DEVELOPMENT OF A VIRTUAL NURSE SYSTEM WITH BASIC HEALTH DETECTION USING GEOLOCATION BASED TECHNOLOGY

Undergraduate Thesis
Submitted to the Faculty of the
Department of Computer Studies
Cavite State University – Imus Campus
City of Imus, Cavite

In partial fulfillment
of the requirements in the degree
Bachelor of Science in Computer Science

VIRGILIO JR. C. DIAZ
RODNIE G. GELLA
SHARINA ACEL V. MACROHON
JANUARY 2025

INTRODUCTION

Background of the Study

In recent years, there has been a notable shift in the wearables market, with users seeking more versatile functionality beyond traditional fitness trackers. Smartwatches have emerged as a preferred choice due to their increasing embedded capabilities, fulfilling the desires of individuals who seek both fitness tracking and general watch features *(Ramezani et al., 2023)*. As such, these devices are greatly useful as they allow their users to seek medical assistance only when it is absolutely necessary. An accelerometer and a gyroscope embedded fall detection system that is featured in smartwatches and other wearables are some of the key modern features of these devices, as they detect such events *(Wixley, 2023)*. These features not only enhance user's safety but also offer peace of mind to their guardians and healthcare providers.

According to *Peek et al.,* (2021), Geolocation-based tracking assures that individuals, especially the vulnerable can be easily located once they step away from the safe zones and accidentally get into trouble. The report indicates that this addition enhances the safety of users to a great extent, especially the elderly or those individuals having cognitive impairment. This is because the caregivers and emergency responders are able to know the person's current GPS coordinates. The device also has the ability to send alerts to caregivers or emergency services when a person accidentally falls, gets injured, or when there is a possibility of harm, which enables them to act quickly. The combination of this technology reduces and guarantees the vulnerability of individuals that are prone to such danger or accidents.

In summary, this combination of a health monitoring app, wearable device with fall detection, and geolocation technology is a better way of looking at personal

healthcare as it addresses the shortcomings of the standard caring methods. By integrating these features into one system, this can also help mitigate the shortage of medical service facilities and healthcare providers in the Philippines. Because caregivers and healthcare providers are able to effectively remotely monitor patients, which also lessens the manual burdens, unnecessary efforts and ensures timely healthcare response *(Alotabi et al., 2020).*

Statement of the Problem

The main problem of the proposed study is focused on the challenges regarding healthcare management in the Philippines, particularly on the well-being of individuals in public hospitals, which sometimes lack staff, equipment, and even hospital beds. These methods require manual routine monitoring and direct involvement of nurses, which makes the process much labor-intensive and prone to errors. The current system creates a significant workload on caregivers, nurses, and doctors who must balance multiple responsibilities, often leading to delays in delivering timely and efficient care.

The specified problems are the following:

- How can current methods of care be improved to reduce the burden on caregivers and healthcare providers while ensuring safety and efficiency?
- How can health monitoring and geolocation-based tracking help lessen the challenges faced by patients and caregivers to improve patient care and safety?
- How can the integration of artificial intelligence improve the accuracy and effectiveness for individuals?

Objectives of the Study

Generally, the study aims to develop a reliable Virtual Nurse System with Basic Health Detection and Geolocation-Based Technology to improve care for basic health needs for individuals. The system will focus on basic health monitoring, alerts, and geolocation tracking to reduce the weight on caregivers and healthcare providers.

Specifically, it aims to:

- Gather information from caregivers, healthcare providers, and individuals to understand their needs;
- Set clear goals and objectives to guide the system's development;
- Identify all key features and technical requirements that the system must have in order to be effective;
- Verify all gathered information to ensure the system will work as intended;
- Produce deliverables, including requirements report and system proposal, to outline the system's design and development plan.

Time and Place of the Study

The study is about the development of a Virtual Nurse System with Basic Health Detection and Geolocation Technology. The study will be conducted in the month of December 2024 to January 2025, taking place in Cavite State University – Imus Campus under the supervision of Mr. Ramil V. Huele, Undergraduate Thesis Professor.

Scope and Limitations of the Study

The proposed Virtual Nurse System with Basic Health Detection and Geolocation-Based Technology mainly focuses on addressing the healthcare delivery for people, as well as offering support to caregivers and healthcare providers through innovative technology. The system will include the following functionalities:

Application. The proposed project will have its own application that the users can download using their smartphones and connect with their devices in order to store their data and provide essential information needed by the system in order to complete the user registration process.

