as Input pin
Serial.begin(19200); // Prepare the Serial Monitor
{
} ()void loop
:put your main code here, to run repeatedly //
(if (digitalRead(pirPin) == HIGH && !inMotion
}
;("Serial.println("Motion Detected


;()motionTimer = millis


;inMotion = true
(else if (millis() - motionTimer >= motionDelay {
;inMotion = false
{
{
```

Figure 4.8: Thermal sensor software

4.4.4 Microcontroller Software

```
#include <DHT.h>


#define Switch 2   //the car Switch input (Input)

#define MotionSensor 3 //This is the D4 pin that we are going to use

#define AOUTpin A0  //the AOUT pin of the CO sensor goes into analog pin A0 of the arduino
(Input)

#define DOUTpin 4  //the DOUT pin of the CO sensor goes into digital pin D8 of the arduino
(Input)

#define DHTPIN 5     // what pin we're connected to (Input)

#define DHTTYPE DHT22   // DHT 22  (AM2302)

#define Alarm 7

#define Windowsopen 8

#define Windowsclose 9

#define airconditioner 10

int S,M,i=0;

DHT dht(DHTPIN, DHTTYPE); //// Initialize DHT sensor for normal 16mhz Arduino


int chk;

float hum;  //Stores humidity value

float temp; //Stores temperature value

int COlimit;

int COvalue;
```

Figure 4.9: Microcontroller Software

```
void setup() {

  pinMode(Switch, INPUT);  //sets the pin as an input to the arduino
  pinMode(MotionSensor, INPUT);
  pinMode(DOUTpin, INPUT);

  pinMode(Alarm,OUTPUT);
  pinMode(Windowsopen,OUTPUT);
  pinMode(Windowsclose,OUTPUT);
  pinMode(airconditioner,OUTPUT);
  dht.begin();
}

void loop()
{
  delay(20000);
  digitalWrite(Windowsopen,LOW);
  digitalWrite(Windowsclose,LOW);
  digitalWrite(airconditioner,HIGH);
  digitalWrite(Alarm,LOW);
```

Figure 4.10: Microcontroller Software

```
i=0;

M=digitalRead(MotionSensor);
S=digitalRead(Switch);

delay(1000);

while(M==HIGH&&S==LOW)
{
  digitalWrite(Windowsopen,LOW);
  digitalWrite(Windowsclose,LOW);
  digitalWrite(Alarm,HIGH);
  M=digitalRead(MotionSensor);
  S=digitalRead(Switch);
  delay(100);
  COvalue= analogRead(AOUTpin); //reads the analaog value from the CO sensor's AOUT
pin
  COlimit= digitalRead(DOUTpin); //reads the digital value from the CO sensor's DOUT pin
  temp= dht.readTemperature();
  while((COvalue>=200)||(COlimit==HIGH)||(temp>=30))
  {

    if(i==0)
    {
```

Figure 4.11: Microcontroller Software

```
digitalWrite(Windowsopen,HIGH);
   digitalWrite(Windowsclose,LOW);
   digitalWrite(Ala-m,HIGH);
   delay(2000);
   i++;
    }
    if(i==1)
   {
   digitalWrite(Windowsopen,LOW);
   digitalWrite(Windowsclose,LOW);
   digitalWrite(Ala-m,HIGH);
    }
    delay(100);
   COvalue= analogRead(AOUTpin); //reads the analaog value from the CO sensor's AOUT
pin
   COlimit= digitalRead(DOUTpin); //reads the digital value from the CO sensor's DOUT pin
   temp= dht.readTemperature();


   }


    while((COvalue<200)&&(COlimit==LOW)&&(temp<30))
  {
   if(i==1)
   {
```

Figure 4.12: Microcontroller Software

```
digitalWrite(Windowsopen,LOW);
  digitalWrite(Windowsclose,HIGH);
  digitalWrite(Alarm,LOW);
  delay(2000);
  i--;
   }
   if(i==0)
  {
  digitalWrite(Windowsopen,LOW);
  digitalWrite(Windowsclose,LOW);
  digitalWrite(Alarm,LOW);
   }
   delay(100);
  COvalue= analogRead(AOUTpin); //reads the analaog value from the CO sensor's AOUT
pin
  COlimit= digitalRead(DOUTpin); //reads the digital value from the CO sensor's DOUT pin
  temp= dht.readTemperature();
  }
 }

 while(M==HIGH&&S==HIGH)
```

Figure 4.13: Microcontroller Software

```
while(M==HIGH&&S==HIGH)
 {
  digitalWrite(airconditioner,LOW);
  digitalWrite(Alarm,LOW);
  M=digitalRead(MotionSensor);
  S=digitalRead(Switch);
  delay(100);
  COvalue= analogRead(AOUTpin); //reads the analaog value from the CO sensor's AOUT
pin
  COlimit= digitalRead(DOUTpin); //reads the digital value from the CO sensor's DOUT pin
  temp= dht.readTemperature();
  while((COvalue>=100)||(COlimit==HIGH)||(temp>=26))
  {

    digitalWrite(airconditioner,HIGH);
    digitalWrite(Alarm,HIGH);

   if(i==0)
   {
    digitalWrite(Windowsopen,HIGH);
    digitalWrite(Windowsclose,LOW);
    digitalWrite(Alarm,HIGH);
    delay(2000);
    i++;
    }
```

Figure 4.14: Microcontroller Software

