Full Length Article

An IOT-Driven Healthcare Monitoring Framework For Continuous Patient Assessment

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Abstract:
In today's rapidly evolving technological landscape, the biomedical sector is experiencing a profound transformation driven by advancements in engineering and connectivity. The widespread adoption of the Internet and the Internet of Things (IoT) has opened new possibilities for improving healthcare delivery, accessibility, and quality. Among these innovations, IoT-enabled health monitoring systems have gained significant traction in recent years. These systems hold immense potential to revolutionize patient care by enabling continuous, remote, and real-time monitoring — particularly benefiting individuals with chronic conditions and those living in remote or underserved areas. Existing IoT-based health monitoring solutions vary considerably in their hardware platforms, sensor selections, software architectures, and overall performance. While most systems rely on sensors to capture vital physiological parameters, they differ in sensor types, accuracy levels, data processing methods, and communication protocols. To address these limitations and advance the current state of technology, this project introduces a novel, cost-effective, and efficient IoT-based health monitoring system. The proposed system facilitates remote and continuous tracking of patients' vital signs and surrounding environmental conditions. It leverages two widely accessible microcontrollers — Arduino Nano and Wemos D1 Mini — to interface with multiple sensors attached to the patient's body. The collected data is transmitted wirelessly to a central monitoring station or cloud platform, enabling healthcare professionals and caregivers to access real-time information. A key advantage of this system is its significantly lower implementation cost compared to many existing commercial solutions, making it more accessible for widespread adoption. The smart healthcare monitoring system is designed to operate within an IoT ecosystem, providing real-time visibility into critical patient parameters such as heart rate, body temperature, blood pressure, and room environmental conditions. By integrating advanced sensing and wireless communication technologies, the system aims to overcome the limitations of traditional healthcare approaches, where medical staff must remain physically present for continuous observation and patients are often confined to hospital beds with bulky equipment.

Keywords: *Arduino UNO, ESP8266, Lm35, Heartbeat Sensor.*

1. Introduction

The increased use of mobile technologies and smart devices in the area of health has caused great impact on the world. Health experts are increasingly taking advantage of the benefits these technologies bring, thus generating a significant improvement in health care in clinical settings. Likewise, countless ordinary users are being served from the advantages of the M-Health (Mobile Health) applications and E-Health (health care supported by ICT) to improve, help and assist their health.

In this proposed work the vital parameters such as temperature, EEG and heart beat readings which are monitored using Arduino Uno. These sensors signals are sent to Arduino Uno via amplifier circuit and signal conditioning unit (SCU), because the signals level is low (gain), so amplifier circuit is used to gain up the signals and transmit the signals to the Arduino Uno. Here patients body temperature, EEG and heart rate are measured using respective sensors and it can be monitored in the screen of computer using Arduino Uno connected to a cloud database system as well as monitored anywhere in the world using internet source.

The proposed method of patient monitoring system monitors patient's health parameters using Arduino Uno. After connecting internet to the Arduino uno, it is connected to cloud database system which acts as a server. Then the server automatically sends data to the receiver system. Hence, it enables continuous monitoring of the patient's health parameters by the doctor. Any abrupt increase or decrease in these parameter values can be detected at the earliest and hence necessary medications can be implemented by the doctor immediately.

2. Existing Method:

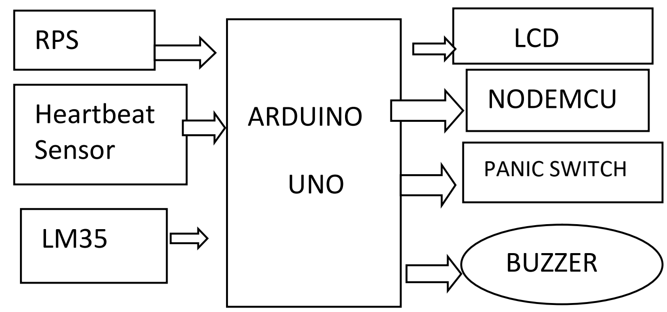
The health care represents one of the top challenges that every country is facing today. Although health care industry invest heavily in IT, yet the promised improvement in patient safety and productivity has not been realized up to the standards even today organizations still rely on paper medical records & hand return notes to inform hand make decisions. Digital information is siloed between departments and applications.

