



IoT-Enabled Motion-Sensor System for Child Fall Prevention

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Abstract: This paper presents the design and development of a smart motion sensing system aimed at preventing child falls from heights, a leading cause of injury among young children. The system integrates motion sensors, including PIR motion sensor, to continuously monitor a child's position and behaviour in high-risk areas such as windows, balconies, and stairs. By analysing real-time data, the system detects potentially dangerous movements or posture shifts that indicate fall risks. In response, it triggers immediate alerts to caregivers via mobile apps or activates automated safety measures, such as locking windows or deploying barriers. Combining sensor fusion and wireless communication, the system offers a scalable, non-intrusive solution for enhancing child safety. Prototype testing and simulations demonstrate its effectiveness as a preventive tool, highlighting its potential for both home and institutional use.

Keywords: Child fall prevention, Fall detection system, Fall risk assessment, Safety monitoring

INTRODUCTION:

One of the main reasons kids are hurt is falls, especially in places like playgrounds, daycare facilities, and houses. For both parents and caregivers, preventing these situations is crucial because they have the potential to cause major physical harm. The potential to improve kid safety through intelligent, sensor-based systems is increasing as a result of the quick development of technology, especially in the field of the Internet of Things (IoT). These systems use Internet of Things (IoT) devices with sensors to track kids' movements in real time and identify possible falls.

What is a motion sensor?

An electronic gadget called a motion sensor is made to recognize movement and alterations in the immediate surroundings. It is frequently utilized in home automation, lighting control, and security systems. The motion sensor can precisely detect motion and set off personalized reactions. Motion sensors offer smooth automation and energy efficiency for everything from turning on lights to setting off alarms.

Passive Infrared (PIR) Sensor

Infrared radiation is produced by all warm-blooded creatures. The thin pyroelectric film material used in passive infrared sensors reacts to infrared radiation by producing electricity. Every time this electrical surge occurs, this sensor will sound the burglar alarm. These sensors are cost-effective, energy-efficient, and long-lasting. Indoor alarms frequently use these sensors.



Passive Infrared Sensor

LITERATURE REVIEW:

Ramesh Rajagopalan, Irene Litvan - Fall Prediction and Prevention Systems: Recent Trends, Challenges, and Future Research Directions – MDPI Journal 2017 [1]

Recent developments in fall detection and prediction systems are reviewed in this paper, with an emphasis on their shortcomings in handling the intricate interactions between behavioral, physiological, and environmental aspects. In addition to addressing the difficulties and potential paths forward in creating more efficient systems, it highlights the promise of integrating contextual data from mobile and Internet of Things devices with physiological health data to enhance fall prediction and prevention.

Pranesh Vallabh, Reza Malekian - Fall detection monitoring systems: a comprehensive review – Springer Journal 2017 [2]

The risk of falls, which can cause serious injuries, makes the aging population—especially in wealthy nations—a major healthcare burden. In order to increase accuracy and support a range of user activities, this study examines several fall detection systems, such as wearable, ambient, and camera-based sensors. It highlights the significance of customized models and cutting-edge algorithms, such as machine learning. Fall detection monitoring systems, or FDMS, are essential for improving safety, especially for the elderly and others who are more susceptible.

Manohar N, Sharanappa V. Halse - IoT Enabled Fall Detection System: Enhancing Safety for Cerebral Palsy Children – International Journal for Research in Engineering Application & Management (IJREAM) 2023 [3]

A multidisciplinary strategy comprising sensors, algorithms, and hardware is needed to implement a fall detecting system. Sensor selection refers to choose appropriate sensors like accelerometers, gyroscope and Integrating hardware and software. Final stage is to fabricate and encapsulate the components in a sophisticated plastic structure followed by testing and validation.

Prof. Arti Bhise, Purva Jadhav - Fall detection system using deep learning – International Journal of Creative Research Thoughts (IJCRT) 2024 [4]

Our fall detection system comprises four core modules. Firstly, preprocessing involves filtering data to enhance accuracy. Segmentation utilizes advanced YOLO algorithms to dissect data into relevant segments. Feature extraction then employs thresholding [9] to isolate crucial fall indicators. Lastly, approximate reasoning and classification analyze features to determine fall occurrence, including area, position, and stage, ensuring a streamlined, cost-efficient, and time-saving detection process.

