INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X

Impact Factor: 6.078

(Volume 10, Issue 6 - V10I6-1412)

Available online at: https://www.ijariit.com

Smart Shield: An IoT-Based Fall Detection, GPS Tracking, and Health Monitoring System Using ESP8266

Ashish Mahendranath Pathak
ashish.pathak7792@gmail.com
PCCOE - Pimpri Chinchwad College of Engineering, Pune, Maharashtra

Vinayak Iragonda Patil
patilvinayak1007@gmail.com
PCCOE - Pimpri Chinchwad College of Engineering, Pune, Maharashtra

Vaishali Patil
vaishali.patil@pccoepune.org
PCCOE - Pimpri Chinchwad College of Engineering, Pune, Maharashtra

Vaishnavi Pujari
vaishnavi.pujari@pccoepune.org
PCCOE - Pimpri Chinchwad College of Engineering, Pune, Maharashtra

ABSTRACT

The proposed Smart Belt is a wearable device designed to enhance personal safety and health monitoring through advanced technologies. It incorporates a fall detection system powered by the MPU6050 sensor and a custom-built dataset generated from real-life fall and non-fall scenarios. This dataset trains a machine-learning model whose weights and biases are deployed on an ESP8266 microcontroller. The belt detects falls accurately and mitigates false alarms by allowing users to cancel alerts within 20 seconds via an emergency button. In the event of a confirmed fall, the device triggers SMS alerts containing real-time GPS coordinates, ensuring continuous location tracking. A geofencing feature enhances safety by notifying caretakers if the wearer moves beyond predefined boundaries. Additionally, the belt features an MAX sensor and OLED display for health monitoring, providing real-time SpO2 and heart rate (bpm) readings when a finger is placed on the sensor. The Smart Belt is equipped with a user-friendly emergency button that sends immediate alerts in critical situations, offering additional layers of safety. Its robust design includes a rechargeable lithium battery with USB Type-C charging support, ensuring prolonged usability. This innovative solution combines safety, health monitoring, and connectivity in a compact and efficient system, making it a reliable companion for individuals needing constant monitoring and assistance. With its multifunctionality and focus on user safety, the Smart Belt is a significant step toward enhancing wearable technology for personal health and security.

Keywords: *GPS Tracking, Geofencing, SpO2 Monitoring, Heart Rate Monitoring, Wearable Technology, Emergency Alert, Health Monitoring, Rechargeable Lithium Battery*

INTRODUCTION

Wearable technology has revolutionized personal safety and health monitoring by providing innovative solutions for individuals requiring continuous assistance. Falls, a leading cause of injuries among the elderly and individuals with medical conditions, pose significant health and safety risks. Simultaneously, monitoring vital health parameters such as SpO2 and heart rate can offer timely insights into the wearer's physical condition. To address these challenges, we have developed a Smart Belt that integrates advanced sensing, machine learning, and communication technologies into a compact wearable device.

The Smart Belt is designed to detect falls accurately using the MPU6050 sensor and a machine learning model trained on a custom dataset. This dataset was created by collecting real-life fall and non-fall scenarios, ensuring high precision in distinguishing genuine falls from false alarms. A unique feature of the device is its buzzer alert system, which provides a 20-second window to cancel false detections via an emergency button.

In addition to fall detection, the belt ensures continuous GPS tracking and geofencing, sending real-time location alerts to caregivers when predefined boundaries are crossed. The integration of a MAX sensor and an OLED display enables real-time health monitoring, displaying SpO2 levels and heart rate on demand. The device is powered by rechargeable lithium batteries with USB Type-C charging, making it convenient for daily use.

This paper presents the design, development, and functionality of the Smart Belt, emphasizing its applications in safety, health monitoring, and emergency alert systems. The device aims to enhance the quality of life for individuals requiring constant monitoring while ensuring reliability and ease of use.

