

Development Of Posture Alert System

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Accepted 07-04-2026

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Abstract

Prolonged sitting in sedentary work environments frequently results in improper posture, which can contribute to chronic back pain and various musculoskeletal complications. This study proposes a wearable real-time posture monitoring system designed to encourage healthier sitting behavior through continuous feedback. The system employs an MPU6050 sensor, which integrates an accelerometer and gyroscope, to measure the orientation and inclination of the user's spine. An ESP32 microcontroller processes the sensor data to evaluate posture by comparing measured angles with predefined threshold values. When the system detects a slouched or incorrect posture, it immediately activates an audible buzzer to alert the user and displays visual feedback on a Liquid Crystal Display (LCD). The display provides posture status messages such as "Good Posture" or "Please Sit Upright." The proposed device offers a cost-effective, lightweight, and non-intrusive solution for posture monitoring and correction. Furthermore, the use of the ESP32 platform enables potential future integration with Internet of Things (IoT) applications for remote monitoring and data analysis. Experimental evaluation demonstrates that the system effectively assists users in maintaining correct posture and reducing prolonged periods of poor spinal alignment, thereby supporting long-term musculoskeletal health.

Keywords: Posture monitoring system, MPU6050 sensor, ESP32 microcontroller, wearable health device, posture correction, LCD feedback system.

Introduction

In recent years, rapid technological advancement has led to the widespread use of computers, smartphones, and other digital devices in daily life. Many individuals spend extended hours sitting while working, studying, or using electronic devices. This prolonged sedentary behavior often leads to poor posture habits, which may result in various health problems such as back pain, neck stiffness, spinal misalignment, muscle fatigue, and reduced blood circulation. Over time, these issues can develop into serious musculoskeletal disorders that negatively affect an individual's health and productivity. A major challenge associated with posture-related problems is the lack of continuous monitoring and awareness. Many individuals are unable to recognize when their posture becomes incorrect, and therefore corrective action is often delayed. To address this issue, a smart posture monitoring and alert system has been designed using Bluetooth-enabled embedded technology. The proposed system continuously observes the user's body orientation and provides immediate alerts whenever an improper posture is detected. The central component of the system is the ESP32 microcontroller, which is widely adopted in embedded system applications due to its high processing capability, energy efficiency, and integrated Bluetooth communication features. The ESP32 acts as the main processing unit responsible for receiving data from sensors, analyzing posture conditions, and transmitting the

results to external devices. The posture detection mechanism relies on the MPU6050 sensor, which integrates both an accelerometer and a gyroscope in a single module. This sensor measures motion, tilt, and orientation of the user's body in real time. By processing the collected motion data, the system can determine whether the user is maintaining a correct sitting position or exhibiting slouching behavior. When abnormal posture is detected, the system generates alerts to encourage immediate correction. In addition to posture detection, the system incorporates additional sensors to monitor health and environmental parameters. The MAX3012 sensor is used to measure the user's heart rate, allowing the system to track basic physiological conditions that may be influenced by posture or physical activity. Furthermore, a DHT sensor is used to measure ambient temperature and humidity levels, which are important environmental factors that may affect user comfort and sitting behavior. Integrating these sensors enhances the functionality of the system by providing a more comprehensive monitoring platform. All sensor data is processed by the ESP32 microcontroller and transmitted wirelessly to a smartphone via Bluetooth communication. The Serial Bluetooth Terminal application serves as the user interface, enabling real-time visualization of posture information, heart rate readings, and environmental conditions. The application also displays warning messages

whenever an incorrect posture is detected, prompting the user to adjust their sitting position.

Motivation

The motivation for developing this project arises from the increasing prevalence of posture-related health issues associated with modern digital lifestyles. The extensive use of computers, laptops, and smartphones has significantly increased the amount of time individuals spend sitting in static positions. As a result, many people unintentionally adopt improper sitting postures, which may lead to discomfort, muscle strain, fatigue, and chronic back or neck pain. In severe cases, long-term poor posture can contribute to spinal deformities and other serious musculoskeletal disorders. Another important factor motivating this work is the lack of awareness regarding posture habits. Most individuals are unaware when their posture gradually becomes incorrect during long periods of work or study. Continuous manual monitoring or correction of posture is impractical in everyday situations. Although ergonomic furniture and posture training programs are available, they can be expensive and are not always accessible to everyone. Therefore, there is a need for an intelligent system capable of automatically monitoring posture and providing immediate corrective feedback.

