IOT HELTHCARE WEARABLE DEVICES

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ABSTRACT

The Internet of Things (IoT) has transformed healthcare through wearable devices that integrate seamlessly with the healthcare system. These IoT-enabled healthcare wearables enhance patient monitoring, enable remote healthcare services, and empower individuals to manage their health. This research paper examines advancements, applications, and challenges in IoT healthcare wearables. It covers the current state of wearable technologies, key use cases, benefits, limitations, ethical considerations, and recommendations for future research. The research paper delves into key use cases of IoT healthcare wearables, offering detailed insights into their practical applications. It explores the utilization of these wearables for remote patient monitoring, chronic disease management, fitness and wellness tracking, and personalized healthcare delivery. Through these use cases, the paper emphasizes the positive impact of IoT healthcare wearables on enhancing healthcare outcomes and optimizing the overall patient experience.

Keywords*: Internet of Things, Health, Sensors*

1. INTRODUCTION

Health is not just the absence of illness or disability; it is a condition of total physical, mental, andsocial well-being. It covers a range of topics, such as adaptability and the capacity to deal with life's problems, as well as aspects like physical health, mental health, and emotional stability. The general well-being and quality of life depend on maintaining healthy health. Many factorsemphasise the need to maintain health in today's fast-paced and demanding world. Physical well-being: Being in good physical condition allows people to go about their daily lives, engage in physical activity, or work out. Chronic conditions like heart disease, diabetes, obesity, and some malignancies are less likely to develop as a result. Longevity, energy levels, and productivity are all intimately related to physical health.

Physical and mental health go hand in hand. Mental health is no different. It has an impact on howwe feel, think, and behave, as well as how we handle stress, keep up with our relationships, and make choices. The likelihood of illnesses like anxiety, sadness, and other mental diseases can be decreased by putting mental health first. It increases emotional stability and contentment while boosting resilience and cognitive performance.

Health is a broad concept that includes a variety of factors, such as mental and emotional stability,social ties, and the capacity to adjust to and overcome obstacles in life. In the modern world, it is essential to put health first in order to live a full life, experience both personal and professional success, prevent diseases, and preserve general well-being. By making an investment in their health, people can improve their quality of life and successfully face the challenges of the modernworld[1]. IoT (Internet of Things) healthcare wearable devices are a category of wearable devicesthat are designed to monitor and improve various aspects of an individual's health and well-being.These devices leverage the power of IoT technology to collect, transmit, and analyse data related to a person's health and medical conditions.

The biggest challenge is providing security to IoT. An IoT device may have a variety of application information from diverse foundations, including individuals. The information that is stored in IoT devices is sensitive and needs to be protected with care. Among many examples we can consider the case of patient’s health history. Despite of IoT while technology significantly enhances communication, a few difficulties such as adaptability, accessibility and reaction time still need to be addressed[2].

Here are some common types of IoT healthcare wearable devices:

1.1 Fitness Trackers:

These devices are primarily used for monitoring physical activities such as steps taken, distance travelled, calories burned, and heart rate. They often include features like sleep tracking and provide real-time feedback to help individuals track and achieve their fitness goals[4].

1.2 Heart Rate Monitors:

These wearables focus on tracking the user's heart rate and heart rate variability. They can provide continuous monitoring during exercise, alert the wearer to abnormal heart rates, and help individuals manage their cardiovascular health.

1.3 Blood Pressure Monitors: Using these tools, users are able to regularly check their blood pressure levels without using a standard cuff and monitor setup. They offer quick, painless methods to measure blood pressure, making it easier for people to keep track of their readings and spot any potential health issues.

1.4 Glucose Monitors:
Glucose monitors enable continuous monitoring of blood sugar levels for people with diabetes. These small devices provide real-time readings that can be sent to a smartphone or app, assisting users in managing their condition effectively.

1.5 Smartwatches: Smartwatches are wearable devices with sensors that monitor various health indicators. They track heart rate, sleep patterns, physical activity, and even oxygen saturation levels. Smartwatches also send notifications and alerts related to health goals or anomalies, helping users stay informed about their well-being.

1.6. Wearable Electrocardiogram (ECG): these devices allow individuals to conveniently conduct ECG tests at home or while on the move. These portable devices can detect irregular heart rhythms such as atrial fibrillation and transmit the collected data to healthcare professionals for analysis and diagnosis.