Sharing of patient data among clinicians, departments & even patients is rare and complex. Embracing IoT tech. in health care may be an answer to enabling healthcare organization to focus their efforts on clinical relevant services and patient outcomes which will make health monitoring diagnostics treatment in more timely & convenient manner with the reduced cost

3. Proposed Method:

The IOT can bring multiple benefits to healthcare through the use of sensors, intelligent equipments, etc. The Internet of Things (IoT) is a new concept that allows users to connect various sensors and smart devices to collect real-time data from the environment. However, it has been observed that a comprehensive platform is still missing in the e-Health and m-Health architectures to use smartphone sensors to sense and transmit important data related to a patient's health. In this project our contribution is twofold. Firstly, we critically evaluate the existing literature, which discusses the effective ways to deploy IoT in the field of medical and smart health care. Secondly, we propose a new semantic model for patients' e-Health. The proposed model named as 'IOT-Healthcare' makes use of the sensor layer, the network layer, the Internet layer and the services layer. All layers cooperate with each other effectively and efficiently to provide a platform for accessing patients' health data using smart phones.

Block diagram



Related Work

A wireless smart sensor platform targeted for instrumentation and predictive maintenance systems is presented. The generic smart sensor platform with „plug-and-play‟ capability supports hardware interface, payload and communications needs of multiple inertial and position sensors, and actuators, using a RF link for communications, in a point-to-point topology. The design also provides means to update operating and monitoring parameters as well as sensor/RF link specific firmware modules „over-the-air‟. Sample implementations for industrial applications and system performance are discussed. In this project has used on Zigbee. This cost is too high and the WSN are controlled by remote access. Radio Frequency Identification and Wireless Sensor Network are two important wireless technologies that have wide variety of applications and provide limitless future potentials. However, RFID and sensor networks almost are under development in parallel way. Integration of RFID and wireless sensor networks attracts little attention from research community. This paper first presents a brief introduction on RFID, and then investigates recent research works, new products/patents and applications that integrate RFID with sensor networks. Four types of integration are discussed. They are integrating tags with sensors, integrating tags with wireless sensor nodes, integrating readers with wireless sensor nodes and wireless devices, and mix of RFID and sensors. New challenges and future works are discussed in the end. RFID readers have relatively low range and are quite expensive, we envision that the first applications will not have RFID readers deployed ubiquitously. The applications which allow mobile readers to be attached to person‟s hands, cars or robots will be good candidates.

4. ARDUINO

Overview:

Arduino Uno is a microcontroller board subject to the ATmega328P (datasheet). It has 14 pushed information/yield pins (of which 6 can be utilized as PWM yields), 6 essential information sources, a 16 MHz completed resonator (CSTCE16M0V53-R0), a USB alliance, a force jack, an ICSP header, and a reset button. It contains all that ordinary to help the microcontroller; on a crucial level interface it to a PC with a USB association or force it with an AC-to-DC connector or battery to begin. You can intrude with your Uno without anguishing essentially overachieving something mistakenly, most central outcome possible you can trade the chip for two or three dollars and start once more. "Uno" suggests one in Italian and was picked to stamp the presence of Arduino Software (IDE) 1.0. The Uno board and structure 1.0 of Arduino Software (IDE) were the reference sorts of Arduino, direct made to unendingly current deliveries. The Uno board is the first in the headway of USB Arduino sheets and the reference model for the Arduino stage; for a sweeping once-over of current, past, or old sheets see the Arduino report of sheets. • Physical contraptions and sensors Physical contraptions and sensors can amass and see sagacious and multidimensional data, and check of the target state of a function uninhibitedly without human mediation. Besides, when contraptions capacity to get data with presented understanding, gadgets can act and respond. Condition setting will at that point be changed and the contraptions will reach out of the blue. In that limit, this assortment structure will be rehashed perseveringly. • Connection and foundation Association and foundation, for example, cloud, security, covering ceaselessly, security, insistence, and controlling, pull in interminable, solid information and data stream and assessment circles.

4. **Nodemcu**

The WI-FI module used in this project is ESP8266. It follows TCP/IP stack and is a microchip which is less in cost. This microchip allows microcontroller to connect to a WI-FI network, by using Hayes style command connections are done or made through TCP/IP connection. ESP8266 has 1MB of built in flash, single chip devices able to connect WI-FI. Espressif systems are the manufacturers of this module, it is a 32 bit microcontroller. There are 16 GPIO pins in this module. This module follows RISC processor. It has 10 bit DAC. Later Espressif systems released a software development kit(SDK) which is used to programme on the chip, so that another microcontroller is not used. Some of the SDK's are Node MCU, Arduino, Micro Python, Zerynth and Mongoose OS. SPI, I2C, I2S, UART are used for communicating between two sensors or modules.

