INTECHBIZ2025
International Conference on Industrial Technology and Business

System Design and Database Design for Fall Movement Monitoring in Elderly using IoT-based Web Technology

Muhamad Nasir[1], Febri Septian Ananda[2], Tengku Musri[3], Eva Kurniawaty[4], Ayu Rahmadhani[5]
[12345]*Informatics Engineering, Politeknik Negeri Bengkalis, Indonesia*
nasir@polbeng.ac.id[1], febriseprianananda@gmail.com[2], musri@polbeng.ac.id[3], evakurni125@gmail.com[4], ayurahmadhani@polbeng.ac.id[5]

Abstract

The elderly are at high risk of fall incidents that can lead to serious injuries or even death if not promptly addressed. Therefore, a system capable of detecting fall events quickly and providing information to relevant parties is necessary. This study aims to design a system and database for monitoring fall movements in the elderly using Internet of Things (IoT) technology with a web-based platform. The system is designed using an accelerometer sensor to detect significant body position changes. The microcontroller functions as the processor for the sensor data and sends information via an internet connection. The database design is intended to store detection data, event timestamps, and user identities, enabling centralized access and analysis. The research methodology includes system requirements analysis, hardware and software architecture design, as well as the design of use cases that describe the interactions between users and the system. The result of this study is a system and database design ready for implementation to support real-time fall monitoring. Physical implementation and system testing will be the next stages of this research.

Keywords : elderly, fall, IoT, accelerometer, database

1. INTRODUCTION

The aging process leads to a decline in physical abilities and body balance in the elderly, which increases the risk of fall incidents. According to the World Health Organization (WHO, 2021), falls are one of the leading causes of injury and death among the elderly population. Fall incidents that are not immediately detected can result in fatal consequences, especially for elderly individuals living alone. Therefore, there is a need for a system capable of automatically detecting fall events and quickly providing alerts to family members or medical personnel so that prompt intervention can be made (Karar et al., 2022; Wang et al., 2020).

Several previous studies have been conducted to develop fall detection systems based on the Internet of Things (IoT). For example, a study by Pratama et al. (2022) designed a fall detection system using an accelerometer sensor and a Wi-Fi module to transmit data to a server. Meanwhile, Rini and Nugroho (2023) developed a fall alert system with notifications via SMS and an Android application. However, most of these studies have focused on hardware implementation and testing, while the systematic design of the system and database structure is often not discussed in depth. In fact, a well-designed system and database foundation are crucial for ensuring that fall detection systems can be developed, tested, and expanded in the future (Mudiyanselage et al., 2025).

This study focuses on the design phase of a system and database for monitoring fall movements in the elderly based on the Internet of Things (IoT) with web technology. The designed system involves an accelerometer sensor to detect significant body position changes, a microcontroller as the data processor, and a database to store detection data and user information centrally. The system is designed to be accessible through a web-based platform that facilitates real-time monitoring and data analysis (Gharghan et al., 2024).

The main objective of this study is to design the system architecture and database structure that can effectively and efficiently support the process of monitoring fall movements in the elderly. This study also aims to provide a conceptual design that is ready for implementation in the next stage of research, including testing the sensors and system performance in a real-world environment (Hussain et al., 2019).

2. REVIEW OF LITERATURE

Falls among the elderly are a serious health concern as they can lead to injuries, functional decline, and even death. According to the World Health Organization, approximately 28–35% of older adults experience falls each year. The frequency and impact of these incidents call for technology-based solutions capable of detecting and monitoring fall events accurately and promptly. Previous studies have commonly utilized motion sensors such as accelerometers and gyroscopes to detect fall movements. Ayu et al. (2021) designed a fall detection system using the MPU6050 accelerometer sensor, which records changes in body acceleration as an indicator of a fall event. Their study showed that acceleration data can serve as a primary signal in identifying abnormal movement patterns in elderly individuals. To improve accuracy, Fauzan and Wibowo (2022) incorporated a gyroscope sensor to capture the orientation and direction of body movement, which, when combined with accelerometer data, enabled more precise detection. These findings indicate that the combination of accelerometer and gyroscope sensors is an effective strategy for supporting fall detection systems.