Basic Health Monitoring. The proposed system will enable the tracking of vital health metrics such as heart rate, blood pressure, fall detection and activity levels to ensure timely detection of any irregularities. This feature will be essential in providing caregivers and healthcare providers with important health data.

Geolocation-Based Tracking. The system will include geolocation technology so that caregivers or healthcare providers can track their patients´ current or exact locations. This feature provides alerts when the patient attempts of happens to move outside of their safe zone, thus maintaining the safety of the user. This is applicable especially for someone with cognitive impairment or other disorders that may trigger disorientation.

Notification System. The system will consistently send only the important alerts to their guardians or healthcare providers to take note of potential emergencies or unusual activity. This specified feature will help improve response time to emergencies and patient needs.

Data Management and Sharing. The system will offer secure access to extremely essential patient information such as previous and current health reports, diagnosis and medications, as well as user location. This feature will be helpful for caregivers, healthcare providers, and patients by ensuring that important data is easily accessible but secured.

Batch Processing Notification. The system allows users to customize the notification interval (e.g., every 10 or 30 minutes), as the system does not offer real-time monitoring. Health and geolocation data are collected continuously and processed at the chosen interval, generating summarized reports for every timestamp of activity. Users can access detailed reports, ensuring a customizable and efficient monitoring.

Accessibility. The proposed system will be designed to be user-friendly, ensuring that users with different levels of knowledge in technology can easily navigate and use the platform.

Connect Device Module. This will be the module upon opening the application where the smartphone will first connect to a nearby smartwatch. After successfully connecting, it will be redirected to the data report module.

Data Report Module. This module will handle all data analysis from the device, creating reliable and organized information that can be viewed by chart, graph, or text.

While the Virtual Nurse System aims to provide comprehensive support, it is subject to the following constraints:

Dependence on Internet Connectivity. The system requires stable internet connection for updates on geolocation tracking, and data synchronization. Poor connectivity in some areas may hinder its performance.

Device Compatibility. The system's effectiveness is reliant on compatible devices (smartphones, smartwatches, or other wearables). Users may face challenges or limitations in using the application's features if they do not own any of the necessary hardware.

Geolocation Accuracy. The accuracy of location tracking may vary depending on GPS signal strength, especially in densely built areas or regions with limited satellite visibility.

Health Monitoring Limitations. The system does not diagnose medical conditions but only provides health metrics. It cannot replace professional medical advice, emergency medical care, and will only produce results from data provided by the user. Any inaccurate or false information provided by the user regarding their health information will not be the responsibility of the system.

User Removal of the Wearable. The system's functionality will mainly depend on the continuous use of the wearable device. If the user removes or discontinues wearing the device, the system will no longer be able to monitor the user's health metrics, location, or provide alerts when needed.. In these cases, the system cannot fulfill health tracking, fall detection or emergency detection as its main function.

Battery Life. Devices used for tracking and monitoring may require frequent recharging, which may interrupt continuous use if not properly managed. If the device happens to run out of battery, it will no longer be the system's responsibility if an emergency is not detected.

Limited User Familiarity. A user with limited experience or familiarity with smartphones, wearable devices, or the application interface may encounter difficulties in maximizing the system's purpose.

Overall, the system's specialization will focus on batch processing for health monitoring and geolocation, and rely on user input and customization. Despite having health monitoring, location tracking and emergency alerts, the system will not have real-time notification function and will only notify users if any unusual activity or events are detected. In addition to that, any inaccurate or false information provided by the user regarding their health information will not be the responsibility of the system.

Definition of Terms

Virtual Nurse System – A system that monitors health and sends alerts to caregivers or healthcare providers using provided health data and geolocation.

Basic Health Detection – Tracking vital signs like heart rate and blood pressure to detect irregularities.

Geolocation-Based Technology – GPS technology used to track an individual's location for safety purposes.

Health Monitoring – Continuous tracking of health metrics to send instant alerts for accidents or possible harm.

Fall Detection – A feature that detects falls and automatically alerts caregivers or emergency services.

Sensor – A device or component that detects and responds to changes in motion, light, temperature, or pressure.

