

# IOT Based Health Monitoring System with Variable Sensors by Using STM32

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## Abstract

The IoT-based health monitoring system using STM32 is developed to track a person's vital health conditions in real time and send the information directly to a smartphone for easy viewing. In this setup, sensors like temperature, heart rate, and humidity are used to collect both body-related and environmental data. These sensors are connected to the STM32 microcontroller, which works as the main unit of the system. The microcontroller receives data from the sensors, processes it, and converts it into understandable values. This information is then sent wirelessly to a smartphone through an IoT module. With the help of a mobile application, users or doctors can check the patient's condition anytime without being physically present. This system is especially helpful for elderly people and patients who need continuous monitoring. It minimizes frequent hospital visits and makes remote healthcare management easier. By combining sensors, STM32 processing, and wireless communication, the system offers a practical and affordable solution for everyday health monitoring.

**Keywords:** IoT, Health Monitoring System, STM32 Microcontroller, Temperature Sensor, Heart Rate Sensor, Humidity Sensor, Wireless Communication, Remote Monitoring, Smart Healthcare.

## I.INTRODUCTION:

The growing demand for remote healthcare, especially after the COVID-19 period, has highlighted the need for reliable patient monitoring systems that reduce hospital visits. However, existing remote health monitoring solutions often face issues related to data security, energy efficiency, and continuous real-time performance. Many systems also lack proper integration of multiple sensors and secure data transmission methods. To address these challenges, this work focuses on developing a secure and efficient IoT-based health monitoring system using STM32. The proposed system ensures real-time data collection, reliable wireless communication, and improved monitoring accuracy, while also considering scalability and future enhancements in remote healthcare applications [1]. The increasing prevalence of respiratory diseases has created a strong need for continuous and non-invasive monitoring solutions. Wearable devices offer a promising approach, but existing systems often face challenges such as limited accuracy, power consumption, user comfort, and data privacy issues. Many current solutions are also complex and not easily adaptable for everyday use. To overcome these limitations, this work focuses on developing a simplified and efficient IoT-based health monitoring system. The proposed approach integrates multiple sensors with an STM32 controller to ensure reliable data collection, real-time monitoring, and improved usability, while supporting future enhancements for advanced healthcare applications [3]. Modern lifestyles have made it difficult for individuals to regularly monitor their health, increasing the risk of unnoticed medical conditions. Although wearable health monitoring devices exist, many of them are bulky, less user-friendly, or lack continuous and accurate tracking. Some systems also fail to provide

timely alerts and easy access to health data. To address these issues, this work proposes an IoT-based health monitoring system using STM32 for efficient and real-time data processing. The system integrates multiple sensors to track vital parameters and ensures reliable wireless communication, enabling users to monitor their health conveniently and take early action when needed [4]. The rapid growth of data in modern systems has created new opportunities for continuous monitoring and intelligent management, especially in healthcare. However, many existing health monitoring systems do not effectively utilize large volumes of data for accurate analysis, prediction, and decision-making. There is also a lack of efficient frameworks for real-time data handling and system reliability. To address these gaps, this work proposes an IoT-based health monitoring system using STM32 that supports continuous data collection and processing. The system aims to improve real-time monitoring, enhance data reliability, and provide a scalable solution for better healthcare management and future data-driven applications [6]. The increasing number of patients requiring continuous medical attention, especially the elderly, has made remote health monitoring an important need in modern healthcare. Although IoT-based patient monitoring systems exist, they often face challenges such as unreliable data transmission, limited real-time performance, and lack of integration between sensors and communication modules. In addition, issues related to system efficiency and scalability remain unresolved. To overcome these challenges, this work presents an IoT-based health monitoring system using STM32 that enables continuous tracking of vital parameters. The system ensures reliable data transmission, real-time monitoring, and improved system performance for effective remote healthcare support [8]. The need for intelligent and predictive monitoring systems has increased across various fields, including healthcare, where real-time data analysis is essential for early diagnosis and prevention. However, many existing health monitoring systems lack predictive capabilities and efficient handling of continuous data streams. They often focus only on basic monitoring without utilizing advanced concepts for system improvement. To address this gap, this work presents an IoT-based health monitoring system using STM32 that supports continuous data collection and real-time analysis. The proposed system aims to improve reliability, enable better decision-making, and provide a foundation for future integration of predictive and smart monitoring techniques [10]. Managing diabetes requires regular monitoring of glucose levels along with other vital parameters, which can be inconvenient with traditional methods. Although wearable devices have been developed, many systems are either invasive, power-consuming, or lack seamless smartphone integration. Some solutions also do not combine multiple sensing methods for better accuracy. To address these limitations, this work proposes an IoT-based health monitoring system using STM32 that supports continuous and real-time monitoring. The system integrates multiple sensors and enables wireless data transmission to a smartphone, improving user convenience, system efficiency, and providing a flexible platform for future healthcare monitoring applications [12]. The COVID-19 pandemic highlighted the urgent need for remote health monitoring systems that reduce direct contact between patients and healthcare workers. Although existing IoT-based systems support remote data collection, they often lack real-time interaction, mobility, and advanced visualization capabilities. In addition, many systems are limited to fixed locations and do not fully utilize intelligent monitoring techniques. To address these issues, this work proposes an IoT-based health monitoring system using STM32 for continuous and reliable data collection. The system ensures real-time monitoring and wireless communication, while providing a simple and scalable solution that can be extended for future smart healthcare applications [11].

