IOT BASED HEALTH CARE MONITORING USING MICROCONTROLLER

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Abstract

The Internet of Things (IoT) must meet a wide range of requirements, but effective and integrated health care is critical. Unnecessary inspection of wheel power for indicators of illness is referred to as irregular health monitoring. The technique's primary goal is to demonstrate a laboratory-scale setup for true online patient health monitoring. The intended approach is used to track body characteristics such as temperature, heart rate, and so forth. The approach's architecture offers an efficient patient health monitoring system that checks patient health using temperature and pulse rate sensors and uses the internet to notify the doctor of any difficulties, if any. A microcontroller, connected to the detectors, keeps tabs on the patient's health and relays any relevant information through an LCD screen and Wi-Fi. If a circuit module monitors a patient's heart rate and/or temperature and notices a change, it sends an alert to the user/doctor through the Internet of Things, drawing attention to the patient's heart rate and/or temperature in real time. Therefore, the IoT-based patient health monitoring approach utilizes the internet to track and record real-time data on the health of individual patients. Patient health monitoring technique's subsystems' architectural design is broken out in detail. The method is shown in practice by simulating data from an Internet of Things device using a microcontroller, a Wi-Fi module, and the item Speak website. The hardware advancements are shown as well.

Keywords: Internet of Things, Patient Health Monitoring System, Microcontroller, Wi-Fi Module, Sensors

I INTRODUCTION

Internet connection has expanded significantly due to the exponential expansion of internet infrastructure. The Internet of Things is a global, ubiquitous network in which all system components are linked using efficient protocols (IoT). Developing an extensive database due to deploying technologies such as IoT illustrates the growth of a comprehensive database.

Data collected by Internet of Things (IoT) components was utilized for analysis and conclusion. Transportation, healthcare, an efficient environment, and individual and group work are examples of IoT uses [1]. Everyone is aware of the many aspects that affect how a 3G/4G networking system, a group networking strategy, and a plethora of smart strategies interact with one another. The strength of the Internet of Things is its considerable influence on people's everyday activities, such as hobbies, professional responsibilities, and communication [2]. Pharmaceuticals and health care are critical components of the Internet of Things [3]. The Internet of Things components have gathered validated, analyzed, and educated people about their health [4]. According to the literature medical and healthcare applications of IoT components include (1) measuring medical parameter values, (2) investigating, (3) monitoring medical equipment, (4) providing a safe interior environment, and (5) intelligent hospital operations. Several medical parametric parameters were required to assess the patient's health [5]. The most challenging aspect is knowing the criteria and properly presenting them to the doctor [6]. The metrics of the IOT based Patient Health Monitoring System (IHMS) have been investigated, and evaluations have been made using the information gleaned from the database at the original source [7]. The simulation results verify the precision of the proposed approach [8].

Santorin designed the first temperature and heart rate detection system in Italy. All medical records have included four crucial indicators: respiration rate, body temperature, pulse rate, and blood pressure (BP) [9]. In 1965, Californians developed the Technicon Medical Informatics System (TMIS) to standardise and simplify paperwork [10]. In the 1980s, the majority of systems offered documentation and planning for nursing care [11]. Documentation for the ambulatory system was created on paper before being converted to a computer. Since then, technology has advanced considerably [12]. Modern computer systems need direct input and prohibit free-text entry [13]. The speech recognition method is evolving. As a result, switching from a collection of unrelated systems to one unified one is a complex process. Modeling formulations is required for biological data collection, representation, processing, and display operations [14]. It is challenging to use these models to develop an advanced computer-based method for supplying information or databases to healthcare planners. Installation and consistent operation are seen in the real world [15].

II BACKGROUND STUDY

Akash, M. et al. [1] Instead of attending the hospital, patients may email the device's results to their doctor. This method not only saves money and time, but also reduces the likelihood that a patient's health may deteriorate as a result of travel. The gadget collects five patient inputs and digitally executes medical tests, showing the findings on an Organic light-emitting diodes (OLED) display and a Mobile Phone application. In addition to generating findings quickly, the technology was inexpensive, making it available to anybody.

