International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 5 Volume No.6 Aug-Sept – 2022
DOI:10.46647/ijetms.2022.v06i05.132 ISSN: 2581-4621

Modern Application of Internet of Things in Healthcare System: Review

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ABSTRACT
The recent advancement in information and Communication Technology has led to the emergence of the Internet of Things (IoT). In the modern medical system, the use of IoT technology has brought so much convenience to doctors and patients, because IoT is suitable for a variety of medical fields (such as real-time monitoring, patient information management, and health care management). Human body sensor network (BSN) technology is one of the core technologies that is being used in the development of IoT in the medical system. This technology is characterized by a little power supply and lightweight wireless sensor nodes that can be used to monitor patients. The research paper highlights the main requirements of modern medical systems based on BSN.
Keywords: Remote health monitoring, Internet of Things, e-health; Arduino UNO

INTRODUCTION

In all applications supported by the Internet of Things (IoT), smart connectivity is a very important application, especially in healthcare. Network sensors are used to collect a lot of information about our health and with the information that network sensors make available; there will be a positive improvement in the healthcare system. Specifically, the data or information provided about our health can: Develop a diagnostic and treatment response paradigm that can predict disease early and support the development of medical practice, personalize treatment choice and management based on each individual's circumstances and needs, help reduce treatment costs while improve results. In this article, we highlight the opportunities and challenges of IoT in achieving the future vision of healthcare. In recent years, interest in the portable sensor has been growing. Based on today's technological trends, it is easy to imagine that soon wearable sensors will be used for continuous physiological monitoring before a routine medical examination. During this time, the sensor continues to record signals related to physiological parameters and then transfers the generated data to a database linked to the patient's medical record. Not only does it provide traditional laboratory tests for physiological and metabolic status, it also provides a richer scope for providing long-term records, and with the help of decision support systems, doctors can provide a large amount of observed data, then doctors can make a better prognosis of patients' health and recommend treatment as a means of timely intervention. This technology can have a transformative impact on the health care system by significantly reducing the cost of treatment and improving the speed and accuracy of diagnosis, which can guarantee an effective improvement in the quality of the health care system. Health monitoring has been a major global challenge. Due to lack of health check, the patient suffers from health problems, when nowadays there are many IoT devices to monitor the patient's health on the internet. Healthcare professionals are also taking advantage of these smart devices to monitor their patients. IoT is rapidly changing the healthcare industry with a slew of new healthcare technology start-ups. In this project, we will make a health monitoring system based on the Internet of Things (IoT) that will record the patient's heart rate and body temperature and send an alarm when critical values are exceeded. In this system, the patient's health status can be monitored from any location via the Internet.

Figure 1 shows the proposed system of health monitoring. These health monitoring sensors are used to collect data, that is, data acquisition. This system can transmit the sensor data wirelessly by the controller over the internet, data processing is done on the server. All data are collected from the server point. It can be displayed on the website, that is, data management.

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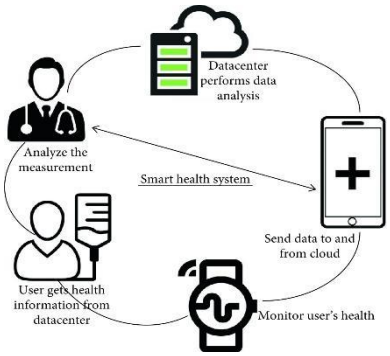

Fig. 1. System diagram

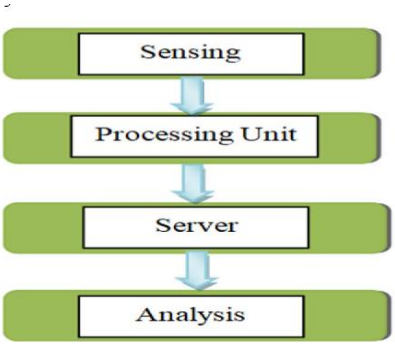

Fig. 2. System operation

Figure 2 shows the system flow chart. The results of the sensor acquisition are analyzed, that is, if abnormal behaviour is detected from the result, the contingency plan starts to inform the doctor about the patient's health status. Health is of paramount importance in our daily lives. The aims of this project are to develop a system that uses LM35 and sensors to provide body temperature and heart rate, respectively. These sensors are interfaced with the microcontroller.

RELATED WORKS

The health monitoring equipment was designed based on the IoT device. The medical IoT devices include, the pulse reader, temperature sensor LM-35, character LCD and ESP8266 Wi-Fi modem are connected to Arduino UNO. The system is built in Arduino UNO. Arduino UNO is one of the most popular prototype boards on the Internet of Things projects, the materials required are:

1) ARDUINO UNO
2) WIFI MODULE ESP8266
3) TEMPERATURE SENSOR LM35
4) HEART RATE SENSOR

METHOD

In the field of healthcare, the number of Internet of Things users is constantly increasing, and so are the solutions for various applications such as patient vital signs monitoring and patient data collection. This method helps improve data accuracy and allows nurses to spend more time providing care.