Literature Survey

Numerous studies have been conducted in the field of posture monitoring and wearable health devices, highlighting the importance of continuous posture awareness and early correction. Researchers have explored various techniques to detect incorrect posture using motion sensors, embedded processors, and wireless communication technologies. With the development of compact sensors and microcontrollers, many posture monitoring systems have become portable, affordable, and suitable for daily use. Several research works have demonstrated the effectiveness of posture correction systems based on microcontrollers and inertial sensors. Systems using the MPU6050 sensor and

microcontrollers such as ESP32 or Arduino are capable of measuring spinal orientation and detecting posture deviations in real time. When a slouched posture is identified, these systems typically provide feedback through alerts such as buzzers, vibration modules, or visual displays. Such feedback mechanisms encourage users to correct their posture immediately, thereby reducing the likelihood of developing long-term spinal problems. Other studies have focused on wearable posture monitoring devices that incorporate accelerometers and gyroscopes for motion analysis. These wearable systems are designed to be lightweight and comfortable so that users can wear them for extended periods without inconvenience. Many of these devices transmit posture data to smartphones or cloud-based platforms, enabling users to analyze their posture behavior and track improvements over time. Recent research has also emphasized the integration of additional health monitoring features into posture detection systems. For instance, some IoT-based systems combine posture sensors with environmental monitoring sensors such as temperature and humidity detectors. These systems provide a more comprehensive view of user comfort and health conditions by monitoring both physiological and environmental factors. Wireless communication technologies such as Bluetooth and Wi-Fi further enhance accessibility by enabling real-time data transmission to mobile devices. The ESP32 microcontroller has become increasingly popular in such applications because of its powerful processing capability and built-in wireless communication features. Several studies involving ESP32 and motion sensors have demonstrated their effectiveness in applications such as activity monitoring, step counting, and motion tracking. These studies confirm that the combination of ESP32 and MPU6050 sensors provides accurate and efficient real-time monitoring capabilities, making them suitable for posture detection systems.

Embedded Systems



Fig 1: A modern example of embedded system

An embedded system is a specialized computing system designed to perform a dedicated function within a larger mechanical or electronic system.

Unlike general-purpose computers, embedded systems are developed to execute specific tasks with high efficiency and reliability. These systems

typically consist of hardware components such as microcontrollers, sensors, actuators, and supporting electronic circuits, along with software that controls the overall operation of the system. Embedded systems are widely used in many application domains including healthcare, consumer electronics, automotive systems, industrial automation, and communication devices. Their popularity is mainly due to their compact size, low power consumption, and ability to perform real-time processing. Because embedded systems operate under strict resource constraints such as limited memory, processing capability, and power availability, careful system design is required to ensure efficient performance and reliable operation.

Many embedded systems operate continuously and must respond immediately to inputs from sensors or external events. Therefore, real-time processing is a critical characteristic of these systems, particularly in monitoring and control applications. Advances in microcontroller technology have significantly improved the performance and capabilities of embedded systems in recent years. Modern microcontrollers such as the ESP32 provide high processing speeds, multiple communication interfaces, and integrated wireless connectivity, allowing developers to design intelligent and connected embedded solutions. In posture monitoring applications, embedded systems play a vital role by acquiring sensor data, processing orientation information, and generating alerts when abnormal posture is detected. The integration of sensors, processing units, and communication modules enables the development of reliable and efficient posture alert systems capable of improving

user awareness and promoting healthier sitting habits.

