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Design Intelligent Protection System Based Microcontroller

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Abstract

Protecting vaccines and making sure they are still good until they are used is a problem that hurts people, especially in countries that don't have the right facilities to make sure vaccines are still good. This is because vaccines can lose their effectiveness if they are used in places other than where they were made. Whether you're putting something away or moving it, it's best to hold it back. In this project, we're going to build a system that will keep an eye on the COVID-19 vaccine and let people know if a vaccine isn't available because of a problem in the supply chain. The system has a microcontroller called the Arduino UNO, a temperature sensor, a GSM type SIM900, and a GPS device. The vaccine storage is measured by the temperature sensor. Messages are sent and received using GSM, which stands for "Global System for Mobile Communication." Satellites are used with GPS (globe position system) to find out where you are. If the temperature is too high (doesn't meet the criteria for storage), the system sends an SMS message with the location of the vaccine box (latitude and longitude). The location is being looked at on Google Maps.

Introduction

As the number of COVID-19 cases rises around the world, drug companies are rushing to make a vaccine as soon as possible. The WHO says that more than 50 potential vaccines for COVID-19 are being made. There are many different kinds, including Pfizer/Biontec, Moderna, Chinese Sinofarm, Astrazeneca, Novafax, and Russian Sputnik. In this system, you will design and build a smart way to track and figure out the state of the vaccine. The system is an embedded real-time system that is made up of both hardware and software. Vaccines are some of the most important materials that are closely related to human life.

Poor storage of vaccines can cost people their lives and cause a disaster. So, we need a system that keeps an eye on the vaccine and alerts us if it is stored wrong (i.e., does not match the recommended vaccine storage conditions during manufacture). It is important for public health that vaccines are safe and protect people from disease. When most people are immunized, the number of people getting sick in a group drops by a lot. If the COVID-19 vaccines work, the world will be healthier. To make sure people get the safest care possible, it's important to think about how vaccination allergies work and how they might change how people are treated (Sampath et al., 2021). Vaccines often contain attenuated organisms or chemicals made from them. There are many different vaccines used today. There are many ways to stay healthy and let your immune system do its best (Callahan, 2011). COVID-19 vaccines are now available or are being researched for the following:

The messenger RNA (mRNA) vaccine

This vaccine tells your body how to make the S protein that covers the COVID-19 virus by using a messenger RNA (mRNA) that has been changed genetically. As soon as the vaccine is given, the cells start making small pieces of protein and putting them on the outside of the cells. IDSA (2022) Your body will want to make more antibodies because of this. These antibodies will help you fight off the COVID-19 virus if you get it. The body starts to read the messenger RNA as soon as it hears the instructions. It can't get into your cells because your DNA makes up most of your cells. Both the Pfizer-Bioentek and Moderna COVID-19 vaccines use messenger RNA (IDSA, 2022).

Vector Vaccine

Take COVID-19's DNA and put it into another virus (called a viral vector). This happens when COVID-19 gets into your cells. It tells your cells to make more S protein, which the virus does. When S proteins appear on the outside of cells, the body makes antibodies and white blood cells. The antibodies help protect you from COVID-19. You cannot get COVID-19 or its virus. Also, the carrier's genetic material won't be added to your DNA. The COVID-19 vaccine is a vector-based one. Based on a virus that is spread by insects, AstraZeneca and Oxford University made the COVID-19 vaccine (FDA, 2022).

Take some of the COVID-19 virus's DNA and put it into a different virus (called a viral vector). This happens when the COVID-19 virus's genetic material gets into your cells. It tells your cells to make more copies of the S protein, which is done by a viral vector. When S proteins show up on the outside of cells, the body responds by making antibodies and white blood cells to protect itself. The antibodies will protect you if you ever get COVID-19 again. They cannot give you COVID-19 or the virus that they use to spread it. Also, the genetic material sent to you by the carrier will not be added to your DNA. Vectors are used to make the real vaccine. Based on a virus that is spread by insects, AstraZeneca and Oxford University have also made a COVID-19 vaccine (FDA, 2022).

