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Mustansriya University

College of Science/Department of Computer Sciences

An IoT Based System to Monitoring the Validity of Covid-19 Vaccine

A project submitted to the Department of Computer Sciences in partial fulfillment of the requirements for the degree of Bachelor of Science in Computer Sciences – branch name

BY

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2021-2022

Supervisor Certification

This is to certify that the project entitled

…… ,

prepared by ……. ,

and ……. ,

submitted to the Department of Computer Sciences / Collage of Science at Mustansriya University in partial fulfillment of the requirements for the degree of Bachelor of Science in Computer Sciences – branch name was made under my supervision and guidance.

Signature:

Name: (Supervisor)

Title:

Date: / /

بسم الله الرحمن الرحيم

﴿ إِنَّمَا يَخْشَى اللَّهَ مِنْ عِبَادِهِ الْعُلَمَاءُ إِنَّ اللَّهَ عَزِيزٌ غَفُورٌ ﴾

صدق الله العلي العظيم

[فاطر: 28]

الإهــداء

بعد سنين من المشوار الدراسي

ها قد وصلت الى نهاية المطاف سنين قضيتها

بالتعب وسهر الليالي وظروف الحياة الصعبة

التي لم تستطيع الوقوف في طريقي

اهدي مشروع تخرجي وإلى من تتسابق الكلمات

لتخرج معبرة عن مكنون ذاتها

من علمتني وعانت الصعاب لأصل إلى ما أنا فيه

وعندما تكسوني الهموم أسبح في بحر حنانها

ليخفف من آلامي ... أمي

وابي واخوتي واخواني واصدقائي

ثم إلى كل من علمني حرفاً أصبح سنا برقه يضيء الطريق أمامي

الشكر والتقدير

الحمد لله حمداً كثيراُ طيباً مُباركاً فيه ... اللهم لك الحمد حتى ترضى ولك الحمد إذا رضيت ولك الحمد بعد الرضا

لا يسع حروفي إلا أن تمتزج لتكون كلمات شكر وعرفان

ليس لأحد معين وإنما لكل من ساهم في تقديم المساعدة لي ولغيري

الى التدريسين في قسم علوم الحاسوب

والاساتذة المشرفين الذي لم يبخلوا بمساعدتنا

إن قلت شكرا فشكري لن يوفيكم حقا

سعيتم فكان السعي مشكورا

جميل من الانسان أن يكون شمعة ينير درب الحائرين

ويأخذ بأيديهم ليقودهم إلى بر الأمان متجاوزا بهم أمواج الفشل والقصور فشكرا لكم من الأعماق...

ومن الله التوفيق

ABSTRACT

Vaccine protection and monitoring until use is a problem that has a negative impact on people's lives, especially in countries that lack adequate facilities to ensure the viability of vaccines. This is because vaccines can lose their effectiveness if they are exposed to conditions outside the country where they are given. It is recommended to use the restraint during storage or transportation.

In this project, we will build a system that monitors a COVID-19 vaccine and lets the center vaccinator know if a vaccine is not valid due to a supply chain issue. The system consists of an Arduino uno microcontroller, ESP, magnetic sensor, temperature sensor, a GSM sim900, GPS device, an LCD, and buzzer.

The temperature sensor is used to measure the temperature of the vaccine. A magnetic sensor is used to detect if the box is open or closed, which can send a sound alarm if the box is opening. GSM (global system for mobile communications) is used to send and receive messages. GPS uses satellites to determine location.

ESP Wi-Fi is used to send the IOT message to telegram. If the temperature exceeds the limit (the temperature does not meet the storage standards), the system sends an SMS with the location of the box in the form of latitude and longitude. The location is displayed in the Google Maps app. Also, a boot telegram is used to get information about the working system by giving specific commands.

The proposed software system is programmed in C++ using the Arduino IDE.

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LIST OF ABBREVIATIONS

RNA	**Ribonucleic Acid**
GSM	**Global System for Mobiles**
GPS	**Global Positioning System**
NEMA	**National Marine Electronics Association**
LCD	**Liquid Crystal Displays**
ESP 32	**Espressif Systems**

1.1 Introduction

As the number of COVID-19 cases increases worldwide, pharmaceutical companies are racing to develop a vaccine as soon as possible. According to WHO, there are more than 50 vaccine candidates for COVID-19 in development, and two of them have been licensed for full use on December 18, 2020, so they can be utilized [1, 2]. Despite agreements in place to ensure enough COVID-19 vaccine supply [3,4], the unusual and quick development of the vaccines may create safety issues. This can make it difficult to vaccine the entire population against COVID-19. Creating a good vaccine may only be the first step in a long and difficult race to get people to accept the vaccine [5].

Previous pandemics such as Influenza A (H1N1) and SARS demonstrated that some people are apprehensive of getting vaccinated against specific diseases. When there were pandemics, people were generally concerned about the adverse effects of vaccines and how well they performed [7]. Some people, like those with low incomes or little formal education, are more afraid of vaccines because they don't understand them or worry about them [8,9].

Acceptance of vaccines varies around the world, and vaccine hesitancy was named by the WHO as one of the top ten threats for 2019 [10]. In this project, Designs and develops a smart system to monitor the validity of the Sinopharm Vaccine.

1.2 Related work

Arduino and sensors are used in a lot of projects because they are easy to program. But as far as we know, there is no solution that takes care of all of these things at once and lets this goal be reached on low-cost hardware at the same time.In [2020], [Wang, Huang, Xiong, Hong]. They show a set of masked face recognition data and talk about how different algorithms can be used to prevent the spread of the coronavirus on campus and in the institution. Also, when it comes to measuring

temperature, there are a lot of different Arduino-based solutions[11]. In the same year (2020), Roy Biswas, MATLAB is used with an Arduino to show the temperature in real time. But the sensor that was used can't measure temperature without touching it [12], [Pramila.M, Shewta], in 2019. They have made a similar system that lets people check the temperature from afar using smartphones and the Arduino Uno [13].

1.3 Vaccines

Vaccines are significant tools for public health because they are safe and effective at preventing illnesses. When the majority of people are immunized, they have a significant role in reducing the number of infections in a group.

Global health will improve if the COVID-19 vaccines are effective. To ensure that people receive the safest care possible, it's critical to consider how vaccination allergies function and how they could alter how people are cared for [14].

1.4 Types of vaccines for COVID-19

Many vaccinations contain attenuated organisms or compounds derived from them. Today, many vaccines are used, but there are many distinct types of vaccines. There are numerous strategies to reduce the likelihood of being unwell while still allowing the immune system to function properly [15].

The following COVID-19 vaccinations are currently available or being researched:

1.4.1 The messenger RNA (mRNA) vaccine.

A genetically modified messenger RNA (mRNA) is used in this vaccine to tell your body how to make the protein on the COVID-19 virus's surface, which is called the S protein. Immediately after the vaccine is given, the cells start making protein fragments and putting them on the outside of the cells. [16] This makes your body

want to make more antibodies. If you get the COVID-19 virus, these antibodies will fight the virus off.

After the body hears the instructions, it starts to read the messenger RNA right away. There is no way for it to get into the inside of your cells, which are made up of a lot of your DNA. Both Pfizer-Bioentek and Moderna both use messenger RNA in their vaccines to protect against COVID-19, and both use this in their vaccines as well [16].

1.4.2 vector vaccine.