## II. LITERATURE SURVEY:

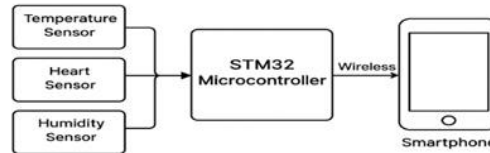
Unnati Sharma et al. (2025) presented a survey on secure remote health monitoring systems using IoT and cloud technologies, where they reviewed different approaches that combine sensors, machine learning, and communication frameworks for real-time patient monitoring. The study also categorized existing systems based on sensor types and monitored parameters, offering a clear overview of current developments in this field. However, despite addressing aspects like security and energy efficiency, many systems still face challenges such as weak data protection and complex implementation. Additionally, there is limited emphasis on low-cost hardware solutions and real-time processing using efficient microcontrollers like STM32, which are essential for practical and scalable healthcare applications [1]. Daniel L. Marino et al. (2023) proposed a data-driven approach for holistic system health monitoring by integrating both cyber and physical anomaly detection using machine learning techniques. The study focused on combining data from cyber and physical components to enable real-time analysis and accurate identification of faults, cyber intrusions, and combined cyber-physical attacks. It also introduced an integrated architecture that improves system awareness and monitoring efficiency. However, the approach mainly targets large-scale critical infrastructures and involves complex implementation. There is limited focus on lightweight, cost-effective solutions suitable for healthcare applications, and it does not address simple embedded system integration using microcontrollers like STM32 for real-time patient monitoring [2]. Zhiyu Jia et al. (2023) presented a comprehensive review of wearable devices for respiratory monitoring, focusing on technologies such as IMU sensors, piezo resistive sensors, and optical fiber sensors for continuous and non-invasive measurement of respiratory parameters. The study discussed various sensor designs, working methods, and their applications in clinical and home environments, highlighting their importance in early diagnosis and continuous monitoring. It also identified key challenges such as power consumption, user comfort, data accuracy, and privacy concerns. However, the review mainly focuses on respiratory monitoring and lacks integration with multi-parameter health systems, with limited attention to simple, low-cost embedded solutions using microcontrollers like STM32 for real-time healthcare applications [3]. Jhansi Bharathi Madavarapu et al. (2023) proposed the HOT Watch, an IoT-based wearable health monitoring system that tracks vital parameters such as heart rate, oxygen saturation, and body temperature using sensors like MLX90614, AD8232 ECG, and MAX30100. The system uses Arduino and Bluetooth technology to transmit real-time data to a mobile application, enabling users to monitor their health conveniently. It also incorporates the Pan-Tompkins algorithm for accurate heart rate detection and includes GPS for location tracking. However, the system is relatively complex and may increase power consumption, with limited focus on low-cost, energy-efficient microcontrollers like STM32 for simpler and scalable implementations [4]. Min Zheng et al. (2022) proposed a universal health management and monitoring system based on IoT designed for resource-constrained environments. The study focused on improving communication efficiency between IoT nodes by introducing an incentive-based strategy, along with techniques such as data demonising, baseline drift filtering, and feature extraction for accurate health monitoring. It also included the design of communication protocols and cloud-based data handling to enhance system performance. However, the approach involves complex network management and cloud dependency, with less emphasis on simple, standalone embedded solutions. Additionally, it does not focus on lightweight microcontroller-based implementations like STM32 for low-cost, real-time health monitoring applications [5]. Kwok Leung Tsui et al. (2019) discussed system health monitoring and management (SHMM) in the context of big data, presenting a framework for continuous data collection, analysis, and interpretation to ensure system stability and performance. The study highlighted the use of large-scale data for tasks such as prediction, fault detection, and decision-making across various domains. It also explored the relationship between