Vaccine for protein subunits

Subunit vaccinations only use parts of the virus that help fight illness. This COVID-19 shot has S proteins in it. When there are S proteins in the body, antibodies and white blood cells are made. If you get COVID-19 in the future, your antibodies will fight it. The COVID-19 vaccine from Novavax uses a technology called immunomodulation (MacNeil et al., 2021). The FDA gave the Comirnaty vaccine from Pfizer and Biointech the green light to protect people aged 16 and up from COVID-19. Comirnaty is the name of the shot. People ages 5 to 11 or 12 to 15 can get the vaccine in an emergency, but it must be approved. The FDA has approved two COVID-19 vaccines made by Moderna and Janssen/Johnson & Johnson to treat the virus (Sudharsanan et al., 2022). So, in this system, we build a real-time system or a critical situation and use an AstraZeneca vaccine as a case study to develop this system.

A real-time system must respond to outside events, like the passing of time, within a certain amount of time. The Oxford Dictionary says that a real-time system is "any system where the rate of output is important." Both the input and output must be the same. The time from input to output must be quick. Any activity or system that processes information and responds to inputs from the outside world in real-time is a real-time system. Systems that work in real-time are always linked (Kopetz & Steiner, 2022).

Related Systems

There are many programs that were designed and built around Arduino. Here are some of these works: In the year 2020, they used ultrasonic sensors to send out pulses of radio waves or microwaves that bounced off any object in their path. Arduino is a single-board microcontroller that can support multiple accessories easily and cheaply. The main goal of their paper was to find both movable and immovable obstacles in a certain range by using processing IDE software and a camera to get an image of the detected obstacles. This system was controlled by a Bluetooth-controlled car (Divya et al., 2020).

In 2021, they will design and install a new way to control the temperature inside. When drivers get into their cars in the summer, especially on sunny days, they feel very hot and uncomfortable. This is especially true if the car is parked facing the sun in a parking lot. So, a lot of cooling energy must be used to bring the temperature down to a comfortable level so that the comfort level can be maintained when the phase change material is used. This clever system is used to control the temperature inside a car that is parked facing the sun. When phase-change materials melt and harden, the energy from the heat is absorbed and released by pouches on the inside of the top of the car (Patel et al., 2021).

In 2022, they said that a system should be made to actively control the CO2 and O2 levels inside a container for storing fruit, even when the temperature inside the container stays the same or changes. A small air blower was used to move gases from the container to the outside and O2 levels inside a container for storing fruit, even when the temperature inside the container stays the same or changes. A small air blower was used to move gases from the container to the outside. A thin, long tube kept air from getting into the container, but when the blower was turned on, it made it easier for air to move around. The blower ON frequency (s h1) was modeled as a function of storage temperature, taking into account the type and amount of fruit, blower properties, tube size, and the setpoint of O2 concentration. The model was then used to program an Arduino microcontroller to control the blower based on measurements of the storage temperature taken in real time. The gas control system was then tested by putting sweet cherries in a container. The system could keep the CO2 level at the setpoint level (12.5%), even when the temperature changed from 17 °C to 9 °C or stayed at 6 °C or 17 °C. The number of times the blower turned on varied from 32 s/h at 6 °C to 350 s/h at 17 °C (Li & Yao, 2003).

Systems that work in real-time include:

Hard Real-Time Systems

All of them have to be done quickly. Even if the results are right, the procedure fails if the time limits aren't met. Robots, planes, and other machines can be controlled with it. When something is mission-critical, it needs to be reliable, safe, and secure. A delay could cause a system to break, things to be lost, or even death (Kopetz & Steiner, 2022).

Real-time system latitude (Soft Real-Time System)

These systems have time limits, but small delays can be accepted to keep the system from failing or causing big losses. Over time, this makes system users angry and unhappy, which increases time-overrun losses. Live video, online shopping, and making card reservations (Shaw, 2000).

Firm RReal-TimeSystems

RTOS must satisfy deadlines. Missing a deadline may not have a large effect, but it could lower a product's quality. The system keeps working and discards late answers (Williams, 2022).