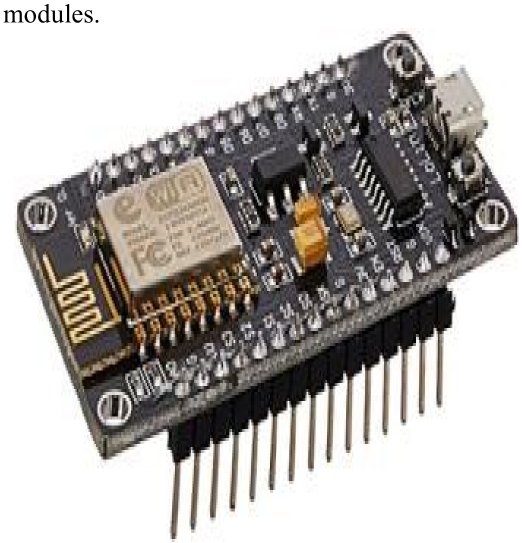


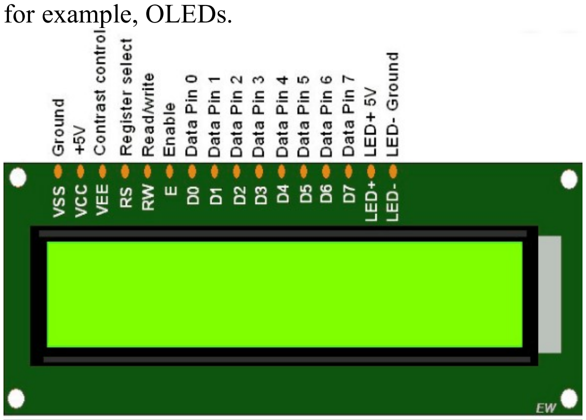
Figure 4 : Wi-Fi module

5. **Lcd**

LCD (Liquid Crystal Display) is such a level board show which utilizes fluid noteworthy stones in its major sort of development. LEDs have a gigantic and moving methodology of usage cases for clients and connections, as they can be customarily found in telephones, TVs, PC screens, and instrument sheets.

LCDs were a basic ricochet the degree that the development they eliminated, which breaker light-passing on the diode (LED) and gas-plasma shows. LCDs permitted partners to be all-around more meager than the cathode bar tube (CRT) development. LCDs eat up liberally less force than LED and gas-show shows since they search after the standard of deterring light instead of delivering it. Where a LED emanates light, the fluid tremendous stones in an LCD pass on a picture utilizing foundation edification.

As LCDs have supplanted dynamically sorted out superstar drives, LCDs have started being eliminated by new presentation improvements, for example, OLEDs.



6. IoT Technology and Applications

IoT development speedily assist the IoT application that focused on the heap industry and specific users, while networks and devices allow connectivity of physical things. IoT application gives reliable vital device-to-human and device-to-device communication. IoT device applications need to ensure that information is received and properly acted according to a suitable specific way, a simple example is that of logistic application monitoring that has the transported status of goods such as organic products, fresh products, meat and dairy terms. Furthermore, during logistics, quality control of climate change, shock and humidity is regularly monitored and suitable movements are strategically and naturally made to preserve goods spoilage from a long distance when connection is out of courage. To claimed that "some examples of IoT applications in existence can be found in Smart Environment, Smart Greenhouse, Smart Cities, Smart Water, Smart Metering, Security and Emergency, Industrial Control, Home Automation and Electronic Health". 'IoT' is therefore stationed on devices that can examine sensed data and then transmit it to the user. K. IoT Challenges As stated in a previous study, there are some challenges that IoT design would face in the coming future generation. All the devices, nodes connected in associate in nursing IoT design needs to have terribly low latency over reliable links. Because of the vast variety of IoT devices and the use of various frequency bands, there would be a crisis in spectrum house. Although IoT devices are expanding on a daily basis that consumes terribly lesser power, still there'll be a big quantity of greenhouse gas emission because of all of these devices. Finally, IoT architecture not solely must be price effective however additionally they have to be capable of supporting heterogeneous applications and devices. As stated above on IoT challenges, IoT applications will have some more basic needs to tackle, for example, Device addressing, Security, Scalability, Mobility, Anchor-less sending and so on. As mentioned, IoT applications contains numerous heterogeneous devices, and however, content security is a key concern that plays a great roles. A previous study has indicated the challenges of both IoT and ICN in their past study, this past study endeavours to combine them where IoT illustrate the different challenges and on the other hand, ICN illustrates the positive solutions. Nonetheless, their study explained initially how different ICN features can address IoT issues and after that, some use cases and contextual investigations are examined