Accelerometer – Type of sensor used to measure acceleration forces. In wearables, it's used for detecting steps, falls, and other movements.

Gyroscope – A device used along with accelerometer to help detecting falls or determining orientation

Smartwatch – Wearable device that performs many of the same functions as a smartphone such as health tracking, sending notifications, and running applications.

Wearable – Devices or technology worn on the body that track or monitor health, fitness, or environmental data.

Notification System – A system that sends alerts to caregivers about emergencies or unusual activities.

Data Management and Sharing – Securely storing and sharing health data between users and caregivers.

Application – A mobile app for users to store data, connect devices, and access system features.

Connect Device Module – A feature that connects the smartphone to compatible wearable devices.

Data Report Module – The system component that organizes and displays health data in readable formats.

Device Compatibility – The system's ability to work with various devices like smartphones and smartwatches.

Internet Connectivity – A stable internet connection required for updates and notifications.

Geolocation Accuracy – The precision of location tracking, affected by factors like signal strength.

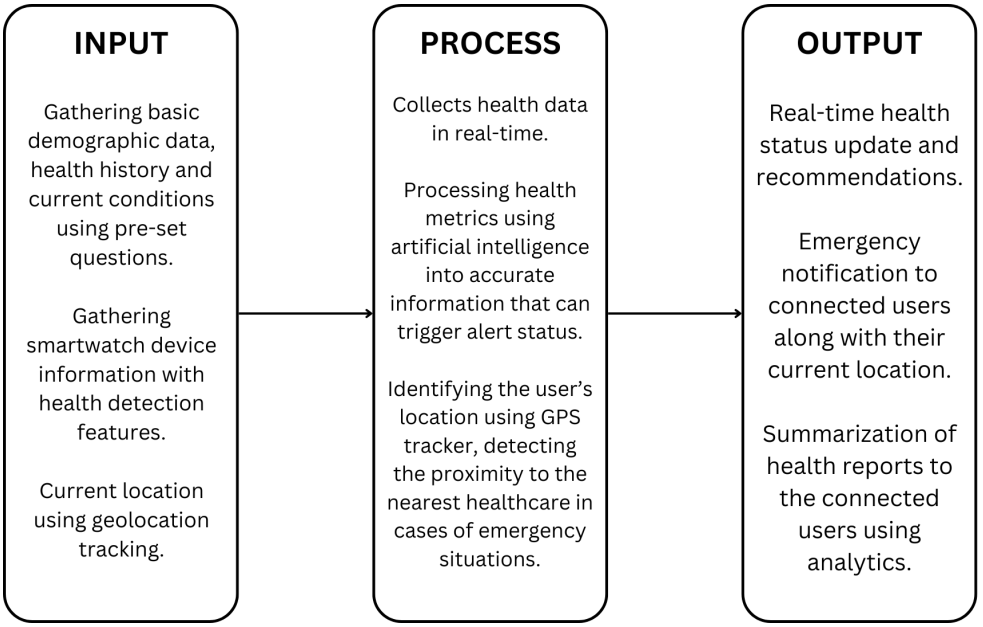
Health Monitoring Limitations – The system provides health data but does not diagnose medical conditions.

Cognitive Impairments – Mental conditions affecting memory and judgment, requiring extra safety measures.

Theoretical Framework of the Study

The foundation of the proposed study dates to the development of an app called Life360 which functions as a surveillance app that tracks and shares users' location. It is marketed to families with children to keep track of their location and prevent them from potential harm. It is said to maintain security of the end user with accurate pinpoint of their current location regardless of its distance to each other (Hasinoff, 2016). The relevance of smartwatches and the implementation of vital signs detection has been utilized for monitoring health-related parameters. Options like step counting, exercise measurement, and sleep monitoring are being used by individuals to gain access to their current information on their health at any time (Kader et. al., 2025).

In a similar study by King & Sarrafzadeh (2017), their study focuses on the practical factors that can contribute to practical implementations using peer-reviewed articles. In conclusion, the factors including managing long-term diseases and home care can be managed by smartwatches as the sensors integrated to the watches can measure and the data gathered by the sensors can be converted into information.