Take genetic material from the COVID-19 virus and incorporate it into a modified virus (called a viral vector). This occurs when the genetic material of the COVID-19 virus gets into contact with your cells. It instructs your cells to produce copies of the S protein, and the viral vector carries out this command. When cells display S proteins on their surfaces, the body begins producing antibodies and white blood cells to defend itself. If you contract COVID-19 at a later date, the antibodies will protect you.

They cannot infect you with COVID-19 or with the virus they employ. Also, the genetic material sent to you by the carrier will not become a part of your DNA. The COVID-19 vaccine is manufactured using vector technology. In addition, AstraZeneca and Oxford University have developed a COVID-19 vaccine based on a virus that is transmitted by insects [17].

1.4.3 Protein subunits vaccine.

Subunit vaccinations only contain the elements of the virus that help your body fight the illness. This type of COVID-19 vaccination contains innocuous S proteins. To protect itself, your body produces antibodies and white blood cells when it recognizes S proteins. If you contract COVID-19 later, your antibodies will combat it because they are produced by your body. The COVID-19 vaccine is being developed by Novavax using immunomodulator technology [18].The US Food and

Drug Administration has approved Comirnaty, a vaccine developed by Pfizer and Biointech, to protect people aged 16 and up against COVID-19. The vaccination is currently known as "Comirnaty." If there is an emergency, people between the ages of 5 and 11 and 12 and 15 can still obtain the vaccine, but it must still be approved. The FDA has also approved the use of two different COVID-19 vaccines, one manufactured by Moderna and one manufactured by Janssen/Johnson & Johnson, to treat persons infected with the virus [19].

1.5 Problem statements

Vaccines are among the most important materials that are closely related to human life. Poor storage of vaccines can lead to human lives and result in a human catastrophe. So , need a system that monitors the vaccine and gives notification in case of improper storage of the vaccine (does not match the recommended vaccine storage conditions during manufacture).

1.6 Aim of the study

The aim of this study is to design and implement a special box for storing vaccines for COVID-19, which has been fully achieved, which helped: -

1- Determine the temperature of the storage area and displaying the value on the LCD screen..

2- Determine the latitude and longitude of the vaccine's location in order to determine its exact position.

3- Keeping the vaccine in an environment that is suitable for storage.

4- Send an alert message , if a problem occurs.

5- Monitor vaccine box information remotely by sending an IoT message on telegram.

6- View the location of the vaccine box on the Google Maps application.

7- An audible alarm sounds when the vaccine door is opened.

1.7 Layout of Project

The project consists of several chapters as follows:

Chapter One: - It includes a general introduction and other works that are related to it. It also talks about vaccines and their types, as well as the research problem and its goals.

Chapter Two: - Includes the theoretical aspects of the embedded system and the real-time system, in addition to the project's hardware components that were used.

Chapter Three:- It includes the practical part of the proposed system.

Chapter Four: - It includes a conclusion and recommendation.

2.1 Real-Time Systems

A real-time system must respond to external events (like physical time passing) within a specified time frame. A real-time system is "any system in which the rate of output generation is significant," according to the Oxford Dictionary. As a result, most of the time, your input and output must match your physical input. The time difference between input and output must be small. Real-time systems can also be defined as any information processing activity or system that must respond to externally generated input stimuli within a specified time period. Real-time systems are always connected to their environment [20].

2.2 Real-Time Systems Type

There are three types as follows:

2.2.1 Hard Real-Time Systems

They are defined by their extreme sensitivity to time, so any breach of the imposed time restrictions is rejected as unacceptable, and the process implementation is considered a failure if it exceeds the specified time limit, even if its results are correct. It is used in many embedded systems, such as aircraft control, robotics, and machine control. It is often described as mission-critical, and its reliability, safety, and security are paramount. Any delay could lead to system failure, material loss, or even death[20].

2.2.2 Real-time systems with latitude (Soft Real-Time System)

These systems also impose time constraints on their activities, though minor delays can be tolerated to avoid system failure or major losses. It gradually agitates and dissatisfies users or beneficiaries of system tasks and services,

increasing time-overrun losses. Systems for live video broadcasting, e-commerce, and card reservation [21].

2.2.3 Firm Real Time Systems

These type of RTOS also need to follow the deadlines. However, missing a deadline may not have big impact but could cause undesired affects, like a huge reduction in quality of a product.When a deadline isn't met, the system keeps working and throws away the late response.[22].

2.3 Embedded systems

They are complete digital systems where the hardware and software are integrated into one environment and the software controls the devices to perform their tasks.

Air conditioners, microwaves, tape recorders, televisions, cell phones, cars, and traffic lights are all embedded systems.[23]

2.4 Real-Time Embedded Systems

Real-time computer systems monitor, respond to, and connect sensors, actuators, and other I/O interfaces that connect the computer system to the environment. Natural and man-made objects as well as animals may also be part of the group.

The computer system must adhere to the timing and other constraints imposed by the real-time behavior of the external world. A real-time computer system may be embedded in a larger system, in which case it is called an embedded system [24].

2.5 Hardware components

The devices were used in the project, which are summarized as follows:-

2.5.1 Arduino microcontroller

Is used to process data from the natural environment, decide on a plan of action based on the data, and then send control signals to carry out the choice.

There are numerous Arduino boards, but we will explore the most popular and extensively used ones, including:

1. Arduino Mega ADK.
2. Arduino Leonardo.
3. Arduino Red Board.
4. Arduino Shields.
5. Arduino UNO.

In our project, the sixth type, the Arduino Uno, was used, and we will discuss its details as follows:

- **Arduino UNO:**

It is an ATmega328P microcontroller board (datasheet). A 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connector, a power jack, an ICSP header, and a reset button. It comes with everything you need to get started, including a USB cord and an AC-to-DC adapter or battery. If you mess up your Uno, you can always change the chip for a few dollars and start over [25] as shown in figure (2.1).

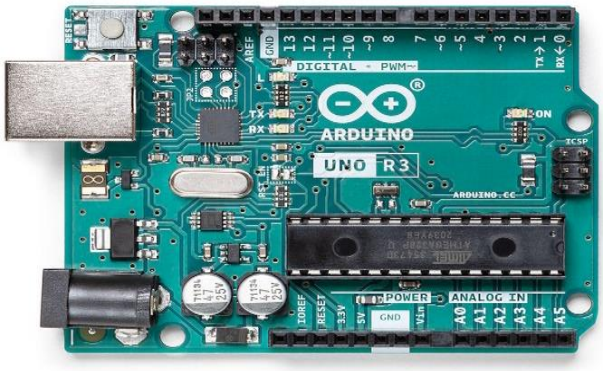


Figure (2.1): Arduino UNO

2.5.2 GSM device (type sim900):

The SIM900 GSM/GPRS shield is a GSM modem for the Arduino UNO that can be used in many IoT projects. That includes sending SMS text messages, receiving phone calls, connecting to the internet via GPRS, TCP/IP and more! Finally, the shield supports quad-band GSM/GPRS networks, making it globally compatible [26]. as shown in figure (2.2).

Figure (2.2): SIM900 GSM/GPRS shield.

2.5.3 GPS :

The Global Positioning System (GPS) is a satellite system developed by the US Defense Department. It uses over two dozen satellites orbiting the Earth to allow receivers on the ground or in the air to pinpoint their location. Devices can detect altitude, heading, and speed using this location. Following a presidential directive in 1983, GPS became available for civilian use. Our project used NEO-6M GPS, which is good for projects because it requires little power to run and has two parts: the antenna and the chip that contains the NEO-6M GPS. as shown in figure (2.3) and figure (2.4).

