Low-Cost IoT-Based Health Monitoring System for Bedridden Patients

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***Abstract*— Access to healthcare remains a significant issue for people living in rural areas. Patients—especially those who are bedridden—are hampered by the absence of ongoing health monitoring due to a shortage of medical facilities and the exorbitant cost of traditional technology. The goal of this project is to create and build an Easy Accessible Band for Bedridden People, a wearable gadget that is affordable and convenient to use and that enables real-time communication and health monitoring. The suggested bracelet combines GPS tracking for emergency response, an alerting GSM module, and vital sign sensors (such as temperature and heart rate) to give caretakers fast notifications of health abnormalities. The device is dependable, portable, and uses little power thanks to an Arduino-based microcontroller. This method is ideal for deployment in poor communities because it prioritizes affordability and accessibility over existing monitoring technologies. The device's potential influence on remote healthcare and geriatric care is increased by its real-time monitoring, AI-based health trend analysis, future wireless charging integration, sensor accuracy, and other features. This solution bridges the gap between technology and health, empowering caregivers and improving bedridden patients' quality of life.**

Keywords— IoT, health monitoring, bedridden patients, ESP8266, GSM, temperature sensor, pulse sensor, remote monitoring

I. Introduction

Describe the challenges that bedridden patients face in obtaining prompt and ongoing health monitoring. Draw attention to the shortcomings of traditional methods and the exorbitant price of the current monitoring systems. Give references to back up these claims. Draw attention to the growing prevalence of chronic illnesses and the need for affordable, easily accessible health monitoring systems. Access to healthcare is still a major problem, especially in poor and rural areas where patients have a difficult time getting timely medical care. Bedridden patients, who need ongoing health monitoring and caregiver support to avoid complications from undiscovered health issues, are among the most vulnerable groups impacted by this constraint. Geographical hurdles, the high expense of conventional monitoring devices, and a lack of proper medical infrastructure all contribute to the issue, which results in delayed diagnosis and detrimental health effects. A low-cost, portable, and easily accessible health monitoring system is needed since chronic illnesses including diabetes, hypertension, and cardiovascular disease are becoming more common. For bedridden patients in remote locations, the current monitoring devices—such as wearable fitness trackers and hospital-based equipment—can be cumbersome because they are typically located in specialized health centres or necessitate frequent trips to medical institutions. Continuous health monitoring is a significant difficulty because the solutions that are now on the market are usually expensive and not designed with immobile patients' unique needs in mind.

This work aims to address these problems by designing an Easy Accessible Band for Bedridden Patients, a low-cost wearable health monitoring tool that tracks vital signs like temperature, oxygen saturation, and heart rate in real time. The gadget makes use of a GPS positioning system for emergency calling, an Arduino microcontroller-based module, and an alerting GSM module. The gadget promotes early identification of declining health, enables timely medical action, and eventually enhances patient outcomes by giving caregivers and medical professionals access to real-time health information. This essay provides a thorough examination of the suggested device's construction, functionality, and use, highlighting its advantages over competing products. In order to guarantee optimal performance, user comfort, and widespread use in rural healthcare, the study also identifies difficulties and potential improvements. By empowering caregivers and greatly enhancing the bedridden patient's quality of life, the system can bridge the access gap to healthcare.

II. Literature Survey

By reading the article published by Jie Wang and et.al., [1], we got to know that the old traditional way of monitoring pulse in China has been restricted so the authors of this article came with a new ideology by making wearable multichannel pulse monitoring system which takes pulse from three places and mapped into 3-dimensional. This provides full information in a wave form

By reading the article published by Bin yang et.al., [2], we got the knowledge about the field communication technology which is combined with the piezoelectric pulse sensor, Lead zirconate titanate piezoelectric film is used the key for the functional layer. This method provides portable and accurate pulse reading.

The article published by S. Paul and et.al., [3], we got the knowledge about the different types of sensors used in building the e-care system for different purposes like checking temperature, heart rate.