INPUT
Gathering basic demographic data, health history and current conditions using pre-set questions.
Gathering smartwatch device information with health detection features.
Current location using geolocation tracking.
PROCESS
Collects health data in real-time.
Processing health metrics using artificial intelligence into accurate information that can trigger alert status.
Identifying the user's location using GPS tracker, detecting the proximity to the nearest healthcare in cases of emergency situations.
OUTPUT
Real-time health status update and recommendations.
Emergency notification to connected users along with their current location.
Summarization of health reports to the connected users using analytics.

REVIEW OF THE RELATED LITERATURE / STUDIES

Foreign Studies

As advanced technological solutions evolve, different countries around the globe are integrating technology into the healthcare field and continue to explore different and unique alternatives to improve the patients' care and make the healthcare system more efficient. Researches that were conducted internationally have emphasized how AI, Internet of Things IoT, as well as other technologies can be further integrated into the healthcare sector. One particular instance is illustrated in the work of *Alotaibi et al.* (2020), in which the authors describe AI driven virtual nurse systems which were used with the intention to assist in the practices-role of healthcare providers. The findings indicated that the patient education using this method highly increased patient involvement, optimized both clinical and non–clinical staff workload and contributed to their well-being. Such systems do demonstrate that some level of education and automation can be delivered in order to improve the quality and efficiency of healthcare services.

A study by *Ramezani et al*. (2023), which focused on the growing use of wearable devices in healthcare, particularly for remote patient monitoring (RPM). This approach was proved to be effective in reducing healthcare costs, personalized health management, and support monitoring of patients in remote areas. Their paper also explored the design and implementation of an Android smartwatch app for monitoring geriatric patients, which provides a case study on overcoming obstacles during app development. It is to assist developers in creating more efficient healthcare apps for wearable systems.

Another notable study from Villa et al. (2024), focused on providing real-time health monitoring by the use of wearable fall detection systems. In such cases that a fall has been detected, the wearable device will send medical alerts to caregivers or

healthcare providers. It also proposed Low power consumption to ensure continuous health monitoring for users.

The chapter by *Peek et al.* (2023) meanwhile discusses the use of geolocation-based technologies for monitoring people with severe mental illness, which emphasize how geolocation sensors combined with their personal devices can be helpful for real monitoring of health behaviors. This can be useful as it continues to track their behavior and provide data that is able to help manage their conditions better. The paper also discusses how promising it is for improving the quality of care for individuals, highlighting those who have mental health conditions, which marks a significant step towards more personalized and efficient healthcare management.

Lastly, the paper by Luo et al. (2024) focuses on wearable healthcare devices being essential for continuous health monitoring. It discusses the widespread use and growing improvement of wearable devices for continuous monitoring of health signs and other vital signs. This paper emphasizes how wearable technology empowers people to take control over their health. This also focuses on the materials used for wearable healthcare devices, to practical applications of wearable devices for real-time health monitoring.

Local Studies

In the Philippines, the healthcare industry is now starting to utilize technological resources in order to overcome the issues of healthcare accessibility to patients, use of comprehensive patient care and maximizing resources. Local studies investigates the utilization of Artificial Intelligence (AI), Internet of Things (IoT) , smart devices, and mobile applications in the provision of healthcare services as an aid in overcoming the challenges in the delivery of the said services. These efforts show

deep focus on the needs of Filipino patients, caregivers, healthcare providers and show the potential role of technology in access to healthcare services and its efficiency. Such findings from these local studies are of great importance for nursing systems promotion and its application in the virtual context in the Philippines. Recent studies about health management systems have been conducted in the Philippines. *Alipio et al.* (2022) study stated the impact of wearable smart devices in improving mental health care delivery, especially in context of global increase in mental health issues**.** It also mentioned positive user feedback on wearable devices, which shows that patients are open to using them for monitoring vital signs and managing their mental health. It also stated the potential growth for wearable technologies, with projections indicating a $70 billion market by 2025.

The study by *Samonte et al.* (2019) mainly focuses on Android-based mobile applications designed to monitor calorie intake, physical activity, sleep levels, and heart rate. It also highlighted important information about obesity as an ongoing epidemic, which is closely linked to chronic diseases (heart disease, diabetes, hypertension, etc.). This app is said to be connected to a wearable device, allowing monitoring of the user's activities. The device also collects data which can be transmitted to health practitioners for analysis, contributing to a more personalized health management system.