Embedded systems

Digital systems that combine hardware and software The software commands the gadgets. A/Cs, microwaves, cassette recorders, TVs, cell phones, autos, even traffic lights have embedded systems (Lutkevich, J022).

Real-Time Embedded Systems

Real-time computer systems watch, respond to, and connect sensors, actuators, and I/O interfaces. Animals and man-made items may be included. The real-time outside world limits computer timing and other elements. A real-time embedded system is part of a larger system (Hierons, 2001).

Hardware Components of the System

The paper's proposed system uses the following devices:

Arduino Microcontroller

It's used to process environmental data, determine a plan of action, and send control signals to accomplish it. The Arduino Mega ADK, Arduino Leonardo, Arduino Red Board, Arduino Shields, and Arduino UNO will be covered. Our paper uses Arduino. It's used to process environmental data, decide on a plan of action, and send control signals to implement the plan. We will look at the Arduino Mega ADK, the Arduino Leonardo, the Arduino Red Board, the Arduino Shields, and the Arduino UNO. Our paper uses the Arduino Uno.

The Arduino UNO is an ATmega328P board (datasheet). A USB connector, a power jack, an ICSP header, and a reset button. Figure 1 shows that it includes a USB cable and an AC-to-DC adapter or battery (Shaw, 2000).

Figure 1. Arduino UNO

GSM device (type sim900)

The SIM900 GSM/GPRS shield is an Arduino UNO GSM modem used in IOT publications. Sending SMS, receiving phone calls, connecting to the internet through GPRS, TCP/IP, and more! The shield supports quad-band GSM and GPRS networks (Arduino, 2015) as shown in Figure (2).

Figure 2. SIM900 GSM/GPRS shield.

The Global Positioning System (GPS)

The US Defense Department created GPS. It uses nearly two dozen satellites to locate receivers on the ground or in the air. Altitude, heading, and speed can be detected here. In 1983, a presidential decision made GPS civilian-friendly. As shown in Figure 3, it is suitable for the proposed system in this paper since it consumes low power and includes two parts: the antenna and the chip. When discussing positioning.

Figure 3. NEO-6M GPS.

Antenna And NEMA

A GPS booster strengthens a solo or embedded GPS signal. GPS antennae can help a GPS unit in a car that can't see the sky (Zaghloul, 2014).

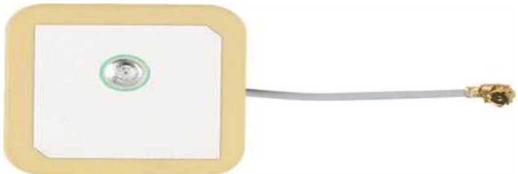

Figure 4. Antenna.

NMEA

Was founded in 1957 to improve dealer-manufacturer relations. GPS makers use NMEA because all digital characters use ASCII. Hardware-software mixing is possible using NMEA. GPS receiver APIs aren't needed. Free visual GPS graphs of GPS NMEA data This program is slow and costly without NMEA (McGuigan, 2023). as shown in Figure 4.

LM35 Sensor

The LM35 is a temperature sensor with analog output. It outputs in C (Celsius). No external calibration is required. The LM35 is 10 mV/°C. The voltage rises with temperature. 250 mV = 25 °C A three-terminal sensor can measure temperatures from -55 to 150 °C. LM35 is more precise than a thermistor.

LCD

Simple display module Using it helps creators focus on their tasks. Figure 5.

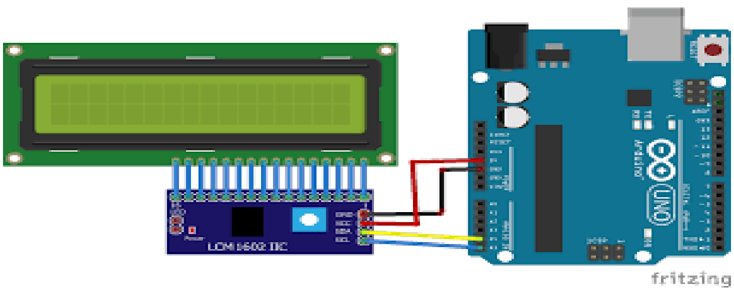

Figure 5. LCD with Arduino

Software Components of the System

The Arduino IDE is used to build sketches. This IDE includes these:

Text Editor

The simplified code for simplified code can be written in a simplified version of the programming language C++.