ARDUINO UNO

Arduino UNO is a microcontroller board based on ATmega328. It is one of the most popular prototyping boards. The board comes with a built-in Arduino bootloader. It has 14 GPIO pins, 6 PWM pins, 6 Analog inputs, a reset button and pin mounting holes. During programming, the board can be connected to a PC via the USB port and the board can run on USB power. Arduino UNO has

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32 KB Flash memory, 1 KB EEPROM and 2 KB SRAM. The board can be connected to various Arduino Shields for connectivity with Ethernet, Bluetooth, Wi-Fi, Zigbee or Cellular networks and can be connected to most IoT platforms.

TEMPERATURE SENSOR

The LM-35 is a precision IC temperature sensor whose output is proportional to temperature. The sensor circuit is sealed; it is not affected by oxidation and other processes. With the LM35, the temperature can be measured more reliably than with the thermistor. The LM35 temperature sensor is a three-pin device + VCC (Pin 1), output (Pin 2) and ground (Pin 3). The voltage range for LM35 operation is between 4V to 20V. The output pin of the LM-35 is connected to pin A1 of the Arduino because the output from the LM-35 is basically analogue.

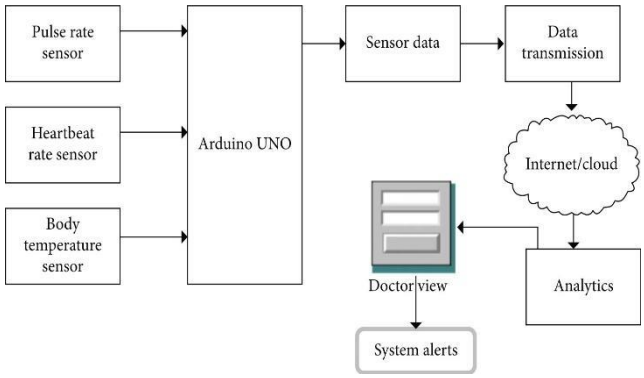


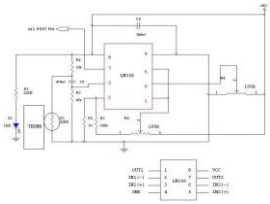
Fig. 3. Patient monitoring system

HEART RATE SENSOR

The heart rate sensor works on the principle of photoplethysmography (PPG). This technique provides valuable information regarding our cardiovascular system. Recent advances in technology have revived interest in this technique, which is widely used in clinical physiological measurement and monitoring. According to the principle, the change in blood volume in an organ is measured by the change in the intensity of light passing through it.

PPG uses low intensity infrared (IR) light. When light passes through biological tissue, it is absorbed by bones, skin pigments, veins, and arterial blood. Because blood absorbs light most strongly by surrounding tissue, the PPG sensor can detect changes in blood flow due to changes in light intensity. The voltage signal of the PPG sensor is proportional to the amount of blood passing through the blood vessels. Even small changes in blood volume can be identified with this method, although PPG cannot be used to check blood volume. Normally the light source in the heart rate sensor is an infrared LED and the detector will be any Photo Detector.

The light source and the detector are placed opposite each other, and a human finger must be placed between the transmitter and the receiver. On the other hand, the light source and detector of the reflective sensor are adjacent to each other, and the human finger must be placed in front of the sensor. A simple heart rate sensor consists of a sensor and a control circuit. The sensor part of the Heartbeat Sensor consists of an IR LED and a photodiode located in the clip. The control circuit consists of an operational amplifier and other components that help in connecting the signal to the microcontroller.



(a)

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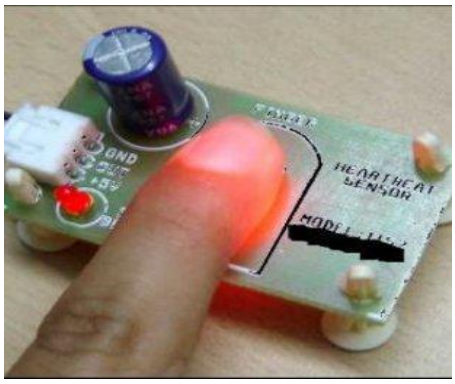

(b)

Fig. 4. (a) Heartbeat Sensor Circuit Diagram (b) Heartbeat Sensor Principle

The heartbeat sensor circuit diagram includes a photodetector and a bright red LED. The LED should have super-light intensity because if the detector detects a finger placed on the led, the maximum light will pass and propagate. When the heart pumps blood through the blood vessels, the fingers become slightly impermeable because there is less light from the LED to the detector. The detector signal generated by the heart rate changes. The detector's signals are different and it becomes an electrical pulse. This electrical signal is amplified, and the logic level signal output of the amplifier is + 5v.

