NATIONAL ENGITECH DIGEST

VOL. 1 ISSUE 1

e-ISSN: 3030-5969

Fall Detector Device for Improved Safety and Independence

Tunku Khairiyah Tunku Norizan, Nor Naematul Saadah Ismail,
Muhammad Azfar Muiz Ahmad Mahdzir
ICT Department, Polytechnic Tuanku Syed Sirajuddin, Pauh Putra,
02600 Arau, Perlis.
khairiyah@ptss.edu.my, naematul@hotmail.com

Abstract:

This paper provides an overview of a Fall Detector Device aimed at improving the safety of individuals with limited mobility, particularly the elderly and vulnerable populations. The device utilizes advanced sensors, including gyroscopes and a Vibration Motion Shock Sensor, to ensure accurate fall detection with minimal false alarms. Its user-friendly wrist-worn design enhances comfort and daily integration. Real-time alerts via a dedicated Android application enable timely notifications to caregivers or emergency services. While the project shows promise in potentially saving lives by addressing the critical need for prompt assistance, certain limitations, such as reliance on the Android application and considerations regarding device placement and user acceptance, need attention for optimal effectiveness. Addressing these issues will enhance the device's utility in supporting individuals with limited mobility and their caregivers, ultimately improving safety and quality of life.

This paper provides an overview of a Fall Detector Device aimed at improving the safety of individuals with limited mobility, particularly the elderly and vulnerable populations. The device utilizes advanced sensors, including gyroscopes and a Vibration Motion Shock Sensor, to ensure accurate fall detection with minimal false alarms. It's user-friendly wrist-worn design enhances comfort and daily integration.

Prototype testing of the Fall Detector Device demonstrated successful integration of hardware and software components, while effectively transmitting real-time alerts to designated contacts via the Android application. This successful integration of technology culminates in a user-friendly and reliable fall detection system that effectively addresses the need for timely assistance and enhanced safety for individuals at Kompleks Penyayang Jejawi.

Key words: *Fall detection, limited mobility, elderly, real-time alerts, user-friendly design.*

Introduction

The growing global population of older adults and those with health concerns necessitates solutions for fall prevention (United Nations, 2019). Falls pose a significant threat to this vulnerable population, leading to injuries, decreased mobility, and diminished quality of life (CDC, 2023; National Institute on Aging, 2020). Additionally, unnoticed falls can have devastating consequences, especially when caregivers are absent (Walsh et al., 2002).

Existing fall detection solutions often fall short, involving bulky wearables or requiring constant monitoring that hinders user independence (Mirelman et al., 2017; Cho & Chung, 2016). Developed specifically for elderly who are staying at Kompleks Penyayang Jejawi, Perlis, the Fall Detector Device addresses these limitations by prioritizing both user comfort and reliable fall detection. The development of this device purposely to develop an accurate fall detection device, to implement real-time mechanism alert and develop a user-friendly android application.

Unlike bulky devices, the Fall Detector Device resembles a wristwatch, seamlessly integrating into users' daily lives. This unobtrusive design promotes user independence while prioritizing comfort. Sophisticated sensors and machine learning algorithms distinguish between falls and everyday activities, ensuring reliable fall detection and eliminating the need for constant monitoring.

Upon detecting a fall, the device instantly sends notifications to designated caregivers through a user-friendly mobile application. This app allows for alert configuration and secure storage of fall data, offering valuable insights for caregivers and healthcare professionals. This real-time alert system ensures timely intervention in case of a fall, potentially mitigating serious consequences and fostering peace of mind for both users and their caregivers.

By bridging the gap in existing solutions, the Fall Detector Device aims to empower individuals to maintain their independence while enhancing their safety. It prioritizes user comfort and independence through a discreet design and eliminates the need for constant monitoring. This innovative approach has the potential to significantly improve

the lives of vulnerable individuals by reducing the risk of falls and their associated consequences, promoting safety and peace of mind for both users and their caregivers.