Message Area

It indicates when an error has occurred and also provides feedback when saving and exporting the code.

Text

The console shows all of the text that the Arduino environment sends out, as well as error messages and other information.

Console Toolbar

This toolbar features Verify, Upload, New, Open, Save, and Serial Monitor. The Current Development Board and Serial Port are indicated in the bottom right corner.

System Circuit

In this part, the system circuit for the suggested system will be explained. Figure 6 shows the system design circuit made with Portus software.

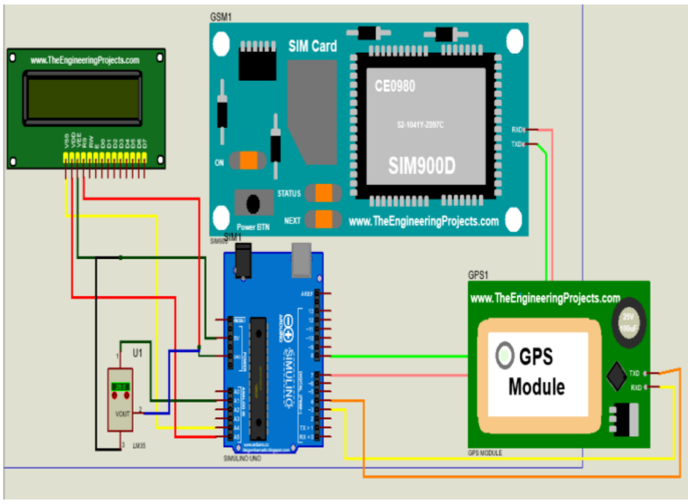

Figure 6. System Circuit.

System Implementation

The system consists of two parts: hardware and software. The hardware architecture is made up of an embedded system built on the Arduino Uno board and an ESP32 module that is connected to the GPS and GSM devices. There is also a temperature sensor and a screen that always shows the current temperature. The temperature sensor measures the temperature of its surroundings. If the temperature goes above the storage conditions, the GPS device is told to figure out where it is, and the GSM device is told to include the exact location in the SMS message.

System Work

In this research, an intelligent system was built and designed to monitor the environment in which the AstraZeneca vaccine is stored.

The Arduino is in control of all the hardware associated with it. The Arduino receives a signal from the sensor, which is a temperature sensor that measures the temperature of the environment in which the vaccine is continuously stored. When the temperature in the environment rises more than the recommended amount for storing the vaccine, the Arduino will tell the GPS and ask the satellite where it is.

An alert message is also sent through the GSM, containing the location where the vaccine is stored. LCD used to display the temperature value.

Also, by sending an audio alarm by using the buzzer Figure 7 shows the block diagram of the system.

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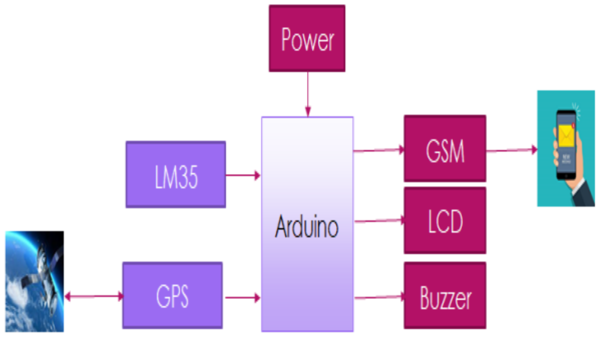

