Design of patient health monitoring system based on iot

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To Cite this Article

Mr.B.Vamsy Krishna, S. Abhinaya Sri, P. Jeevana Sree, S. Poorneswari, Ch. Kalyan Babu, "Design of patient health monitoring system based on iot", Journal of Science Engineering Technology and Management Science, Vol.03, Issue03, March 2026,pp: 565-573, DOI: http://doi.org/10.64771/jsetms.2026.v03.i03.pp565-573

Submitted: 12-02-2026 Accepted: 19-03-2026 Published: 25-03-2026

Abstract

The proposed system is an IoT-based Patient Health Monitoring System designed to continuously track essential physiological parameters of a patient in real time. It incorporates a heartbeat sensor, blood pressure sensor, and ECG sensor to monitor pulse rate, blood pressure, and cardiac signals, while a DHT11 sensor measures the surrounding temperature and humidity. All sensor data is collected and processed by an Arduino UNO, which acts as the main control unit of the system. A NodeMCU (ESP8266) module transmits the processed data to the ThingSpeak cloud platform, enabling doctors and caregivers to remotely access and monitor the patient's health condition from any location. For local observation, a 16×2 LCD is used to display live readings at the patient's side. In addition, a buzzer is integrated to provide immediate alerts whenever any of the measured parameters exceed preset threshold values, ensuring quick response during emergencies. The system operates on a regulated 5V power supply supported by a 12V 1A adapter to guarantee stable performance. This smart solution minimizes the need for continuous manual checking, enhances patient safety, and is highly suitable for hospitals, home healthcare, and elderly care monitoring.

Keywords— *Keywords: IoT-Based Health Monitoring, Arduino UNO, Remote Patient Care, Physiological Sensors, Cloud Data Transmission*

1. INTRODUCTION:

The Health Monitoring System for the Aged is designed to support the continuous observation and management of an elderly person's health in a simple, reliable, and cost-effective manner. As aging individuals are more vulnerable to sudden health complications such as irregular heart rate, abnormal blood pressure, and respiratory problems, there is a need for an automated system that can monitor vital signs without requiring constant physical supervision. This system focuses on providing real-time tracking of essential physiological parameters and the immediate identification of abnormal conditions. The system integrates various biomedical sensors to measure vital health indicators such as heart rate, blood pressure, and body temperature. These sensors collect data continuously and transmit it to a central processing unit, where the information is analyzed and compared with predefined safe limits. If any abnormality is detected, the system generates alerts in the form of sound notifications and remote messages, ensuring that caregivers or medical personnel are informed without delay. In addition to real-time alerts, the system allows remote access to patient data, enabling doctors and family members to monitor the elderly person's health status from distant locations. By reducing the need for frequent manual check-ups and enabling faster response during emergencies, the Health Monitoring System for the Aged enhances safety, improves quality of care, and supports Remote Patient Monitoring (RPM) has emerged as a crucial component of modern healthcare, enabling the continuous observation of patients' health conditions beyond the boundaries of traditional clinical settings. With the rapid advancement of wireless communication and Internet of Things (IoT) technologies, RPM systems have made it possible to collect, transmit, and analyze vital physiological data in real time. This approach significantly reduces the need for frequent hospital visits, minimizes healthcare costs, and improves overall patient comfort, particularly for individuals with chronic illnesses, the elderly, and those in post-operative recovery. This comprehensive study explores the various technologies, architectures, and methodologies used in remote patient monitoring systems. It examines the role of wearable and non-invasive biomedical sensors in measuring parameters such as heart rate, blood pressure, oxygen saturation, body temperature, and electrocardiogram (ECG) signals. The study also discusses the integration of embedded systems and microcontrollers, along with cloud-based platforms, that enable secure data transmission, storage, and remote access. Furthermore, the research highlights the importance of real-time data visualization, automated alert mechanisms, and decision-support tools in enhancing clinical decision-making. In addition, this study addresses key challenges such as data privacy and security, system accuracy, network reliability, and energy efficiency. It also reviews current trends and future opportunities in the field, including artificial intelligence-driven analytics, predictive health monitoring, and personalized healthcare solutions. Overall, this work emphasizes the transformative impact of remote patient monitoring in improving healthcare delivery, promoting early intervention, and supporting a more proactive approach to patient care [2]. The implementation of a health-care monitoring system using a Raspberry Pi aims to provide a compact, efficient, and cost-effective platform for real-time patient health observation. With the growing need for continuous monitoring of vital signs, especially among elderly individuals and patients with chronic illnesses, automated systems have become essential in modern healthcare environments. The Raspberry Pi, due to its small size, low power consumption, and high processing capability, serves as an ideal core controller for integrating multiple biomedical sensors and communication modules into a single monitoring unit. In this system, various sensors are connected to the Raspberry Pi to measure critical physiological parameters such as heart rate, body temperature, blood pressure, and oxygen levels. The device processes the collected data and compares it with predefined threshold values to identify abnormal conditions. When any irregularity is detected, alerts can be generated and transmitted to caregivers or medical professionals through wireless communication methods such as Wi-Fi or cloud services. The system can also store and display real-time patient data using a web interface or mobile application, allowing remote access and continuous supervision. This Raspberry Pi-based healthcare monitoring solution reduces the dependence on manual measurement, improves response time in emergency situations, and enhances the overall quality of patient care. It is suitable for use in hospitals, home-based healthcare systems, and remote health monitoring applications, contributing to a more efficient and technology-driven healthcare infrastructure [3]. Body temperature is one of the most important vital signs for assessing human health, as abnormal variations can indicate infections, inflammation, or other serious medical conditions. In recent years, the need for remote health monitoring has increased due to the growing demand for home-based care, chronic disease management, and the reduction of unnecessary hospital visits. As a result, automated systems capable of measuring and transmitting body temperature from a distant location have become an essential part of modern healthcare solutions. This remote health monitoring system is designed to accurately measure an individual's body temperature using a digital temperature sensor integrated with a microcontroller-based platform. The sensor continuously records temperature readings and sends the data to a processing unit, where it is analyzed and compared with normal temperature ranges. The system then transmits the information to a remote server or cloud-based platform using wireless communication technologies such as Wi-Fi or IoT networks. This enables healthcare professionals and family members to monitor the patient's condition in real time from any location. In addition to real-time data transmission, the system can generate alerts when the temperature exceeds predefined safe limits, allowing for timely medical attention. This approach minimizes the need for manual temperature checks, reduces the risk of delayed diagnosis, and supports efficient monitoring of patients in home environments, hospitals, and isolated or high-risk areas. Overall, the system provides a reliable, cost-effective, and scalable solution for continuous body temperature monitoring in remote healthcare applications [4].