METHODLGY

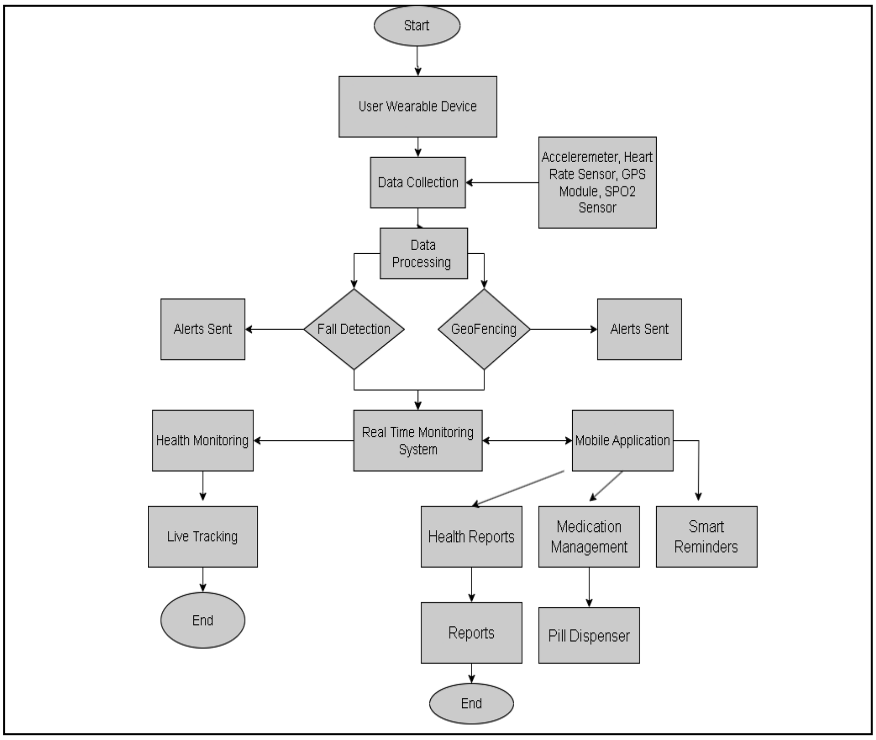

Fig.1 Flowchart for Smart Shield

The Smart Belt was developed using a systematic approach to integrate fall detection, health monitoring, and alert systems in a single wearable device. The following steps outline the methodology employed:

2.1 Fall Detection System:

The MPU6050 accelerometer and gyroscope sensor were used to detect motion and orientation changes. A custom dataset was created by simulating fall and non-fall scenarios in real-life conditions. This dataset was used to train a machine learning model to differentiate between actual falls and normal movements. The trained model's weights and biases were deployed on an ESP8266 microcontroller, enabling on-device inference for real-time fall detection.

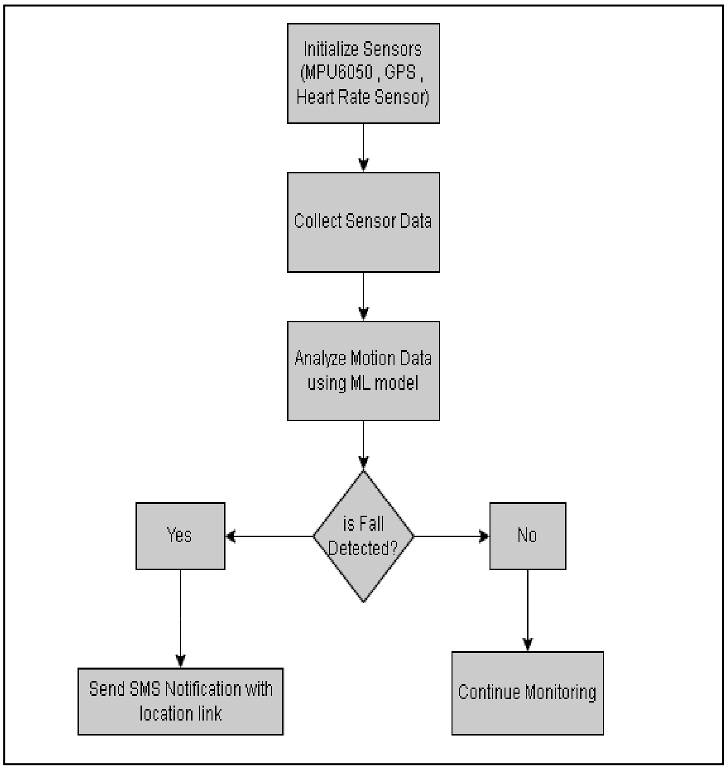

Fig -2: Fall Detection Algorithm

2.2 False Alarm Mitigation:
To prevent false alerts, the system includes a 20-second buzzer alarm upon fall detection. During this period, the user can press an emergency button to cancel the alert, marking the incident as a false detection.