Figure 7. The block diagram of the system

Figure 8 shows the main steps of the algorithm for the system

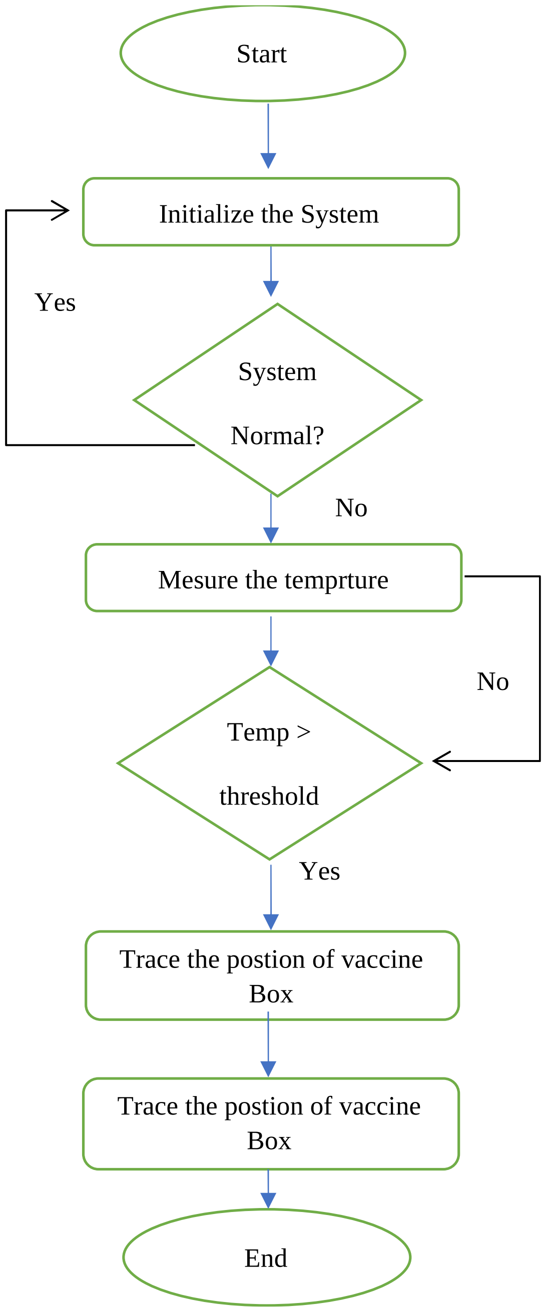

Figure 8. The algorithm of the system

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System Testing

The results were recorded after putting the project through its paces by raising the temperature and sensing it with the temperature sensor. The coordinates of the fund's location were communicated to the researchers through text message using the GSM smartphone.

Figure 9 shows the alarm message that sends As, we can see in Figure 10 the value of temperature that is displayed in the LCD.

Figure 9. Display temp, on LCD

Figure 11 shows that the alarm message will be sent with the address if the temperature is raised

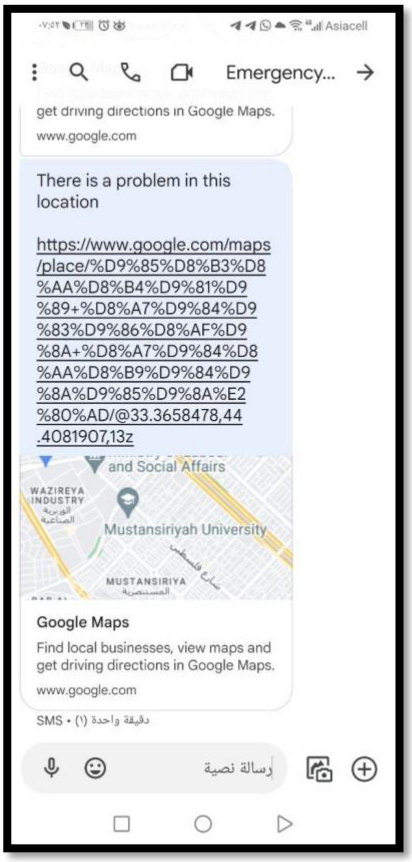

Figure 8. Display temp, on LCD

Conclusion

The Arduino-based Vaccine Fund project was established to protect them from damage and to be in safe hands and not to be tampered with by those who are not concerned facilitate knowing the locations of vaccines that deviated from the storage conditions by locating them on the map.

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