2. RELATED WORKS:

The prototype of a group heart rate monitoring system using the NodeMCU ESP8266 is developed to enable the simultaneous observation of heart rate data from multiple individuals in a simple and efficient manner. The increasing need for continuous health monitoring in group environments such as hospitals, gyms, elderly care centers, and sports training facilities has created a demand for systems that can handle real-time data from more than one user at a time. The NodeMCU ESP8266, with its built-in Wi-Fi capabilities and compact design, serves as the core controller for acquiring, processing, and transmitting heart rate signals. In this system, heart rate sensors are connected to the NodeMCU for each individual, allowing the microcontroller to read and process pulse signals continuously. The measured data is then transmitted wirelessly to a cloud-based platform or local server, where it can be stored, analyzed, and displayed through a web or mobile interface. This provides healthcare providers and supervisors with real-time access to group heart rate information from any location. In addition, the system can be configured to trigger alerts if any recorded heart rate falls outside normal ranges, enabling immediate attention to potential health risks. This prototype demonstrates a cost-effective, scalable, and easy-to-implement solution for group health monitoring applications. It reduces the need for manual checks, improves monitoring efficiency, and supports early detection of abnormal heart conditions, making it suitable for use in healthcare facilities, fitness centers, and remote health monitoring environments. [6]. The design of an ECG monitoring healthcare system based on the Internet of Things (IoT) and the Blynk application aims to provide continuous, real-time monitoring of cardiac activity in a simple, accessible, and cost- effective manner. Electrocardiogram (ECG) signals play a vital role in detecting heart conditions and abnormalities, yet continuous monitoring in traditional clinical environments often requires expensive equipment and direct supervision by medical professionals. The integration of IoT technology with mobile applications has opened new possibilities for remote and automated cardiac monitoring. In this system, an ECG sensor is used to acquire the electrical activity of the heart, and the signals are processed by a microcontroller- based platform. The collected data is then transmitted through a Wi-Fi-enabled module to the Blynk application, where it is displayed in the form of real-time graphs and numerical values on a smartphone or tablet. This allows healthcare providers and family members to remotely monitor the patient's heart condition from any location with internet access. In addition, the system can be programmed to generate instant notifications whenever abnormal ECG patterns or critical values are detected. The proposed IoT-based ECG monitoring system reduces the dependence on bulky medical equipment, supports early detection of heart-related issues, and enhances patient care through continuous, real-time access to vital cardiac information. Its compact design, low cost, and remote accessibility make it suitable for use in hospitals, home healthcare environments, and long-term patient monitoring applications. [7]. Cloud-based real-time heart monitoring and ECG signal processing systems are designed to provide continuous and remote assessment of cardiac activity using advanced sensing and communication technologies. The increasing prevalence of heart-related diseases and the need for long-term observation have highlighted the importance of systems that can collect, process, and store ECG and heart rate data outside conventional clinical environments. By combining biomedical sensors with cloud computing, such systems enable real-time access to vital cardiac information from any location. In this approach, ECG and heart rate sensors acquire the electrical signals generated by the heart and transmit the data to a processing unit, where noise is filtered and key features are extracted. The processed data is then uploaded to a cloud server through an internet-enabled module, allowing it to be securely stored and analyzed over time. Healthcare professionals and caregivers can access this data through web-based or mobile applications, enabling continuous monitoring, historical data analysis, and early detection of abnormal heart conditions. The system can also be configured to trigger real-time alerts when irregular ECG patterns or abnormal heart rates are detected. This cloud-based model not only enhances the efficiency and accuracy of cardiac monitoring but also reduces the need for frequent hospital visits, lowers healthcare costs, and supports remote patient care. Its scalability and accessibility make it a valuable solution for hospitals, home healthcare, sports monitoring, and long-term cardiac health management. [8]. The construction of multi-hop Wireless Body Area Networks (WBAN) for Healthcare IoT represents a significant advancement in continuous and reliable patient monitoring. WBANs consist of wearable or implantable sensors that collect vital physiological data, such as heart rate, body temperature, blood pressure, and oxygen saturation, directly from the human body. In healthcare IoT applications, these sensors are connected through a wireless network to transmit data efficiently to a central processing unit or cloud server. A multi-hop network architecture improves the reliability and scalability of WBANs by allowing data to be relayed through intermediate nodes before reaching the central gateway. This reduces transmission failures, extends coverage, and conserves energy in sensor nodes, which is critical for wearable or battery- powered devices. The collected data can be analyzed locally or sent to cloud-based platforms for storage, real-time monitoring, and decision-making by healthcare professionals. This multi-hop WBAN approach enhances the performance of healthcare IoT systems by enabling uninterrupted, real-time monitoring of patients, even in environments with limited direct connectivity. It supports proactive health management, early detection of medical conditions, and timely intervention, making it suitable for hospitals, elderly care facilities, home-based monitoring, and remote healthcare services. [12]. Health Gear is a real-time wearable system designed to continuously monitor and analyze physiological signals, offering an efficient solution for personal and clinical health management. Wearable devices have become increasingly important in modern healthcare due to their ability to provide continuous, non-invasive monitoring of vital parameters such as heart rate, body temperature, blood pressure, and electrocardiogram (ECG) signals. Health Gear integrates multiple sensors into a compact, wearable platform, allowing for seamless and unobtrusive data collection during daily activities. The collected physiological data is processed in real time by an embedded microcontroller and can be transmitted to a cloud-based platform for storage, analysis, and remote access. Advanced algorithms are applied to detect abnormal patterns and generate alerts for potential health risks. The system also provides visualization of real-time measurements via a connected mobile or web application, enabling patients, caregivers, and healthcare providers to make timely and informed decisions. Health Gear enhances proactive healthcare by supporting early detection of critical conditions, reducing the need for frequent hospital visits, and promoting continuous health monitoring. Its real-time analysis, portability, and connectivity make it suitable for home care, clinical applications, fitness tracking, and chronic disease management, contributing to improved health outcomes and patient safety. [13].