ESP8266 WI-FI MODULE

The ESP8266 Wi-Fi unit is used to supply the Arduino board with a Wi-Fi router so that it can access the cloud. Each ESP8266 module comes with pre-programmed AT command set firmware. The module is available in two models - ESP-01 and ESP-12. The ESP-12 has 16 pins available for connection, while the ESP-01 only has 8 pins available.

Table 1. Technical specifications of Arduino

Item	Specification
Operating Voltage	5V
IO Current	40 mA
Program Memory	32kB
Frequency	16 MHz
Input / Output	14xDIO
ADC Pin	6x10 Bit

CHALLENGES AND RISK FACTORS

Security is one of the main challenges for IoT in general. When it comes to healthcare, it becomes even more critical because sensitive patient data flows through the network without any encryption and can be used for medical identity theft, blackmail, etc. Patient data can be altered by a hacker and he could use this altered data to make life decisions and death of the patient. Data plays a vital role in the entire process, and when it comes to healthcare, time-critical execution and synchronization are extremely important. In healthcare, there are different types of sensors from which data is collected, such as implantable sensors, wearable sensors, and others. Today, 3.7 million devices are used to monitor different parts of the body.

IoT in healthcare consists of different types of body sensors to measure blood pressure, heart rate, temperature, etc. Security challenges related to IoT in general are directly applicable and critical to IoT in healthcare. The security of IoT systems is the biggest reason why IoT systems are not adopted on a larger scale.

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Wearable sensor devices used by patients can be from different vendors; there may be a case where a patient needs to use more than one wearable sensor device. All these sensor devices are supposed to communicate with each other, but sensor devices from different vendors cannot communicate with each one because they have different communication protocols. Because of this issue, sensors must be used from the same vendor in order for the sensors to communicate with each other; is a potential bottleneck for large-scale implementation of IoT systems. This can cause vendor lock-in. The interoperability issue even affects the development of IoT applications that expose multiple platforms.

UPCOMING WORKS AND ITS FUTURE

Growing demand for remote patient monitoring. This factor is made up of two trends: the increase of chronic diseases (especially asthma, diabetes or cancer) and the aging of the population.
Many healthcare domains will profit highly from big data and beyond, making big data technology the most watched technology. Eliminates medication errors. It provides more security. It improves the quality of services. Reasons for IoT in healthcare range from turning data into action, improving patient health, supporting preventive care, increasing patient engagement and satisfaction, and advancing care management.
The implementation of telemedicine in healthcare will aim to provide real-time access to patients and doctors to prevent proper prevention before a medical emergency occurs.
Smart pills, also called smart drugs or digital pills, are small electronic devices in pharmaceutical capsules carrying ingestible sensors.
Such smart pills can perform multiple functions such as monitoring important indicators of well-being (local pH, temperature, blood pressure), delivering drugs to the target area, imaging for effective diagnosis of gastrointestinal disorders, etc.

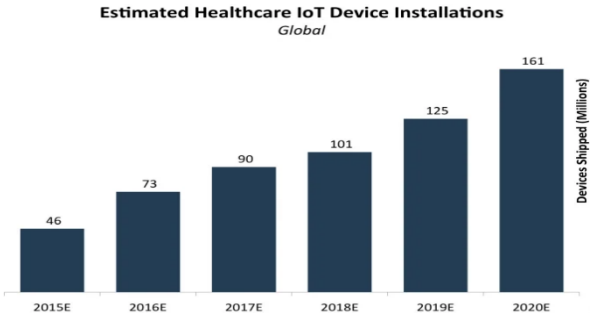

Fig. 5. Estimated healthcare IoT Device Installations

CONCLUSION

In this work, we propose a future direction for the integration of remote health monitoring technology into clinical practice. The IoT is already leveraging most of these technologies to help advance healthcare, and this development will continue. Sooner than later, healthcare and the Internet of Things will connect, improving our access to healthcare. IoT will be an integral part of the patient's diagnosis, treatment and recovery process. IoT data collection mechanism along with predictive analytics will improve healthcare and reduce human errors. We must strive to overcome design difficulties that must be resolved before systems can be developed for integration into clinical practice. IoT enables medical devices to collect important data and transmit it to doctors. The summaries provide a perfect assessment of the patient's health status regardless of place or time. Early warning can be helpful in life-threatening conditions.

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