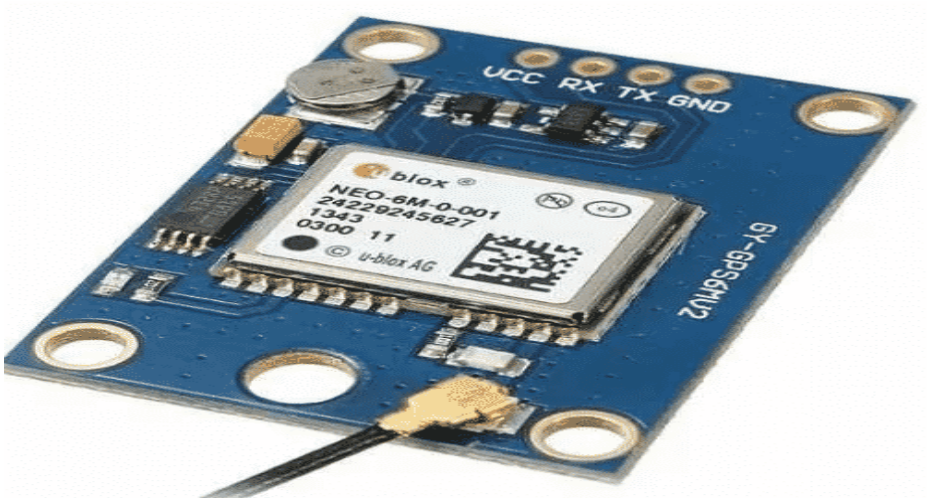


Figure (2.3): a NEO-6M GPS .

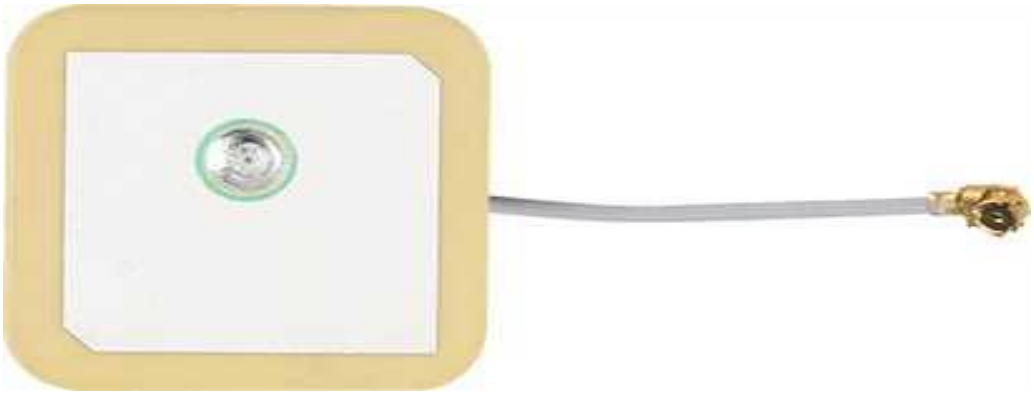


Figure (2.4): Antenna.

When discussing positioning, we must define two key terms: **antenna and NEMA.**

1- **An antenna** : A GPS booster helps a standalone or embedded GPS receiver receive a stronger signal. A GPS antenna can help a GPS unit that is out of line of sight with the sky, such as in a car.[27]

2- **NEMA:** The National Marine Electronics Association (NMEA) existed before GPS. dealers formed the NMEA in 1957 to better communicate with manufacturers. Today, all GPS manufacturers use NMEA, just as all digital computer characters use ASCII. NMEA's goal is to enable hardware-software mixing. Developers can write software for a variety of GPS receivers without having to write custom interfaces for each one. Visual GPS (free) accepts NMEA data from any GPS receiver and displays it graphically. This software would be time-consuming and costly without NMEA.[28]

2.5.4 LM35 senser

The LM35 is a temperature sensor with a proportional analog output voltage. as shown in figure (2.5).

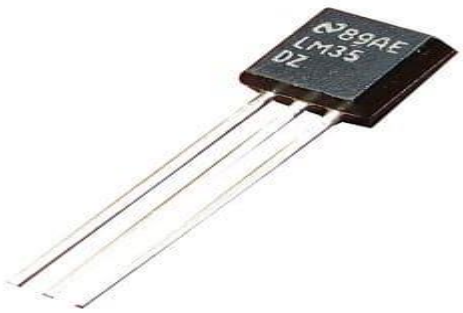


Figure (2.5): LM35.

It gives an output voltage in C (celsius). No external calibration circuitry is required.

The LM35's sensitivity is 10 mV/°C. Temperature increases the output voltage.

250 mV equals 25 °C.

It is a three-terminal sensor capable of measuring temperatures ranging from -55 °C to 150 °C.

The LM35 outputs temperature more precisely than a thermistor.

2.5.5 Magnetic Sensor

A magnetic contact is a door and window sensor that uses a magnet and an internal reed switch. This is how most door and window sensors work. These devices are known for their ease of use and security system enrollment.as shwon in figure (2.6)

Figure (2.6): Magnetic Sensor.

A door and window sensor monitors a door or window and alerts an alarm system when it is opened. Due to their operation, these devices are sometimes called "magnetic contacts." While not all door and window sensors work the same, the majority do.

2.5.6 LCD

It is an easy-to-use display module. Using it can make making easier, allowing makers to focus on the work itself. as shwon in figure(2.7)

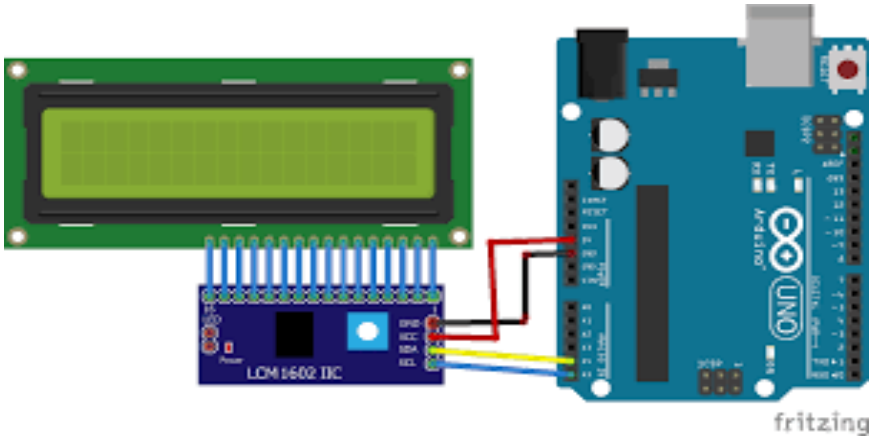


Figure (2.7): LCD with Arduino.

2.5.7 ESP 32

ESP32 is powerful SoC (System on Chip) microcontroller with integrated Wi-Fi 802.11 b/g/n, dual mode Bluetooth version 4.2 and variety of peripherals. It is an advanced successor of the 8266 chip primarily in the implementation of two cores clocked in different version up to 240 MHz. Compared to its predecessor, except these features, it a

lso extends the number of GPIO pins from 17 to 36, the number of PWM channels per 16 and is equipped with 4MB of flash memory. as shwon in figure(2.8)

Figure (2.8): ESP 32

2.5.8 Jumper wires:

The end of a wire that allows it to be used to connect two points without soldering. as shwon in figure(2.9)

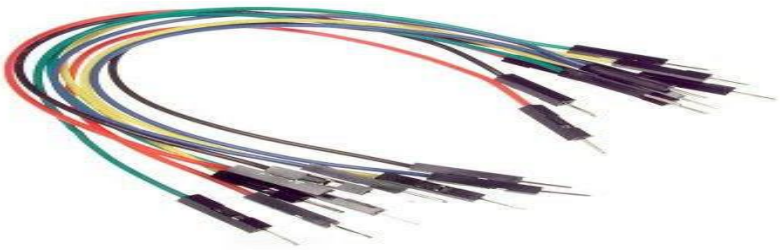


Figure (2.9): Jumper wires.