Frameworks are also being developed to help in monitoring health. A study by *Madrid & Cagadas* (2023) focuses on developing a framework for health monitoring applications, specifically using Microsoft PowerApps. This helps manage health data amidst the COVID-19 pandemic. The study also emphasizes how smartphones and connectivity can be leveraged to improve health monitoring and risk management, especially in private institutions.

Meanwhile, Guadana et al. (2023) conducted a study focused on health monitoring applications on the Power App platform, which addresses the health challenges brought by the COVID-19 pandemic. Their research highlights the importance of using widely accessible technology such as smart-phones and other devices to enhance health monitoring and management in private institutions. The study also mentioned technology as a key tool in adapting to the “new normal”, providing a unique and efficient way to track and manage user’s health-related data. In addition, incorporating wearable devices into applications like this can make the integration of technology to healthcare efficient.

For the last study published by Santos et al. (2020), “Bandilyo app” involves the use of geolocation technology and mobile applications for improving real-time responses in critical situations. The study also integrates ICTs like mobile and web apps, SMS, and geolocation to improve coordination and communication, similar to how IoT connects devices for improved efficiency in hospital settings. The app is also directly related to emergency management and real-time incident monitoring, which aligns with our topic, although it focuses on disease surveillance in rural areas.

Table of Comparison

STUDY/ REFERENCE	FOCUS AREA	KEY FINDINGS	RELEVANCE TO PROPOSED SYSTEM
Developing a smartwatch-based healthcare application	Smartwatch-based healthcare application	Demonstrated effectiveness of wearable devices for remote monitoring, reducing costs, and enabling personalized health management.	Highlights app integration to wearables and overcoming development challenges for patient monitoring.

Exploring the Impact and Applications of AI in Advancing Medical Practices	AI-driven virtual nurse systems	AI systems optimize workloads, improve patient involvement, and enhance care quality.	Insight into how AI can help improve patient engagement and system efficiency.
Using Geolocation-based Technologies for Monitoring Mental Health	Geolocation-based monitoring for mental health	Found that geolocation tracking aids in managing mental health and improves care quality.	Relevant for tracking patient behaviors and enhancing emergency response in hospital systems.
Wearable Fall Detectors Based on Low Power Systems	Wearable fall detection systems	Low-power wearable devices for fall detection that sends real-time alerts to caregivers.	Relevant to real-time emergency response in hospitals, such as fall detection.
Recent Advances in Wearable Healthcare Devices	Advances in wearable healthcare devices	Focused on wearable devices for continuous health monitoring and patient empowerment.	Supports IoT-based wearable monitoring in hospital settings.
Impact of Wearable Devices in Mental Health and Quality of Life	Wearable devices for mental health	Wearable devices for mental health	Demonstrates wearable technology's role in patient monitoring, especially in mental health.
Using a Wearable Device for an Android-based Weight Management System	Android-based health management system	Monitoring of calorie intake, activity, and vital signs, contributing to obesity and chronic disease management.	Provides data sharing and monitoring, aligning with IoT-based hospital systems.

Development of In-patient Digital Healthcare System	IoT-based health monitoring framework	Developed a framework for health monitoring using PowerApps, emphasizing smartphone connectivity.	Offers a framework for integrating IoT technology into hospital health monitoring systems.
A Development Framework for a Health Monitoring Application	Health monitoring application framework	Focused on health monitoring using Power Apps during the COVID-19 pandemic, integrating wearable devices.	Aligns with wearable device integration and IoT-based systems for health monitoring.
Bandilyo App: Disaster Risk Reduction and Incident Reporting	Geolocation and real-time incident monitoring	Used geolocation and mobile apps for emergency management and improving communication during incidents.	Shows the use of geolocation and real-time response technologies for IoT-based hospital monitoring and emergency management.

REFERENCES

Alipio, J. S., Bautista, M. C., Mendoza, G., Narvaez, R. A., Sudaypan, M., & Peco, R. A. (2022). Impact of wearable devices in mental health and quality of life. *St. Paul University Philippines Graduate School Journal*, 17(3-4). Retrieved from https://cjni.net/journal/?p=10472

Alotaibi, F. M., Almazam, A. A., Emam, A. M., Alqahtani, N. S., Alheggi, A. I., Alshahrani, W. N., Alanazi, A. F.,…Alharbi, N. H. M. (2020). Exploring the impact and applications of artificial intelligence in advancing modern medical diagnostic practices—Role of healthcare providers. *International Journal of Health Sciences, 4*(S1). https://doi.org/10.53730/ijhs.v4nS1.15087