1.7 Smart clothing: IoT-Smart clothes- smart clothing, equipped with Internet of Things (IoT) technology, incorporates sensors directly into the fabric. This innovative approach enables the tracking of vital signs, posture, body temperature, and other health-related variables without the need for separate wearable devices. With continuous monitoring capabilities, smart clothing offers a convenient and integrated solution for keeping track of one's health.

IoT healthcare wearable devices capture and analyse data for remote monitoring and early detection of health conditions. They supplement healthcare services and promote individual well-being. The devices collect data like heart rate, sleep patterns, and activity levels[5,6]. This data is securely stored and analysed using advanced analytics techniques.
Remote access to the data allows healthcare practitioners to make informed decisions and provide personalised care. However, these devices should not replace expert medical advice and diagnosis. They serve as a convenient tool for individuals to track their health and support healthcare professionals in delivering comprehensive care.

2. IOT IN HEALTH MONITORING SYSTEM

By facilitating early identification of health conditions, strengthening treatment adherence, and encouraging patient engagement, IoT-enabled devices and systems have the potential to completely transform the way healthcare provided. More proactive and individualised care is made possible by these developments, which could result in improved health outcomes.

Fig. 1 Iot based health monitoring system.

The pulse sensor on the Arduino gathers real-time health information by measuring heartbeat frequency, or BPM (beats per minute). The patient's body temperature is measured via a digital temperature sensor that is connected to an Arduino.

When the patient's heartbeat happens or is identified, a buzzer emits audible beeps. A healthcare expert can quickly learn from this how a patient's heart is functioning under a certain set of conditions. Simply listening to the sounds can reveal abnormal heartbeats.

In addition to connecting the device to the internet and delivering health data to a Thingspeak. IoT server for storage and monitoring, a generic ESP8266 IoT module is connected to the Arduino via UART. In addition to transmitting patient health information to a server, this circuit is also able to display real-time data on a 162-pixel LCD screen. A healthcare worker who is on the scene and actively monitors

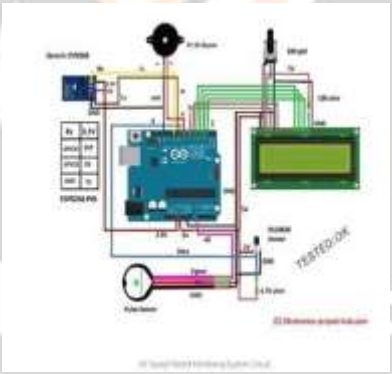

Fig. 2 overall diagram of patient monitoring system circuit

3. HARDWARE DESCRIPTION

The hardware required for this project is.

-Arduino UNO

-Pulse sensor or heartbeat sensor

-Temperature sensor

– ESP8266

-LCD display

3.1 Arduino UNO

Open-source microcontroller based on the ATmega328p used in the Arduino board. It is a common development board that is used for testing and acts as an Internet of Things (IoT) connector.

A voltage regulator, crystal oscillator, serial connection, and other components are also on the board. It can be readily formatted using the free and open-source Arduino IDE software and has 32 kB of flash memory, 1 kB of ROM, and 2 kB of RAM.

In Arduino, there are numerous GND pins, and any of them can be used to shave your circuit. 5V (4) and 3.3V (5): One 5V pin powers the Arduino UNO with 5 volts, and the other 3.3V pin influences the device with 3.3 volts. the components that are easiest

: **Fig. 3** Arduino UNO

3.2 Pulse sensor/ Heartbeat sensor

The rate of the heart's beat per minute is known as the heartbeat. A heartbeat is measured in bpm. Sinus rhythm refers to the typical human heartbeat. According to the body's physiological needs and activities, the sinus rhythm ranges from 50 to 90 beats per minute. The exchange of sodium and potassium is the heart rhythm[3]. The sodium and osmium contents will change as a result of the following factors: low sodium and osmium contents, low body temperature, low oxygen content in the body, and low value with high hydrogen contents. These accented notes employ the hertz rhythm. Heartbeat's rhythm needs to be in order.

Fig -4: PULSE SENSOR

3.3 Temperature sensors

Heat-resistant heat exchanger with a centigrade temperature, the LM35 series is well-integrated. When compared to Kelvin's few direct temperature sensors, the LM35 gadget has an advantage because it allows for simple Centigrade measurements without requiring the user to create significant, uninterruptible power interruptions. The LM35 gadget can offer normal details of 14 °C at room temperature and 34 °C in addition to the whole temperature range of 55 °C to 150 °C without the need for external measurement or cutting.