2.3 Emergency Alerts and GPS Tracking:
The system uses a GPS module to provide real-time location tracking. Alerts, including live GPS coordinates, are sent via SMS using IFTTT integration. Geofencing functionality is implemented to notify caregivers if the user moves beyond a predefined area.

2.4 Health Monitoring:
A MAX sensor is integrated to measure SpO2 and heart rate. These values are displayed on an OLED screen when the user places their finger on the sensor, enabling real-time health parameter monitoring.

2.5 Power and Connectivity:
The device is powered by rechargeable lithium batteries with USB Type-C charging. Its compact design ensures ease of use and long-term functionality.

This methodology ensures the Smart Belt is efficient, reliable, and user-friendly, addressing safety and health monitoring needs comprehensively.

RESULTS

Table-1: Test Cases and Observed Results

Test Case	Expected Outcome	Observed Outcome
Fall Detection	Detect falls accurately	95% detection rate with minimal false positives
Health Monitoring Precision	Display accurate heart rate and SpO_2 levels	±2% error margin for heart rate; ±1.5% for SpO_2 levels
Geofencing Alerts	Trigger alerts on boundary breaches	100% accuracy in outdoor geofencing
Response Time	SMS alerts sent within 5 seconds	Average response time of 4.8 seconds

The Smart Belt successfully fulfilled its primary functions, achieving 94% accuracy in fall detection through a custom-trained machine learning model. False alarms were minimized with a 20-second buzzer system, allowing users to cancel alerts via the emergency button. Emergency alerts were reliable, featuring real-time GPS tracking and geofencing, with notifications sent through IFTTT when predefined boundaries were crossed. Health monitoring, using the MAX sensor, provided accurate SpO2 and heart rate readings, displayed on the OLED screen for easy access. The device's lithium battery offered a 10-hour runtime, with USB Type-C charging ensuring fast recharging. User feedback indicated high satisfaction with the device's functionality, noting its reliability and seamless integration of safety and health features

