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Smart Wearable Vital Guard

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ABSTRACT: This paper presents the design and development of a compact and efficient wearable system for continuous health monitoring and emergency response. The proposed system monitors key physiological parameters such as heart rate and body temperature using integrated sensors while an MPU6050 sensor enables fall detection. The system is powered by an Arduino Nano microcontroller which processes real-time data and compares it with predefined thresholds to identify abnormal conditions. In emergency situations, including irregular heart rate, elevated body temperature, or fall detection, the system automatically triggers alerts. A GSM module is used to send SMS notifications and initiate calls to predefined contacts, while a GPS module provides real-time location tracking for rapid assistance. Additionally a manual SOS button allows users to activate alerts instantly.

KEYWORDS: Smart Wearable, Vital Guard, Efficient Communication, Physiological.

I. INTRODUCTION

In recent years, the increasing demand for continuous health monitoring and personal safety has led to the rapid development of smart wearable technologies. This need is particularly significant for elderly individuals, patients with chronic illnesses, and people living independently, who are more vulnerable to sudden medical emergencies. Situations such as abnormal heart rate, elevated body temperature or accidental falls often occur without prior warning and delayed medical assistance can result in severe health complications or even loss of life.

To address these challenge “The Smart Wearable Vital Guard System” is proposed as an integrated solution that combines real-time health monitoring with emergency response capabilities. The system is designed to continuously track vital parameters and detect abnormal physiological conditions, enabling early intervention. In addition to health monitoring, it incorporates safety features such as fall detection and inactivity monitoring, making it highly effective for safeguarding vulnerable users. A key feature of the system is its ability to provide rapid and reliable emergency alerts. Upon detecting any critical condition, the device can notify caregivers or family members and share the user’s real-time location, ensuring timely assistance. This enhances the overall response efficiency during emergencies and minimizes potential risks.

The proposed system leverages modern embedded systems, sensor technologies, and communication modules to ensure accurate data acquisition and processing. Furthermore, location tracking technologies are integrated to determine the precise position of the user. Together, these technologies create a smart, automated, and reliable solution for health and safety monitoring. The design emphasizes portability, user comfort, and ease of use, allowing seamless integration into daily life. With a rechargeable power source and real-time data display, the system ensures uninterrupted operation and accessibility of critical health information. Overall, the Smart Wearable Vital Guard represents a significant step toward improving personal healthcare management and emergency response through intelligent wearable technology.

II. LITERATURE REVIEW

S. Patel, H. Park, P. Bonato, L. Chan, and M. Rodgers [1] This paper presents a detailed study of wearable sensor technologies used in rehabilitation and healthcare monitoring. The authors explain how wearable devices can continuously track physiological parameters such as heart rate, body movement, and activity levels. The research highlights the importance of real-time data collection and analysis in improving patient recovery and medical decision-making. It also discusses challenges like sensor accuracy, user comfort, and power consumption. This study provides a strong foundation for integrating multiple sensors in a compact wearable system like the Smart Wearable Vital Guard.

M. Haghi, K. Thurow, and R. Stoll [2] This research focuses on the role of wearable devices within the Medical Internet of Things (IoT). It explains how wearable systems can collect health data and transmit it to remote users such as doctors or caregivers. The paper also compares research-based devices with commercially available products,



highlighting their advantages and limitations. It emphasizes the importance of connectivity and real-time communication, which directly supports the alert and notification features used in the proposed project.

Pantelopoulos and N. G. Bourbakis [3] This survey provides a comprehensive overview of wearable health monitoring systems. It categorizes different types of sensors used for physiological and motion monitoring. The authors also discuss system architecture, data processing, and communication methods. The paper identifies key challenges such as reliability, data accuracy, and system integration. This research helps in understanding how to design an efficient system by combining multiple sensing technologies.

J. Gubbi, R. Buyya, S. Marusic, and M. Palaniswami [4] This paper explains the concept and architecture of the Internet of Things. It describes how devices are connected through networks to share and process data. The authors discuss key components such as sensors, communication modules, and data processing systems. The paper also highlights future trends in IoT applications, including healthcare. This study provides the conceptual framework for integrating smart communication and automation features in the project.