Fig -5: Temperature sensor

3.4.ESP8266

A simple and affordable instrument for net production is the ESP8266. The module will function independently as an associated objective access point (which can display a hotspot) and as a channel (which can connect to Wi-Fi), where it will merely download data and upload it to the web, establishing a web of things as basic as accessible. In order to create more intelligently, it may also obtain data from the web exploitation API, which allows any project to access any data that is made public online. Additionally, this has an intriguing quality.

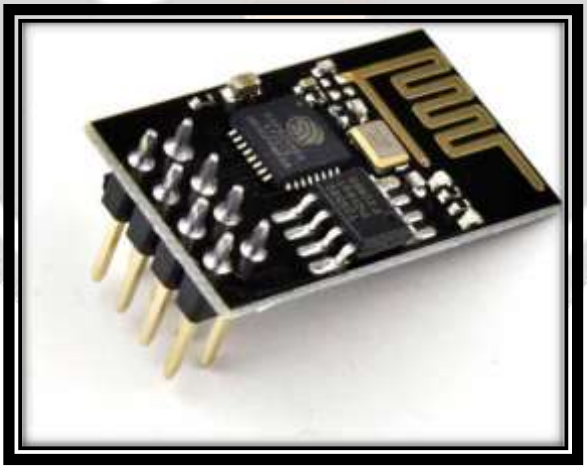

Fig. 6 ESP8266

the Arduino IDE, making it simple to use a lot of times. module is that it is frequently designed to do so. When it warns you and your family, the ESP8266 module can occasionally be killed by 3.7 volts.

3.5 LCD Display

LCDs are flat optical displays that employ polarizers along with the light-modulating capabilities of liquid crystals. Liquid crystals don't emit light directly; instead, they produce colour or monochromatic images using a backlight or

reflector.

Fig. 7 LCD Display

3.METHODOLOGO AND DESIGN

An Internet of Things (IoT)-based health surveillance system utilises patient bodily measurements such as body temperature and pulse rate. The patient's body is connected to a temperature-sensing device, and a heartbeat monitor is attached to their fingertips. The dynamic vital signs of the patient determine the resistance of the temperature sensing element, which is supported by a pulse rate sensing element, a vibration sensing element, or a flow sensing element. The values obtained from these sensors are communicated to the Arduino UNO, which manages and processes the data. The data is simultaneously displayed on a display screen and transmitted to the IoT system using a Wi-Fi module. This system utilises two sensors for heat and heart rate measurements. An Android app called BLYNK is employed for data visualisation and filtering.

In summary, the IoT-based health surveillance system incorporates temperature and pulse rate sensors connected to the patient's body. The Arduino UNO manages the data obtained from these sensors, which is displayed on a screen and sent to the IoT system via Wi-Fi. The system utilises two sensors, and an Android app facilitates data visualisation and filtering.

IoT and mobile technologies are used to access the cloud. A Wi-Fi connection is required in order to use this programme. Using a Wi-Fi module, the Arduino board connects to the Wi-Fi network capabilities. Two senses taught the Arduino board to sin. Then, using a Wi-Fi module, this installation is uploaded to an IoT cloud. On the LCD panel, rated inputs are displayed. When the application is accessed, the measured data is presented on the screen, and at the same time, this data is sent to the IoT cloud. System has been specified as the limit value range. If the value is available.

EXPERIMENT SETUP-

The experimental configuration for our system, which includes sensors and related accessories such as biomedical pads and sensor cables, a Raspberry Pi camera, an Arduino UNO, a Raspberry Pi 2, and a Wi-Fi dongle. Any connections between sensors and an Arduino board or a Raspberry Pi and additional devices (such as a camera or a Wi-Fi dongle) an experimental setup. The experimental setup for our system and consists of sensors along with their related accessories, such as biomedical pads and sensor cables, a Raspberry Pi camera, an Arduino UNO, a Raspberry Pi 2, and a Wi-Fi dongle. Any connections between sensors and an Arduino board or a Raspberry Pi and additional devices (such as a camera or a WiFi dongle) The experimental setup for our system and consists of sensors along with their related accessories, such as biomedical pads and sensor cables, a Raspberry Pi camera, an Arduino UNO, a Raspberry Pi 2, and a Wi-Fi dongle. Any connections between sensors and an Arduino board or a Raspberry Pi and additional devices (such as a camera or a WiFi dongle). All of the connections between the Raspberry Pi and additional devices (such as the Pi Camera and Wi-Fi Dongle) or between sensors and the Arduino Board.

