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Paralysis Patient Health Monitoring System Using Embedded and IoT Technologies

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ABSTRACT:

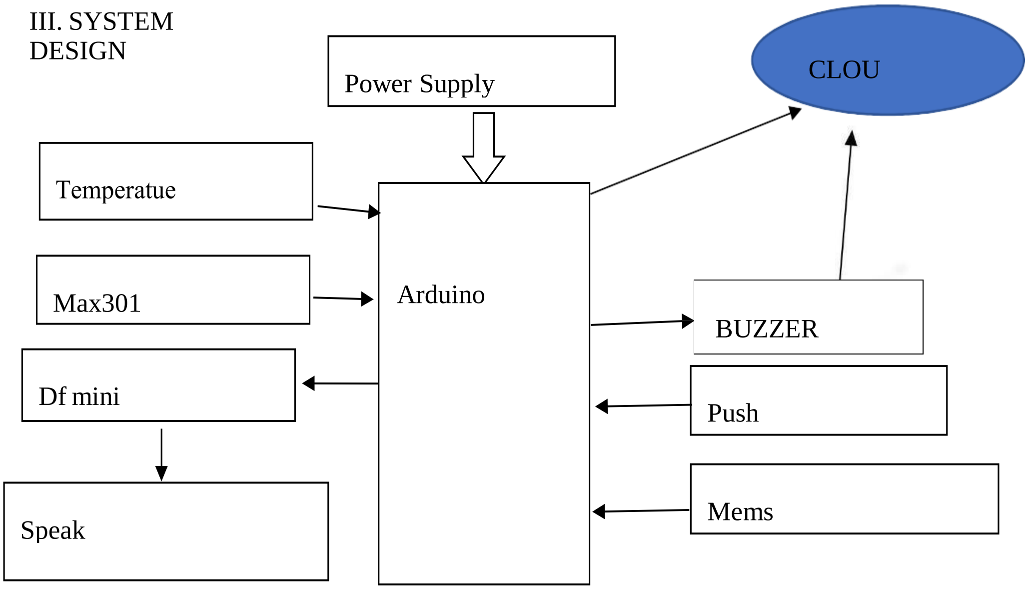
In the contemporary world, numerous individuals are experiencing physical disabilities resulting from paralysis or various accidental incidents. A significant portion of these patients relies heavily on caregivers for support. Paralysis refers to a condition characterized by the impairment of one or more muscles within the body. To aid these patients, microcontroller-based circuitry is instrumental in the development of assistive systems. Additionally, certain devices can be operated through the patient's hand movements. This system is also designed to monitor the patient's heartbeat; should it exceed the normal range, an alarm will sound, and a message will be displayed on an LCD screen for the attention of doctors and caregivers.

KEYWORDS: *Arduino UNO, Temperature Sensor, Buzzer, LCD Display, Heartbeat Sensor, ESP8266,MEMS sensor,DF mini MP3 player*

1. INTRODOUCTION

In recent times, the progress made in embedded systems and the Internet of Things (IoT) has transformed the healthcare sector by fostering the creation of cutting-edge patient monitoring solutions. These advancements hold the promise of elevating patient care, improving diagnostic accuracy, and enabling remote health monitoring. The suggested patient health monitoring system combines multiple sensors with an Arduino Uno microcontroller and an ESP8266 module to ensure wireless connectivity to the cloud. This system is designed to facilitate continuous tracking of vital signs and to issue prompt alerts in the event of irregular readings or fall incidents, thereby promoting patient safety and overall well-being.

III. SYSTEM DESIGN



2. SYSTEM ANALYSIS

2.1 EXISTING SYSTEM

Conventional patient monitoring systems typically depend on fixed equipment situated within clinical environments, which restricts patient mobility and confines continuous monitoring to hospital settings. Furthermore, these systems often do not support real-time data transmission, complicating the provision of prompt interventions during emergencies. The emergence of embedded and IoT technologies has prompted a transition towards more portable and adaptable monitoring solutions that facilitate continuous observation beyond clinical confines. Nevertheless, numerous existing systems continue to encounter challenges related to mobility, connectivity, and scalability.