```
}
if(l==1)
{
digitalWrite(Windowsopen,LOW);
digitalWrite(Windowsclose,LOW);
digitalWrite(Alarm,HIGH);
}
delay(100);
COvalue= analogRead(AOUTpin); //reads the analaog value from the CO sensor's AOUT
pin
COlimit= digitalRead(DOUTpin); //reads the digital value from the CO sensor's DOUT pin
temp= dht.readTemperature();
}

while((COvalue<100)&&(COlimit==LOW)&&(temp<26))
{

digitalWrite(airconditioner,LOW);
digitalWrite(Alarm,LOW);
if(l==1)
{
```

Figure 4.15: Microcontroller Software

```
  digitalWrite(Windowsopen,LOW);
     digitalWrite(Windowsclose,HIGH);
     digitalWrite(Alarm,LOW);
     delay(2000);
     i--;
     }
     if(i==0)
    {
     digitalWrite(Windowsopen,LOW);
     digitalWrite(Windowsclose,LOW);
     digitalWrite(Alarm,LOW);
     }


     delay(100);
    COvalue= analogRead(AOUTpin); //reads the analaog value from the CO sensor's AOUT
pin
    COlimit= digitalRead(DOUTpin); //reads the digita  value from the CO sensor's DOUT pin
    temp= dht.readTemperature();
   }
  }


}
```

Figure 4.16: Microcontroller Software

4.5 Modeling CO_2 concentration in vehicle cabin.

The model predicts temporal CO_2 concentration changes as a function of cabin volume, vehicle body leakage, and number of passengers. This model can be used to design and control air conditioning for a variety of vehicle conditions.

Passengers are the source of CO_2 within the cabin. The normal human breath exhales CO_2 at levels ranging from 38,000 ppm to 56,000 ppm with rates ranging from 220 milliliter per minute (ml/min) at rest to 1650 (ml/min) during moderate exercise, this high concentration exhale can lead to high levels of the CO_2 concentration in enclosed spaces like the vehicle cabin unless it is well ventilated. The outside CO_2 concentration is fixed at the ambient CO_2 level which is around 385 to 395 ppm − 390 ppm was used for all fits, while the in-cabin CO_2 concentration can vary as a function of the strength of the source term (number of passengers), cabin volume (Vc) and body leakage flow (Q_l=Q_i=Q_o). Q_l can vary as a function of other parameters such as ventilation fan speed, vehicle speed, geometry of the HVAC duct system.

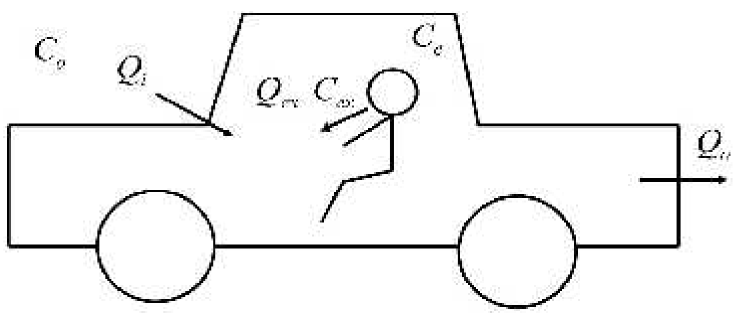


Figure 5.1: Vehicle cabin air system

The CO_2 mass balance equation for the vehicle cabin can be expressed as Equation 5.1:

$$\frac{dm_c}{dt} = n \cdot C_{ex} \cdot Q_{ex} + C_o \cdot Q_l - C_c \cdot Q_l$$

Where m_c is the mass of CO_2 in cabin, t is the time, n is the number of passengers, C_{ex} is the concentration of CO_2 in exhale and Q_{ex} is the flow rate of exhale, C_o is the CO_2concentration outside, Q_l is the body leakage flow, and Cc is the CO_2 concentration in cabin.

Equation 5.2: Shows relationship between the cabin volume, CO_2 mass and CO_2

$$C_c = \frac{m_c}{V_c} \quad \text{then} \quad dC_c = \frac{dm_c}{V_c}$$

concentration.

Where V_c is the cabin volume.After substituting equation 2 into equation 1, the governing equation which determines CO_2 concentrations in the vehicle cabin can be expressed by Equation 5.3:

$$V_c \cdot \frac{dC_c}{dt} = n \cdot C_{ex} \cdot Q_{ex} + C_o \cdot Q_l - C_c \cdot Q_l$$

The solution of the Equation 5.3 predict CO_2 concentrations of the cabin air under various conditions. It is worth to note that the body leakage (Q_l) should be determined to solve the Equation 3. When the vehicle is motionless and ventilation fan is off, the body leakage (Q_l) becomes nearly zero.

4.6 Conclusion

The aim of this project was to predict drivers' drowsy driving and stop drivers from driving under a drowsy state, also protect children trapped in parked vehicles for preventing accidental death.

Anything that could reduce prevalence drowsy driving and help trapped children in parked vehicle will have a huge impact on the number of crashes and associated death. The project is applicable to a real car where its cost is low and its handling is simple and is expected to be of great benefit in preserving human life from similar accidents.

4.7 Recommendation

- The project will be highly efficient if the system is connected to the driver's phone, sending a message telling him that his son has forgotten in the vehicle to keep the children safe.
- The project should be implemented mainly in student buses, schools and traffic.
- The project must be applied in all vehicles because it limits accidents and is considered as a driver alert system during driving.

Reference

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