The article published by Tanveer Reza et.al.,[4], discusses about the development of a real-time heart monitoring system that aims to provide convenient and secure monitoring for the pulse. this system utilizes a pulse rate.

By reading this article published by Yutaka Hata et.al.,[5] describes the development about the development of heart pulse monitoring system using both air pressure and ultra sonic sensors. Both the sensors are placed in different places for different purposes which provides higher accuracy.

The article published by Tanwar and et.al., [6], A life-saving alarm system has been developed to address the concern of elderly individuals passing away during sleep due to heart irregularities. The device, utilizing a pulse sensor and Arduino microcontroller, continuously monitors the person's heartbeat. If it detects a critical condition, it triggers an alarm and sends an emergency notification to the person's guardian. This innovative solution aims to prevent helplessness and potentially save lives by providing timely assistance to those in need during nighttime emergency.

This paper published by Anikwe and et.al., [7], talks about the research work in field, highlighting sensor categories with a preference for heterogeneous sensors due to their versatility. The paper also outlines the standard procedures, including data collection, preprocessing, and the use of supervised machine learning algorithms for health monitoring. The review discusses challenges and offers solutions for improving sensor-based health monitoring systems. It acknowledges progress in the field but emphasizes the need for further research and development.

This paper published by Raju et.al., [8] describes a wearable health sensor network system designed for patient monitoring using IOT, that mainly focus on the ICU patients in hospitals. It utilizes multiple wearable sensors to track various health parameters, such as heart rate, temperature, and vibration. The collected data is processed by an ARDUINO module and transmitted to an IoT-based server, where it can be continuously monitored for any significant changes in the patient's health. The system also incorporates a smart IoT gateway for data processing and cloud connectivity, facilitating data storage, processing, and visualization in an IoT cloud platform.

The paper published by Zhou and et.al., [9], discusses the remote monitoring system of blood pressure (BP) monitoring for early cardiovascular disease prevention and the challenges facing wearable BP monitoring devices, such as motion noise and slow response times. It highlights the pulse wave transit time method, which combines photoplethysmography waves for accurate and dynamically responsive BP monitoring. The paper reviews the latest developments in wearable continuous BP monitoring devices based on this method, analyzing their design, preparation processes, and properties. It also explores potential directions and challenges in the future development of such devices.

This paper [10] introduces a wearable health sensor network system designed for IoT-connected safety and health applications, particularly in ICU settings. The system employs multiple wearable sensors to monitor environmental and physiological parameters, including heart rate, temperature, and vibration. These sensors communicate and transmit data to a gateway via an IoT platform medical signal sensing network. The collected health data is processed by an ARDUINO module, displayed on an LCD, and posted to an IoT-based server for continuous monitoring.

By reading the article presented by the Y.Yamana et.al., [11], we came to know about the they have used 40 Khz ultra sonic sensor for monitoring pulse, respiration they have placed the sensor under the bed , the reflected ultrasonic rays are received but the receivers pair so, that all the parameters can be measured.

The paper presented by S. K. Kumar et.al.,[12] describes about a solution to this by proposing an idea of a wearable Health monitoring system along with a Smart pill dispenser box. Therefore, the goal of this survey is to evaluate the different methods of monitoring systems using the technology used and to compare its merits and demerits to help the upcoming researchers to make a system as per the need to overcome the coercions in the existing systems.

Paper presented by Kalimuthukumar et.al.,[13] The most common vitals that have to be noticed are heart rate, body temperature and respiratory rate. But the existing techniques proposed either a health monitoring system or pill dispenser.

N. Muralikumar et.al.,[14] proposed in their paper The core objective of the IoT-based Heart Rate Monitor for Pilots project is to enhance flight safety and reduce the likelihood of pilots experiencing heart-related issues during aviation operations, and its role in detecting potential heart failures and safeguarding the lives of pilots and passengers is invaluable.