HARDWARE DESCRIPTION

The ESP32 microcontroller functions as the central processing unit of the system. It is responsible for acquiring sensor data, performing data processing, and enabling wireless communication through Bluetooth. Several sensors are interfaced with the ESP32 to collect information related to posture, physiological conditions, and environmental parameters. The MPU6050 motion sensor is used to measure body orientation and movement in order to detect posture deviations. To extend the monitoring capabilities, the MAX30102 sensor is used to measure heart rate and blood oxygen levels, providing insight into the user’s physiological condition. In addition, a DHT11 sensor is incorporated to measure temperature and humidity, which may influence comfort and sitting posture. This chapter also introduces the block diagram of the system, which visually represents the connections between different components and illustrates how information flows within the system. The block diagram provides a clear understanding of the system architecture and the functional relationships between the sensors, controller, and output devices. Furthermore, each hardware component used in the project is described in detail, including its operating principle and role in the overall system. By presenting the design and operational details of the hardware modules, this chapter establishes the technical foundation for the implementation and experimental analysis described in the subsequent chapters.

Block Diagram and Explanation

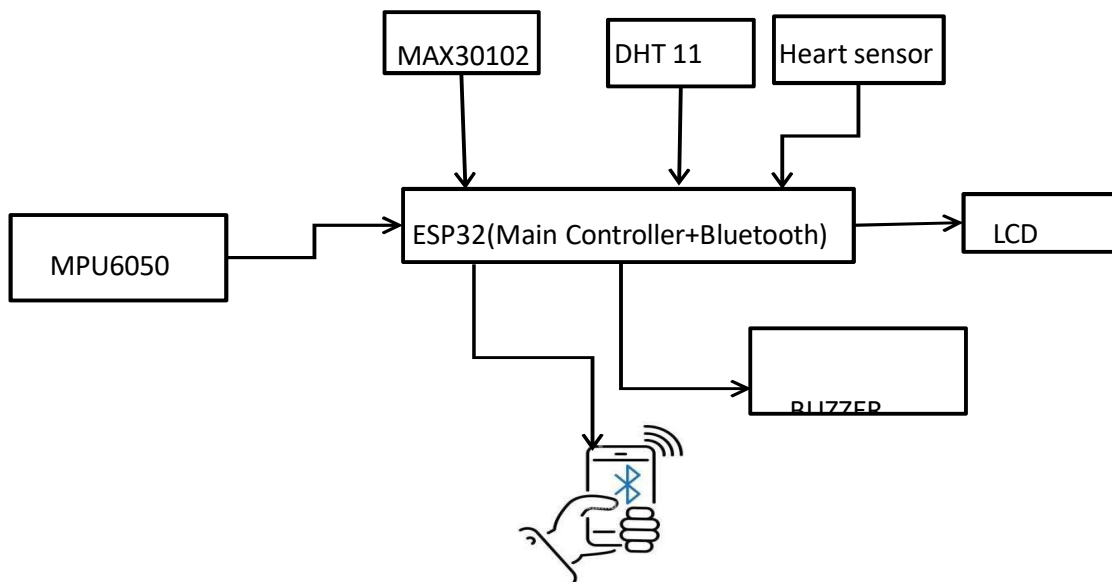


Fig 2: Block diagram

The block diagram illustrates the structural organization and functional relationships among the components of the posture alert system. It provides a simplified representation of how the various sensors, the ESP32 microcontroller, and output devices interact to perform the required operations. Through this diagram, the flow of data from input sensors to the processing unit and finally to output interfaces can be clearly understood. The ESP32 microcontroller serves as the central controller of the system. It collects data from multiple sensors, processes the information, and generates corresponding outputs such as alerts, display messages, and wireless communication signals. The MPU6050 motion sensor, which contains both an accelerometer and a gyroscope, is connected to the ESP32 and continuously measures the orientation and movement of the user's body. By analyzing this motion data, the system determines whether the user is maintaining an appropriate sitting posture or exhibiting slouching behavior. When the measured orientation exceeds predefined threshold limits, the system interprets it as an incorrect posture. To enhance the health monitoring capabilities of the system, the MAX30102 sensor is included to measure heart rate and blood oxygen levels. This sensor operates using optical detection techniques and measures variations in blood flow to determine physiological parameters. Monitoring these parameters provides additional information about the user's physical condition and helps extend the functionality of the posture monitoring system. Environmental conditions are measured using the DHT11 sensor, which detects temperature and humidity in the surrounding environment. These environmental factors can influence comfort levels and may indirectly affect posture behavior. The sensor transmits the measured values to the ESP32 for processing along with the other sensor inputs. After collecting and analyzing the sensor data, the ESP32 performs decision-making operations to determine whether corrective feedback is required. If an incorrect posture is detected, the controller activates a buzzer to generate an audible alert that prompts the user to adjust their posture. Additionally, an LCD display is used to present real-time information such as posture status, heart rate, temperature, and humidity. This allows the user to observe system outputs directly without requiring additional devices. Another important feature of the system is wireless communication through Bluetooth. The ESP32 contains built-in Bluetooth functionality that enables sensor data to be transmitted wirelessly to a smartphone. Using a mobile application such as the Serial Bluetooth Terminal, users can monitor posture data and other parameters in real time. This feature enhances the usability and portability of the system by providing convenient access to monitoring information.

