PROGRESS IN ENGINEERING APPLICATION AND TECHNOLOGY
e-ISSN: 2773-5303

PEAT

Vol. 6 No. 1 (2025) p. 471-477
https://publisher.uthm.edu.my/periodicals/index.php/peat

IoT Based Household Elderly Monitoring System with Connection Through Wi-Fi

Choong Wei Jun[1], Faiz Asraf Saparudin[1]*

[1] *Department Of Electrical Engineering Technology, Faculty of Engineering Technology Universiti Tun Hussein Onn Malaysia, 84600, Pagoh, Johor, MALAYSIA*

*Corresponding Author: faizs@uthm.edu.my
DOI: https://doi.org/10.30880/peat.2025.06.01.049

Article Info

Received: 17 January 2025
Accepted: 26 January 2025
Available online: 30 April 2025

Keywords

IoT, surveilance, Telegram API, visual impaired elderly

Abstract

Malaysia's aging population has led to an increased risk of elderly individuals living alone experiencing falls and delayed medical attention, compounded by the limitations of current solutions such as privacy concerns, high costs, and complex installation. To address these issues, this project introduces a cost-effective and user-friendly IoT-based surveillance system designed specifically for visually impaired elderly individuals. By utilizing ESP32-CAM, ESP32, and ESP32-C3 devices integrated into a wearable solution, the system transmits live image and ambient environmental data to enable early detection of distress signals, focusing on low latency, speed, and accuracy to ensure timely assistance. Experimental results show that the system significantly reduces response times compared to traditional phone-based methods by 69.5% while prioritizing user privacy and data security through secure transmission and access controls, offering a promising solution to enhance the safety and well-being of elderly individuals living independently.

1. Introduction

Falls are a common cause of major morbidity and increased mortality among older people in Malaysia. 14.1% of older people reported experienced at least one falls every year [1]. The recent 5th Malaysia Population and Family Life Survey documented over 70% of older Malaysians who were living with family members and others in their household, about 21% were living with spouse only, and 9% were living alone [2]. This means that 9% of elderly people are at risk of mortality when falls or accidents of similar elements are to happen. The first 60 minutes after traumatic injury which is the most crucial period that determines the patient's outcome has been termed the "golden hour" [3]. To prevent 9% elderly living alone missing the golden hour to receive appropriate treatment, a monitoring system is required to ensure family of the elderly get informed when an accident occurs.

There have been alternative monitoring systems that is distributed in another country to tackle this issue such as HoME+ developed by the Singapore Red Cross Society [4]. It uses motion sensor and panic buttons to monitor the residents' activities. In the event of anomalies or emergencies, such as falls or prolonged inactivity, the system alerts caregivers or emergency services to ensure timely assistance. By being camera-free, this approach addresses privacy concerns while providing a safety net for elderly individuals. Figure 1 below shows the components of the system.

Fig. 1: HoME+ system by Singapore Red Cross Society [4]

Malaysia does not have an official or government-endorsed system developed or distributed. Solutions available on Malaysia's market will utilise a central server which proposes risk towards users' privacy. Gadgets with touch screen interfaces or complicated buttons could not be utilised properly by visually impaired elderlies. Most of the alternatives operates on a subscription-based system, which could be costly when used for a long period of time.

The goal of this present article is to develop a monitoring system for visually impaired elderlies that is local to our society while maintaining privacy protection and ease of access for both caretakers and seniors. We hypothesize that the system developed will be easier to use and faster to be reacted when compared to traditional method of telephone calls. To test this hypothesis, we developed a monitoring system and evaluated the duration needed to react during emergencies.

2. Methodology

To achieve the objective of this project, this project was mainly separated into three parts; Understanding the behaviour patterns of visually impaired elderly, developing a monitoring system, and evaluating the system compared to the traditional method of telephone calls.

