IJIRIS: International Journal of Innovative Research in Information Security
Volume 11, Issue 10, November 2025
E-ISSN: 2349-7017
P-ISSN: 2349-7009
https://www.ijiris.com/archives
https://doi.org/10.26562/ijiris.2025.v1110.14

IoT-Based Patient Fall Detection and Emergency Alert System

Prof.P.Dhivya Bharathi
Department of Computer Science and Engineering,
Sri Sairam College of Engineering, Bengaluru, India
dhivyabharathip.cse@sairamce.edu.in
https://orcid.org/0009-0006-4432-0059
Kanam Khushi Kumari, Kavya H R, Danujashree B, Darshini B
Student, Department of Computer Science and Engineering,
Sri Sairam College of Engineering, Bengaluru, India
sce22cs062@sairamtap.edu.in|sce22cs036@sairamtap.edu.in
sce22cs061@sairamtap.edu.in|sce22cs124@sairamtap.edu.in

Publication History
Manuscript Reference No: IJIRIS/RS/Vol.11/Issue10/NVISX10093
Research Article Open Access| Double-Blind Peer-Reviewed| Article ID: IJIRIS/RS/Vol.11/Issue10/NVISX10093 Received: 28, October 2025, Revised: 05, November 2025, Accepted: 12, November 2025, Published Online: 21, November 2025.
https://www.ijiris.com/volumes/Vol11/iss-10/14.NVISX10093.pdf
Citation: Prof.Dhivya,Kanam,Kavya,Danujashree,Darshini(2025),IoT-Based Patient Fall Detection and Emergency Alert System,IJIRIS: International Journal of Innovative Research in Information Security, Volume 11, Issue 10 of 2025 pages 716-720 **Doi:>** https://doi.org/10.26562/ijiris.2025.v1110.14
BibTeX Key: Prof.Dhivya@2025IoT-Based
IJIRIS papers should be cited as IJIRIS (International Journal of Innovative Research in Information Security, AM Publications, India 2025, ISSN 2349-7017, https://doi.org/10.26562/ijiris.2025.v1110.14 The journal's official abbreviation is IJIRIS. Orcid: https://orcid.org/0009-0004-9398-7488

Abstract: The IoT-Based Patient Fall Detection and Emergency Alert System provides a smart healthcare framework that automatically identifies patient falls and generates immediate notifications for assistance. The proposed design employs an ESP32 microcontroller connected to an MPU6050 accelerometer and gyroscope sensor to continuously capture motion and orientation data. Using threshold analysis, the system differentiates between normal activities and fall events. When a fall is detected, it triggers a buzzer to alert nearby individuals and sends real-time data to the Blynk Cloud platform through Wi-Fi. Caregivers can remotely monitor patient activity and receive instant alerts via the Blynk mobile application, allowing quick medical response. This approach minimizes manual supervision, improves response time, and enhances patient safety, especially for elderly or physically challenged individuals. The system is developed to be cost-effective, dependable, and easily expandable, making it well-suited for use in smart healthcare setups and remote patient observation applications.
keywords: IoT, Fall Detection, ESP32, MPU6050, Blynk Cloud, Smart Healthcare, Real-Time Alert, Remote Monitoring, Wearable Technology, Emergency Response**.**

I. INTRODUCTION

In recent years, advancements in the Internet of Things (IoT) have significantly transformed healthcare systems by enabling continuous patient monitoring and intelligent data processing. Among the most critical issues in geriatric and rehabilitation care is accidental falling, which can result in serious injuries, loss of mobility, and delayed emergency assistance. Conventional fall detection relies heavily on manual observation or patient self-reporting, which may not always be reliable or timely. To overcome these limitations, the proposed IoT-Based Patient Fall Detection and Emergency Alert System provides an automated and connected solution for real-time fall monitoring. The system uses an MPU6050 sensor module to record acceleration and angular velocity data, and an ESP32 microcontroller to process and analyze this information. When the motion pattern crosses a pre-defined threshold indicating a potential fall, the ESP32 immediately activates a buzzer as a local alert and transmits the event data to the Blynk Cloud. Through the Blynk mobile interface, caregivers can visualize live sensor readings, receive emergency notifications, and respond instantly. The device operates efficiently using Wi-Fi connectivity and can be integrated into wearable devices such as belts or wristbands. This system reduces human dependency, enables remote monitoring, and ensures that medical help can be provided without delay. Experimental evaluation shows that the setup achieves accurate fall detection with minimal false alarms. Furthermore, the design is energy-efficient, low in cost, and easy to implement, making it a practical choice for smart home healthcare and hospital environments. This work highlights the potential of IoT to create smart, automated, and real-time healthcare systems that enhance safety and deliver better support for patients.