Chaudhury, S. et al. [3] this research investigates the Internet of Things (IoT) technologies utilized in smart hospitals and their techniques, benefits, and drawbacks. Intelligent hospitals and Telehealth were successfully working as expected. Tele health telegraph has been shown to be a successful, efficient, and user-friendly approach with several advantages. To overcome current limitations, the framework of IoT-based health care, which was as dynamic as the internet, needs the creation of ever-more-powerful technology.

Kamal, N., & Ghosal, P. [7] these authors' systems may create reports in two modes: accuracy (200 samples) and quick (100 samples) (50 samples). The technology processes data locally before sending it to a website. This device detects hypothermia, heatstroke, and bradycardia by measuring body temperature and heart rate (at 200 samples per second). The system provides authentication for accessing a healthcare practitioner's patient health data. The technology offers constant monitoring and appropriate reaction through controllers. Adopting the recommended solution was both trustworthy and cost-effective. The device may notify the care of the resident health status.

Krishna, C. S., & Sampath, N. [9] Internet of Things (IoT) technology was being used to reduce healthcare expenses and boost system scalability via the simple addition of nodes for data collecting and processing. Loss of a single node does not cripple IoT-based systems because of their dispersed nature. The use of IoT standards simplifies the integration of third-party applications and devices.

Patel, W. et al. [11] the goal of India's Smart City and Smart Health initiatives was to improve residents' quality of life by using novel approaches to each of the eight pillars that make up a smart city. Simple, low-energy, and constantly-input smart frameworks were developed for one of the most delicate and important industries: the delivery of long-lasting pharmaceutical drugs. The architecture examined and detailed in the study promises to improve the quality of HealthCare administrations while lowering overall human service costs by eliminating unnecessary hospitalizations and speeding the delivery of emergency care to those in need. It was a system that transmits heart rate and body temperature readings to therapeutic component monitoring through GSM and web technologies.

Satija, U. et al. [13] the author provide a novel IoT-enabled ECG telemetry system that considers signal quality for applications related to heart health monitoring. This study describes a lightweight ECG signal quality assessment (ECG-SQA) method for automatically assessing the quality of ECG signals recorded during rest, ambulation, and physical activity. The suggested ECG-SQA outperforms other existing methods based on morphological and RR interval aspects, as well as machine learning approaches, according to the results of an experiment. Furthermore, the research demonstrates that more strenuous physical exercise significantly alters ECG signals. The proposed quality-aware ECG telemetry system saves energy by transmitting ECG data of an acceptable quality and putting IoT devices to sleep when poor quality ECG signals are identified, as shown by the real-time assessment findings.

Zilani, K. et al. [15] these authors research investigates a possible low-cost Internet of Things solution for medical health monitoring systems. Constant patient monitoring was complex in locations where trained medical workers were scarce. This research examines a wireless Internet of Things (IoT) gadget that collects patients' ECG, respiratory airflow, and blood oxygenation data and sends it to a central server to monitor more patients while saving time successfully.

III MATERIALS AND METHODS

Coal mine workers' health parameters, such as health care and respiratory rate, are recorded in the proposed system. Each sensor sends the properties it is monitoring to the IoT website on a continuous basis. The sensors are programmed with a certain range of values; when the sensor outputs exceed or fall outside of this range, the buzzer is triggered. The number of times a person's heart beats in sixty seconds is referred to as a pulse. Pulse rates differ from person to person.