2.2 PROPOSED SYSTEM

1. The proposed health monitoring system for patients addresses the shortcomings of conventional monitoring systems by utilizing embedded and Internet of Things (IoT) technologies. This system is equipped with a range of sensors, including those for measuring temperature, heart rate, SpO2 levels, and a MEMS sensor designed for fall detection, all connected to an Arduino Uno microcontroller. The Arduino Uno facilitates communication with an ESP82 module, enabling wireless connectivity to the Firebase Cloud platform, where the gathered data is stored and analyzed in real-time. In the event of abnormal vital signs or fall detection, the system activates alerts through a combination of audio signals via a DF Mini MP3 player and visual notifications using a buzzer.

FIG 3.1 BLOCK DIAGRAM

2.3 BLOCK DIAGRAM DESCRIPTION

A. ARDUINO UNO

FIG 3.2.1 ARDUINO UNO

The ATmega2560 functions as a microcontroller, operating at a voltage of 5 volts. It is recommended that the input voltage be maintained between 7 volts and 12 volts, although it can accept a range from 6 volts to 20 volts. This microcontroller features 54 digital input/output pins, of which 15 are capable of providing PWM output. Additionally, it includes 16 analog input pins. Each input/output pin can handle a direct current of 40 mA, while the 3.3V pin can accommodate up to 50 mA. The device is equipped with 256 KB of flash memory, of which 8 KB is utilized by the bootloader. It also contains 8 KB of static random access memory (SRAM) and 4 KB of electrically erasable programmable read-only memory (EEPROM). The clock speed is set at 16 MHz, and the USB host chip integrated into the design is the MAX3421E. The dimensions of the board are 152 mm in length and 53.3 mm in width, with a total weight of 3 grams.

B. ESP8266:

FIG 3.2.2 ESP8266

The ESP8266 12-E chip is equipped with 17 GPIO pins. However, not every GPIO is accessible on all ESP8266 development boards; certain GPIOs are discouraged for use, while others serve particular functions. This guide will provide you with the knowledge to effectively utilize the ESP8266 GPIOs, helping you to select the most appropriate pins for your projects and thereby preventing unnecessary frustration.

C. MAX30100:

FIG 3.2.3 MAX30100

The MAX30100 is a comprehensive sensor solution that functions as both a pulse oximeter and a heart-rate monitor. This optical sensor utilizes two light-emitting diodes (LEDs)—one red and one infrared—to obtain readings by measuring the absorbance of blood pulsations via a photodetector. The specific combination of LED colors is optimized for accurate data collection through the fingertip. The device is fully configurable through software registers, and it features a 16-deep FIFO for storing digital output data. Communication with a host microcontroller is facilitated through an I2C digital interface.

The pulse oximetry subsystem of the MAX30100 includes ambient light cancellation (ALC), a 16-bit sigma-delta analog-to-digital converter (ADC), and a proprietary discrete-time filter. Its ultra-low-power operation makes it particularly suitable for battery-operated systems, functioning effectively within a supply voltage range of 1.8 to 3.3V. This sensor can be integrated into various applications, including wearable technology, fitness monitoring devices, and medical monitoring systems. Additionally, the MAX30100 can be powered down via software, resulting in minimal standby current, which allows it to remain connected to the power supply at all times.

D.PUSH BUTTON

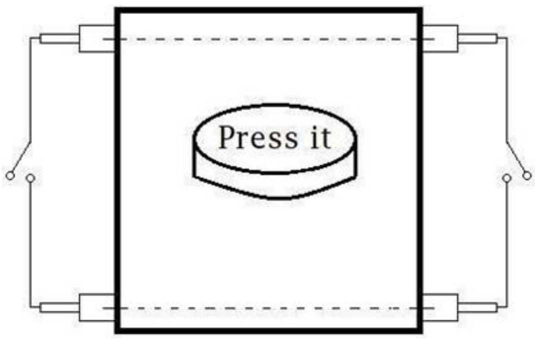


FIG 3.2.4 Push button

A Push Button is a specific type of switch that operates based on a straightforward mechanism known as "Push-to-make." In its default condition, it remains in the off state or is considered normally open. However, upon being pressed, it facilitates the flow of current, effectively completing the circuit. Typically, the body of a Push Button is constructed from either plastic or metal, depending on the variant. The structure of a Push Button consists of four legs, with two positioned on one side and the other two on the opposite side. This design allows for the operation of two circuit lines using a single Push Button. The legs on both sides are internally connected, as illustrated in the accompanying figure.