It's possible to observe HDMI and power supplies clearly. Sensors and their accessories, including biomedical pads and sensor cables, a Raspberry Pi camera, an Arduino UNO[7], a Raspberry Pi 2, and a wi-fi dongle, make up the experimental configuration for our system. All of the connections between the Raspberry Pi and additional devices (such as the Pi Camera and Wi-Fi Dongle) or between sensors and the Arduino Board.

Table: Body Temperature

Body temperature	State
36.0 – 37.5 ^{o}C	Normal
>37.5 ^{o}C	High
<36.0 ^{o}C	Low

Similarly, to determine the health state of the patient, different range of pulse rate reading is also considered as in Table II.

Table: pulse rate

Pulse rate	Rate
60 – 100 BPM	normal
>100 BPM	HIGH
>60 BPM	LOW

The table presents the fundamental measurements of human body temperature and pulse rate, enabling individuals to assess their overall physical condition. By referring to these measurements, individuals can gain insights into their body's state and potentially identify any abnormalities. Monitoring body temperature and pulse rate can provide valuable information about a person's health and help them make informed decisions about their well-being.

It includes sensors and accessories, including biomedical pads and sensors, an Arduino UNO, an LCD display, a Wi-Fi dongle, and other devices. Each and every connection between a sensor and an Arduino board.

Three senses were employed in our work. First, let's talk about the LM35D temperature sensor we employed to gauge the patient's temperature. The temperature sensor works best when it is placed on the tongue or under the armpit. Another sensor that was utilised in this research was the heartbeat sensor, which gauges heart rate by observing the backlight LED's impact on the front-facing light sensor. The sensor can be placed on the ear and fingernails for more precision. The analogue pins on the Arduino board were connected to all of the sensors. Based on the input parameter, each of these sensors supplied a power differential, and these power variables were converted to output; the output of the LM35 sensor was transformed.

Result

The body temperature sensor, pulse rate sensor, room temperature sensor, and humidity sensor values are accurately calibrated through the microcontroller in the health monitoring system prototype. This comprehensive system incorporates various sensors that measure vital parameters, and the calculated output values are prominently displayed on an LCD display. The purpose of this display is to ensure that the patient, as well as other relevant individuals, can easily view and interpret the recorded values without any inconvenience. By providing real-time and easily accessible information, this prototype enhances the monitoring and understanding of the patient's health status.

Fig. 9 sensors values displayed on LCD.

The sensor values obtained from the health monitoring system are seamlessly transmitted to a dedicated database server. This server acts as a central repository, storing the collected data for further analysis and accessibility. Authorized users, through the IoT application platform, can securely access these data from the cloud. This organized system ensures that the sensor readings are efficiently captured, stored, and made available for authorized individuals to monitor and analyse the health parameters remotely. The integration of cloud technology and the IoT application platform enhances the convenience and effectiveness of accessing and utilizing the collected data.

4. CONCLUSIONS

The Internet of Things is currently regarded as one of the most workable alternatives for any remote value tracking, particularly in the sphere of health monitoring. It makes it easier for people to have their personal financial data secured in the cloud, have fewer hospital stays for standard checkups, and—most importantly—have access to any doctor, anywhere in the world, to monitor their health and identify diseases. This study built a system for IoT-based health monitoring. Sensors in the system, which are also shown on an LCD, were used to monitor body temperature, pulse rate, and the temperature and humidity of the room. Following that, wireless connectivity is used to send these sensor values to a medical server. Then, via IoT, these data are received on a personal smart phone that is authorised. One of the most significant uses of the IoT is as the primary provider of health care systems. removes constraints related to geography, timing, and other factors while also expanding their reach and efficiency to better provide healthcare to individuals in any location at any time. The IoT health revolution is a reality, and as a result, people may receive high-quality treatment at fair prices. Large amounts of sensor data are produced by these applications, and they must be monitored and handled carefully. A promising strategy for effective knowledge processing in the healthcare industry is cloud computing. The framework offered is unique and can be used to manage network and cloud data relevant to a patient. Built on the IoT and its design tenets.

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