Working Principle

The posture alert system operates by continuously monitoring the user's body orientation and analyzing sensor data to determine posture correctness. The MPU6050 sensor constantly measures the orientation and motion of the user's body. This information is transmitted to the ESP32 microcontroller, which analyzes the tilt angle and movement patterns to determine whether the user is maintaining a proper sitting position. The system compares the measured orientation values with predefined reference thresholds representing correct posture. If the user begins to lean forward, bend excessively, or slouch for a prolonged period, the deviation is identified as an incorrect posture. Once such a condition is detected, the ESP32 activates the alert mechanism to notify the user.

The alert mechanism consists of both visual and audio feedback. The LCD module displays warning messages such as reminders to maintain proper posture, while the buzzer generates an audible signal that immediately attracts the user's attention. When the user corrects their posture and returns to the proper position, the alert automatically stops and the system resumes normal monitoring. In addition to posture monitoring, the system also measures environmental and physiological parameters. The DHT11 sensor continuously records temperature and humidity values, which are transmitted to the ESP32 for processing and display. Similarly, the MAX30102 sensor measures heart rate and blood oxygen levels, providing valuable information about the user's physical condition.

The system operates automatically without requiring manual input from the user. Experimental testing demonstrated that the MPU6050 sensor provides stable orientation measurements and accurately detects posture changes in real time. The LCD display effectively presents system information, while the buzzer alert mechanism provides timely reminders to correct posture. The integration of low-cost sensors and a compact microcontroller makes the system portable, reliable, and suitable for everyday use.

DHT11 Sensor

The DHT11 is a widely used digital sensor designed to measure temperature and relative humidity in the surrounding environment. Due to its simplicity, affordability, and ease of interfacing, it is commonly used in embedded system projects involving environmental monitoring. The sensor consists of a thermistor for temperature measurement and a capacitive humidity sensing element for detecting moisture levels in the air. An internal microcontroller processes the measured signals and converts them into digital output values. Because the sensor provides digital output directly, it eliminates the need for additional analog-to-digital conversion circuitry, simplifying integration with microcontrollers such as the ESP32. The DHT11 sensor measures temperature in degrees Celsius and

humidity as a percentage of relative humidity. Its typical operating range is approximately 0°C to 50°C for temperature with an accuracy of $\pm 2^\circ\text{C}$, and 20% to 90% for humidity with an accuracy of $\pm 5\%$. Although the sensor does not provide extremely high precision, it is suitable for general environmental monitoring applications. Within the posture alert system, the DHT11 sensor is used to measure environmental conditions that may influence user comfort and posture behavior. For instance, high humidity or elevated temperature levels may lead to discomfort, which could indirectly encourage improper sitting posture. By monitoring these parameters, the system provides additional environmental information alongside posture and health data. The DHT11 communicates with the ESP32 through a single-wire digital communication protocol, which minimizes wiring complexity. Data is transmitted periodically to the microcontroller, where it is processed together with other sensor inputs. As a result, the DHT11 enhances the system by adding environmental awareness and contributing to a more comprehensive monitoring platform.