Bhaltadak, V., Ghewade, B., & Yelne, S. (2024). A comprehensive review on advancements in wearable technologies: Revolutionizing cardiovascular medicine. *Cureus, 16*(5), e61312. https://doi.org/10.7759/cureus.61312

de los Santos, J. R. N., de los Santos, M. G., Copino, R. C., & Loyaga, L. (2020). Bandilyo App: A disaster risk reduction monitoring and incident reporting system with geolocation and SMS technology. In *2020 IEEE 12th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment, and Management (HNICEM)* (pp. 1–5). Manila, Philippines: IEEE. https://doi.org/10.1109/HNICEM51456.2020.9400138

Guadana, R. R., Caballa, V. K., Correa, C. E., Borgona, D. L. J., Itulid, K. Z., Avendano, M. F., Trillanes, A., & Cruz, C. (2022). A development framework for a health monitoring application in the Power App platform. In *2022 2nd International Conference in Information and Computing Research (iCORE)* (pp. 197–201). https://doi.org/10.1109/iCORE58172.2022.00054

Kader, F., Bayramoglu, B., & Tayfur, I. (2025). Evaluation of the performance and reliability of a smartwatch capable of performing ECGs: A prospective observational study. *Heliyon, 11*(1), e41682. https://doi.org/10.1016/j.heliyon.2025.e41682

Kalusivalingam, A. K., Sharma, A., Patel, N., & Singh, V. (2021). Enhancing patient care through IoT-enabled remote monitoring and AI-driven virtual health assistants: Implementing machine learning algorithms and natural language processing. https://doi.org/10.53730/ijhs.v4nS1.15087

King, C. E., & Sarrafzadeh, M. (2018). A survey of smartwatches in remote health monitoring. *Journal of Healthcare Informatics Research, 2*(1), 1–24. https://doi.org/10.1007/s41666-017-0012-7

Luo, X., Tan, H., & Wen, W. (2024). Recent advances in wearable healthcare devices: From material to application. *Bioengineering*, 11(4), 358. https://doi.org/10.3390/bioengineering11040358

Madrid, C. M. J., & Cagadas, D. O. (2023). *Development of in-patient digital healthcare system: A health monitoring device for patients using IoT*. University of Science and Technology of Southern Philippines. Retrieved from https://www.researchgate.net/publication/377221240_DEVELOPMENT_OF_IN-PATIENT_DIGITAL_HEALTHCARE_SYSTEM_A_HEALTH_MONITORING_DEVICE_FOR_PATIENT_USING_IoT

Peek, N., Fraccaro, P., & van der Veer, S. (2023). Using geolocation-based technologies for monitoring people with severe mental illness. In *Tracking People* (1st ed., pp. 22). Routledge. Retrieved from https://www.taylorfrancis.com/chapters/edit/10.4324/9780367443597-9/using-

geolocation-based-technologies-monitoring-people-severe-mental-illness-niels-peek-paolo-fraccaro-sabine-van-der-veer

Ramezani, R., Cao, M., Earthperson, A., & Naeim, A. (2023). Developing a smartwatch-based healthcare application: Notes to consider. *Center for Smart Health, University of California, Los Angeles, CA, USA, & Probabilistic Risk Assessment Group, North Carolina State University, Raleigh, NC, USA.* https://doi.org/10.3390/s23156652

Samonte, M. J. C., Naquila, K. R. P., Camba, J. P., & Ignacio, R. C. C. (2019). Using a wearable device for an Android-based weight management system. *TENCON 2018 - 2018 IEEE Region 10 Conference*. https://doi.org/10.1109/TENCON.2018.8650490

Subramaniam, S., Faisal, A. I., & Deen, M. J. (2022). Wearable sensor systems for fall risk assessment: A review. *Frontiers in Digital Health, 4*, 921506. https://doi.org/10.3389/fdgth.2022.921506

Villa, M., & Casilari, E. (2024). Wearable fall detectors based on low power transmission systems: A systematic review. *Technologies, 12*(9), 166. https://doi.org/10.3390/technologies12090166

Wixley, H. (2023). Smart application for fall detection using wearable ECG & accelerometer sensors. *arXiv*. https://doi.org/10.48550/arXiv.2207.00008