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Smart Insole System

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Abstract: Wearable technology is becoming increasingly important in modern applications such as fitness tracking, sports analysis, and smart systems. Traditional methods for analyzing foot pressure and movement are limited and do not provide continuous real-time data. To address these limitations, this paper introduces SmartInsole, a smart insole system designed to monitor foot pressure, temperature, and motion using embedded sensors.

The system is built using an ESP32 microcontroller, pressure sensors, a temperature sensor (DS18B20), and an MPU6050 motion sensor integrated into an insole. The data collected is shared to a mobile application for real-time monitoring.

The system works by collecting sensor data and processing it through the microcontroller, which then sends the information to the mobile app using IoT technology. Experimental results show that the system accurately monitors foot pressure distribution, temperature variations, and motion patterns.

This system provides a simple, portable, and effective solution for continuous foot activity tracking and analysis, making it highly useful in fitness, sports, and wearable technology applications.

Keywords: Smart Insole, IoT, ESP32, Pressure Sensor, MPU6050, Motion Tracking, Wearable Device, Embedded System.

I. INTRODUCTION

Foot pressure and movement analysis play an important role in applications such as sports performance, fitness tracking, and smart wearable systems. Continuous monitoring of these parameters helps in understanding walking patterns and improving performance.

Traditional methods rely on manual observation or specialized equipment, which may not provide continuous or real-time feedback. These approaches are time-consuming and less efficient. With advancements in wearable technology, smart systems can now continuously track foot pressure, movement, and orientation. Smart insoles are an emerging solution that enables real-time data collection and analysis. By integrating sensors like pressure sensors, temperature sensors, and motion sensors such as MPU6050, the system can capture detailed information about walking patterns and movement dynamics. In this work, a Smartinsole system is developed using embedded sensors and IoT technology. The system is designed to provide real-time monitoring and analysis, improving usability and efficiency. The main objective of this project is to develop a reliable, compact, and efficient smart insole that enhances activity tracking and reduces dependency on manual methods.

II. LITERATURE REVIEW

Several studies have explored wearable systems, particularly smart insoles for gait analysis and activity tracking. Researchers have used pressure sensors and temperature sensors to analyze walking patterns and detect variations. IoT-based systems enable real-time data transmission and remote access, improving usability. Previous works also highlight the importance of pressure distribution analysis in understanding movement patterns. However, challenges such as power consumption, sensor accuracy, and system integration still exist. The Smartinsole system addresses these issues by combining efficient sensors, low-power microcontrollers, and wireless communication for improved performance.

III. DESIGN AND SYSTEM ARCHITECTURE

The SmartInsole system is designed as a wearable insole embedded with sensors and electronic components.

A. Main Components

- ESP32 Microcontroller
- Pressure Sensors (FSR)
- Temperature Sensor (DS18B20)
- Battery Module (Rechargeable)
- Wi-Fi(Built-in ESP32)
- Insole Base Structure
- MPU6050 (Accelerometer + Gyroscope)

B. System Description

The ESP32 acts as the central processing unit, collecting data from sensors. Pressure sensors are placed at key points of the foot to measure pressure distribution. The DS18B20 sensor monitors temperature.

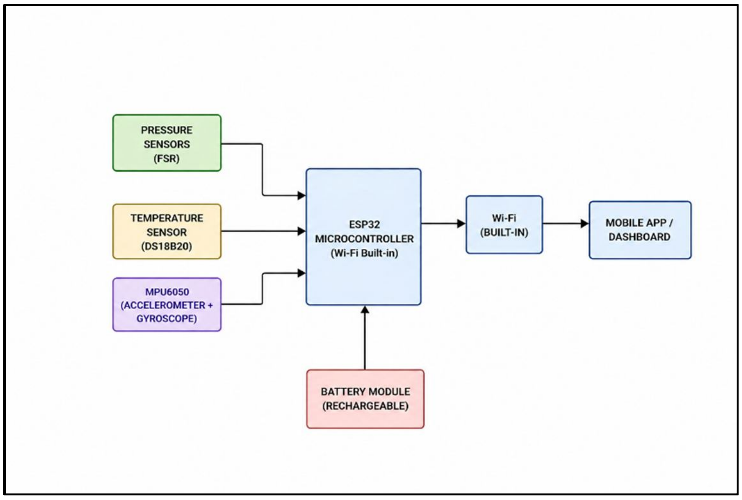

Fig :Block diagram of SmartInsole.