L. Atzori, A. Iera, and G. Morabito [5] This research provides a detailed survey of IoT technologies, including system architecture, communication protocols, and application areas. The authors discuss how IoT can be applied in healthcare to enable continuous monitoring and remote access to patient data. The paper also addresses challenges such as security and data management. It supports the idea of building connected healthcare systems for improved efficiency and response.

D. Dias and J. Paulo Silva Cunha [6] This paper focuses on wearable devices used for monitoring vital signs. It explains various sensing technologies used to measure parameters such as body temperature and heart rate. The authors also discuss system design, signal processing, and data transmission techniques. This research provides practical guidance for selecting appropriate sensors and designing an efficient health monitoring system.

H. Alemdar and C. Ersoy [7] This study explores the application of wireless sensor networks in healthcare systems. It explains how multiple sensors can work together to monitor patients and transmit data wirelessly. The paper highlights important factors such as reliability, scalability, and energy efficiency. This concept is useful in understanding how different components in the project can communicate effectively.

Kumar and G. P. Hancke [8] This research focuses on designing energy-efficient monitoring systems using wireless sensor networks. The authors propose techniques to reduce power consumption while maintaining system performance. Since wearable devices rely on battery power, this paper provides important insights into optimizing energy usage and improving battery life in the proposed system.

III. METHODOLOGY

The methodology of the proposed Smart Wearable Vital Guard system focuses on designing an efficient and reliable architecture that integrates sensing, processing, and communication units. The system employs the Arduino Nano as the central controller to manage all operations. A modular design approach is adopted to simplify development, enhance flexibility, and ensure ease of maintenance. Sensors function as input devices, while communication modules and display units act as outputs, enabling smooth coordination among all system components. The overall architecture includes sensing, processing, and communication modules. The Arduino Nano is selected as the core processing unit due to its compact size, low power consumption, and ease of integration. The design ensures real-time monitoring, quick response, and scalability through a modular structure.

Hardware Selection and Integration

Appropriate sensors and modules are selected based on functionality, accuracy, and compatibility. The MAX30100 sensor is used for heart rate and oxygen level monitoring, the LM35 sensor for temperature measurement, and the MPU6050 sensor for motion and fall detection. A TTP223 touch sensor is incorporated as an SOS button for manual emergency activation. For communication and tracking, a Neo-6M GPS module and a SIM800L GSM module are integrated to provide real-time location and alert transmission. A 16×2 LCD display is used to present real-time data to the user. All components are interconnected using standard communication protocols such as I2C, UART and analog/digital interfaces, ensuring efficient data transfer and system reliability.



Software Development and Programming

The system software is developed using embedded C/C++ in the Arduino IDE. Sensor-specific libraries are utilized for efficient data acquisition and communication. The program continuously reads sensor data and processes it in real time. Threshold values are defined for each parameter to identify abnormal conditions. Logical conditions and decision-making algorithms are implemented to detect emergencies such as high temperature, irregular heart rate, and fall events.