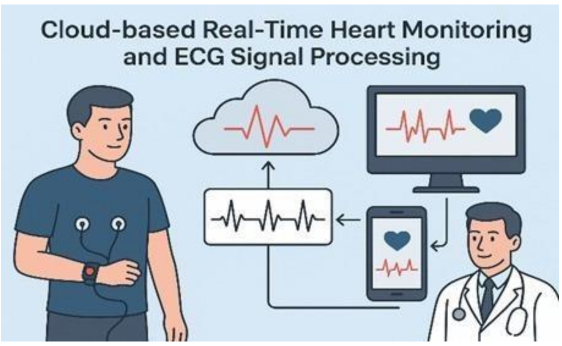

Figure 2: Fig1 – Cloud-Based Real-Time ECG and Heart Monitoring System for Remote Cardiac Care

Figure 2: Fig2 - Real-Time Healthcare Monitoring Through IoT and Cloud Integration

Figure 2: Fig3 - Health Gear: A Real-Time Wearable System for Continuous Physiological Monitoring and Proactive Healthcare

3. PROPOSED METHOD

The Arduino UNO and NodeMCU (ESP8266), which function as the primary control and communication units of the system, are supplied with a regulated 5V DC input to ensure stable and reliable operation. This regulated voltage supports the proper functioning of all connected biomedical sensors, the 16×2 LCD display, and the alert buzzer, while also preventing fluctuations that could affect data accuracy. A 12V, 1A adapter is used as the main power source and is stepped down to 5V using a voltage regulation module, enabling safe, continuous, and efficient performance of the entire monitoring system. Fig. 4 The block diagram illustrates a cloud-based real-time health monitoring system using an Arduino Uno as the central processing unit. The system integrates multiple biomedical sensors, including a heartbeat sensor, DHT11 temperature and humidity sensor, blood pressure (BP) sensor, and ECG sensor, to continuously acquire vital physiological data. The Arduino Uno processes the incoming signals, displays the measured parameters on an LCD, and triggers a buzzer to alert users in case of abnormal readings. Simultaneously, the processed data is transmitted to a NodeMCU module, which uploads the information to an IoT cloud platform for remote monitoring and storage. This architecture enables real-time access to critical health data, supports historical analysis, and facilitates timely intervention, enhancing patient care both at home and in clinical settings.