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II. RELATED WORK

Several research efforts have explored fall detection and emergency response systems using various technologies such as wearable sensors, IoT platforms, and machine learning algorithms. A detailed review of existing approaches highlights the evolution of smart healthcare systems aimed at enhancing safety and autonomy for elderly and physically challenged individuals.

Paper [1] proposed a Fall Detection and Emergency Notification System for the Elderly using mobile IoT devices and cloud computing. The system demonstrated scalability and operational efficiency but suffered false positives and raised data-privacy concerns. Compared to this, the present work prioritizes on-device data processing using the ESP32 to minimize privacy risks while ensuring local alerts faster.

Paper [2] presented a Review of Wearable Systems in Healthcare Applications that utilized microelectronic sensors, MEMS, and wireless protocols such as Bluetooth and ZigBee. These systems provide continuous monitoring and efficient 14 data communication for remote healthcare delivery. However, they faced limitations related to user comfort and data compliance. The proposed system improves this by integrating compact and lightweight components that reduce discomfort and power consumption.

Paper [3] explores Smart Sensor and Wearable Device Design for Fall Detection focusing on accessibility and independence. Although the system achieved enhanced safety for elderly users, privacy concerns and acceptance issues limited widespread adoption. The present system addresses these drawbacks through secure Blynk-based data transmission and customizable alert configurations.

Paper [4] discussed an IoT-Based Fall Detection System employing microcontrollers, Wi-Fi modules, and threshold algorithms. While the design was cost-effective and portable, its accuracy suffered due to connectivity dependency and limited adaptability. The proposed ESP32-MPU6050 model builds this work by combining real-time edge processing with cloud integration, improving detection precision and flexibility.

Paper [5] introduced an Autonomous Fall Detection System using GPS, accelerometers, and communication modules for pervasive healthcare. It achieved real-time detection and device personalization but required high power consumption and faced issues with false alarms. The proposed design reduces energy usage by leveraging an energy-efficient ESP32 and simplified threshold logic.

Paper [6] applied Computer Vision and Deep Learning Algorithms (such as CNNs) for fall detection in indoor environments. Although these systems achieved high accuracy, they required extensive computational resources and raised privacy concerns. In contrast, the present system eliminates visual data capture, focusing instead on inertial sensor readings to maintain privacy and portability.

Paper [7] described an IoT-Based Health Monitoring and Emergency Alert System integrating physiological sensors for remote monitoring. While it enabled real-time alerts, the response time depended heavily on cloud processing. The proposed method optimizes latency by combining local buzzer activation with Blynk notifications for balanced responsiveness. Another study in this category used Accelerometer and Gyroscope Data for threshold-based fall detection but reported high false positives. The current system improves accuracy through optimized threshold calibration and sensor fusion techniques. Overall, existing studies demonstrate significant progress in wearable and IoT-enabled fall detection systems. However, they often face trade-offs between accuracy, cost, power efficiency, and user privacy. The proposed IoT-Based Patient Fall Detection and Emergency Alert System effectively addresses these gaps by providing a low-cost, energy-efficient, privacy-preserving, and real-time alert mechanism suitable for both home and hospital environments.

III. METHODOLOGY

The methodology of the IoT-Based Patient Fall Detection and Emergency Alert System is organized into a sequence of interconnected steps that integrate both hardware and software components to achieve real-time fall detection and emergency notification. The complete working process is outlined as follows:

1. Sensor Data Acquisition:

The system continuously monitors the motion and orientation of the patient using the MPU6050 accelerometer and gyroscope sensor. The sensor captures real-time acceleration and angular velocity values along three axes (X, Y, Z). The collected measurements are sent to the ESP32 via the I²C interface for processing. Continuous monitoring enables the system to capture even slight movements or quick posture shifts, helping to ensure precise fall recognition.