The paper presented by S.K.kumar et.al., [15] of this project is to send the message to the caretaker as fast as possible and this IoT based system to send and receive an SMS by using LabVIEW Software is implemented.

The paper presented by S.Kalimuthukumar et.al.,[16] proposed a diagnostic system based on vocal disorders by detecting the extraction of vocal characteristics (speech). In this study, the subjects that voice signals used to allow the computer to decide whether the person is affected by the disease or not. We have collected the voice sample of affected patients with Parkinson's disease and subsequently extracted from 1 to 22 Mel's frequency cepstral coefficient for each patient.

The paper proposed by K.Sakthivel et.al., [17] describes The phenomenon increases attention to the scientific community. A wheelchair cum Stretcher the pre-existing technique in this domain includes either wheel cum stretcher that are joined by linkages or mechanical systems. cum stretcher. Therefore, the goal of the survey is to criticize the researchers and compare between the various types of mechanisms involved in the designing of wheelchair cum stretcher in the previous decade.

III. METHODOLOGY

The entire hardware and software configuration of the health monitoring system. Fig1 explains about a block diagram that shows how the data flows.

Sensors: Describe the features, accuracy, and limitations of the temperature and pulse sensors that are used.

Microcontroller(ESP8266): Talk about the choice of the ESP8266 microcontroller and list its features, such as processing, low power consumption, and Wi-Fi. The overall architecture of the health monitoring system, including the hardware and software components. Include a block diagram illustrating the data flow.

GSM Module: Describe the GSM module's communication protocols, coverage area, and how it is used to transmit alert notifications. Firmware Development: Describe the ESP8266 microcontroller's firmware, the programming language used, and the methods used for data processing, transmission, and acquisition.

Webpage Development: Describe the technology used and the functionality included in the webpage designed for data visualization (e.g., real-time data display, historical data analysis).

Transmission Protocol: Explain the data transmission protocol (such as HTTP or MQTT) that is used to send data from the ESP8266 to the webpage An alarm message is immediately sent to the caregiver for the emergency via the GSM Module if any odd behaviour is noticed.

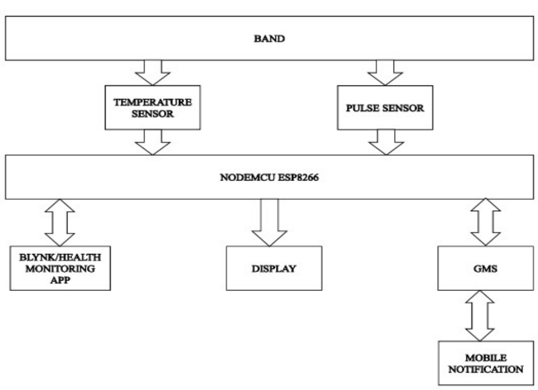

Fig 1: Block diagram representation for proposed Methodology

IV. SOFTWARE IMPLEMENTATION

Software Through an intuitive user interface, our low-cost IoT-based health monitoring system enables real-time monitoring of bedridden patients' vital indicators, such as temperature (37.3°C) and pulse rate (73 BPM) represented in Fig 2. The technology enables caregivers to intervene promptly by offering continuous monitoring, steady trend analysis, and instant notifications. This approach enhances healthcare efficiency and remote patient care through its inexpensive IoT integration.