C. LM35:

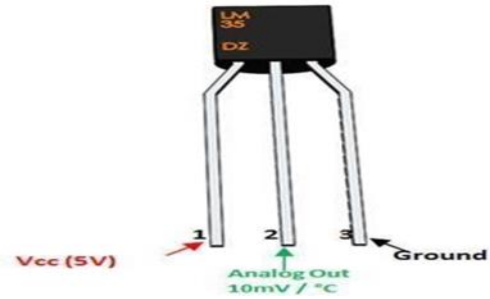


FIG 3.2.5 Temperature Sensor

The LM35 is a temperature sensor that generates an analog output signal directly proportional to the current temperature. This output voltage can be easily converted to a temperature reading in degrees Celsius. One of the key benefits of the LM35 compared to thermistors is that it does not necessitate any external calibration. Additionally, its protective coating prevents self-heating. With a low cost of around $0.95 and enhanced accuracy, it has gained popularity among hobbyists, DIY circuit designers, and students. Numerous budget-friendly products leverage its affordability and precision by incorporating the LM35 into their designs. Although it has been over 15 years since its initial release, the sensor remains relevant and is widely utilized in various applications.

D. BUZZER:

1. n audio signaling device, such as a beeper or buzzer, can be classified as electromechanical, piezoelectric, or mechanical. Its primary purpose is to transform audio signals into sound. Typically, it operates on direct current (DC) voltage and is utilized in a variety of applications, including timers, alarm systems, printers, and computers. Depending on the specific design, it is capable of producing a range of sounds, including alarms, music, bells, and sirens.

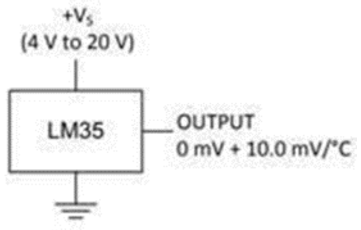
FIG 3.2.6 Buzzer

TEMPERATURE SENSOR:

LM34, DS18B20, DS1620, LM94022

HOW TO USE LM35 TEMPERATURE SENSOR

The LM35 is a precision integrated circuit temperature sensor, characterized by an output voltage that fluctuates in accordance with the surrounding temperature. This compact and cost-effective integrated circuit is capable of measuring temperatures ranging from -55°C to 150°C. It can be seamlessly interfaced with any microcontroller equipped with an ADC function or with development platforms such as Arduino. To power the integrated circuit, apply a regulated voltage of +5V (VS) to the input pin and connect the ground pin to the circuit's ground. Subsequently, temperature can be measured in the form of voltage as illustrated below.



If the temperature is 0°C, then the output voltage will also be 0V. There will be rise of 0.01V (10mV) for every degree Celsius rise in temperature. The voltage can converted into temperature using the belowformulae.

Power Supply:

1. Alternating current (AC) is utilized for the transmission of power along power lines and for high-power devices, including appliances and lighting. The inherent properties of AC render it particularly suitable for long-distance transmission and for supplying substantial amounts of power for various applications, such as heating and illumination. In contrast, lower power devices necessitate the precise regulation provided by direct current (DC). Since residential buildings are typically supplied with AC, it must be converted to DC for numerous applications. To understand the process of creating an AC to DC converter, consider the following guidelines.

A transformer consists of two wire windings that are magnetically coupled. The first winding is referred to as the primary winding, which is energized by the main AC supply. The second winding, known as the secondary winding, functions as the power input for the AC to DC converter. Both the transformer and the additional components required to construct the AC to DC converter can be easily found at electronic and hobbyist stores.

DF player mini mp3:

The DFPlayer Mini MP3 Player For Arduino is a small and low cost MP3 module with an simplified output directly to the speaker. The module can be used as a stand alone module with attached battery, speaker and push buttons or used in combination with microcontrollers such as Arduino, ESP32, Raspberry Pi and any microcontrollers with Uart.

Specification

Sampling rates (kHz): 8/11.025/12/16/22.05/24/32/44.1/4824 -bit

DAC output, support for dynamic range 90dB , SNR support 85dBFully supports FAT16 , FAT32 file system, maximum support 32G of the TF card, support 32G ofU disk, 64M bytes NORFLASH

A variety of control modes, I/O control mode, serial mode, AD button control mode advertising sound waiting function, the music can be suspended. when advertising is over in the music continue to play audio data sorted by folder, supports up to 100 folders, every folder can hold up to 255songs 30 level adjustable volume, 6 -level EQ adjustable application

Car navigation voice broadcast;

Road transport inspectors, toll stationsvoice prompts;

Railway station, bus safety inspectionvoice prompts;

Electricity, communications, financial business hall voice prompts;

Vehicle into and out of the channelverify that the voice prompts;

The public security border controlchannel voice prompts;

Multi-channel voice alarm or equipment operating guide voice;

The electric tourist car safe driving voice notices;

Electromechanical equipment failure alarm Fire alarm voice prompts;

The automatic broadcast equipment,regular broadcast.