MAX30102 Sensor

The MAX30102 is a compact optical sensor designed for monitoring heart rate and blood oxygen saturation levels. It is widely used in wearable health monitoring devices due to its small size, low power consumption, and high measurement accuracy. The sensor operates based on the principle of photoplethysmography (PPG), which detects changes in blood volume within tissue. The MAX30102 contains integrated red and infrared light-emitting diodes along with a photodetector. When the sensor is placed on the skin, the LEDs emit light into the tissue, and the photodetector measures the amount of light reflected back. As blood flow changes during each heartbeat, the intensity of the reflected light also varies. These variations are processed to determine heart rate and oxygen saturation levels. The sensor communicates with the ESP32 microcontroller using the I2C communication protocol. This digital communication method simplifies data acquisition and ensures reliable signal transmission. In the proposed system, the MAX30102 is primarily used to monitor heart rate, providing useful physiological information alongside posture monitoring. By integrating heart rate monitoring into the posture alert system, users gain additional insights into their physical condition. This feature allows the system to function not only as a posture monitoring device but also as a basic health monitoring platform.

Heart Sensor

A heart sensor is an electronic device used to measure the pulse rate of an individual in real time. These sensors are commonly employed in medical monitoring devices, fitness trackers, and wearable health systems. The sensor detects variations in

blood flow within the body to determine the heart rate. The operation of most heart sensors is based on photoplethysmography, where light emitted from an LED passes through the skin and interacts with blood vessels. A photodetector measures the intensity of reflected light, which varies as the volume of blood changes during each heartbeat. These fluctuations are converted into electrical signals and processed to calculate the pulse rate in beats per minute. In this system, the heart sensor continuously measures the user's pulse rate and transmits the data to the ESP32 microcontroller. The measured values are displayed on the LCD screen and can also be transmitted to a smartphone via Bluetooth. Monitoring heart rate provides useful information regarding the user's physical condition, stress level, and overall health.

MPU6050 Sensor

The MPU6050 is a six-axis motion sensing device that integrates a three-axis accelerometer and a three-axis gyroscope within a single integrated circuit. It is widely used in embedded systems for motion tracking, orientation measurement, and gesture recognition. The sensor is developed using MEMS technology, which enables accurate detection of linear acceleration and angular velocity. One of the significant features of the MPU6050 is the presence of an onboard Digital Motion Processor (DMP). This component performs complex motion processing tasks internally and provides processed motion data such as orientation and motion vectors. By performing sensor fusion internally, the DMP reduces the computational load on the microcontroller. The accelerometer measures linear acceleration along the X, Y, and Z axes, enabling the detection of tilt, vibration, and movement. The gyroscope measures angular velocity, allowing the system to detect rotational motion. Combining these two sensors enables accurate motion tracking and orientation estimation. The sensor communicates with microcontrollers such as ESP32 through the I2C communication protocol. Because of its small size, low cost, and efficient performance, the MPU6050 is widely used in applications such as drones, self-balancing robots, gesture recognition systems, and wearable devices. Within the posture alert system, the MPU6050 plays a critical role by continuously monitoring the orientation of the user's body. By analyzing the tilt angle and movement data, the system can determine whether the user is maintaining correct posture.

ESP32 Microcontroller

The ESP32 is a powerful microcontroller designed for embedded and Internet of Things applications. Developed by Espressif Systems, it integrates wireless communication capabilities such as Wi-Fi and Bluetooth, making it suitable for connected devices. The ESP32 contains a dual-core Tensilica Xtensa processor capable of operating at clock

speeds up to 240 MHz. This high processing capability allows it to handle complex tasks such as sensor data processing, wireless communication, and multitasking. The microcontroller also includes internal memory and supports external flash memory for data storage. In addition to its processing power, the ESP32 provides numerous input and output interfaces including GPIO pins, analog-to-digital converters, digital-to-analog converters, PWM outputs, timers, and communication protocols such as SPI, I2C, and UART. These features enable the ESP32 to interface easily with a wide variety of sensors and peripherals. The microcontroller also incorporates multiple power-saving modes, making it suitable for battery-powered and portable devices. Due to these features, the ESP32 has become widely used in smart home systems, industrial monitoring applications, wearable health devices, and wireless sensor networks.