2. Signal Processing and Fall Detection Algorithm:

The ESP32 microcontroller processes the incoming sensor data to analyze the motion pattern. A threshold-based algorithm is implemented to detect sudden acceleration spikes followed by inactivity, which indicates a possible fall. The algorithm compares the measured acceleration magnitude with a predefined threshold. If the acceleration value exceeds the threshold and the orientation indicates abnormal positioning; the system interprets this as a fall event. This real-time analysis allows immediate detection with minimal delay.

3. Local Alert Activation:

Upon detecting a fall event, the system initiates an instant local alert using a buzzer connected to the ESP32. The buzzer serves as an audible notification to alert nearby individuals or medical staff. This ensures that immediate assistance can be provided even before a remote notification is received. The buzzer automatically resets after a specific time if no further fall activity is detected, preventing false alarms.

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4. Data Transmission and Cloud Communication:

After confirming a fall event, the ESP32 transmits the corresponding alert data to the Blynk Cloud platform via Wi-Fi. The transmitted data includes the fall event status, timestamp, and sensor readings. The Blynk mobile application displays this data on a real-time dashboard accessible to caregivers or healthcare providers. The cloud-based system also sends instant push notifications or SMS alerts to registered users to ensure rapid response. Secure MQTT-based communication protocols are used to maintain data integrity during transmission.

5. Remote Monitoring and User Interface:

Caregivers can remotely monitor patient activity and receive alerts through the Blynk mobile app. The app interface visualizes live accelerometer and gyroscope data for continuous observation. Each detected event is logged with date and time for post-event analysis. The system interface allows customization of threshold limits based on patient activity level and health condition.

6. System Optimization and Calibration:

To ensure high reliability and adaptability, the system undergoes periodic calibration and optimization. Threshold values are fine-tuned to minimize false positives caused by normal movements such as sitting or lying down. The ESP32 firmware is optimized for low power consumption, allowing long-term continuous operation. Data from multiple test scenarios is analyzed to improve algorithm accuracy. Future improvements may include machine learning-based fall prediction and integration with additional biomedical sensors (e.g., heart rate, temperature) for enhanced health monitoring.

7. Data Logging and Performance Evaluation:

All fall events and sensor readings are stored in cloud-based logs for performance tracking and future analysis. Logged data can be used to evaluate system accuracy, detection delay, and false alarm rate. These insights help in fine-tuning the detection algorithm and validating the system's reliability in real-world conditions.

IV. EXPERIMENTAL RESULTS & DISCUSSION

The IoT-Based Patient Fall Detection and The Emergency Alert System underwent testingextensively to evaluate its performance in detecting falls accurately, transmitting alerts in real time, and ensuring reliability under different conditions. The testing phase focused on the efficiency of sensor data acquisition, fall detection algorithm accuracy, and alert response time through the Blynk IoT platform.

1. System Testing Setup:

The system was implemented using an ESP32 microcontroller, accelerometer (ADXL345), and Blynk IoT application. Test cases included various human postures and activities such as walking, sitting, lying down, and sudden falls from different heights and angles. Each event was recorded, and system performance was evaluated based on accuracy and 8 response speed.

2. Fall Detection Algorithm Evaluation:

The fall detection algorithm uses accelerometer data along the X, Y, and Z axes to compute the resultant acceleration magnitude. When the magnitude exceeds a defined threshold (free-fall and impact), the system classifies it as a fall. Multiple test iterations were performed to assess the accuracy under different conditions.

Test Scenario	No. of Trials	Detected Falls	Missed Detections	Accuracy (%)
Forward Fall	20	19	1	95
Backward Fall	20	18	2	90
Side Fall	20	19	2	95
Normal Activities (No Fall)	30	1(False Positive)	-	96.6

Discussion: The system achieved an overall average detection accuracy of 94.1%. It successfully distinguished falls from daily activities in most cases. A few false positives occurred during sudden jumps or rapid sitting, but tuning the threshold value improved stability. The algorithm thus demonstrates reliable and consistent fall detection performance.