Annalakshmi D, Karuppusamy M - Survey on AI-Enabled Smart Safety Wearable For Child Protection – IJSART 2025 [5]

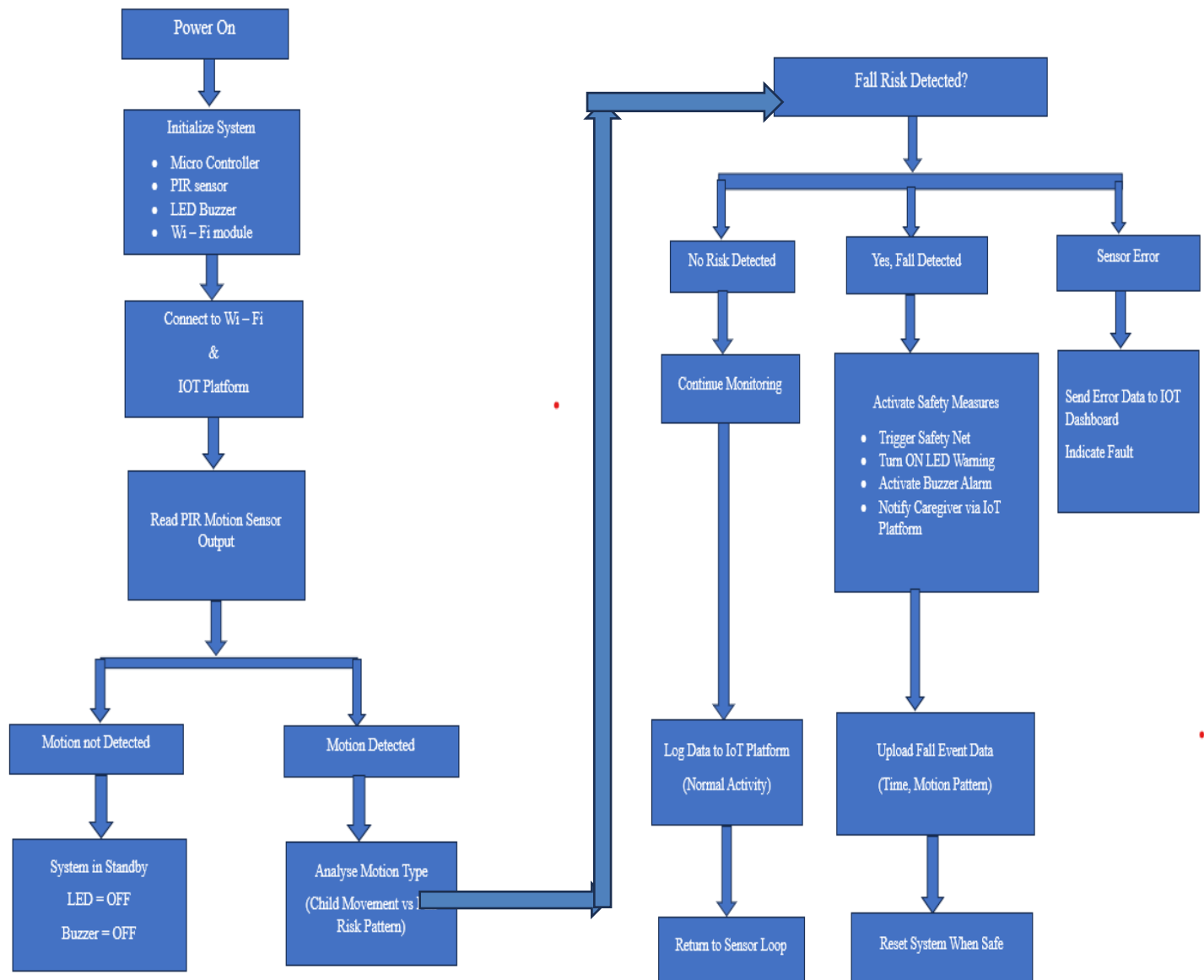
IoT-based child safety devices offer a promising solution for enhancing security and protection in diverse environments by integrating advanced sensors, real-time communication modules, and AI-driven analytics. These devices provide effective preventive measures and responsive solutions. Future advancements should focus on improving data security, user comfort, and expanding integration capabilities for smarter, safer communities.

S. Priyadharshini M. Nisha, A. Peer Mohamed - Smart fall prevention and detection for the patients using IOT
– International Journal of Research and Analytical Reviews 2025 [6]

This project presents an IoT-based system designed to address the critical issue of fall prevention and real-time health monitoring. By leveraging advanced motion sensors, the system is capable of accurately detecting fall symptoms and providing immediate alerts. The dual-stage approach ensures that potential falls are addressed swiftly, whether through vibration warnings or automated emergency notifications.