Advancements in Internet of Things (IoT) technology have opened new opportunities for the development of automated and real-time health monitoring systems. IoT enables physical devices, including sensors, microcontrollers, and data processing units, to connect via the internet and exchange information efficiently. In the context of healthcare monitoring, IoT has been widely used to track vital signs, physical activities, and environmental conditions surrounding patients. Sari et al. (2022) developed a heart rate monitoring system using the ESP32 microcontroller connected to Firebase for data storage. Their study demonstrated that IoT-based systems can manage sensor data quickly and accurately, though they still require well-designed system architecture and databases to ensure optimal data flow. In the development of fall monitoring systems, IoT plays a central role in collecting data from sensors, transmitting it to servers, and integrating with web-based interfaces for visualization and remote supervision.

Beyond data collection and transmission, the management of sensor data in IoT systems is a critical factor that determines overall system effectiveness. Sensor data is typically continuous and voluminous, necessitating a database system that is efficient, secure, and scalable. Han et al. (2020) stated that relational databases remain highly relevant in IoT applications due to their ability to store structured data and support complex queries. Similarly, Rahman and Fitri (2023) demonstrated that designing databases using the Entity Relationship Diagram (ERD) model can enhance data access efficiency and security in IoT-based systems. In the context of fall monitoring for the elderly, the database must be designed to store various types of information, including user identity, event timestamps, and movement detection data. These data not only serve as records but can also be analyzed to identify patterns and support informed decision-making in healthcare management.

From the perspective of communication and notification, Telegram has emerged as a practical solution for IoT-based systems. Telegram supports a Bot API that allows software applications to send and receive messages automatically, making it an ideal medium for delivering alerts in monitoring systems. Nurhalimah et al. (2022) developed a fire alert system integrated with Telegram that was capable of sending notifications within five seconds after fire detection. Likewise, Putra and Salsabila (2023) utilized Telegram Bots in a soil moisture

monitoring system and achieved efficient real-time data delivery. Integrating Telegram into a fall detection system offers added value in terms of fast notification delivery and user accessibility, particularly for family members or healthcare personnel who need immediate alerts through mobile devices.

Based on the review of previous studies, it is evident that various fall detection systems using sensors, IoT integration, and automated notification mechanisms have been developed. However, most of these studies focus on the implementation and testing of hardware components. There remains a gap in research related to the structured design of systems, particularly in terms of system architecture and database development that effectively manage sensor data. Moreover, the integration of web technologies as user interfaces has not been explored extensively within the context of fall detection. Therefore, this study focuses on the design of a system and database for monitoring elderly fall movements using web-based IoT technology, emphasizing connectivity, data management, and system readiness to support future implementation stages.

3. METHOD

This study adopts a software engineering approach, focusing specifically on the design of a system and database intended to monitor fall movements in elderly individuals using Internet of Things (IoT)-based web technology. The methodology comprises several structured stages: system requirements analysis, system architecture design, web interface design, database design, and logical system flow simulation.

1. System Requirements Analysis

In the initial stage, the system's functional and non-functional requirements are identified. The functional requirements include the ability to receive motion data from sensors (accelerometer and gyroscope), store the data in a structured database, and display real-time alerts directly through the website interface. The non-functional requirements address accessibility via the web interface, system scalability, and data security to ensure reliable performance in future implementation stages.

2. System Architecture Design

The system architecture is designed to describe the interaction between key components, including motion sensors, a microcontroller, a Wi-Fi network, a database server, and a web interface. Sensor data is transmitted from the microcontroller to the server using HTTP protocols, stored in a relational database, and displayed in real time through the website interface. The architecture is modular, allowing for easier scalability and future integration of additional features.

3. Web Interface Design

The web-based user interface is designed to allow users—such as caregivers or medical personnel—to visually monitor motion detection data. The interface design is created using mockups that illustrate key features, including a dashboard overview, fall history records, user profile information, and sensor connection status. The web interface is planned to be developed using modern web technologies such as HTML, CSS, and JavaScript, with an emphasis on responsiveness, ease of use, and real-time data visualization.