Heartbeat Sensor

Heartbeat Sensor is an electronic device that is used to measure the heart rate i.e. speed of the heartbeat. Monitoring body temperature, heart rate and blood pressure are the basic things that we do in order to keep us healthy.In order to measure the body temperature, we use thermometers and a sphygmomanometer to monitor the Arterial Pressure or Blood Pressure.

Heart Rate can be monitored in two ways: one way is to manually check the pulse either at wrists or neck and the other way is to use a Heartbeat Sensor. Monitoring heart rate is very important for athletes, patients as it determines the condition of the heart (just heart rate). There are many ways to measure heart rate and the most precise one is using an Electrocardiography, But the easier way to monitor the heart rate is to use a Heartbeat Sensor. It comes in different shapes and sizes and allows an instant way to measure the heartbeat.

In this project, we have designed a Heart Rate Monitor System using Arduino and Heartbeat Sensor. You can find the Principle of Heartbeat Sensor, working of the Heartbeat Sensor and Arduino based Heart Rate Monitoring System using a practical heartbeat Sensor. Heartbeat Sensors are available in Wrist Watches (Smart Watches), Smart Phones, chest straps, etc. The

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heartbeat is measured in beats per minute or bpm, which indicates the number of times the heart is contracting or expanding in a minute.

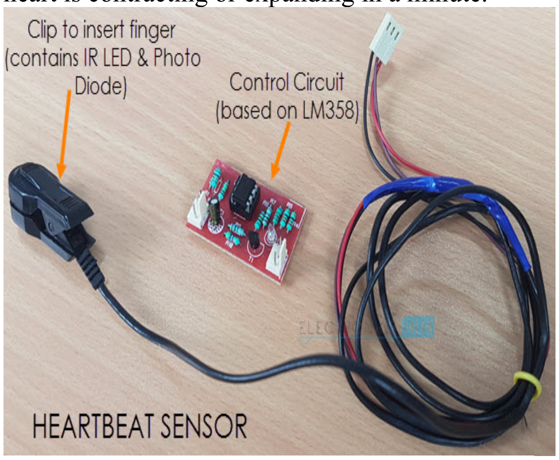

Fig Heart beat sensor

Temperature Sensor

LM35 is a precision IC temperature sensor with its output proportional to the temperature (in C°). The sensor circuitry is sealed and therefore it is not subjected to oxidation and other processes. With LM35, temperature can be measured more accurately than with a thermistor. It also possesses low self-heating and does not cause more than 0.1 C° temperature rise in still air.

The operating temperature range is from -55°C to 150°C. The output voltage varies by 10mV in response to every C° rise/fall in ambient temperature, i.e., its scale factor is 0.01V/ C°.

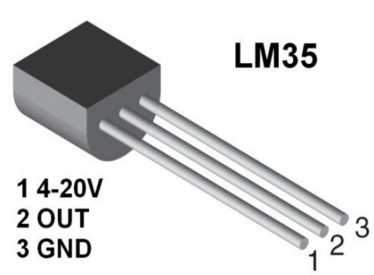

Fig LM35 sensor

Main advantage of LM35 is that it is linear i.e. 10mv/°C which means for every degree rise in temperature the output of LM35 will rise by 10mv. So if the output of LM35 is 220mv/0.22V the temperature will be 22°C. So if room temperature is 32°C then the output of LM35 will be 320mv i.e. 0.32V.

9. Software Tools

Arduino IDE (Integrated Development Environment)

The Arduino progress condition contains a word processor for including code, a message zone, a book maintains, a toolbar with gets for crucial cutoff regular environmental factors, and an improvement of menus. It interfaces with the Arduino contraption to move activities and talk with them.