Accelerometer:

An accelerometer is an electromechanical device that will measure acceleration force.

It shows acceleration, only due to cause of gravity i.e. g force. It measures accelerationin g unit.

FIG 3.2.7 Acclerometer

3.1 SOFTWARE DESCRIPTION

3.2.1 ARDUINO IDE

Arduino represents an open-source electronics platform characterized by its user-friendly hardware and software. The boards are capable of interpreting various inputs—such as light detected by a sensor, a finger pressing a button, or a message from Twitter—and converting these into outputs, which may include activating a motor, illuminating an LED, or publishing content online. Users can instruct the board by transmitting a series of commands to the microcontroller embedded within it. This is accomplished through the Arduino programming language, which is based on Wiring, and the Arduino Integrated Development Environment (IDE), which is derived from Processing.

Over the years, Arduino has served as the foundation for countless projects, ranging from simple everyday items to sophisticated scientific instruments. A global community of makers—including students, hobbyists, artists, programmers, and professionals—has formed around this open-source platform. Their collective contributions have resulted in a vast repository of accessible knowledge, beneficial to both novices and seasoned experts.

Arduino originated at the Ivrea Interaction Design Institute as a straightforward tool for rapid prototyping, specifically designed for students lacking a background in electronics and programming. As it gained popularity, the Arduino board evolved to meet diverse needs and challenges, expanding its offerings from basic 8-bit boards to products tailored for Internet of Things (IoT) applications, wearables, 3D printing, and embedded systems. All Arduino boards are entirely open-source, empowering users to construct them independently and customize them to suit their specific requirements. The software is also open-source and continues to evolve through the contributions of users around the globe.

3.2.2 INTRODUCTION TO IOT

The Internet of Things (IoT) encompasses a network of interconnected devices, ranging from smartphones and vehicles to home appliances and wearable technology equipped with sensors and actuators. This connectivity enables these objects to share data with one another over the Internet. It is noteworthy to highlight the distinction between IoT and the traditional Internet, primarily characterized by the lack of human intervention. IoT devices possess the capability to generate insights regarding individual behaviors, analyze this data, and initiate actions autonomously, thus demonstrating a level of intelligence that surpasses that of the conventional Internet.

One may ponder the significance of IoT in our lives. Consider this scenario: while en route to a meeting, your vehicle could access your calendar to determine the optimal route. In the event of heavy traffic, your car might automatically send a message to the meeting participants, informing them of your delay. Imagine if your alarm clock awakens you at 6 a.m. and simultaneously instructs your coffee maker to begin brewing coffee. The ability to remotely control your home's lighting or heating through your smartphone before your arrival is also a reality. All these functionalities are made possible through the advancements of IoT.Smart System and the Internet of the Things are driven by a combination for:

1. Sensors & Actuators
2. Connectivity 3.People & Process

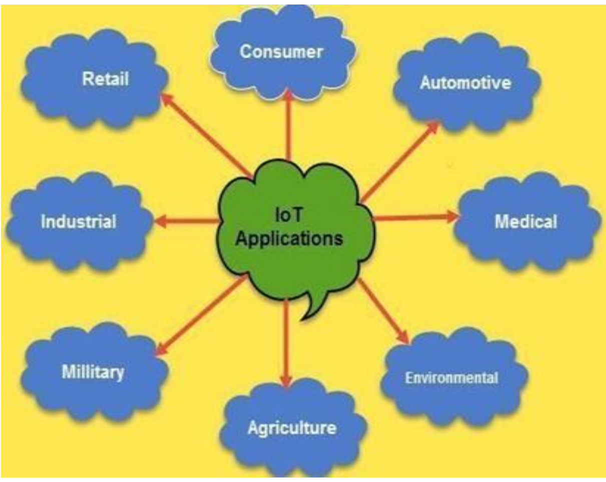


FIG 3.3.3 IOTAPPLICATION

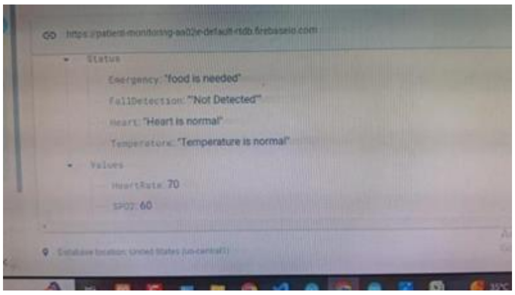
FIREBASE CLOUD MESSAGING (FCM)