Research Methodology

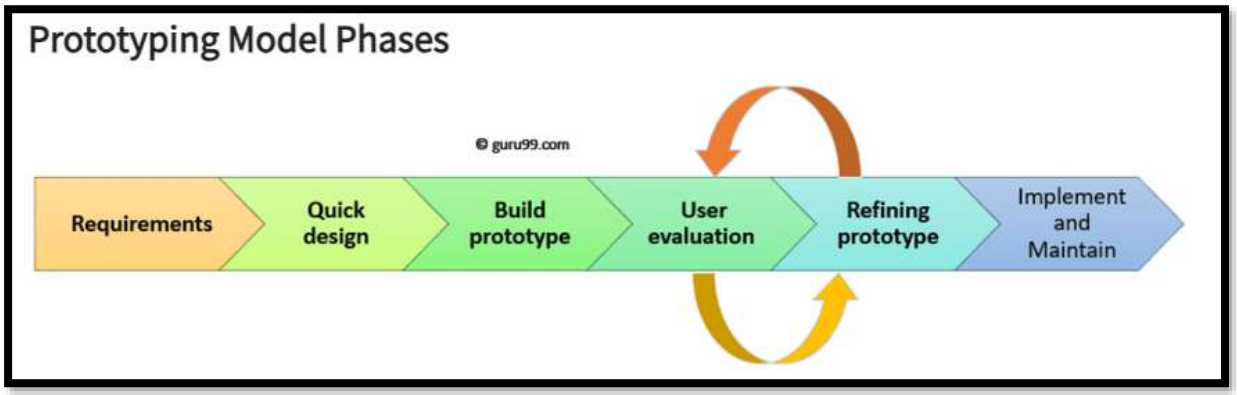
The Prototype Methodology guides the comprehensive development of the Fall Detector Device through six well-defined phases, ensuring a user-centric and goal-oriented approach. Beginning with Phase 1, the Requirements phase, the team gathers and prioritizes the needs and expectations of end-users and stakeholders through interviews and research. These defined requirements provide a solid foundation, aligning the development process with user needs and project objectives.

Advancing into Phase 2, the Quick Design phase condenses initial ideas into a concise plan, involving the creation of wireframes and outlining the basic structure of the prototype. This early design serves as a focal point for discussions, allowing for iterative feedback and alignment with user requirements, setting the stage for subsequent development phases.

Phase 3, the Build Prototype stage, marks the transition from conceptualization to practical implementation. Core features are emphasized, and coding, hardware assembly, or software configuration bring the prototype to life as a functional model. This phase bridges the gap between theoretical concepts and tangible reality, offering a hands-on representation of the intended user experience.

Following the prototype's construction, the methodology enters the User Evaluation phase, where actual end-users rigorously test and evaluate the functional prototype. Their feedback is collected, analyzed, and used to iteratively improve the design in Phase 5, the Refining Prototype phase. This iterative process ensures the elimination of flaws and the optimization of features, steering the prototype toward its final, user-friendly form.

The final two phases, Refining Prototype and Implement, form a seamless transition. The insights gained from iterative testing are applied to construct a production-ready version in the Implement phase. This involves full-scale development, coding, integration, and finalization of the user interface. The result is a robust and deployable Fall Detector Device that not only meets user needs but also aligns closely with the outlined project objectives, ensuring a coherent and effective final product.



Analysis and Discussion

The Fall Detector Device boasts advanced features designed to ensure precise fall detection, primarily utilizing the MPU6050 sensor to distinguish between falls and routine activities. Tailored for the comfort and integration into the daily lives of the elderly and individuals with health concerns, the device triggers alerts, activating a buzzer and notifying selected contacts through a dedicated Android app. Its comprehensive algorithm minimizes false alarms, providing reliable fall identification and significantly enhancing user safety. This integration of cutting-edge technology directly addresses the pressing need for timely fall detection and assistance, creating a safer environment for vulnerable individuals at Kompleks Penyayang Jejawi.

The non-functional requirements of the system are pivotal to its effectiveness, with the dedicated Android app playing a central role in notifying predetermined contacts promptly in the event of a fall. This seamless communication through a dedicated notification system ensures timely alerts for caregivers, emergency services, and family members. By emphasizing these non-functional aspects, the project aims to create a responsive and user-friendly fall detection solution that meets the diverse needs of its users.

The hardware and software requirements form a foundational aspect of the Fall Detector Device. The hardware components, including the ESP8266-based development board and the buzzer, contribute to the device's compact and efficient design. On the software side, the integration of Android for the mobile application and Arduino for coding ensures the proper functioning of the sensor and notification systems. This harmonious combination of

hardware and software components ensures that the Fall Detector Device meets its specified requirements, contributing to its overall efficiency and reliability.