Making Sketches

Programming made using Arduino is called follows. These depictions are written in the substance boss. Depictions are saved with the record progress .ino. It has featured for cutting/staying and for looking/dislodging content. The message a region gives input while saving and passing on what's more shows abuses. NB: Versions of the IDE before 1.0 saved draws with the expansion pde It is possible to open these records with understanding 1.0, you will be begun to save the sketch with the .ino progression on save.

The Arduino condition uses the opportunity of a sketchbook: a standard spot to store your undertakings (or depicts). The depictions in your sketchbook can be opened from the File Sketchbook menu or the Open catch on the toolbar.

Tabs, Multiple Files, and Compilation

Connects with you to figure out draws with more than one record (all of which appear in its own astounding tab). These can be typical Arduino code records (no new unexpected new development), C reports (.c speeding up), C++ records (.cpp), or header records (.h).

Conclusion

This project has successfully developed a cost-effective, reliable, and scalable IoT-based remote health monitoring system using Arduino Uno and Wemos D1 Mini microcontrollers. The system enables continuous tracking of vital health parameters and environmental conditions, transmitting data securely to the cloud for real-time access by authorized medical personnel.

By addressing key limitations of traditional healthcare monitoring — such as delayed response, high costs, and limited accessibility — the proposed solution offers a practical pathway toward proactive, patient-centric, and efficient healthcare delivery. Its modular architecture, ease of use, and affordability make it particularly suitable for deployment in hospitals, home care, and remote areas.

The successful implementation and positive simulation outcomes validate the system's potential to enhance healthcare quality, reduce operational costs, and improve patient outcomes. As IoT, cloud computing, and data analytics continue to advance, this work lays a strong foundation for future innovations in digital healthcare, contributing meaningfully to the vision of accessible and intelligent health monitoring for all.

This project has successfully designed and implemented an IoT-based remote health monitoring system using Arduino Uno and Wemos D1 Mini microcontrollers. The core objective was to enable continuous, real-time acquisition and transmission of critical vital signs — including body temperature, heart rate, and SpO_2 — to a cloud platform for secure storage, analysis, and intelligent alert generation. By harnessing the power of IoT, wireless communication, and cloud computing, the system provides healthcare professionals with a reliable, scalable, and efficient solution for remote patient monitoring. This approach not only enhances the quality of patient care through proactive interventions but also contributes to a meaningful reduction in overall healthcare costs. As IoT technologies continue to evolve and integrate with other healthcare innovations, the proposed system holds strong potential to significantly transform remote patient monitoring practices and improve health outcomes on a broader scale.

The project presents a detailed overview of both hardware and software components, encompassing biomedical sensors, microcontrollers, communication modules, cloud services, web interfaces, and mobile applications. Comprehensive evaluations were conducted to assess the system's accuracy, reliability, efficiency, and usability. The study also critically examines the current limitations, technical challenges, and opportunities for future enhancements — particularly in areas such as data security, system scalability, interoperability with other medical devices, and expanded functionality.

The principal contributions of this work include the development of an affordable, user-friendly, and highly efficient IoT-based health monitoring solution. The system demonstrates clear potential to improve the accessibility and quality of healthcare services, especially for patients managing chronic conditions or residing in remote locations. Furthermore, the project underscores the practical value and promising future of integrating IoT technologies into healthcare ecosystems.

Owing to its modular and scalable architecture, the proposed system can be easily extended and integrated with emerging healthcare technologies. This flexibility positions it as a valuable asset in modern healthcare settings, supporting the transition toward more connected, proactive, and patient-centric models of care.

FUTURE SCOPE

The proposed system has strong potential for further development and integration with emerging technologies. Future enhancements may include:

- Integration of Artificial Intelligence (AI) and Machine Learning algorithms for advanced disease prediction and personalized health recommendations.
- Addition of more biomedical sensors (e.g., ECG, blood glucose, respiration rate) to provide comprehensive health monitoring.
- Implementation of blockchain technology for enhanced data security and patient privacy.
- Development of a mobile application with advanced features such as video consultation and automated emergency response.
- Integration with wearable devices and smart home systems for holistic health and environment monitoring.
- Expansion to support large-scale deployments in smart hospitals and telemedicine platforms.
- Incorporation of edge computing to enable faster local data processing and reduced dependency on constant cloud connectivity.

With continued advancements, the system can evolve into a comprehensive digital healthcare ecosystem, significantly improving healthcare delivery in both urban and rural settings.

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