SHMM and other disciplines, emphasizing the importance of data-driven approaches. However, the work mainly focuses on large and complex systems, with limited attention to real-time, low-cost healthcare monitoring solutions, and does not address simple embedded implementations using microcontrollers like STM32 for practical IoT-based health applications [6]. Mustufa Haider Abidi et al. (2021) proposed a big data-based smart health monitoring system that integrates wearable sensors, cloud computing, and deep ensemble learning for analysing large-scale healthcare data. The system uses Hadoop MapReduce for efficient data processing and applies optimization techniques to improve feature selection and classification accuracy. It focuses on monitoring elderly individuals by collecting data from multiple body sensors and performing advanced analytics for better healthcare decisions. However, the approach is complex and highly dependent on cloud infrastructure and big data frameworks, with limited emphasis on simple, low-cost embedded implementations and real-time processing using microcontrollers like STM32 for practical IoT-based healthcare systems [7]. Basheera M. Mahmmod et al. (2022) presented a comprehensive review of IoT-based patient monitoring systems, discussing their architecture, sensor technologies, communication protocols, and applications in real-time healthcare monitoring. The study highlighted the importance of monitoring vital parameters such as temperature, heart rate, sleep patterns, and blood pressure to improve patient care and reduce healthcare costs. It also examined current research trends and identified key challenges and open issues in the field. However, the work mainly focuses on theoretical analysis and system overview, with limited emphasis on practical implementation, low-cost solutions, and real-time processing using embedded microcontrollers like STM32 for efficient healthcare monitoring systems [8]. Sangeen Khan et al. (2023) proposed a digital twin-based Internet of Robotic Things (IoRT) system for remote health monitoring of COVID-19 patients, where a virtual model replicates the real-time condition of patients using data collected from sensors through robotic devices. The system integrates IoT, robotics, and virtual reality to enable real-time monitoring, visualization, and interaction while reducing direct contact between patients and healthcare providers. It also ensures accurate data transmission and efficient monitoring performance. However, the approach is complex and resource-intensive, with limited focus on simple, low-cost implementations and does not emphasize lightweight embedded solutions using microcontrollers like STM32 for practical healthcare monitoring systems [11].

### III. PROPOSED METHODOLOGY:

The proposed system is developed to observe key health parameters continuously and make them available for remote monitoring. As illustrated in the block diagram, the system uses multiple sensors, including temperature, heart rate, and humidity sensors, which are connected to an STM32 microcontroller. Each sensor captures specific data in real time. The temperature sensor records body temperature, the heart rate sensor measures pulse, and the humidity sensor monitors surrounding environmental conditions. These inputs are received by the STM32, where the signals are processed and converted into readable values. The processed information is then transmitted wirelessly to a smartphone through a communication module such as Wi-Fi or Bluetooth. A mobile application is used to display the data, making it easy to track the user's condition at any time. If any unusual readings occur, the system can notify the user for further action. This approach supports continuous monitoring without requiring frequent hospital visits and provides a practical and cost-effective solution for basic healthcare tracking.

**BLOCK DIAGRAM:**



**FIG: 1 BLOCK DIAGRAM**

**SYSTEM REQUIREMENTS:**

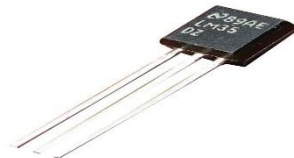
**HARDWARE REQUIREMENTS:**

- HEART BEAT SENSOR
- DTH11 SENSOR
- STM32

**SOFTWARE REQUIREMENTS:**

- AURDINO IDE
- EMBEDDED C

**TEMPERATURE SENSOR**



**FIG: 2 TEMPERATURE SENSOR**

The temperature sensor is used to measure the body temperature of the person in real time. It plays an important role in identifying conditions such as fever or abnormal temperature changes. The sensor works by detecting heat and converting it into an electrical signal that can be read by the microcontroller. In this system, the sensor is placed in contact or close to the body to ensure accurate readings. The measured values are continuously sent to the STM32 controller for processing. This helps in early detection of health issues and allows users or doctors to monitor temperature variations over time.

**HEART RATE SENSOR**



**FIG: 3 HEART RATE SENSOR**

The heart rate sensor is responsible for measuring the pulse rate of an individual. It detects the variation in blood flow through the skin using optical or electrical methods. When the heart beats, blood flow changes, and the sensor captures these changes to calculate the heart rate. The output from the sensor is sent to the STM32 microcontroller, where it is processed and converted into beats per minute (BPM). Monitoring heart rate regularly helps in identifying irregularities such as too fast or too slow heartbeat, which may indicate potential health problems and require medical attention.