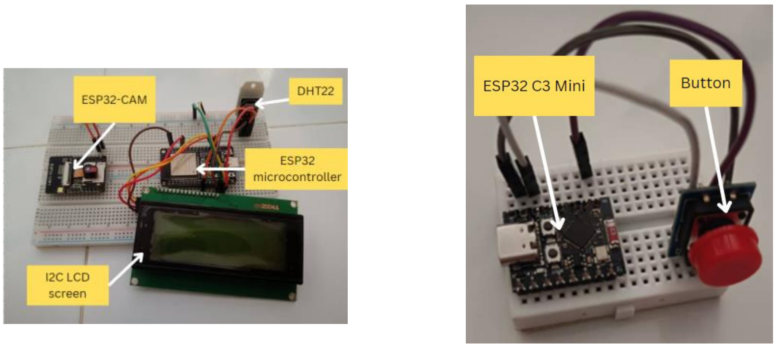
2.1 Hardware used

Three microcontrollers are used in this project, namely ESP-32, ESP32-CAM, and ESP32-C3 Mini. Figures of the microcontrollers are shown in Fig.2. ESP32-CAM can act as a camera that captures images and videos. The microcontroller can communicate through Wi-Fi network which does not require any additional setup when used in resident households. ESP-32 was used mainly in processing ambient data and communication between user and the system. ESP32-C3 Mini was utilized in the portable part of the device to send out distress signal in times of emergency.

(a) **(b)** **(C)**

Fig. 2: Microcontroller used (a) ESP32-CAM; (b) ESP32-C3 Mini; (c) ESP-32

Fig.3 shows the overall system working and the components involved. In the figure, the comprehensive system components are depicted, strategically placed to be housed within a box. These components include the ESP32-CAM, ESP32 microcontroller, DHT22 sensor, I2C LCD screen and will be powered through a USB Type-C cable. The wearable part of this system containing a button connected to ESP32 C3 Mini microcontroller and a 3.7V Lithium Ion Battery. The system will receive command and send information via Telegram API (Application Programming Interface). Fig.4 shows the flowchart of the system.



(a) **(b)**

Fig. 3: Overall System Working (a) Stationary part of project; (b) Wearable part of project

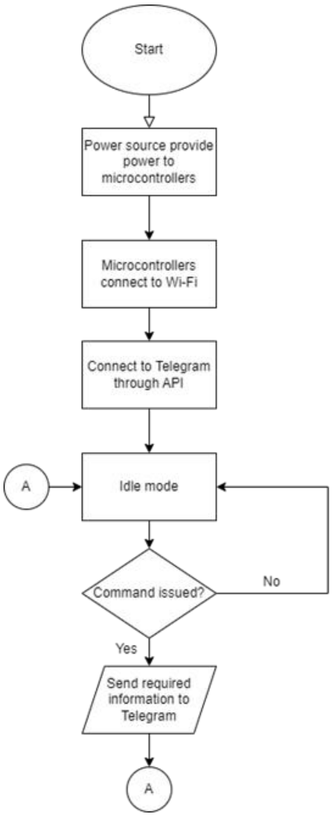


Fig. 4: System flowchart

2.2 Behaviour study

The behaviour of visually impaired elderly is studied through journals with emphasis on how they navigate the surroundings, the ability to operate gadgets and relationship between environmental factor and risk of falls.

2.3 Evaluation method

To prove the hypothesis, experiments and tests were conducted to obtain data. These tests were focused on speed and accuracy. For speed, an experiment is carried out by simulating a situation where visually impaired elderly had fell and will need to call for assistance with either telephone calls or the emergency button developed in this project. The time used by both methods was recorded and compared. For accuracy, parameters such as temperature,

For speed, an experiment is carried out by simulating a situation where visually impaired elderly had fell and will need to call for assistance with either telephone calls or the emergency button developed in this project. The time used by both methods were recorded and compared.

For accuracy, parameters such as temperature, humidity and time delay for cameras are recorded and analysed in terms of accuracy.

3. Results and Discussion

This chapter aims to comprehensively analyse and discuss the data collected from various experiments conducted in relation to the project's objectives.

3.1 Analysis of behaviour of visually impaired elderly

To understand the behaviour of visually impaired elderly, paper studies were conducted and recorded here for development of projects.

It is known that visually impaired older adults face challenges with daily activities like using the telephone, shopping, and cleaning due to reduced mobility and passive attitudes [5]. Physical activity avoidance is common, leading to functional decline and increased fall risks [6]. Many visually impaired elderly individuals experience fewer social contacts and conditions like Charles Bonnet Syndrome (visual hallucinations) [7], which can compromise mobility and safety [8]. Highly care-dependent elderly have limited capacity to adopt adaptive measures during heatwaves [9]. Heatstroke cases rise sharply when temperatures exceed 36°C and humidity surpasses 58% [10].

3.2 Evaluation of System

Evaluations were focused on speed and accuracy of the system.