LCD Display

A Liquid Crystal Display (LCD) is a flat-panel display technology that uses liquid crystals to control light and display visual information. LCDs are widely used in electronic devices due to their compact size, low power consumption, and clear display characteristics. The display operates by manipulating liquid crystal molecules between two polarized glass layers. When an electrical voltage is applied, the orientation of these molecules changes, controlling the amount of light that passes through the display. This process allows the display to present characters, numbers, and images. Character-based LCD modules such as 16x2 displays are commonly used in embedded systems to display

sensor readings and system status information. In the posture alert system, the LCD is used to display parameters such as posture status, heart rate, temperature, and humidity. The LCD provides a simple and effective method for presenting information to the user without requiring external devices. Its low power consumption and easy interfacing with microcontrollers make it a suitable display solution for embedded monitoring systems.

SOFTWARE IMPLEMENTATION

This chapter describes the software components involved in the implementation of the posture alert system. The software framework enables communication between the hardware sensors, the ESP32 microcontroller, and the user interface. Instead of employing complex software platforms, the system adopts a simple approach that relies on Bluetooth communication and a mobile application for data visualization. The ESP32 microcontroller processes sensor readings and transmits the processed data wirelessly to a smartphone using Bluetooth technology. A mobile application known as Serial Bluetooth Terminal is used to display the transmitted information. Through this application, users can monitor posture status, heart rate, temperature, and humidity values in real time. The use of wireless communication improves system portability and eliminates the need for wired connections between the device and monitoring interface. This simplified software approach reduces development complexity while maintaining efficient real-time monitoring capability.

Serial Bluetooth Terminal



Fig 3: Serial Bluetooth Terminal

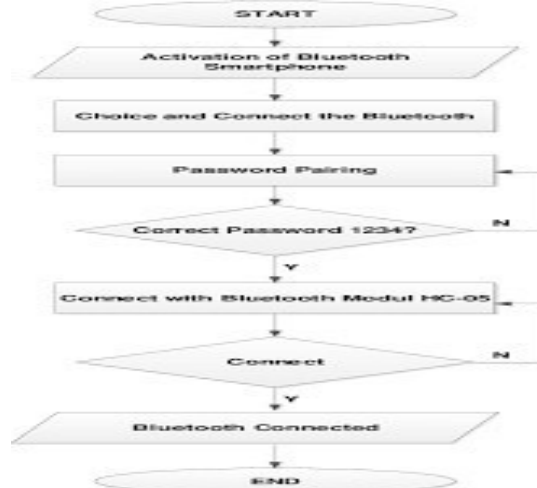


Fig 4: Flow Chart for Serial Bluetooth Terminal

The Serial Bluetooth Terminal application serves as the primary interface between the posture monitoring system and the user. This mobile application enables real-time communication with Bluetooth-enabled devices such as the ESP32 microcontroller. It provides a simple platform for receiving and displaying data transmitted from the system. Within the proposed system, the application displays information related to posture condition, heart rate, temperature, and humidity measurements. It also shows warning messages whenever incorrect posture is detected. The application supports continuous data reception, allowing users to observe real-time updates without delays. Because of its simplicity and ease of use, the Serial Bluetooth Terminal application is well suited for rapid implementation and practical monitoring.

Bluetooth Communication

Wireless communication in the system is achieved using the built-in Bluetooth functionality of the ESP32 microcontroller. The ESP32 operates as a Bluetooth device capable of transmitting sensor data to nearby smartphones. Initially, the smartphone is paired with the ESP32 through standard Bluetooth settings. After successful pairing, the Serial Bluetooth Terminal application establishes a communication connection with the microcontroller. Once the connection is established, the ESP32 continuously sends sensor readings to the smartphone. These readings include posture information obtained from the MPU6050 sensor, heart rate measurements from the MAX30102 sensor, and environmental parameters collected from the DHT11 sensor. The smartphone application receives and displays this information in real time. Whenever the system detects improper posture, an alert message is transmitted along with the sensor data. The application displays this warning, enabling the user to respond quickly and correct their posture. Wireless communication significantly enhances

system convenience and portability by eliminating the need for physical connections.