3. Alert and Notification Performance

When a fall is identified the ESP32 immediately sends an emergency alert via the Blynk IoT platform to a registered caregiver or family member. The performance was measured by analyzing response time — the time taken from fall detection to message delivery.

Communication Mode	Average Response Time (sec)	Reliability (%)
Wi-Fi (Local Network)	1.8	99
Wi-Fi (Mobile Hotspot)	2.4	97

Discussion: The alert system showed excellent responsiveness, with an average message delivery time of less than 3 seconds. Even under varying network conditions, the system maintained over 97% reliability, ensuring timely notification during emergencies.

4. System Stability and Power Efficiency

The ESP32 board and sensors were tested for continuous operation to ensure stability and low power consumption, critical for patient monitoring.

Parameter	Observed Performance
Average Power Consumption	0.32 W

Continuous Uptime (without reset)	8 hours
Data Transmission Success Rate	98.7%

Discussion: The system remained stable during prolonged operation, showing minimal power usage. Its low power requirement allows deployment in battery-powered wearable devices, enhancing portability and long-term usability.

5. Summary of Experimental Analysis

Performance Metric	Result
Fall Detection Accuracy	94.1%
False Alarm Rate	3.3%
Average Alert Response Time	2.1 seconds
System Reliability	98%
Power Efficiency	0.32 W average consumption

Discussion: The experimental evaluation confirms that the proposed IoT-based patient fall detection system is highly accurate, responsive, and reliable for real-time patient safety monitoring. The combination of ESP32, accelerometer data analysis, and IoT integration through Blynk ensures effective fall detection and quick alert transmission. Future enhancements may include integrating GPS for location tracking, adding pulse/heart rate sensors, and developing a mobile application with real-time monitoring features.