2.5.9 Breadboard:

There is a way to build electronics without a soldering iron. Components are pushed into the breadboard's sockets and then connected with jumper wires. as shwon in figure(2.10)

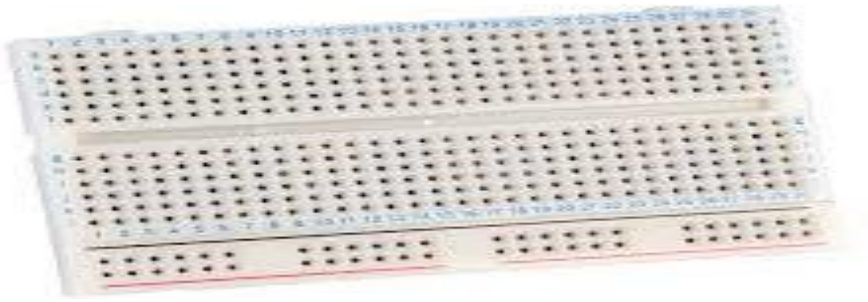


Figure (2.10): Breadboard.

2.6 Software Components

The Arduino IDE Is the software used to build such sketches for an Arduino. This IDE includes the following components:

• **Text editor**: In this section, a simplified form of the C++ programming language can be used to write the simplified code for the simplified code.

• **Message area:** It indicates when an error has occurred and also provides feedback when saving and exporting the code.

• **Text:** In addition to error messages and other information, the console displays text output by the Arduino environment in its entirety.

• **Console Toolbar:** This toolbar contains a number of different buttons, including Verify, Upload, New, Open, Save, and Serial Monitor, among others. The Development Board and the Serial Port that are currently in use are displayed in the bottom right-hand corner of the window [29].

2.7 Iot technology

The term IoT, or the Internet of Things, refers to a group of connected devices and technologies that facilitate communication between devices and the cloud, as well as between the devices themselves. Thanks to the advent of affordable computer chips and high-bandwidth connections, we now have billions of devices connected to the Internet. This means that the devices we use every day such as toothbrushes, vacuum cleaners, cars and machines can use sensors to collect data and respond intelligently to users. We used IoT in this project in Section(2.8.1).[30].

2.7.1 Telegram bot

The Telegram bot can interact with users by sending messages. A telegram bot is a specific type of user that is not human but a computer program that can serve to do many features like sending information, reminders, ordering and more. In this project , An integration between the smartphone messenger Telegram and the Arduino platform using Telegram Bots is developed. A telegram bot is allowing for people to create hardware prototypes and communicate with them using the same tool applied in the communication with other people. [31]. as shwon in figure(2.11)

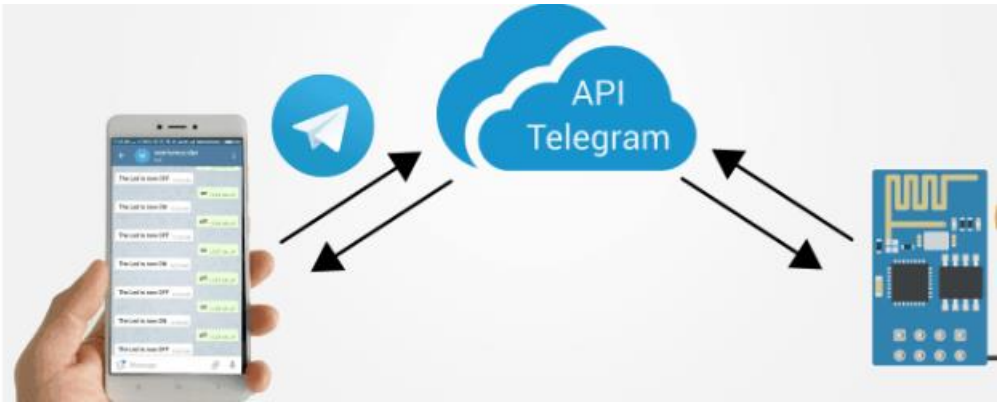


Figure (2.11): Telegram bot

3.1 Introduction

This chapter discusses the detailed implementation of the design system. The system's requirements and implementation are also explained. Following testing and achieving the required findings. In this system , An Arduino Uno is used to measure the temperature and deliver a warning message containing the box's exact location.

3.2 The block diagram of the System:

Figure (3.1) is the block diagram that shows the mechanism of the system's work, as it appears that the system consists of several devices connected with each other, as some of them are considered inputs for data and others as outputs. The temperature is sensed by the temperature sensor LM35 and displayed on the LCD, and when the temperature exceeds the permissible limit, the location will be determined by GPS and sent a message via the GSM device. Magnetic sensor is used to checks a close/ open door of vaccines. Also, an audible alarm will sound, if the door of the box opened. Furthermore , IoT technology is applied by sending information of the box by ESP module to Telegram bot , when the user (admin) send a specific commands.