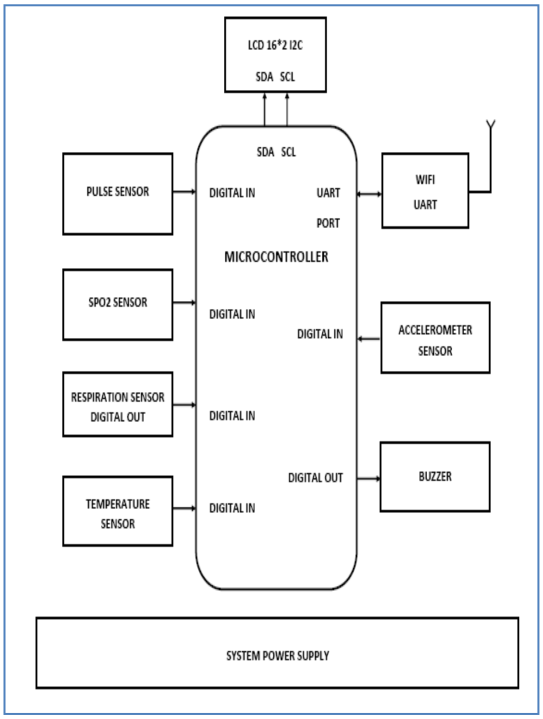

Figure 1: Block Diagram for proposed system

3.1 Pulse sensor

Our module's pulse sensor may also be used as a heart rate monitor and is compatible with Arduino and other microcontrollers. It's easy to install and use because of its plug-and-play simplicity. In addition to its medical uses, students and anybody with a rudimentary understanding of the sensor may use them to enter real-time heart rate data into mobile apps and other technology-related projects. This sensor's job is to clip it to your finger or earlobe and then attach it to your microcontroller through connecting wires. To get the most out of our module, you must also understand the specs of the sensors you use. The pulse sensor has an LED on one side and circuitry on the other. The sensor must be positioned, so the LED sticks to the skin while adequately positioned on top of the vein to compute the pulse. The pulse rate is determined by the LED's ability to detect a change in the quantity of light reflected from the sensor when blood flows at regular intervals.

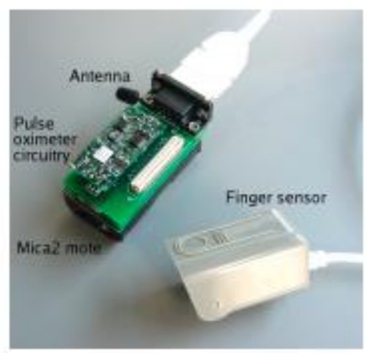

Figure 2 Pulse sensor

3.2 SPO2 sensor

Saturation of the blood with oxygen is related to it. It is one of the most significant values in medicine since it indicates how well the lungs are working and how well the red blood cells are able to transport oxygen throughout the body. Therefore, oxygen saturation (SpO2) is defined as the ratio of the quantity of oxygen-carrying hemoglobin in the blood to the amount of haemoglobin that does not transport oxygen (oxygenated and deoxygenated hemoglobin). HbO2 absorbs and scatters more infrared light, whereas hemoglobin does the opposite for red light. Red LEDs (660 nm) and infrared LEDs (940 nm) are often used to measure the coefficients in this scenario. The photodiode in certain oximeters is designed to pick up both the on and off signals from the pulsating blood flow, and the devices use parallel LEDs that are turned on and off at intervals of a few hundred microseconds. Due to the photodiode's low microampere output during light conversion, a transient impedance operational amplifier is necessary to convert the microamperes to millivolts for the two AC signals created by the LEDs. After passing through a high-pass filter, the signals are amplified and inverted by a high-gain inverted amplifier. There are two distinct components to the processed signal: an alternating current (AC) component produced by arterial blood uptake, and a direct current (DC) component caused by tissue uptake and non-pulsating blood uptake. The SPO2 sensor (Figure 2) has a 16-bit sigma-delta ADC and operates at 1.8V while needing a 3.3V LED supply voltage (for infrared and red).

Figure 2 SPO2 sensor

3.3 Wi-Fi-UART

A Wi-Fi to UART bridge is undoubtedly not a new technology, and everyone has come across one. This paper suggests a novel adapter with two additional pins to force a bootloader entry before sending data across interfaces. This is an application-specific bridge, and its primary role is to enable Internet-based firmware updates. Figure 3 depicts the proposed design.