OBJECTIVES:

- Develop a Real-Time Fall Detection System
- Minimize False Positives and Negatives
- Enhance Child Safety Monitoring
- Integrate IoT for Remote Monitoring
- Evaluate System Performance and Reliability
- Ensure Scalability and Affordability
- Explore Future Technologies for Fall Prevention

FLOW CHART

WORKING PRINCIPAL

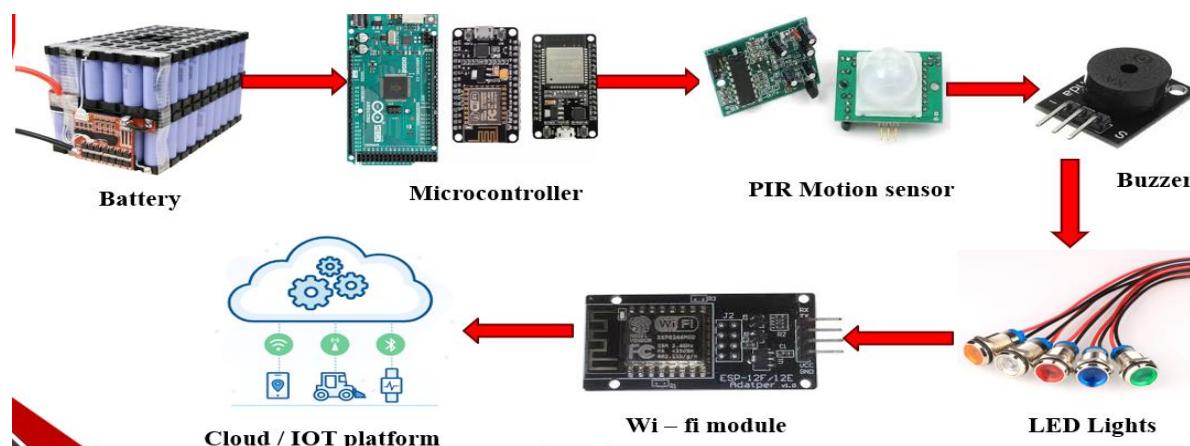
This IoT enabled fall-prevention system is designed to detect abnormal motion in children especially sudden fall motions and activate safety and alert mechanisms.

The system begins operating once power is supplied, initializing the microcontroller and all connected modules such as the PIR motion sensor, LED, buzzer, and Wi-Fi module. After connecting to the IoT platform and sending an active status, the PIR sensor continuously monitors infrared motion around the child. If no movement is detected, the system enters standby mode with the LED and buzzer off, conserving power. When motion is detected, the microcontroller analyses its speed, direction, pattern, and intensity to differentiate between normal movement and abnormal, fall-like motion. All sensor readings and system behaviour are continuously monitored for accuracy.

Based on the analysis, the system decides whether a fall risk exists. Normal movement is simply logged on the IoT platform, whereas a fall triggers immediate safety actions such as deploying a safety net, activating the LED and buzzer, sending urgent IoT alerts, and uploading event details. If irregular sensor output occurs, an error message is sent to the IoT dashboard. After any fall event, the system automatically resets or can be manually reset by a caregiver. It then returns to continuous monitoring, maintaining constant surveillance to ensure the child's safety at all times.

RESEARCH METHODOLOGY:

The research methodology for a IOT - enabled fall prevention system for child care using motion sensor involves identifying the problem of child falls, reviewing existing technologies for fall detection, and selecting appropriate sensors (e.g., PIR motion sensors). The system design integrates IoT communication protocols to transmit data to a cloud or mobile app. Machine learning algorithms or threshold-based models are developed to detect falls accurately. The system is tested in real-world environments for performance, including accuracy, power consumption, and false alarm rates. Finally, the results are analyzed, and future improvements, such as AI-based predictive models, are proposed.



ANALYSIS:

The analysis of a IOT - based fall prevention system for child care using motion sensor evaluates the system's accuracy in detecting falls, minimizing false positives and negatives. It assesses sensor performance, communication reliability, and cloud integration for real-time alerts. Power consumption is analyzed to ensure long battery life, while user experience and system scalability are considered for ease of use and wider adoption. Additionally, the impact on child safety, including response time and proactive fall prevention, is evaluated. The analysis also addresses privacy concerns and explores future integration of AI for predictive fall prevention.

CONCLUSION:

IOT-based fall prevention systems using motion sensor offer a promising solution to enhance child safety by detecting falls in real-time and alerting caregivers. These systems leverage various sensors for accurate monitoring, with the advantage of continuous, non-intrusive oversight. While challenges such as false alarms, power consumption, and sensor accuracy remain, ongoing advancements in technology and algorithms can improve system reliability and scalability. Ultimately, these systems have the potential to significantly reduce fall-related injuries and improve child care safety globally.

FUTURE SCOPE:

IOT - enabled fall prevention systems for child care using motion sensor face several limitations, including the potential for false positives and negatives in fall detection, which can reduce system reliability. Sensor accuracy may be affected by environmental factors and the child's activity. Additionally, power consumption remains a challenge, limiting battery life. Privacy concerns regarding continuous monitoring and data security also need to be addressed. Finally, the high cost of deployment and the need for a seamless user experience in diverse environments can hinder widespread adoption. The system can be enhanced to send automatic text/SMS alerts to parents or caregivers when abnormal motion or a potential fall is detected. Expansion to include voice call for immediate caregiver response with the vibration setup which is useful for blind people.

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