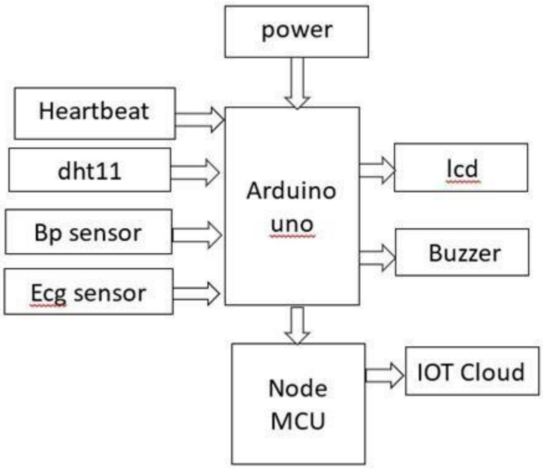

Figure 3: Fig4 -Block diagram

4. METHODOLOGY

Principle of Functioning: The system functions by continuously monitoring the vital health parameters of a patient through an integrated network of biomedical sensors. The heartbeat, blood pressure, and ECG sensors capture the patient's pulse, blood pressure, and cardiac signals, respectively, while the DHT11 sensor records the ambient temperature and humidity. These sensor signals are fed into an Arduino UNO, which serves as the central processing unit, converting the raw analog and digital inputs into meaningful data. The processed health information is then transmitted to the ThingSpeak cloud platform via the NodeMCU (ESP8266), allowing healthcare providers to access the patient's condition remotely in real time. For on-site monitoring, a 16×2 LCD continuously displays live readings, and a buzzer provides immediate alerts if any parameter exceeds predefined safe limits. The system is powered by a regulated 5V supply derived from a 12V, 1A adapter to ensure consistent and reliable operation. By combining real-time sensing, data processing, remote communication, and alerting, the system offers a smart, automated solution that reduces the dependency on manual monitoring and enhances patient safety and responsiveness. Hardware & Alerts: The proposed patient health monitoring system utilizes a combination of sensors and microcontrollers to track vital health parameters accurately. The primary hardware components include a heartbeat sensor, blood pressure sensor, and ECG sensor for monitoring pulse rate, blood pressure, and cardiac activity, along with a DHT11 sensor to measure ambient temperature and humidity. An Arduino UNO serves as the central processing unit, coordinating data collection from all sensors and preparing it for transmission. A NodeMCU (ESP8266) module enables real-time uploading of the processed data to the ThingSpeak cloud platform for remote monitoring. For local observation, a 16×2 LCD continuously displays live readings at the patient's side. Additionally, a buzzer is integrated into the system to provide immediate alerts whenever any of the measured parameters exceed preset safe thresholds, ensuring that caregivers can respond promptly to potential emergencies. The entire system is powered by a regulated 5V supply supported by a 12V, 1A adapter, guaranteeing stable and reliable operation. Power Requirements: Technical statements like "The Raspberry Pi, which acts as the central processing unit, requires a stable 5V DC input with sufficient current to support both its computational tasks and peripheral devices" can be modified to: "The central Raspberry Pi microcontroller is powered with a regulated 5V DC supply, ensuring stable operation for processing and connected peripherals." Performance Comparison Table: Table 1 The proposed system is an IoT-based patient health monitoring solution designed to track vital physiological parameters in real time. An Arduino UNO serves as the central controller, collecting data from a heartbeat sensor, blood pressure sensor, and ECG sensor to monitor the patient's cardiovascular condition. A DHT11 