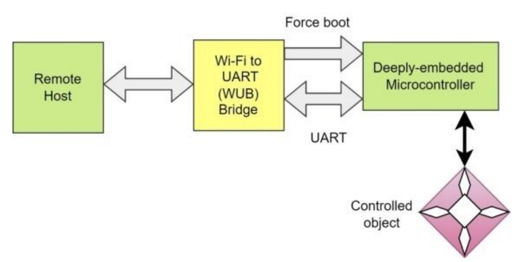

Figure 3 Wi-Fi adapter used for microcontroller programming

The term "remote host" refers to a system that is physically located elsewhere, such as a computer, smart device, or other embedded system. It's capable of using any OS or even just the bare metal firmware. Connecting to the boot loader firmware of the target device requires a software to be performed on the host computer. A UART connection is now being investigated since UART bootloaders are incorporated in even the most basic microcontroller types.

3.4 Accelerometer sensor

An accelerometer is a device that measures acceleration automatically, detects and measures vibration (vibration), and measures body acceleration (inclination). Vehicles, motors, structures, and safety systems may all benefit from the accelerometer's detection of vibrations. Video on demand (VOD) employs a 3D motion and the 3D object may be translated into an image like JPG, which has a continuous function depending on the light intensity in a dimension, therefore an accelerometer can be used for multimedia reasons like VOD as well as for measuring seismic activity. Multiple sensors are at your disposal for intricate navigational tasks. Over time, acceleration produces a speed condition. The process of acquiring speed over time is referred to as acceleration. However, deceleration occurs when a vehicle's speed decreases from its previous speed. Because velocity drops as vector quality rises, acceleration is similarly affected by direction or orientation. Acceleration is experienced by both the object and the direction it is moving in when it changes direction. The distance information needed by the output sensor can only be obtained from the accelerometer sensor using a dual integral technique. Accelerometer sensors are now being developed for use in a variety of applications, one of which is the detection of motion, such as the detection of foot motions as a navigation function and the detection of motion as a controller for a video game console or other applications.

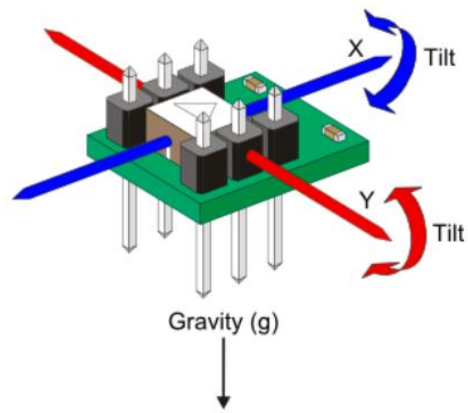

Figure 4 Accelerometer sensor

3.5 Respiration Sensor

A thin plate (diaphragm) made of metal or metal-coated quartz is used as the capacitor plate in a capacitive respiration sensor. It is typically constructed using sensors that detect changes in spacing according to the standard equation.

$C = \varepsilon_0 \varepsilon_r \frac{A}{d}$ ----- (1)

The electric constant is 0 e, the relative static permittivity is r, the cross-sectional area is A, and the separation between the plates is d. The variation in capacitance, C, at a parallel plate separation of d equals

$\Delta C = -\frac{C}{d} \Delta d$ ------ (2)

Consequently, capacitance scales linearly as dimensions shrink to sub-millimetre silicon dimensions, while the percentage change in capacitance with displacement stays constant. The capacitive respiration sensor may replace the piezoresistive pressure sensor because it is more stable, produces less heat, and needs less power. One side of the plate receives the process pressure while the other receives the reference pressure. Force variations result in bending and a shift in capacitance. Figure 5 shows the effect that breathing has on the area and distance between plates (c). Breathing generates centrifugal force, which pushes the plates closer together. Depending on the material, the change in capacitance may or may not be linear with force but is normally just a few percent of the overall capacitance. It is possible to measure capacitance by changing the oscillator's frequency or the coupling of an alternating current signal. The signal conditioning electronics should ideally be placed in close proximity to the sensor in order to reduce the potential for harmful stray capacitance. The abdominal and chest muscles flex during breathing due to their physiological properties. Muscle contraction produces an amount of outward force.