4. Database Design
To ensure effective data management, the database is designed by defining the required tables, which are then translated into a relational schema. The main entities include the User table and the Sensor Data table. The relationships between these entities are structured to support data integrity, efficient querying, and future scalability. This design enables the system to store time-stamped motion events, sensor metadata, and user information in a secure and organized manner.

5. Logical System Flow Simulation
Although this study does not include physical implementation, the system design is logically modeled using flowcharts and use case diagrams. These visual representations illustrate the operational flow of the system—starting from data acquisition by sensors, transmission to the server, storage in the database, and real-time alert delivery through the website. This simulation ensures that all system processes are clearly defined and well-prepared for future development.

This methodology results in a complete system blueprint, including architecture design, web interface wireframes, and database schema, which can be used as a foundation for further development and physical implementation of an IoT-based fall detection monitoring system for the elderly.

4. RESULT & DISCUSSION

4.1 System Design

The overall design of the device is presented in the form of a diagram accompanied by a detailed explanation. The general appearance of the device can be seen in Figure 1 below.

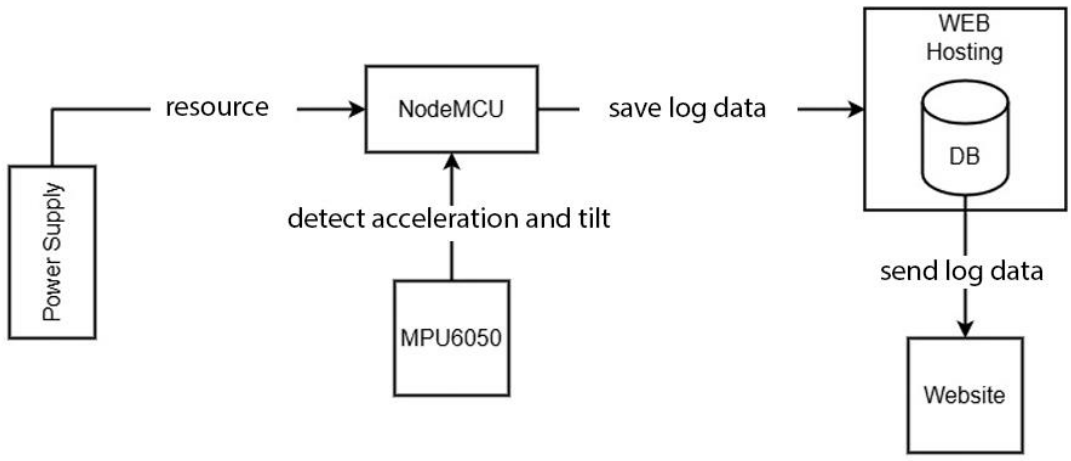


Fig. 1. System Design

The image illustrates the working process of this prototype fall monitoring system for the elderly. When the device is turned on, the accelerometer and gyroscope sensors detect changes in acceleration and angle. The MPU6050 sensor (accelerometer and gyroscope) captures the data. These values are then processed in the NodeMCU by calculating calibration. The results are then saved to a database and displayed on a monitoring website.

4.2 Use Case Diagram

The following is an illustration of the use case diagram that was designed. This is shown in Figure 2 below.

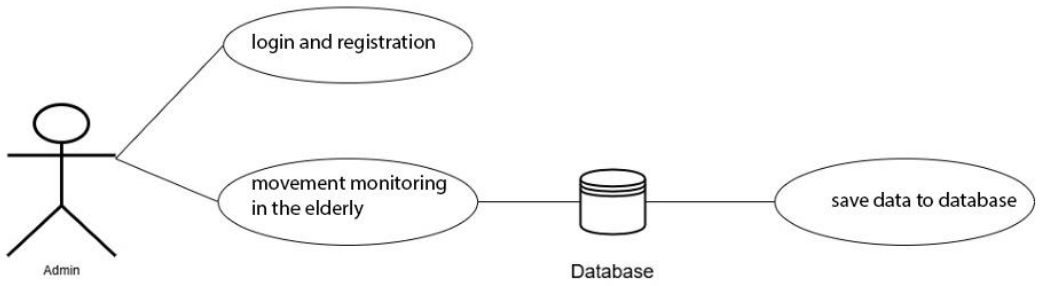


Fig. 2. Use Cae Diagram

Here is the explanation of each element in the use case diagram:

1. **Use Case Name** : Login and Registration
   Actor : Admin
   Description : The Admin can perform login and registration on the elderly fall movement monitoring website.
2. **Use Case Name** : Elderly Movement Monitoring
   Actor : Admin and Database
   Description : The Admin can monitor the movements performed by the elderly, which are obtained from sensor data.

4.3 Hardware Design

The hardware design for this prototype fall monitoring system for the elderly can be seen in Figure 3 below. The design illustrates the connection and interaction between key hardware components, including motion sensors (accelerometer and gyroscope), a microcontroller, power supply, and communication modules. Each component plays an essential role in detecting movement, processing sensor data, and transmitting information to the web server. This hardware configuration serves as the foundation for the system's functionality, ensuring accurate data collection and reliable communication between the device and the web-based monitoring platform.

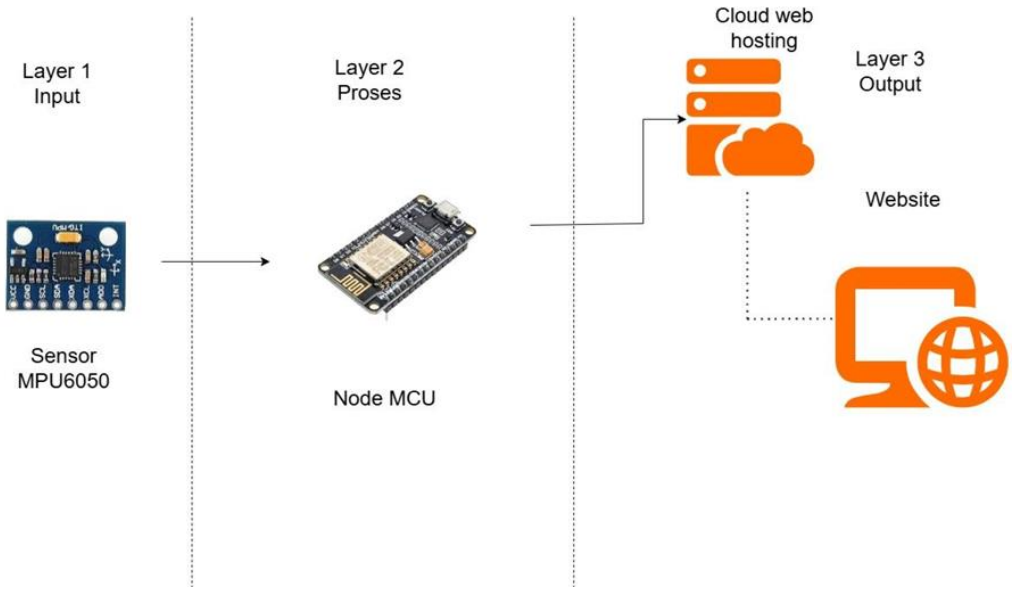


Fig. 3. Hardware Design

4.4 Database Design

The database design is used to store data from the MPU6050 sensor readings, namely total acceleration and total slope change log data. The database to be designed is as follows:

Table 1. Table User

Column	Data Type	Description
User_id	Int (Primary Key, Auto Increment)	User ID
Username	Varchar (50)	User Name
Password	Varchar (10)	Password