Tools Used

The software implementation of the system relies on minimal tools and avoids complicated programming frameworks. The ESP32 microcontroller handles data acquisition, processing, and wireless communication. The Serial Bluetooth Terminal mobile application acts as the primary monitoring interface. By utilizing built-in Bluetooth functionality and readily available mobile applications, the system reduces development complexity and implementation time. This approach makes the project easier to deploy and operate while still providing reliable real-time monitoring capabilities.

Programming Language

The system software is developed using C++, a widely used programming language known for its efficiency, flexibility, and performance. C++ provides both low-level hardware control and high-level programming capabilities, making it suitable for embedded system development. Because C++ supports object-oriented programming principles such as encapsulation, inheritance, and polymorphism, it allows developers to structure programs in a modular and organized manner. The language also offers strong support for hardware interaction, enabling efficient control of sensors and communication modules. C++ programs are compiled directly into machine code, which ensures fast execution and efficient use of system resources. For these reasons, C++ is commonly used in embedded systems, operating systems, robotics, and real-time applications. In the posture alert system, C++ is used to implement sensor data acquisition, posture analysis algorithms, and Bluetooth communication functionality within the ESP32 microcontroller.

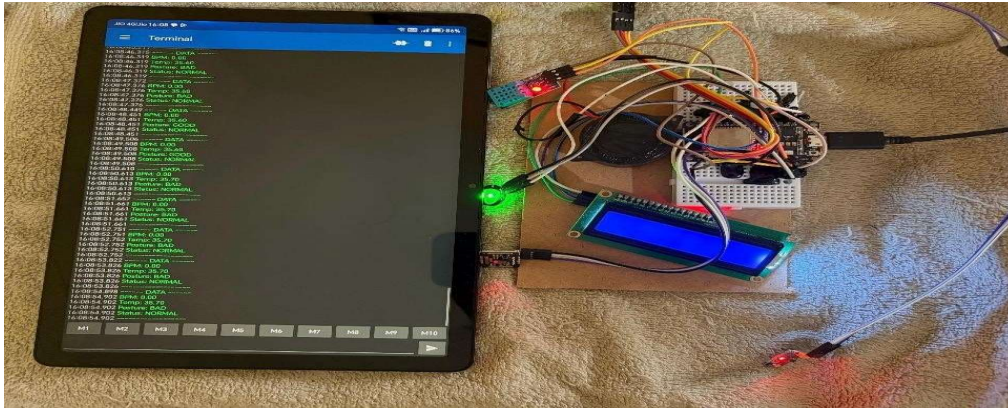


Fig 1 Result

The proposed posture alert system was successfully implemented using an ESP32 microcontroller integrated with multiple sensors, including the MPU6050 motion sensor, MAX30102 heart rate sensor, DHT11 temperature and humidity sensor, and an additional pulse sensor. After assembling the hardware components and establishing the communication interface, the system was tested under different user conditions to evaluate its functionality and reliability. The experimental results demonstrate that the system can effectively monitor the user’s body orientation and detect posture deviations in real time. During testing, the MPU6050 sensor continuously measured body tilt and orientation, allowing the system to determine whether the user was maintaining a proper sitting posture. When the user adopted an incorrect posture such as slouching or excessive forward bending, the ESP32 processed the sensor data and activated the alert mechanism. The buzzer provided an immediate audible warning, prompting the user to adjust their posture. This real-time feedback mechanism proved effective in encouraging users to maintain correct posture. In addition to posture monitoring, the system also successfully collected physiological and environmental parameters. The MAX30102 sensor measured heart rate data, while the DHT11 sensor recorded temperature and humidity levels from the surrounding environment. These sensor readings were processed by the ESP32 and transmitted wirelessly to a smartphone through Bluetooth communication. The smartphone application, Serial Bluetooth Terminal, displayed all monitored parameters in real time, including posture status, heart rate, temperature, and humidity values. The application provided a continuous data stream without noticeable delay, demonstrating the efficiency of the Bluetooth communication interface. Throughout the testing phase, the system produced stable readings and operated reliably under normal indoor conditions.