The MPU6050 sensor measures acceleration and angular velocity, allowing the system to detect foot movement, orientation, and walking patterns.

The collected data is processed and transmitted wirelessly to a mobile application for real-time monitoring and analysis.

Table 1: Components Used in SmartSole System

S.No	Component	Specification	Function
1	Microcontroller	ESP32	Data processing & communication
2	Pressure Sensors	FSR	Measure foot pressure
3	Temperature Sensor	DS18B20	Measure foot temperature
4	Battery	Li-ion	Power supply
5	Insole	Flexible Material	Structural support
6	Motion Sensor	MPU6050	Measure acceleration & orientation
7	Communication	Wi-Fi	Data sharing

IV. SOFTWARE CONFIGURATION

The Smartinsole system uses IoT platforms such as BlynkIot for monitoring. The ESP32 is programmed using Arduino IDE.

Sensor calibration is performed to ensure the readings. The system transmits real-time data such as pressure values and temperature to the mobile dashboard.

MPU6050 sensor is interfaced with the ESP32 using I2C communication protocol to obtain acceleration and gyroscope data for motion analysis.

V. EXPERIMENTAL RESULTS AND DISCUSSION

The system successfully measured:

- Foot pressure distribution
- Temperature variations
- Motion and orientation (using MPU6050)
- Walking patterns

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Table 2: Performance Specifications

Parameter	Value
Sensor Type	Pressure + Temperature
Communication	Wi-Fi
Power Supply	Rechargeable Battery
Monitoring	Real-time
Application	Mobile Dashboard

Table 3: Pressure Variation vs Activity

Activity	Pressure Level
Standing	Low
Walking	Medium
Running	High

Results show that the system accurately detects pressure changes and temperature variations. It provides stable performance and reliable data transmission.

VI. CONCLUSION

The Smartinsole system provides an innovative solution for continuous foot activity tracking and analysis. It reduces the need for manual observation and enables real-time monitoring of important parameters.
The system improves usability, enhances data analysis, and supports better understanding of movement patterns.
The MPU6050 sensor is interfaced with the ESP32 using I2C communication protocol to obtain acceleration and gyroscope data for motion analysis.
Future improvements may include:

- AI-based gait analysis
- Advanced sensors for additional parameters
- Improved battery life
- Integration with advanced wearable platforms

This project demonstrates how wearable IoT devices can play a vital role in modern smart technology applications.

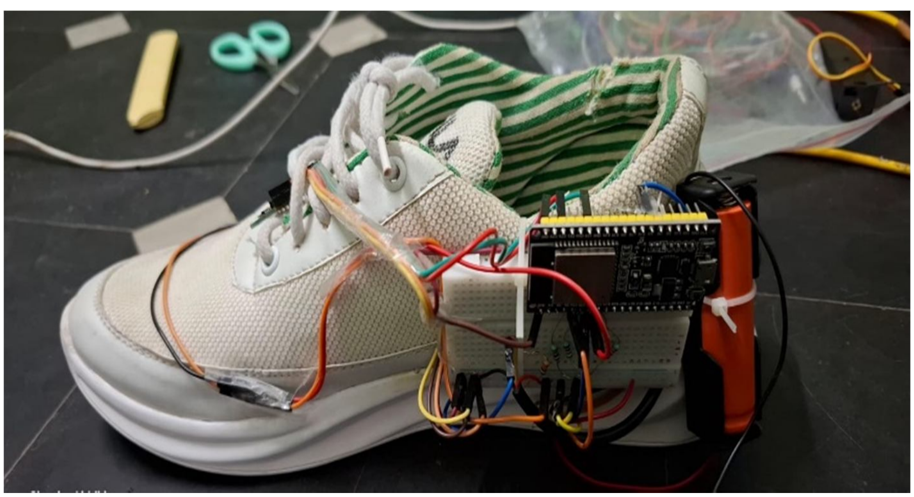

Fig :Smart Insole Project

Fig Output Dashboard.

VII. ACKNOWLEDGMENT

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