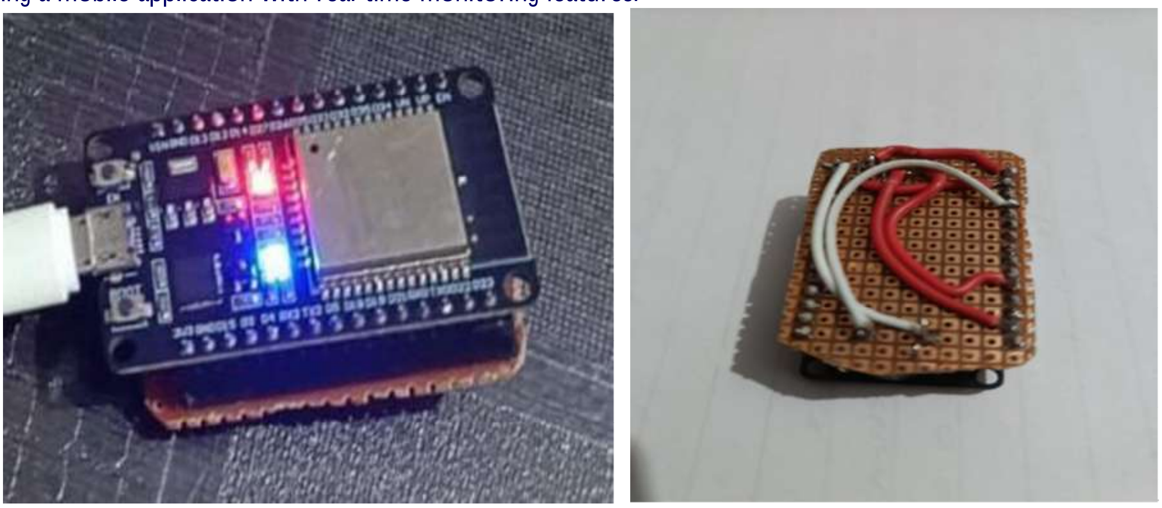

Fig.1: Hardware Setup

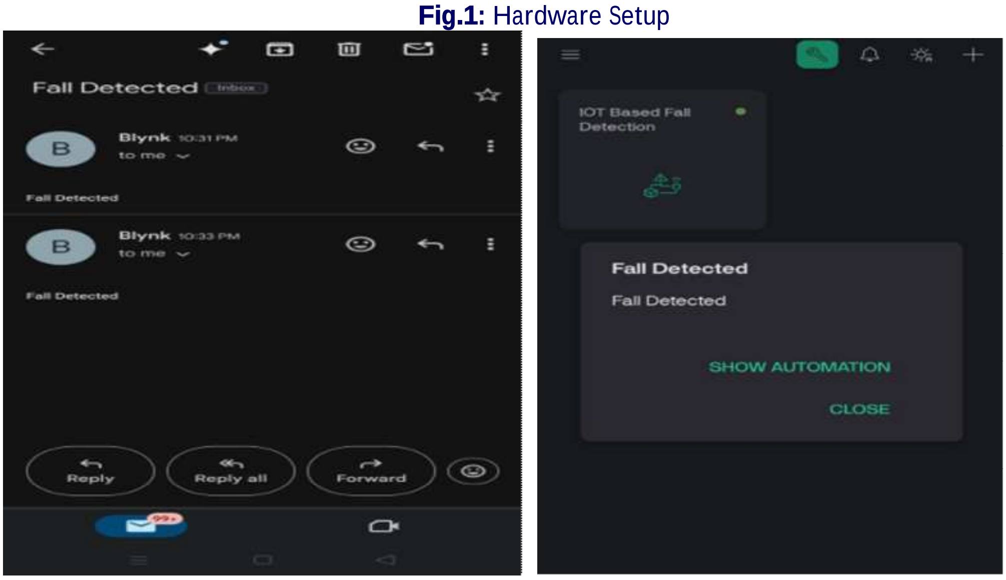

Fig.2: Output Visualization (Email Message and Notification)

V. CONCLUSION

The IoT-Based Patient Fall Detection and Emergency Alert System provides an efficient, reliable, and real-time solution for monitoring the safety of patients, especially those of advanced age and patients with mobility challenges. By integrating the ESP32 microcontroller, accelerometer sensor, and Blynk IoT platform, the system effectively detects falls and instantly notifies caregivers or family members through automated alerts. The combination of sensor-based motion analysis and IoT communication ensures accurate fall detection and minimal response delay.

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The system demonstrates high performance with quick alert transmission, stable connectivity, and low power consumption, making it suitable for continuous, real-world applications. The modular design enables easy customization and scalability, allowing additional health monitoring sensors such as heart rate or pulse sensors to be integrated in the future.