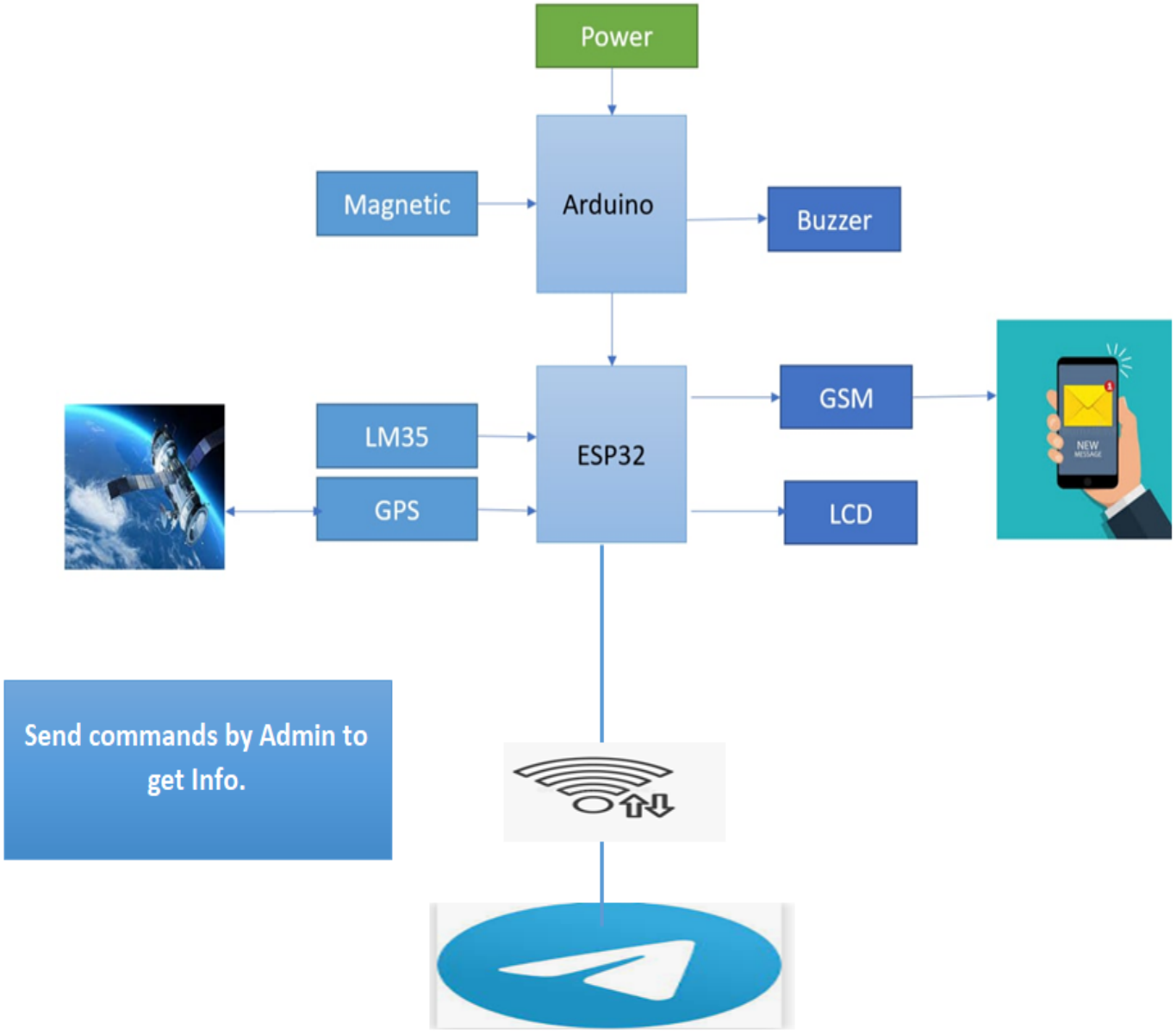
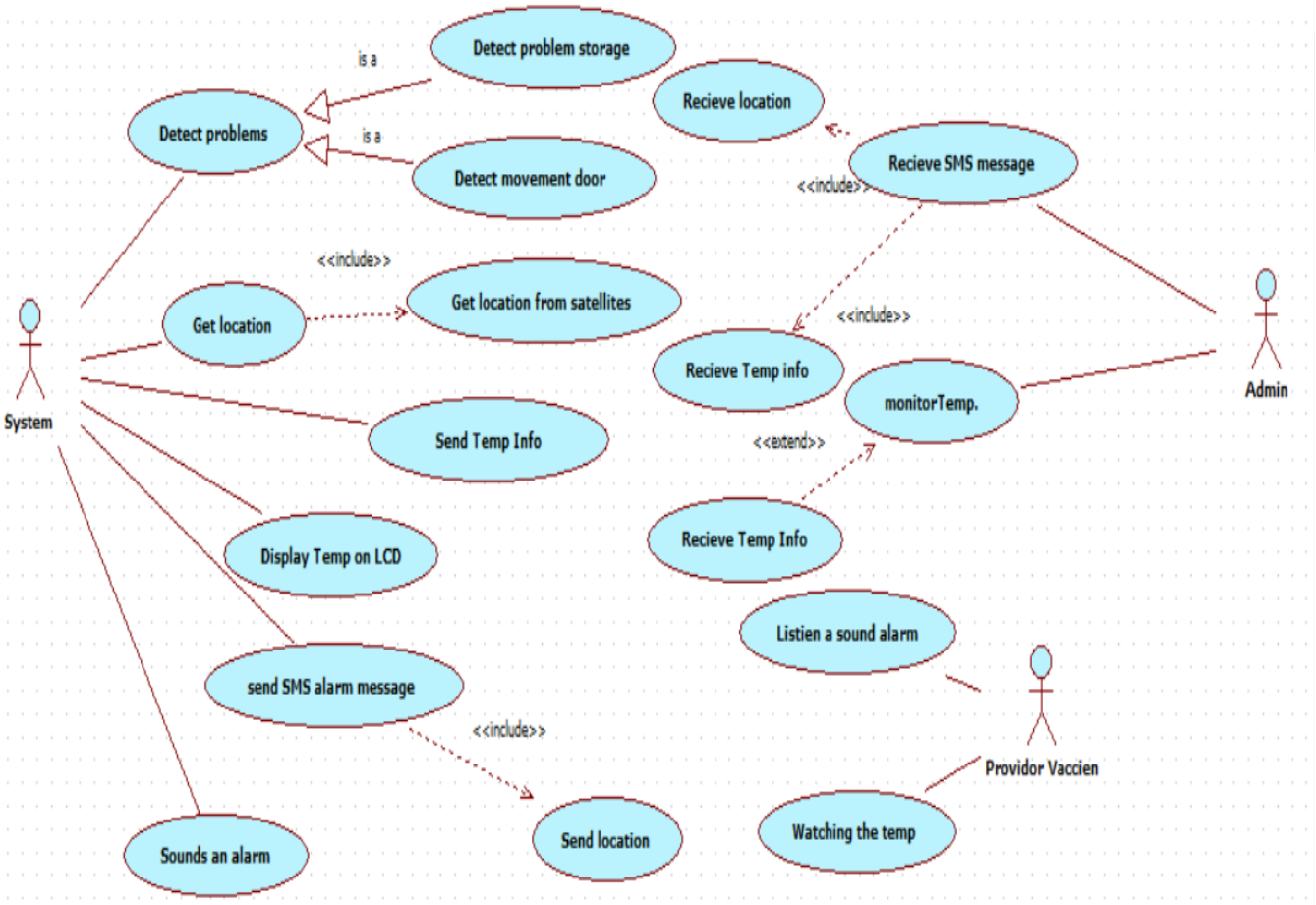


Figure (3.1): The System's block diagram

3.3 Use Case Modeling



Figer (3.2) Use Case Modeling

Figure (3.2) represents the functionality of the system. The use case modeling of the system consists of three actors, with a total of ten basic use cases. The association relation is connected between the actors and use cases. Additionally, generalization, inclusion, and extension relations are found between use cases.

3.4 System requirements

System requirements are divided into two categories: hardware requirements and software requirements for hardware programming. Chapter Two talks about the main pieces of hardware and software that make up the proposed system.

3.5 System Circuit

The suggested system's system circuit will be introduced in this part. Figure (3.3) depicts the system design circuit with Portus software.