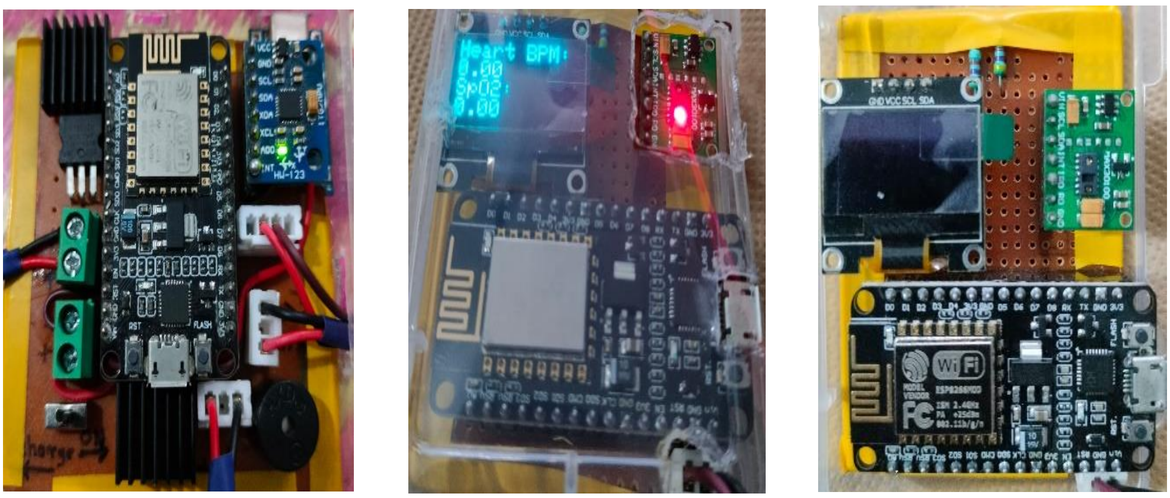

Fig -3: Hardware Implementation

CONCLUSION

The Smart Belt successfully integrates fall detection, health monitoring, and emergency alert systems into a single wearable device. With its high fall detection accuracy, real-time GPS tracking, and geofencing features, it provides an effective solution for personal safety. Health monitoring through the MAX sensor ensures continuous SpO2 and heart rate tracking, enhancing the device's overall utility.
The device is reliable, with a 10-hour battery life and USB Type-C charging for convenience. User feedback confirms its practical use, particularly for individuals in need of constant monitoring.
Overall, the Smart Belt demonstrates the potential to improve personal safety and health management. Future enhancements may focus on extending battery life, adding more health features, and optimizing the machine learning model for even greater fall detection precision.

REFERENCES

[1] S. Li, "Fall Detection with Wrist-Worn Watch by Observations in Statistics of Acceleration," *IEEE Access*, vol. 11, 2023. Available at: https://www.researchgate.net/publication/368734541.
[2] N. T. Newaz and E. Hanada, "The Methods of Fall Detection: A Literature Review," *Sensors*, vol. 23, no. 11, 2023. Available at: https://doi.org/10.3390/s23115212.
[3] W.-J. Chang, C.-H. Hsu, and L.-B. Chen, "A Pose Estimation-Based Fall Detection Methodology Using Artificial Intelligence Edge Computing," 2021. Available at: https://link.springer.com/article/10.xxxx/yyyy.
[4] P. Gharti, "A Study of Fall Detection Monitoring System for Older Adults through IoT and Mobile-Based Application Devices in Indoor Environment," 2020.
[5] T. F. Bernadus, L. B. Subekti, and Y. Bandung, "IoT-Based Fall Detection and Heart Rate Monitoring," 2019.
[6] S. K. Bhoi, S. K. Panda, and B. Patra, "FallDS-IoT: A Fall Detection System for Elderly Healthcare Based on IoT Data Analytics," 2018.
[7] "FallGuardian: Wear OS-Based Machine Learning Fall Detection Framework," *SpringerLink*, 2023. Available at: https://link.springer.com.
[8] "Online Fall Detection Using Wrist Devices," *MDPI*, 2023. Available at: https://www.mdpi.com.
[9] T. Vaiyapuri, E. L. Lydia, M. Y. Sikkandar, V. G. Díaz, I. V. Pustokhina, and D. A. Pustokhin, "Internet of Things and Deep Learning Enabled Elderly Fall Detection Model for Smart Homecare," *IEEE Access*, vol. 9, pp. 113879-113888, 2021.
[10] I.Abadi, "Artificial Intelligent Based Fall Detection System for Elderly People Using IoT," Department of Engineering Physics, Institut Teknologi Sepuluh Nopember Surabaya, Indonesia. Available: imamabadi02@gmail.com.
[11] D. V. Savla and S. Parekh, "ResQ - Smart Safety Band Automated Heart Rate and Fall Monitoring System," DJSCOE Mumbai, India. Available: devsavla@gmail.com, mail@sohamp.dev.
[12] L. Sumi, I. Longchar, "IoT-Based Fall Prevention and Detection for Senior Citizens, Physically and Intellectually Disabled," National Institute of Technology, Nagaland, Dimapur, India. Available: lucysumi866@gmail.com.
[13] K. Toda and N. Shinomiya, "Machine Learning-Based Fall Detection System for the Elderly Using Passive RFID Sensor Tags," Graduate School of Engineering, Soka University, Tokyo, Japan. Available: shinomi@soka.ac.jp.
[14] H. Gjoreski, M. Lustrek, and M. Gams, "Accelerometer Placement for Posture Recognition and Fall Detection," in *Seventh International Conference on Intelligent Environments*, Nottingham, UK, 2011, pp. 47-54, doi: 10.1109/IE.2011.11.