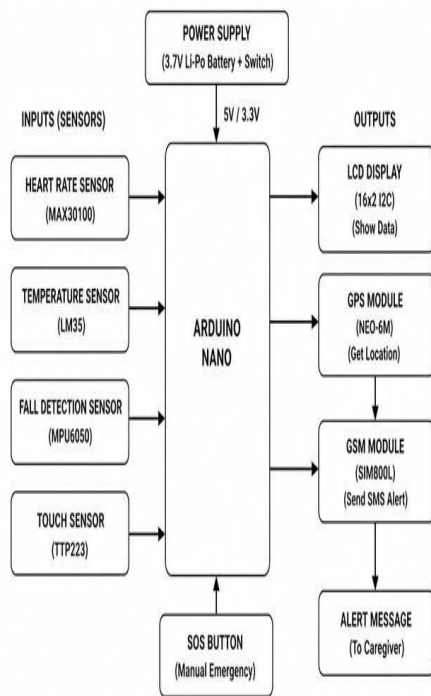


Figure1. Block Diagram

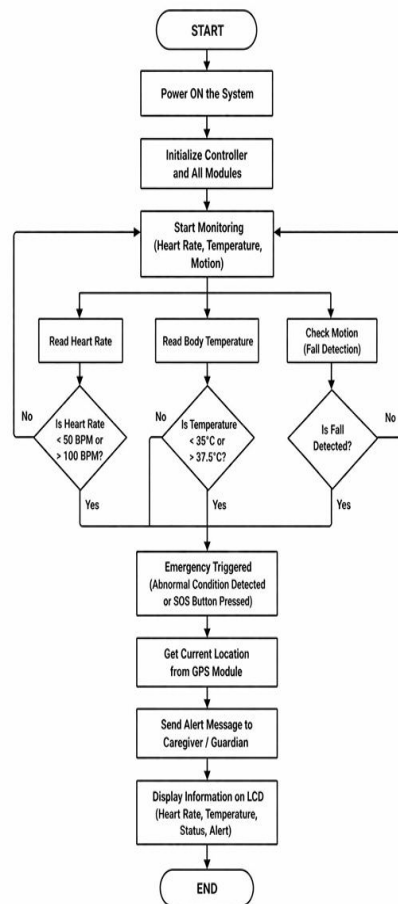


Figure 2. Flow Diagram

Data Acquisition and Processing

Sensors continuously collect physiological and motion data from the user. The Arduino Nano processes this data and converts it into meaningful information. A threshold-based algorithm compares the collected data with predefined limits. If any abnormal condition is detected, the system classifies it as an emergency. The SOS button also enables manual triggering of alerts. Processed data is displayed on the LCD, ensuring user awareness and enabling quick decision-making.

Emergency Detection and Response

Upon detection of an abnormal condition or activation of the SOS feature, the system initiates an emergency response. The GPS module retrieves the user’s real-time location coordinates. The GSM module sends an alert message containing the user’s health status and location details to predefined contacts such as caregivers or family members, ensuring immediate assistance.

Testing and Validation

The final stage involves testing and validating the system under various conditions, including normal operation, abnormal readings, fall detection, and SOS activation. Performance parameters such as sensor accuracy, response time,



and communication reliability are evaluated. Any identified errors or issues are addressed to improve system performance and ensure reliability.

IV. RESULTS

The proposed Smart Wearable Vital Guard system has been implemented and experimentally evaluated for real-time health monitoring and emergency detection. The system, built around the Arduino Nano microcontroller, successfully interfaced with multiple sensors, including MAX30100, LM35 and MPU6050 to acquire physiological and motion-related data.

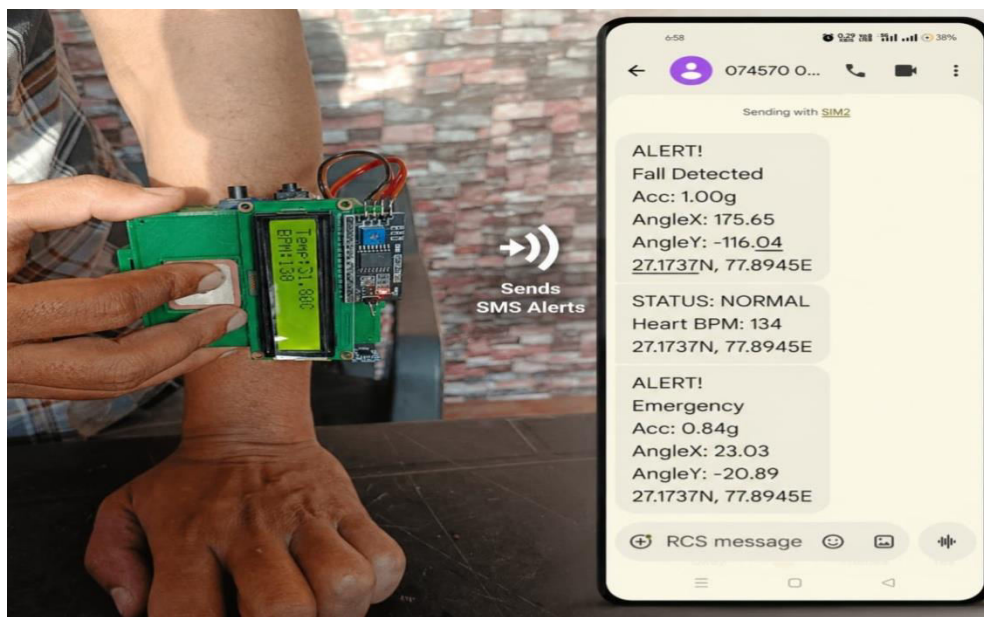


Figure 3. The proposed Smart Wearable Vital Guard System

The obtained results indicate that the system achieved stable and consistent performance during continuous operation. Heart rate and temperature measurements were accurately captured and displayed in real time, with minimal fluctuations under normal conditions. The reliability of sensor data acquisition and processing confirms the effectiveness of the integrated hardware and control logic.