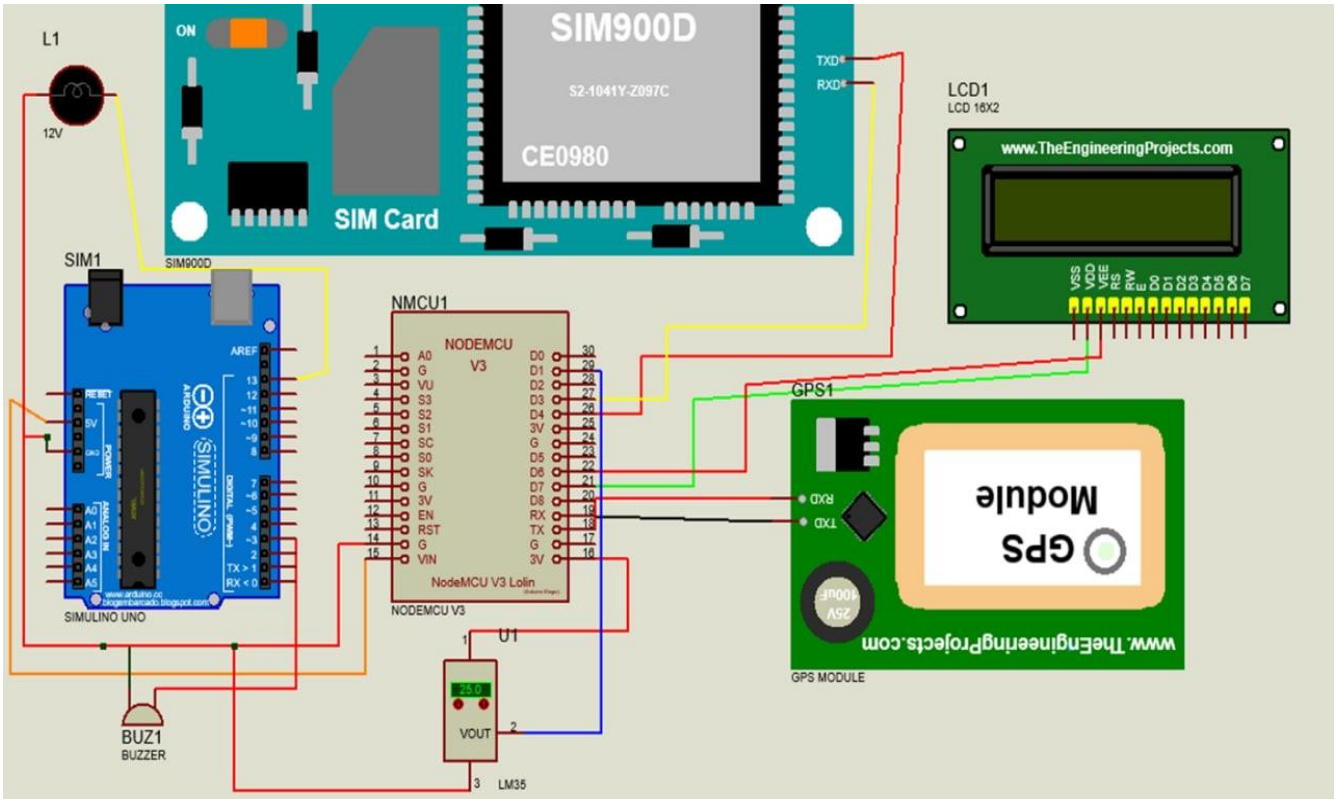


Figure (3.3) System Circuit.

3.6 system implementation

The system is divided into two parts: hardware and software.

The hardware architecture consists of an embedded system based on the Arduino Uno board and an ESP32 module that is linked to the GPS and GSM devices, as well as a temperature sensor and a screen that continuously displays the temperature.

The temperature sensor detects the temperature of the surrounding environment. If the temperature rises and exceeds the storage condition, the GPS device is instructed to determine the location, and the GSM device is instructed to include the exact location in the SMS message. which is then sent to the phone number of the person responsible for vaccine storage or safety, also an IoT Telegram bot is used to send and receive the messages. The admin send to the bot a specific command and he get the information remotely.

3.7 Result Discussion

In this section, discusses the result in to two perspective , the general system result and IOT result.

3.7.1 System testing

To test the system, the software code is uploaded to the Arduino control board and ESP32, and the devices are connected to each other by connecting them using wires . as shwon in figurs(3.4), (3.5).

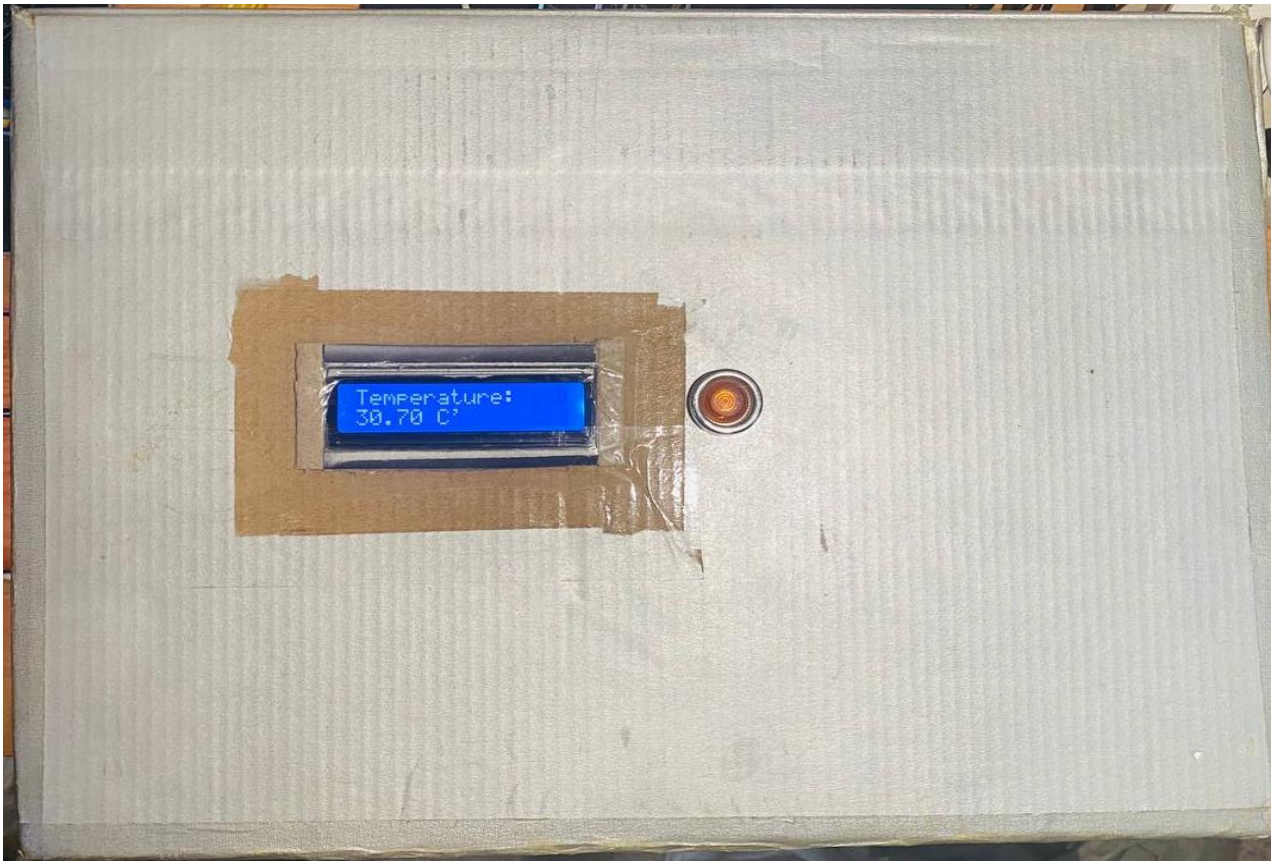


Figure (3.4) Final system (external view).