The meticulous system configuration includes essential components such as the WEMOS D1 MINI, MPU6050 sensor, and Buzzer, creating a robust and user-friendly fall detection system. The adoption of Android Studio with Java and Firebase for backend operations ensures secure storage of fall-related data. This configuration not only addresses the critical need for timely fall detection and assistance but also provides a scalable and efficient solution for individuals at Kompleks Penyayang Jejawi. The careful integration of these elements ensures that the system functions seamlessly, meeting both user requirements and broader project objectives.

Conclusion and Recommendation

The Fall Detector Device project offers several notable advantages, primarily centered around its accurate fall detection capabilities, user-friendly design, real-time alerting mechanisms, and potential to save lives. By incorporating advanced sensors such as gyroscopes and a Vibration Motion Shock Sensor, the device ensures precise fall identification, reducing the occurrence of false alarms and effectively distinguishing between falls and regular activities. Additionally, the device's wrist-worn design enhances user comfort and integration into daily life, catering to individuals with limited mobility. The implementation of real-time alerting mechanisms through a dedicated Android application further enhances its usability, providing timely notifications to caregivers or emergency services in the event of a fall. Ultimately, the project addresses the critical need for timely assistance for elderly and vulnerable individuals, offering comprehensive safety features, affordability, and potentially life-saving capabilities.

While the Fall Detector Device presents significant advantages, it's essential to acknowledge certain limitations. These include reliance on the Android application, which may pose challenges for users unfamiliar with smartphones, as well as the requirement for a stable internet connection for optimal functionality. Issues such as the audibility of the buzzer in noisy environments and the need for proper device placement to ensure accurate fall detection also need consideration. Despite of producing alert sound, another alternative mechanism such as direct connectivity to emergency services or designated caregivers can be considered prior to certain type of vulnerabilities. User acceptance and compliance, along with potential resistance to wearing the device regularly, could impact its effectiveness. Thus, additional research focusing on understanding needs and preferences as well as the potential barriers should be done further. Addressing concerns related to battery life and privacy issues associated with data storage are also crucial for refining and improving the device's performance. Therefore, low low-energy fall detection algorithms and investigate alternative power sources to extend the device's operating time should be explored more for the future works.

The development of the Fall Detector Device represents a significant advancement in enhancing the safety and well-being of individuals with limited mobility, including those with disabilities and mobility challenges. Through the integration of various components such as the Velcro strap, NodeMCU ESP8266, Buzzer, Jumper Wire, 9V Battery, and MPU6050 Gyro Accelerometer Sensor, the project has successfully created an affordable and accessible solution for fall detection. The device not only detects falls accurately but also provides rapid alerts and real-time connectivity through a dedicated application, empowering caregivers and family members with timely assistance. By reducing the risk of serious injuries and potentially saving lives, the project aims to make a lasting positive impact on the lives of individuals with limited mobility and their caregivers, offering peace of mind and security.

To further improve the device's effectiveness, recommendations include comprehensive user training, improved app functionality for intermittent internet connections, enhanced alert audibility, addressed privacy concerns, optimized battery life, refined device placement guidelines, and ongoing collaboration with caregivers and healthcare professionals. By implementing these recommendations, the project can further refine its performance and meet the evolving needs of users and caregivers in fall prevention and assistive technology.

References

United Nations Department of Economic and Social Affairs, Population Division. (2019). World Population Prospects 2019. https://population.un.org/wpp/

Centers for Disease Control and Prevention. (2023, January 11). Older Adult Falls. https://www.cdc.gov/falls/index.html
National Institute on Aging. (2020, August 21). Falls and Fractures in Older Adults: Causes and Prevention. https://www.ncbi.nlm.nih.gov/books/NBK560761/

National Council on Aging. (2020, September 24). The State of Long-Term Care in America: 2020. https://www.ncoa.org/

Walsh, J. K., Wang, C. Y., & Hernandez, M. E. (2002). Detection of unrecognized falls with a triaxial accelerometer. Biomedical Instrumentation & Technology, 36(6), 505-512. https://pubmed.ncbi.nlm.nih.gov/19965262/

Mirelman, A., et al. (2017). Detection of falls by a wrist-worn accelerometer using a decision tree model. PLoS One, 12(3): e0174150. https://www.researchgate.net/publication/263295850_Detecting_Falls_with_Wearable_Sensors_Using_Machine_Learning_Techniques

Araújo, F., Nogueira, M. N., Silva, J., & Rego, S. (2021). A technological-based platform for risk assessment, detection, and prevention of falls among home-dwelling older adults: protocol for a Quasi-Experimental Study. JMIR research protocols, 10(8), e25781.