Table 2. Table Sensor Data

Column	Data Type	Description
Data_id	Int (25)	Data ID
Sensor_id	Int (20)	Sensor ID
Elder_id	Int (20)	Elder ID
Accel_x	Float (20)	Acceleration value on the X axis
Accel_y	Float (20)	Acceleration value on the Y axis
Accel_z	Float (20)	Acceleration value on the Z axis
Gyro_x	Float (20)	Rotation value on the X axis
Gyro_y	Float (20)	Rotation value on the Y axis
Gyro_z	Float (20)	Rotation value on the Z axis
Timestamp	Timestamp	Time the data was recorded

4.5 Website Application User Interface

The user interface is the visual aspect of a website, determining how a user interacts with the application and how information is displayed on the screen. The purpose of the user interface

is to improve usability and, ultimately, the user experience. An example of a user interface design can be seen in the image below:

a. Login Page

The login page is intended for users. Users enter their username and password. The login page can be seen in the following image.

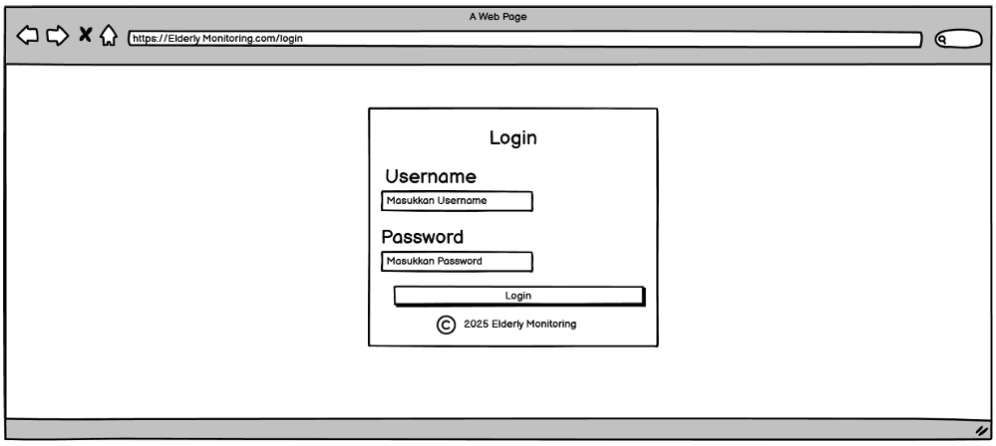


Fig. 4. Login Page

b. Dashboard Page

After logging in, the dashboard page appears on the website. The dashboard page can be seen in the following image.

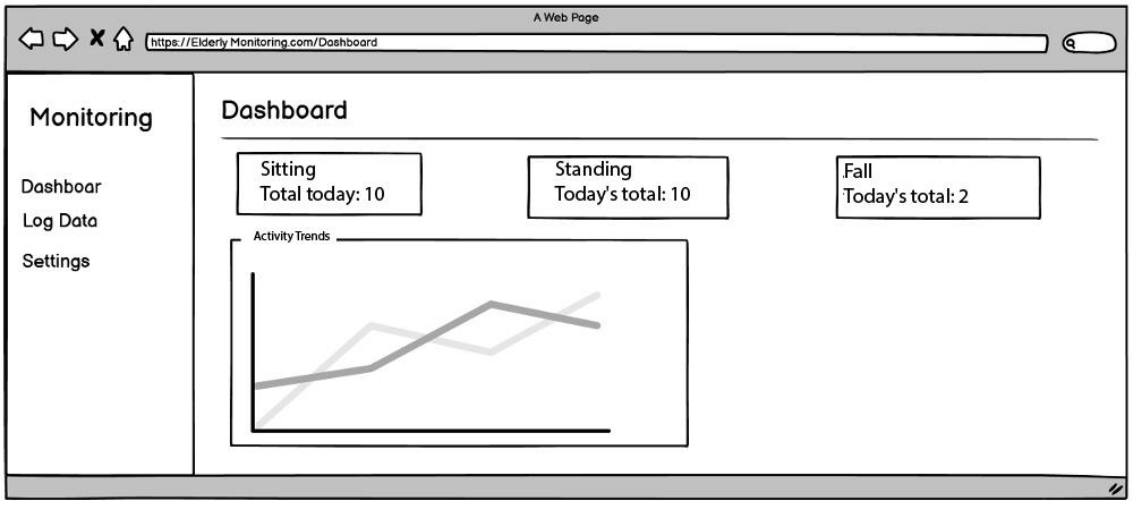


Fig. 5. Dashboard Page

5. CONCLUSION

From the design process carried out, an integrated system architecture was developed that connects sensors, a microcontroller, a database server, and a web-based interface. The system is designed to receive motion data from the sensors, store it in a structured manner, and display the information visually through a web dashboard.