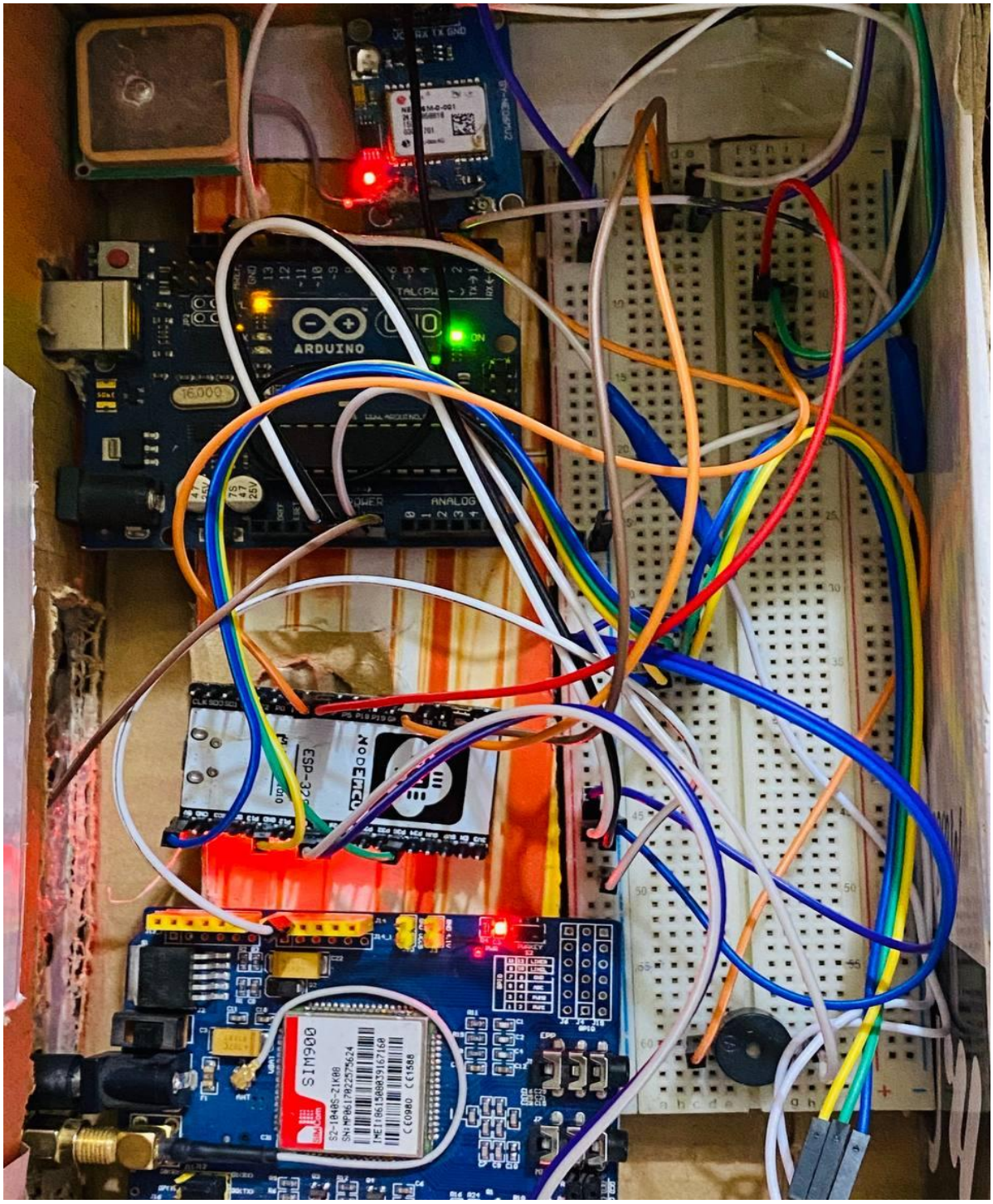


Figure (3.5) components of the system (Internal view)

When the system supplied with electrical power, it will operate directly .The GSM device is connected to the wireless phone network through the antenna in the device, and that takes a few seconds. as shwon in figure (3.6).

Figure (3.6) GSM turn on

The GPS device works and determines the actual location of the system. By sends a signal to satellites. as shwon in figure (3.7).

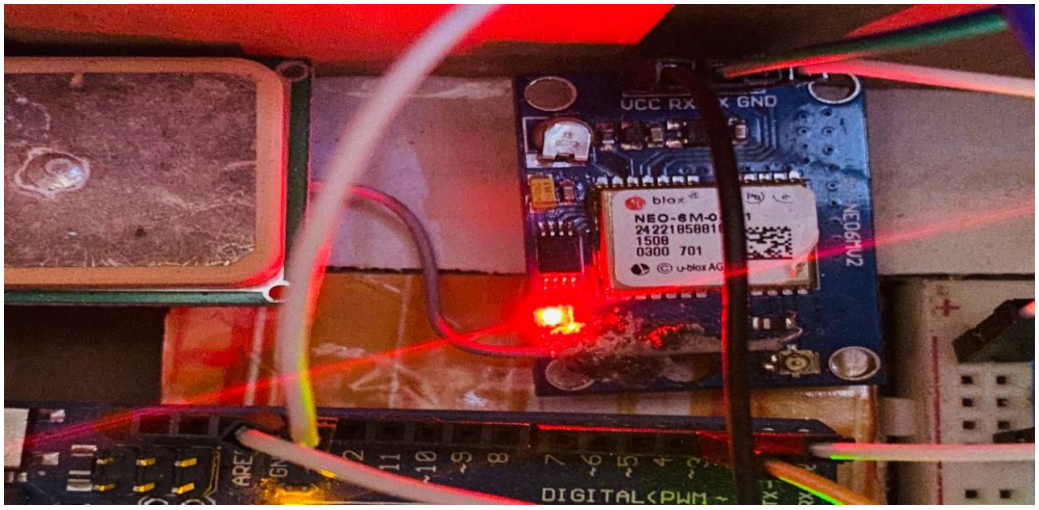


Figure (3.7) GPS sends/ receives signals

The temperature is measured by the temperature sensor in the system and displays it on the LCD screen. as shwon in figure (3.8).

Figure (3.8) Display temp, on LCD

When the box is opened, the magnetic sensor informs the Arduino of the opening process, and thus it notifies the acoustic alarm to sound a whistle upon opening.

Figure (3.9). shows the alarm message when the temperature irises above the required limit. The GSM device sends a text message to the Admin that includes a warning message attached with a link that opens in Google Maps to show the actual location of the box.

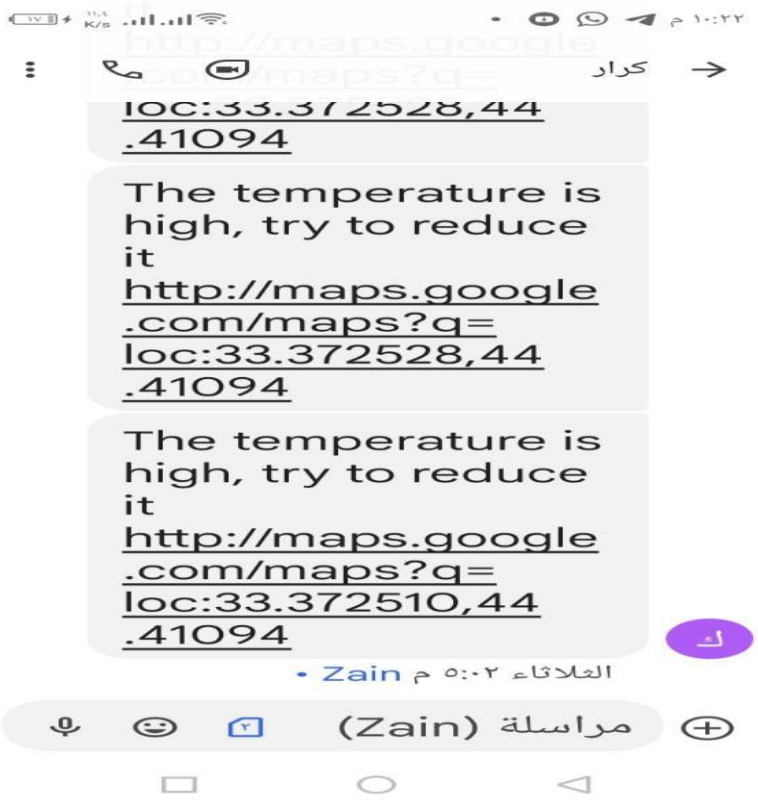


Figure (3.9) Alarm message SMS system.