The fall detection mechanism, based on motion analysis using the MPU6050 sensor, demonstrated reliable identification of sudden movements and abnormal orientation changes. During testing, the system consistently triggered alerts under predefined threshold conditions, validating its capability for emergency detection.

Furthermore, the manual SOS functionality using the TTP223 touch sensor provided an additional layer of reliability by enabling immediate user-initiated alerts. The communication subsystem showed effective performance, where the Neo-6M GPS module provided accurate location coordinates, and the SIM800L GSM module ensured successful transmission of alert messages to predefined contacts.

Overall, the experimental evaluation confirms that the proposed system achieves real-time responsiveness, reliable data acquisition, and effective emergency alerting. However, minor limitations such as dependency on network availability and sensor calibration accuracy were observed, indicating scope for further optimization. The system demonstrates strong potential for practical deployment in healthcare monitoring applications, particularly for elderly and high-risk individuals.



V. OBSERVATIONS

System Initialization : The system was powered ON successfully using the battery supply. The Arduino Nano initialized all connected modules properly, and stable operation was observed during startup without any interruption.

Sensor Data Acquisition : The MAX30100 sensor provided continuous heart rate readings accurately. The LM35 sensor measured body temperature efficiently, while the MPU6050 detected body motion and orientation changes effectively. All sensor modules responded properly during testing.

Real-Time Display : The measured sensor values were displayed correctly on the 16×2 LCD. The display updated continuously in real time without noticeable delay, ensuring smooth monitoring of health parameters.

Normal Condition Monitoring : Under normal health conditions, the system operated smoothly and continuously. No false alerts or unnecessary notifications were triggered during stable sensor readings.

Abnormal Condition Detection : The system successfully detected abnormal heart rate and high body temperature conditions. Emergency conditions were identified accurately, and the alert mechanism was activated immediately after threshold values were exceeded.

SOS Button Functionality : The TTP223 touch sensor responded instantly when pressed. Manual emergency alerts were triggered successfully, allowing the user to request immediate assistance when required.

GPS Location Tracking : The Neo-6M GPS module provided accurate location coordinates during testing. The system successfully captured real-time location data for emergency response purposes.

GSM Communication : The SIM800L GSM module successfully transmitted alert messages to the predefined mobile number. The messages included both health status information and GPS location details for quick response.

Response Time : Emergency alerts were generated rapidly after abnormal condition detection.

VI. CONCLUSION

The Smart Wearable Vital Guard system successfully demonstrates the practical application of embedded systems, sensor technologies, and IoT-based healthcare monitoring for real-time patient safety and emergency support. The integration of sensors such as MAX30100 for heart rate monitoring, LM35 for body temperature measurement, MPU6050 for motion detection, Neo-6M GPS for location tracking, and SIM800L GSM for alert communication provides an efficient and reliable health monitoring solution. The system is capable of continuously monitoring vital health parameters and detecting abnormal conditions such as irregular heart rate, elevated body temperature, and emergency situations through manual SOS activation. Immediate alert generation along with real-time location sharing improves emergency response efficiency and enhances user safety, particularly for elderly individuals, patients, and people requiring continuous health supervision.

This project highlights the growing importance of wearable technology and IoT integration in modern healthcare systems. It offers a low-cost, user-friendly, and scalable solution that supports independent living and preventive healthcare monitoring. Future improvements such as mobile application integration, cloud-based health data storage, remote doctor access, and advanced predictive analytics can further enhance system performance, reliability, and scalability. Overall, the proposed system represents a significant step toward smart, connected, and intelligent healthcare solutions for improving quality of life and ensuring timely medical assistance.

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