Although this study does not yet include the stages of physical implementation or system testing, the resulting design provides a comprehensive blueprint that can serve as a foundation for further development. With this well-prepared design, the research is expected to contribute to the development of an IoT-based elderly fall monitoring system that is effective, secure, and user-friendly—supporting caregivers and medical personnel in enhancing the safety and quality of life of elderly individuals.

6. REFERENCES

World Health Organization. (2021). Falls.

Karar, M. E., Al-Dahoul, N., Almaadeed, N., & Al-Maadeed, S. (2022). Elderly fall detection and alert system using machine learning and wearable sensors. Sensors, 22(5), 1915.

Wang, J., Zhang, Z., Li, B., Lee, S., & Sherratt, R. S. (2020). An enhanced fall detection system for elderly person monitoring using consumer home networks. IEEE Transactions on Consumer Electronics, 66(1), 67–76.

Pratama, M. A., Suryanegara, M., & Gunawan, A. (2022). Design of IoT-based fall detection system using accelerometer and Wi-Fi communication. Indonesian Journal of Electronics and Instrumentation Systems, 12(3), 145–153.

Rini, D. A., & Nugroho, Y. S. (2023). Development of fall alert system for elderly using SMS and Android application. International Journal of Emerging Technology and Advanced Engineering, 13(4), 67–74.

Mudiyanselage, T. D., Wickramasinghe, D. R., & Bandara, H. M. N. D. (2025). IoT-based intelligent monitoring framework for elderly fall detection and health data management. Journal of Ambient Intelligence and Humanized Computing, 16(2), 1123–1135.

Gharghan, S. K., Al-Naji, A., & Chahl, J. (2024). IoT-based wearable fall detection and monitoring system for elderly people using web technology and cloud integration. IEEE Access, 12, 55832–55845.

Hussain, F., Hussain, R., Hassan, S. A., & Hossain, E. (2019). Machine learning in IoT security: Current solutions and future challenges. IEEE Communications Surveys & Tutorials, 22(3), 1686–1721.

Ayu, D. R., Prasetyo, A. B., & Kurniawan, D. (2021). Design of fall detection system for elderly using MPU6050 accelerometer sensor and ESP8266 module. Journal of Physics: Conference Series, 1899(1), 012034.

Fauzan, M. A., & Wibowo, H. (2022). Development of IoT-based fall detection system using accelerometer and gyroscope sensors. International Journal of Intelligent Engineering and Systems, 15(6), 245–254.

Sari, D. P., Ramadhan, A., & Wibisono, M. (2022). IoT-based heart rate monitoring system using ESP32 and Firebase database. International Journal of Advanced Computer Science and Applications, 13(9), 421–427.

Han, Q., Meng, X., & Chen, J. (2020). Database technologies for Internet of Things: A survey. IEEE Access, 8, 201451–201466.

Rahman, F., & Fitri, A. N. (2023). Design and implementation of IoT database using Entity Relationship Diagram (ERD) model for data efficiency and security. Journal of Information Systems and Informatics, 5(1), 56–65.

Nurhalimah, S., Ardiansyah, D., & Fathurrahman, R. (2022). Design of IoT-based fire alert system using NodeMCU and Telegram notification. Journal of Robotics and Control (JRC), 3(4), 523–530.

Putra, M. R., & Salsabila, N. (2023). Implementation of Telegram Bot for IoT-based soil moisture monitoring system. International Journal of Computer Applications Technology and Research, 12(5), 187–193.