sensor is used to measure ambient temperature and humidity. The processed data is transmitted to the ThingSpeak cloud platform through a NodeMCU (ESP8266) module, enabling remote access for doctors and caregivers. A 16×2 LCD provides local display of real-time readings, while a buzzer generates alerts when any parameter exceeds predefined safe limits. The system is powered by a regulated 5V supply supported by a 12V, 1A adapter, ensuring stable operation. This solution reduces the need for manual monitoring and is suitable for hospitals, home care, and elderly care environments. Table 2 The proposed patient health monitoring system integrates multiple sensors and modules to enable continuous, real-time observation of vital health parameters. At the core of the system, an Arduino UNO serves as the central controller, efficiently collecting and processing data from various sensors. Heart rate is continuously monitored using a dedicated heartbeat sensor, while blood pressure

 ISSN: 3049-0952
www.jsetms.com

levels are tracked through an automated blood pressure sensor. Cardiac activity is analyzed using an ECG sensor, providing insights into the patient's heart function. Environmental conditions around the patient, including temperature and humidity, are measured using a DHT11 sensor to ensure a comprehensive monitoring environment. For enhanced accessibility and remote monitoring, the system employs a NodeMCU (ESP8266) module in combination with ThingSpeak, enabling real-time cloud-based data transmission to doctors or caregivers. A 16×2 LCD is included for local display of all vital parameters, ensuring that critical information is readily available near the patient. In addition, a buzzer provides immediate audible alerts when any measured parameter exceeds predefined thresholds, ensuring timely interventions. This integrated approach addresses limitations of conventional health monitoring systems by combining automated data acquisition, real-time analysis, and multi-channel alerting within a cost-effective and reliable framework.

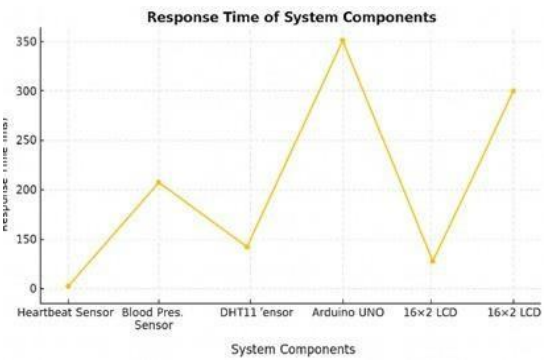

Figure 4: Graph 1: Reaction time of system components X-axis: Hardware Modules Y-axis: Response Time (s)

Parameter	Specification / Metric	Description
Central Controller	Arduino UNO	Acts as the main control unit, collecting and processing all data received from the sensors.
Heart Rate Monitoring	Heartbeat Sensor (BPM)	Continuously measures the patient's pulse rate in real time.
Blood Pressure Monitoring	Blood Pressure Sensor (mmHg)	Monitors systolic and diastolic blood pressure levels of the patient.
Cardiac Signal Monitoring	ECG Sensor	Captures and analyzes the electrical activity of the heart.
Environmental Monitoring	DHT11 Sensor (0–50°C, 20–90% RH)	Measures the ambient temperature and humidity around the patient.
Cloud Communication	NodeMCU (ESP8266) + ThingSpeak	Transmits processed sensor data wirelessly to the cloud for remote monitoring by doctors/caregivers
Local Display	16×2 LCD	Displays real-time health parameter readings for nearby observation.
Alerting Mechanism	Buzzer	Provides an audible alert when any measured parameter exceeds preset threshold values.