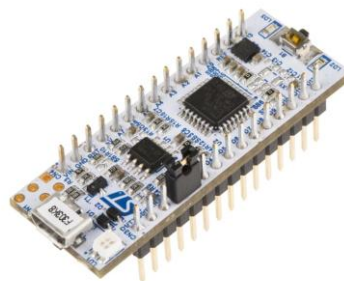
### HUMIDITY SENSOR



**FIG: 4 HUMIDITY SENSOR**

The humidity sensor measures the moisture level in the surrounding environment. Although it is not directly related to body parameters, it provides useful information about environmental conditions that may affect a person's comfort and health. The sensor detects the amount of water vapour present in the air and converts it into an electrical signal. This data is sent to the STM32 for processing. Monitoring humidity is important, especially for patients with respiratory problems, as high or low humidity levels can influence breathing conditions and overall well-being.

### STM32 MICROCONTROLLER

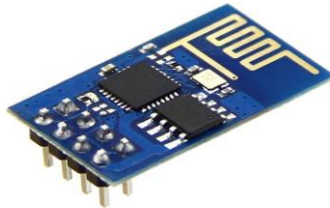


**FIG: 5 STM32 MICROCONTROLLER**

The STM32 microcontroller acts as the main control unit of the entire system. It receives input data from all the connected sensors and processes it in real time. The controller converts analog signals into digital form, performs necessary calculations, and prepares the data for transmission. STM32 is preferred due to its high speed, low power consumption, and ability to handle multiple inputs efficiently. It ensures smooth

operation of the system and accurate data handling. After processing, it sends the information to the wireless module, making it available for remote monitoring through a smartphone.

## WIRELESS COMMUNICATION MODULE



**FIG: 6 WIRELESS COMMUNICATION MODULE**

The wireless communication module is used to transfer the processed data from the STM32 microcontroller to a smartphone. It can be based on technologies such as Wi-Fi or Bluetooth, depending on the system design. This module enables real-time data transmission without the need for physical connections. Once the data is sent, it can be viewed through a mobile application. This feature allows users or healthcare providers to monitor health conditions from any location. Reliable communication is important to ensure that the data is transmitted accurately and without delay.

## SMARTPHONE



**FIG: 7 SMARTPHONE**

The smartphone acts as the user interface of the system. It receives the health data from the wireless module and displays it through a mobile application in an easy-to-understand format. Users can check parameters such as temperature, heart rate, and humidity at any time. The smartphone also allows data storage, tracking, and alert notifications in case of abnormal readings. This makes it convenient for both patients and doctors to monitor health conditions remotely. By using a smartphone, the system becomes more accessible and practical for everyday use without requiring specialized equipment.

## IV.RESULT AND DISCUSSION:

The developed IoT-based health monitoring system using STM32 was tested to observe its performance in measuring and transmitting real-time health parameters such as temperature, heart rate, and humidity. The system successfully collected sensor data and displayed it on a smartphone without noticeable delay. The readings obtained were stable and consistent under normal conditions, indicating reliable performance of the sensors and proper data handling by the STM32 microcontroller. Wireless communication was also

found to be smooth, ensuring continuous monitoring without interruption. In comparison with traditional health monitoring methods, the proposed system provides continuous observation instead of periodic measurements taken during hospital visits. This helps in identifying sudden changes in health conditions at an early stage. Compared to some existing IoT-based systems, the use of STM32 offers better processing speed and lower power consumption, making the system more efficient. Additionally, the integration of multiple sensors in a single setup provides a more complete understanding of the user's health condition rather than focusing on a single parameter. From an analysis perspective, the system demonstrates good accuracy for basic health monitoring applications. The response time of the system is quick, and the data transmission to the smartphone is reliable. The overall design remains simple and cost-effective, which makes it suitable for everyday use. However, minor variations in readings may occur due to sensor placement or environmental factors. Despite this, the system performs effectively for continuous monitoring and can be further improved by adding more advanced sensors and features for enhanced accuracy and functionality.

#### V. CONCLUSION:

The proposed system demonstrates a simple and effective way to monitor basic health parameters in real time using STM32 and multiple sensors. It reduces the need for frequent hospital visits by allowing continuous tracking through a smartphone. The system performs reliably for everyday health observation and is suitable for low-cost applications. In the future, additional sensors such as SpO<sub>2</sub>, ECG, or blood pressure can be included to improve functionality. The system can also be enhanced with cloud storage and alert features for better remote healthcare support.

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