Applications

Posture monitoring systems have gained increasing importance in modern society due to the widespread

use of computers, smartphones, and other digital devices. One of the primary applications of such systems is in workplace ergonomics, particularly for individuals who spend long hours working on computers. Employees in office environments, including IT professionals and remote workers, often develop poor sitting habits that can lead to musculoskeletal disorders. A posture alert system can continuously monitor sitting posture and provide timely alerts through mobile applications, helping users maintain proper body alignment and reduce health risks. Another important application area is intelligent furniture design. Modern smart chairs and ergonomic seating solutions incorporate sensors that measure pressure distribution and body posture. These systems analyze how a user sits on the chair and detect improper positions such as leaning forward, slouching, or uneven weight distribution. When posture deviations occur, the system can notify the user or automatically adjust the chair to improve sitting comfort. Posture monitoring technology is also useful in addressing health issues related to mobile device usage. Many individuals frequently bend their necks while using smartphones, leading to a condition commonly referred to as “text neck.” Monitoring applications can analyze head and neck angles during smartphone use and alert users when excessive neck flexion is detected. This helps reduce strain on the cervical spine and promotes healthier device usage habits. In the healthcare sector, posture monitoring systems can support rehabilitation and physical therapy programs. Such systems can assist elderly individuals or patients recovering from injuries by continuously monitoring their posture and body movements. By providing real-time feedback, the system helps users maintain correct body alignment and avoid movements that could worsen existing conditions.

Conclusion

The posture alert system developed in this project presents an effective approach for monitoring body posture and promoting healthier sitting habits. The

system integrates an ESP32 microcontroller with multiple sensors, including the MPU6050 motion sensor, MAX30102 heart rate sensor, DHT11 environmental sensor, and a pulse sensor. This combination enables the system to simultaneously monitor posture, physiological parameters, and environmental conditions. The MPU6050 sensor plays a critical role in detecting body orientation and identifying posture deviations in real time. When incorrect posture is detected, the system generates immediate alerts through a buzzer, encouraging the user to correct their sitting position. Additionally, the integration of Bluetooth communication allows the ESP32 to transmit sensor data to a smartphone, where it is displayed through the Serial Bluetooth Terminal application. This wireless monitoring capability enhances the accessibility and usability of the system. The project demonstrates that embedded systems combined with low-cost sensors can be used to create practical health monitoring solutions. The developed system is compact, affordable, and easy to operate, making it suitable for use in offices, educational institutions, and home environments. Although the sensors used in the system have certain limitations in terms of measurement precision and operational range, the overall system performance remains reliable and satisfactory. In conclusion, the proposed posture alert system successfully achieves its objective of providing real-time posture monitoring along with basic health and environmental data. The project highlights the potential of embedded technologies and wireless communication in improving health awareness and encouraging better lifestyle habits.

Future Scope

Although the current system provides effective posture monitoring and health parameter tracking, several improvements can be implemented to enhance its functionality and usability. One possible enhancement involves the development of a dedicated mobile application instead of relying on the Serial Bluetooth Terminal application. A customized application could provide a more user-friendly interface and include graphical visualization of posture trends and health data. Another potential improvement is the integration of cloud-based data storage. By storing posture and health information in a cloud platform, users could track their posture habits over extended periods and analyze long-term behavioral patterns. Cloud connectivity would also enable remote monitoring and data sharing with healthcare professionals if necessary. The physical design of the system can also be improved by making the device more compact and wearable. For example, the sensors and microcontroller could be integrated into smart clothing, wearable bands, or ergonomic accessories that can continuously monitor posture without interfering with daily activities.

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