Table 4.1: Table 1 Performance Comparison Table

Parameter	**Existing Methods**	**Proposed Approach (Our System)**
Central Controller	Basic microcontrollers with limited processing capabilities, often handling one sensor at a time.	Arduino UNO – capable of collecting and processing multiple sensor data efficiently in real time.
Heart Rate Monitoring	Manual pulse checking or standalone heartbeat sensors with no data logging.	Heartbeat Sensor (BPM) – continuously monitors pulse rate and sends data to the system for analysis.
Blood Pressure Monitoring	Traditional cuff-based measurement, requires manual operation.	Blood Pressure Sensor (mmHg) – automated monitoring, integrated into the system for continuous tracking.
Cardiac Signal Monitoring	Standalone ECG machines, not connected to cloud for remote monitoring.	ECG Sensor – captures real-time cardiac signals and transmits data for analysis and storage.
Environmental Monitoring	Single-parameter sensors or manual checks, limited coverage.	DHT11 Sensor – monitors temperature and humidity around the patient for holistic environmental awareness.
		NodeM

Table 4.2: Table 2: Comparative Analysis of Conventional Techniques and the Developed Approach

5. I. RESULTS

Fig.5 The image depicts a multi-parameter health monitoring system integrating several sensors with an Arduino microcontroller. The setup includes an ECG sensor for monitoring heart activity, a blood pressure (BP) sensor for capturing systolic and diastolic readings, and a DHT11 sensor for measuring ambient temperature and humidity. The sensors are interfaced with an Arduino board, which processes the data and displays the results on an LCD screen in real time. This configuration allows simultaneous monitoring of vital physiological parameters, providing a compact and efficient system for personal health tracking or experimental analysis. The wiring connections are neatly arranged to ensure proper signal transmission between sensors and the microcontroller, demonstrating a practical implementation of an embedded health monitoring prototype. Fig6 The image depicts a health monitoring prototype that integrates multiple sensors with a microcontroller to measure vital parameters. The system is equipped with an ECG sensor for heart activity monitoring, a temperature sensor to record body temperature, and a humidity sensor to track ambient conditions. The measured data is displayed in real-time on an LCD screen, providing clear and immediate feedback. The prototype demonstrates a compact and efficient approach to continuous health monitoring, combining sensor data acquisition, processing, and visual output in a single embedded platform. This setup is suitable for experimental or educational purposes, highlighting the potential of IoT-based health monitoring systems. Fig.7 The image illustrates a blood pressure monitoring setup used as part of a health monitoring system. A digital blood pressure sensor is worn on the user's wrist to measure systolic pressure, diastolic pressure, and pulse rate. The sensor operates non-invasively and provides instant readings, which are essential for continuous cardiovascular assessment. The measured values can be interfaced with an embedded controller for further processing and display. This arrangement demonstrates a practical and user-friendly method for real-time blood pressure monitoring, suitable for remote health observation and clinical assistance applications. Fig8 The image shows the experimental setup of a wearable blood pressure monitoring unit integrated with an embedded health monitoring system. A wrist-mounted digital blood pressure sensor is used to acquire systolic and diastolic pressure values along with pulse rate in a non-invasive manner. The sensor is connected to a microcontroller-based platform, where the acquired data is processed and transmitted to an LCD module for real-time visualization. This configuration demonstrates a compact and efficient approach for continuous cardiovascular parameter monitoring and validates the practical integration of wearable sensors with embedded systems for health observation applications.

Figure 5: Fig5- Hardware Kit

Figure 5: Fig6- LCD-Based Real-Time Display of ECG, Temperature, and Humidity Parameters in an Embedded Health Monitoring System

Figure 5: Fig.7-Wrist-Worn Digital Blood Pressure Measurement Integrated with an Embedded Health Monitoring Setup

Figure 5: Fig. 8: Blood Pressure Monitoring Demonstration with Real-Time Data Display on an Embedded Health Monitoring Platform.

6. II. CONCLUSION

By utilizing soil moisture and DHT11 sensors, the system ensures precise water management and real-time climatic monitoring, while the integration of IR and webcam modules strengthens crop protection through proactive intrusion detection. The inclusion of GSM alerts and local alarms further enhances farmer awareness and responsiveness, reducing dependence on manual supervision. Overall, this intelligent design not only minimizes water wastage and improves crop reliability but also establishes a sustainable, cost- effective, and scalable solution for modern agriculture.

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