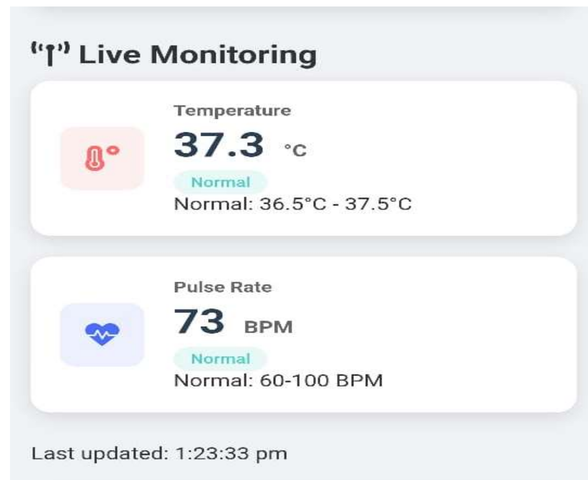

Fig 2: Implementation of software design

With the aid of Internet of Things sensors, our system continuously records and graphs temperature and pulse rate history. Real-time graphical data makes it easier for caregivers to examine health patterns over a range of time periods (1, 6, and 24 hours), enabling efficient remote monitoring and prompt interventions and Fig 3 shows the temperature monitoring history in the mobile app.

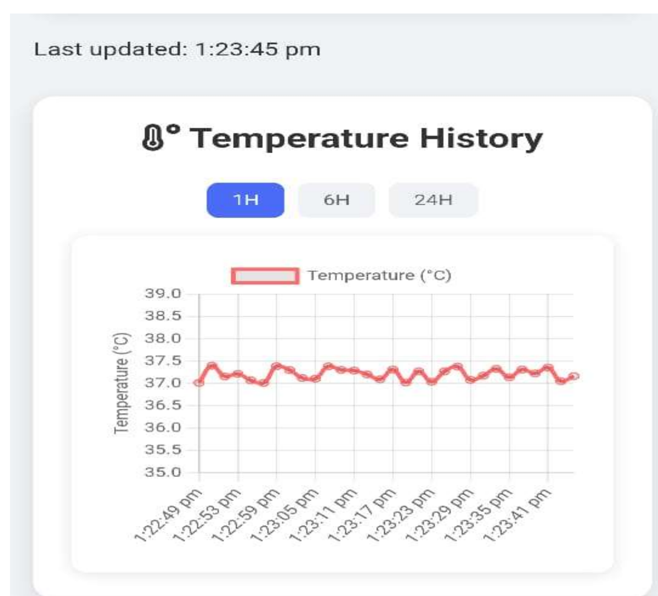

Fig 3: Temperature monitoring history

Our system offers real-time pulse rate monitoring with historical data visualization across 1H, 6H, and 24H intervals. With IoT sensors, it facilitates round-the-clock remote monitoring, providing early identification of anomalies and enhanced efficiency in patient care.

Fig 4: Pulse monitory history

By analyzing patterns in temperature and pulse rate as in Fig 4, the device provides real-time medical summaries. Through remote access and early anomaly detection, IoT-based data capture enables ongoing monitoring and enhances patient care.

V. Simulation model for proposed methodology

For real-time health monitoring and communication, the ESP8266 NodeMCU serves as the core controller for integrating with the GSM SIM800L module, MAX30102 pulse oximeter sensor, and MLX90614 infrared temperature sensor. With its SDA and SCL pins linked to GPIO4 (D2) and GPIO5 (D1) of the ESP8266, respectively, the MLX90614 sensor functions using the I2C protocol. In addition to using I2C communication, the MAX30102 pulse sensor shares the same SDA (D2) and SCL (D1) lines as the MLX90614. The TX and RX pins of the GSM SIM800L module, which is in charge of delivering SMS alerts, are linked to GPIO13 (D7) and GPIO15 (D8) of the ESP8266 via UART connection.

The ESP8266 NodeMCU is the main controller for combining with the GSM SIM800L module, MAX30102 pulse oximeter sensor, and MLX90614 infrared temperature sensor for real-time health monitoring and communication. The I2C protocol is used by the MLX90614 sensor, which has its SDA and SCL pins connected to GPIO4 (D2) and GPIO5 (D1) of the ESP8266, respectively. The MLX90614 and the MAX30102 pulse sensor share the same SDA (D2) and SCL (D1) lines in addition to I2C communication. GPIO13 (D7) and GPIO15 (D8) of the ESP8266 are connected via UART to the TX and RX pins of the GSM SIM800L module, which is responsible for sending SMS alerts.