1. Firebase Cloud Messaging (FCM) establishes a dependable and energy-efficient link between your server and devices, facilitating the transmission and reception of messages and notifications across iOS, Android, and web platforms at no expense. You are able to send notification messages with a limit of 2KB and data messages with a limit of 4KB. FCM allows for precise targeting of messages through predefined segments or custom segments based on demographics and user behavior. Messages can be dispatched to a collection of devices subscribed to specific topics, or even directed to an individual device. FCM is capable of delivering messages immediately or scheduling them for a future time in the user's local time zone. Additionally, you can send tailored app data, including priority settings, sounds, and expiration dates, while also tracking custom conversion events. A significant advantage of FCM is the minimal coding required for implementation. It is fully integrated with Firebase Analytics, providing comprehensive tracking of engagement and conversions. The origins of Firebase trace back to 2011 when it was known as Envolve, a startup that offered developers an API for incorporating online chat features into their websites. Interestingly, developers utilized Envolve not only for chat messages but also for synchronizing application data, such as real-time game states among users. This prompted the founders, James Tamplin and Andrew Lee, to distinguish between the chat system and the real-time architecture. In April 2012, Firebase emerged as an independent entity offering Backend-as-a-Service with real-time capabilities. Following its acquisition by Google in 2014, Firebase has significantly transformed into a comprehensive mobile and web platform.

PROCEDURE

1. Step 1: We have to install Arduino ide for coding purpose. Then perform the coding part according to your components used and required output.Once the coding part is done, we have tocompile and upload it, then we will get to see the outputs on serial monitor or on serial plotter.
2. Step 2: Once the circuitry is completed ok then we have to go for web part.
3. Step 3: In web part there are 3 modules doctor module, patient module and admin module as discuss above. For accessing a particular system, he/she has to be enrolled in the system asadmin, as patient (or caretaker) or as doctor.
4. Step 4: Once all the setup is done, we have to start the server (currently we are storingdatabase locally)
5. Step 5: After all the above processes are done successfully, then the sensor data will bepassed to website.
6. Step 6: Data coming from sensors which are mounted on patient body will be given to the system and the doctor will be able to monitor patient’s health. If there are some extreme situations then alerts will be given to patient as well as doctor and can take actions accordingly.

RESULT



3.5 CONCLUSION

The implementation of the proposed patient health monitoring system demonstrated its effectiveness in continuous monitoring of vital signs and fall detection. Real-time data transmission to the Firebase Cloud platform enabled remote access to patient data and timely interventions in case of emergencies. The integration of audio and visual alerts enhanced the system's ability to notify caregivers and healthcare providers of abnormal conditions. Overall, the system offers a scalable and portable solution for patient monitoring, with potential applications in home healthcare, assisted living facilities, and remote patient monitoring. Further enhancements and optimizations could be explored to improve the system's accuracy, reliability, and usability in real-world settings.

This document outlines the design, implementation, and evaluation of a patient health monitoring system using embedded and IoT technologies. By leveraging these technologies, the proposed system offers a comprehensive solution for continuous monitoring of vital signs and fall detection, with the potential to enhance patient care and safety.

3.6 FUTURE WORK

The future scope of the project

In future, the system can be made smart and efficient by making the goggle wireless for eyeblink detection. It can be made by using Bluetooth and Wi-Fi technology. So as to make system efficient and secure as well as easy to handle. Also, for constant patient monitoring some indications for security can be added like light indicators. Instead of using GSM modulemonitor patient's parameters on mobile in case of if patient is in hospital. So, it becomes useful in hospitals for continuous monitoring of body parameters on doctors mobile or main mobile of hospital ward. According to the availability of sensors or development in biomedical trend more parameter can be sensed and monitored which will drastically improve the efficiency of the wireless monitoring system in biomedical field. Agraphical LCD can be used to display a graph of rate of change of health parameters over time. The whole patient's healthcare monitoring system which we have framed can be integrated into a small compact unit as small as a cell phone or a wrist or smart watch. This device is easy to handle the patients or other persons.

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