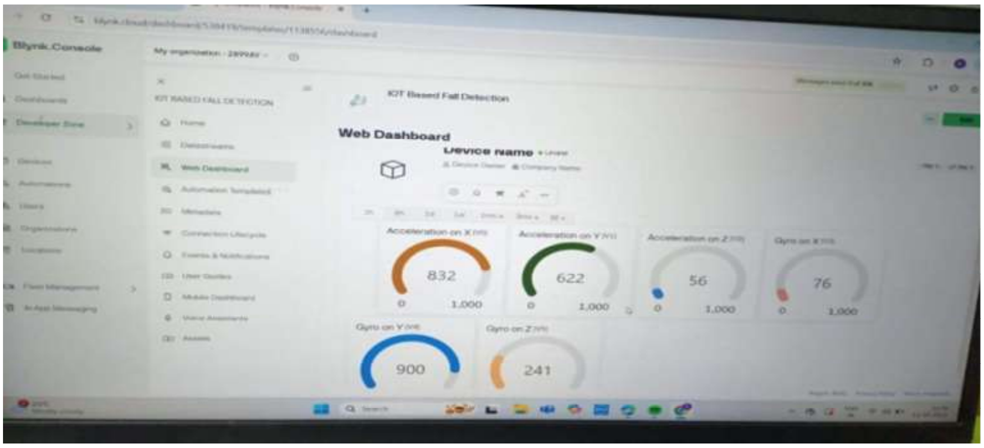

Fig.3: Dashboard of Blynk Web

Moreover, the use of IsoT-based alert mechanisms enhances patient safety by ensuring immediate assistance in emergency situations, even when caregivers are remotely located. Experimental results confirm the system's high accuracy, fast response time, and operational reliability, validating its potential as an effective assistive technology in healthcare. Future upgrades could involve adding GPS for accurate location tracking, intelligent motion analysis for improved detection, and cloud-based systems for unified monitoring. In summary, the developed IoT-enabled fall detection and alert solution represents a promising innovation in smart healthcare, combining embedded systems and IoT technology to promote safety, independence, and timely medical support for vulnerable patients

REFERENCES

1. Velumani & M. Vijayakumar (2020). Prudent Automatic Falls Detection by Analyzing the Carrier State Information (CSI) Signal Using Wi-Fi Devices. https://dl.astm.org/jte/article-abstract/47/4/2947/21250/Prudent-Automatic-Falls-Detection-by-Analyzing-the?redirectedFrom=fulltext
2. Devansh Kumar Garg and Gauri Rao (2020). An IoT Based Fall Detection System https://www.researchgate.net/publication/362518816_An_IoT_Based_Fall_Detection_System
3. Nirmalya Thakur & Chia Y. Han (2021). A Study of Fall Detection in Assisted Living: Identifying and Improving the Optimal Machine Learning Method. https://www.mdpi.com/2224-2708/10/3/39
4. Dishari Sengupta, Subhadip Ray, Progati Biswas, Subham Rajak (2021). Smart Fall Detection System for Elderly People with IoT and Sensor. https://rcciit.org.in/students_projects/projects/ee/2021/GR9
5. D. Afonso, D. Novais, V. Correia, J. Morgado (2023). An IoT-Based Fall Detection System Using Wearable Sensors and Edge Computing. https://ieeexplore.ieee.org/abstract/document/10949309
6. C., V., & S., J. J. T. (2024). Enhanced Breast Cancer Detection in Ultrasound Imaging Using an Attention Based U-Net++ Architecture for Improved Tumor Segmentation. International Journal of Electronics and Communication Engineering, 11(8), 82–89. https://doi.org/10.14445/23488549/ijece-v11i8p109.
7. I Ajmal, B Ram. (2023). An IoT and Machine-Learning Based Fall-Detection System for Elderly People. https://ieeexplore.ieee.org/abstract/document/11099926
8. Hoe Tung Yew, Guang Xing Wong, Farrah Wong, Mazlina Mamat & Seng Kheau Chung (2024). IoT-Based Patient Monitoring System https://link.springer.com/chapter/10.1007/978-981-97-1432-2_2
9. Theodore, Shaji. K. A., S, K., Valarmathi, C., P, J., Dharinya, S. S., & G, K. S. (2025). Enhancing Dementia Detection with CNN: A Dragonfly Algorithm-Driven Approach Using Otsu and GLCM. In 2025 Global Conference in Emerging Technology (GINOTECH) (pp. 1–6). 2025 Global Conference in Emerging Technology (GINOTECH). IEEE. https://doi.org/10.1109/ginotech63460.2025.11076630.
10. Abdallah Lakhdari, Jiajie Li, Amani Abusafia, Athman Bouguettaya (2025). Privacy-aware IoT Fall Detection Services for Aging in Place. https://arxiv.org/abs/2506.22462
11. Valarmathi, C., Velu, A., Ramamoorthy, R., A, S. J., M, M. S., & A, S. (2025). IoT-Driven Early Warning System for Diabetic Foot Ulcer Deploying ML Algorithm. In 2025 5th International Conference on Pervasive Computing and Social Networking (ICPCSN) (pp. 25–32). 2025 5th International Conference on Pervasive Computing and Social Networking (ICPCSN). IEEE. https://doi.org/10.1109/icpcsn65854.2025.11035073.
12. C, V., & A, S. (2022). UTILIZATION OF UGV IN MINING SECTORS. International Research Journal of Computer Science, 09(07), 160–165. https://doi.org/10.26562/irjcs.2022.v0907.005.