Figure 5 Respiration Sensor

3.6 16x2 LCD

162 Characteristics Liquid-crystal display (LCD) is a basic LCD module often used in electrical products and projects. It has two rows, each of which can display sixteen characters. Figure 6 shows the pinout of a 16x2 Character LCD panel. It has two power inputs, Common Collector Voltage (Vcc) and GND, much like other devices. The voltage at the Voltage at Common Emitter (VEE) terminal determines display contrast. To modify the contrast, connect the two fixed ends of a

10K potentiometer to Vcc and GND and the pot's variable end to VEE. The LCD module cannot operate without data and orders from the microprocessor. Data specifies the ASCII value (8 bits) of the shown character, whereas Command controls all other aspects of the LCD display, including where the character is displayed. The LCD's RS (Register Select) input multiplexes data and instructions into a single set of data lines. The LCD takes it as data to be shown when it is HIGH and as a command when it is LOW. The E (Enable) input on the LCD is used for a strobe of data. The LCD acknowledges the data or command as legitimate when E (Enable) is set to HIGH. The R/W input signal determines whether the LCD is being read from or written to. Usually, reading is necessary. Thus it is connected to GROUND in the circuits shown in Figure 6.

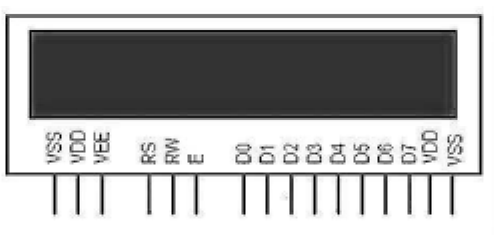

Figure 6 16x2 LCD

Depending on the method used to provide data and instructions to the LCD, the interface between the microcontroller and LCD might be either 8 bits or 4 bits. In 8-bit mode, information and commands are sent in groups of eight across data lines DB0 through DB7 and the LCD's E input is used as a data strobe. However, just four data lines are needed for the 4-bit mode. Two sets of data and instructions, each consisting of four bits, are sent consecutively on data lines DB4 through DB7, with their own data strobes coming in via the E input. Saving microcontroller pins inspired the creation of the 4-bit communication method.

IV RESULT AND DISCUSSION

Following the installation of the system's hardware and software, results are generated and may be seen on PHP websites. This application is the most powerful Internet of Things connection (IoT). Ubidots is a platform that enables developers to easily gather and translate sensor data into useful information. Use the Ubdiots platform to send data to the cloud from any device with an Internet connection.

The sensors were subjected to the real world and the semi/unstructured sensory output data were recorded. These data were then processed and converted to structured data to fit the K-Means model. A total of 2000 instances of data were collected from various sensors. It was then clustered using K-Means Clustering algorithm and the following clusters were observed for different activities performed:

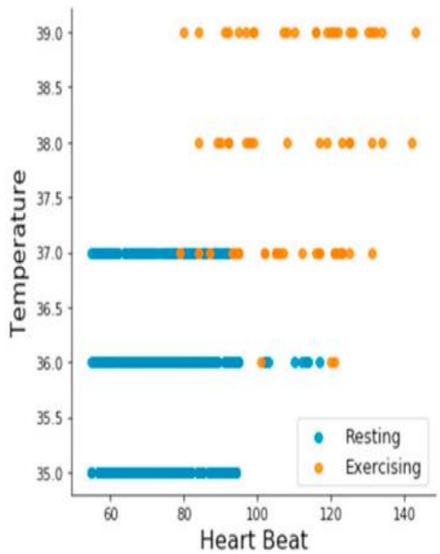

Figure 7 CNN forming 2 clusters for Temperature Vs Heart Beat

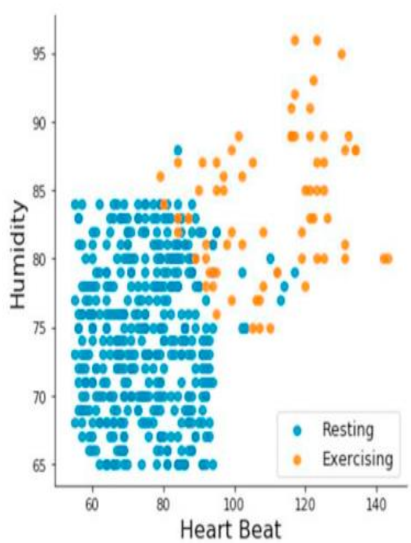

Figure 8 Humidity Vs Heart Beat respectively

The data is a incredible fit for the model since it contains two distinct clusters. The two created clusters symbolise the states of rest and exercise. The data graphs reveal the picture crystal and help us understand how the output of the numerous sensors contributes to the two states. Temperature vs Heart Rate and Humidity versus Heart Rate plots are effective identifiers of the aforementioned states, hence they were chosen for further investigation. The graph shows that a low heart rate and low temperature suggest rest, whereas the opposite implies exertion. Low heart rate and humidity indicate a state of rest, while high heart rate and humidity indicate a state of physical activity. The model perfectly suits the real-world environment and clusters the sensor data.

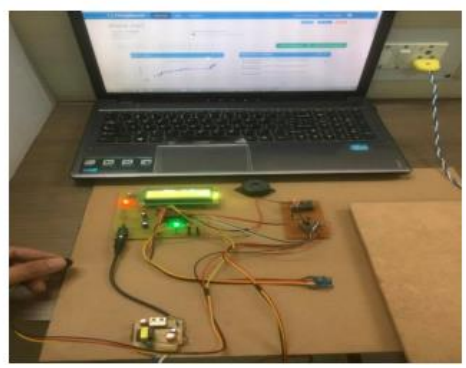

Figure 9 proposed system hardware design

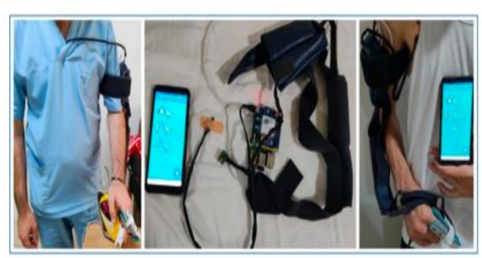

Figure 10 testing of the proposed system

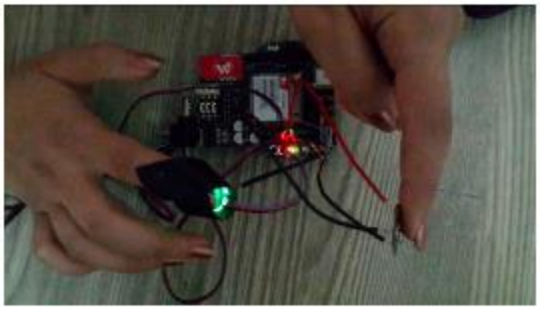

Figure 11 system hardware model

V CONCLUSION

A powerful IOT Based Health care management system (IHMS) has been developed, and tools have been built to monitor patients' current conditions regardless of whether or not a doctor is available (indeed, in real-time). Information about a patient, such as their heart rate and temperature, is recorded and sent to doctors by means of a device, technique, or system. A database of five patients was used to evaluate a device/system for assessing patients' health state. Medical professionals have been monitoring their patients' conditions and encouraging them to improve their well-being. Therefore, it is concluded that the IHMS of human pulse rate and body temperature conveys any abnormalities and unhealthy parameters in health conditions via alerts or signals, like an audio buzzer and LED indication, via IoT devices/components/systems/units (such as Wi-Fi modules) and open-source IoT websites (such as ThingSpeak.com). Incorporating the IHMS's suggested hardware setup for a microcontroller-based circuit yielded promising results. Future work scope may include enhancing the system, device, or unit by adding features or specifications to the website/mobile application, such as interfacing ambulance support, information about renowned specialists/super-specialists/expert doctors and their areas of expertise, and details about various hospitals outfitted with necessary facilities, services, laboratories, and so on.

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