3.7.2 IoT Testing

An ESP module makes the system to connect to the internet by Wi-Fi . A Chabot telegram is created in this project. The admin sends a commands to telegram and the bot will be get the information from the system. Table 1 shows these commands

Table 1: the command for Bot telegram

Bot commands	**system response**
/start	The system initializes to send information about the box and the vaccine it contains
/tempC	Send current temperatures of the storage box or environment

Figure (3.10) illustrates the IOT bot telegram process.

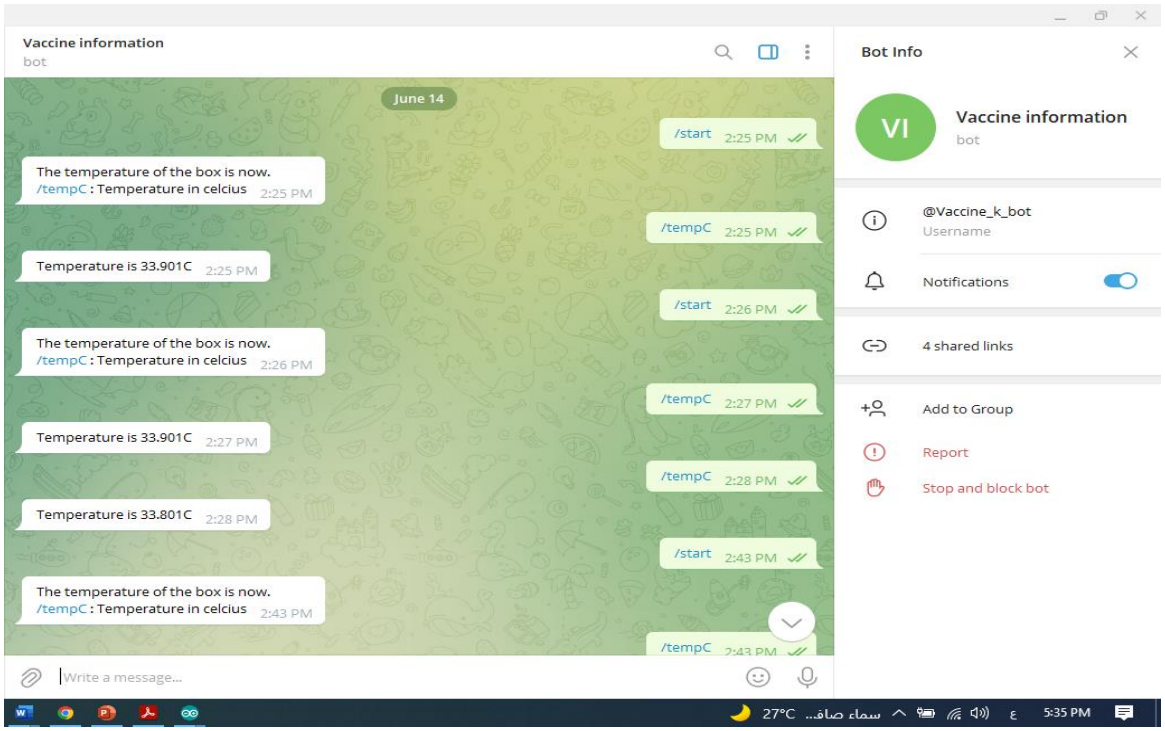


Figure (3.10) commands telegram bot

4.1 Conclusion:

In this project, an IOT smart system was designed and implemented in order to monitor the storage of the vaccine and inform the admin in case it is improperly stored. This was accomplished by sending a warning text message including a warning of high temperature and a link to the specific location of the box, which can be viewed on Google Maps from any location in order to know the location on the map. In addition to this, it sounds an audible alarm whenever the door of the vaccination box is opened and displays the value of the temperature sensor on the LCD screen in order to keep track of any shifts that may occur in the temperature.

IOT technology helps to monitor the state of the box remotely by telling the Chabot a command message to get the information from the vaccine's box.

4.2 Recommendation:

The following was suggested during this research: -

1- The system can have enhanced by adding flame sensor and a hardware device that puts out fires on its own.

2- The system enhanced can add a gas sensor that runs the air vacuums when it detects a gas leak.

3- Read the QR barcode on each vaccine package to find out when it will go bad.

4- Adding a sensor to measure the weight and pressure of the box when it is full and giving a condition when reaching a certain level of unloading warns the user to put more vaccines in the box so that the box doesn't stay empty.

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الخلاصة

تعتبر حماية اللقاحات ومراقبتها حتى استخدامها من اهم المشاكل التي تؤثر سلبيا على حياة الناس، لا سيما في البلدان التي تفتقر إلى المرافق الكافية لضمان صلاحية اللقاحات. وذلك لأن اللقاحات يمكن أن تفقد فعاليتها إذا تعرضت لظروف خارج معايير تخزينها أثناء النقل او التقييد ، لذلك يوصى بالمراقبة المستمرة لضمان صلاحية اللقاح. في هذا المشروع ، تم بناء نظامًا يراقب لقاح COVID-19 ويتيح لمقدمي اللقاحات في المراكز معرفة ما إذا كان اللقاح غير صالح بسبب مشكلة في سلسلة التوريد. يتكون النظام من متحكم Arduino UNO و ESP ومستشعر مغناطيسي ومستشعر درجة الحرارة و GSM SIM900 وجهاز GPS وشاشة LCD و Buzzer. يتم استخدام مستشعر درجة الحرارة لقياس درجة حرارة تخزين اللقاح. يستخدم المستشعر المغنطيسي للكشف عما إذا كان الصندوق مفتوحًا / مغلقًا، والذي يمكن أن يرسل إنذارًا صوتيًا إذا كان الصندوق مفتوحًا. يستخدم نظام GSM (النظام العالمي للاتصالات المتنقلة) لإرسال الرسائل واستلامها. يستخدم GPS للحصول على الموقع من الأقمار الصناعية. يستخدم ESP Wi-Fi لإرسال رسالة باستخدام تقنية إنترنت الأشياء إلى روبوت الرد الالي الذي تم انشاءه على التليكرام. إذا تجاوزت درجة الحرارة الحد الأقصى (درجة الحرارة لا تفي بمعايير التخزين)، يرسل النظام رسالة نصية قصيرة مع موقع صندوق اللقاح على شكل (خطوط الطول والعرض). يتم عرض الموقع في تطبيق خرائط Google. أيضًا، يتم استخدام Boot Telegram للحصول على معلومات نظام العمل من خلال أرسال أوامر محددة.

وتم استخدام لغة برمجة. Arduino C++

إقرار المشرف

اوكد بأن هذا المشروع الموسوم:

الذي تم اعداده من قبل الطالبين:

والمقدم الى قسم علوم الحاسوب - كلية العلوم – الجامعة المستنصرية كجزء من متطلبات نيل شهادة البكالوريوس في علوم الحاسوب – تخصص
قد تم تحت أشرافي وتوجيهاتي.

التوقيع:
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جمهورية العراق

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نظام قائم على إنترنت الأشياء لمراقبة صلاحية لقاحCovid-19

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