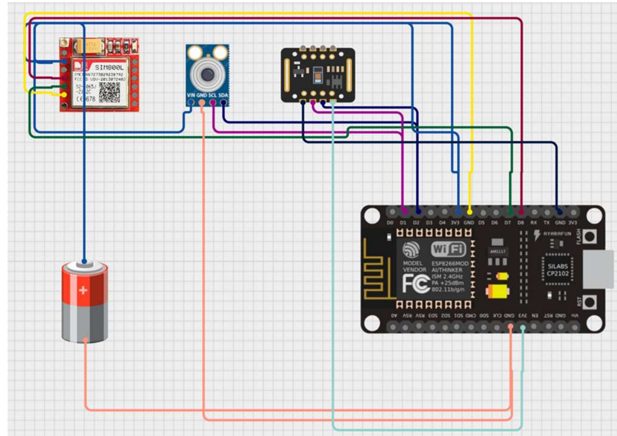

Fig 5: Hardware Implementation

VI. Results and Discussion

Vital health indicators such as body temperature, respiration rate, heart rate, and blood oxygen saturation (SpO2) were successfully tracked by the Easy Accessible Band for Bedridden Individuals. Caregivers received real-time data, guaranteeing 24-hour health monitoring. When a fall was detected, the fall detection feature was successful in automatically notifying caretakers. Patients were able to call for assistance or send distress signals with the least amount of physical activity necessary because to the communication's speech and gesture characteristics. Additionally, the band had a longer battery life of up to 48 hours, which decreased the need for recharging and minimized disruptions during monitoring.

By providing immobile patients with a reliable health monitoring system and an open line of contact, the band was able to meet its design goals. Continuous vital sign monitoring improved patient safety by enabling caregivers to keep an eye on health indicators in real time and respond quickly to an emergency. By facilitating easy contact between patients and caregivers, the speech and gesture recognition-based communication system helped to reduce feelings of loneliness. While there is room for improvement, providing non-verbal patients with more options for customized messages or alternative forms of communication, including eye tracking, is one example. Patients' and nurses' comments emphasized the band's comfort and convenience of use, as well as how lightweight it was for prolonged usage. In order to serve a wider user base, future enhancements might include expanding the spectrum of health metrics, using AI-based predictive analytics for early health issue identification, and adding more communication tools..

VII. Conclusion

For bedridden patients, the Easily Accessible Band for Bedridden Individuals successfully addressed significant problems like continuous health monitoring and caregiver communication. Patient safety and caregiver response times were significantly improved by the device's real-time vital sign monitoring and fall detection capabilities. By using speech and gesture commands, the communication system reduced patients' sense of isolation by making it simple for them to ask for assistance and interact with caregivers.

There is room for improvement even though the band was judged to be helpful. Future developments might include adding more health metrics (such as blood pressure and glucose levels) and using AI predictive health monitoring to foresee and prevent potential medical crises. The device may become even more accessible if communication features are improved further to accommodate more non-verbal patients or those with limited mobility. Overall, the experiment demonstrated that wearable technology has the potential to significantly improve the quality of life for patients who are bedridden by offering a valuable tool for remote monitoring, individualized care, and improved caregiver support.

VIII. Future Work

In order to investigate long-term patient histories and provide early warnings of upcoming health risk factors, we intend to include AI-powered predictive analytics in future developments. Mobile applications, SMS, and intelligent assistants like Google Assistant and Alexa will all have access to real-time alert systems, giving caretakers with life-threatening illnesses prompt notice. We plan to offer wireless wearable sensors that continuously take vital signs without the need for intrusive corded electrodes, improving patient comfort and mobility.

Additionally, adopting cloud-based data storage will make it simple to retrieve patient files remotely, enabling physicians to efficiently monitor a large number of patients. Integrating with electronic health records (EHRs) will improve decision-making, streamline medical documentation, and give medical staff access to comprehensive patient history

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