For speed, three tests were conducted on the system. The first one was the time delay of the camera image. The way the camera works is that the ESP32-CAM will save an image at a certain time interval in the memory of microcontroller and sends it out when requested. By minimising the delay, important details are less likely to be missed. The camera was pointed at a digital clock displaying the time; the time a request is sent, time image is received and time recorded on the image is tabulated into table 1. The delay shown is with acceptable range for assistance within golden hour.

Table 1: Time difference between requesting and receiving image data

Attempts	Issued time	Received time	Time of received image	Delay(seconds)
1	09:01:31PM	09:01:39PM	09:01:02PM	37
2	09:02:05PM	09:02:10PM	09:01:17PM	53
3	09:02:34PM	09:02:38PM	09:01:37PM	61
4	09:03:07PM	09:03:16PM	09:02:07PM	69
5	09:03:30PM	09:03:40PM	09:02:36PM	64
6	09:04:04PM	09:04:11PM	09:03:12PM	59
7	09:04:23PM	09:04:30PM	09:03:38PM	52
8	09:04:50PM	09:04:59PM	09:04:09PM	50
9	09:05:12PM	09:05:19PM	09:04:29PM	50
10	09:05:38PM	09:05:45PM	09:04:57PM	48

The second test was done on the delay of the buttons. When the emergency button is pressed, a message will be sent through Telegram Bot to users' smartphone. The delay is tabulated into table 2. Fig.5 shows an example of messages shown. The delay shown is negligible and is proved to be fast.

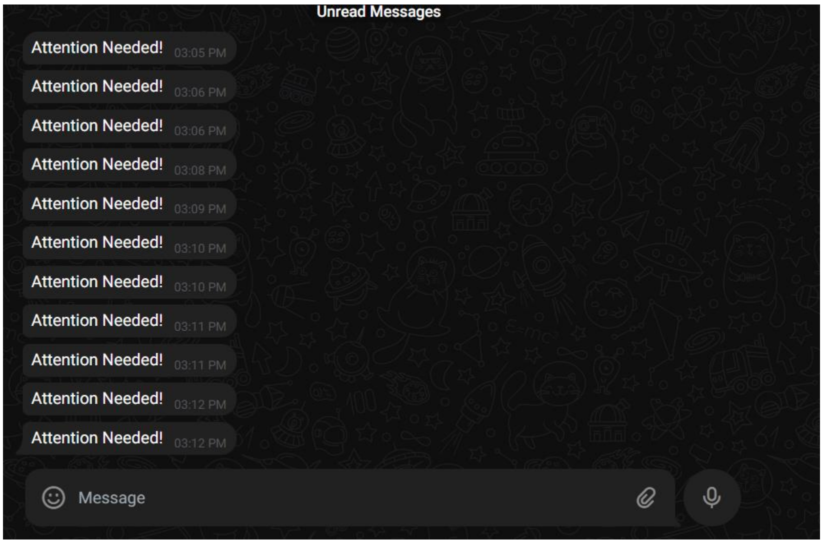


Fig. 5: Examples of Distress signal

Table 2: Latency of button calls

Attempts	Issued time	Received time	Delay(seconds)
1	03:05:03PM	03:05:06PM	3
2	03:06:14PM	03:06:18PM	4
3	03:08:40PM	03:08:43PM	3
4	03:09:14PM	03:09:17PM	3
5	03:10:15PM	03:10:17PM	2
6	03:10:38PM	03:10:41PM	3
7	03:11:01PM	03:11:04PM	3
8	03:11:46PM	03:11:49PM	3
9	03:12:05PM	03:12:07PM	2
10	03:12:30PM	03:12:33PM	3

To prove that this method is faster than the traditional method of making phone calls, the third test was an experiment that recorded time taken by elderly with impaired visibility making calls while comparing it to prototype designed in this project. This experiment is designed to simulate situation when elderly had experienced a forward fall and is contacting family members or caretakers via smartphones with touch screen interface in their pocket for assistance. Results were tabulated in table 3 and Fig.6. From the experiment, it was apparent that the prototype takes lesser time (69.5%) than traditional methods of calling with phones. Proving the system is efficient especially when the users are visually impaired and are unable to operate complicated gadgets.

Table 3: Time difference between Smartphone calls and button

Attempts	Time taken for calls (Seconds)	Time taken for buttons (Seconds)	Difference(seconds)
1	27.11	7.06	20.05
2	25.23	6.18	19.05
3	14.33	4.29	10.04
4	15.65	7.52	8.13

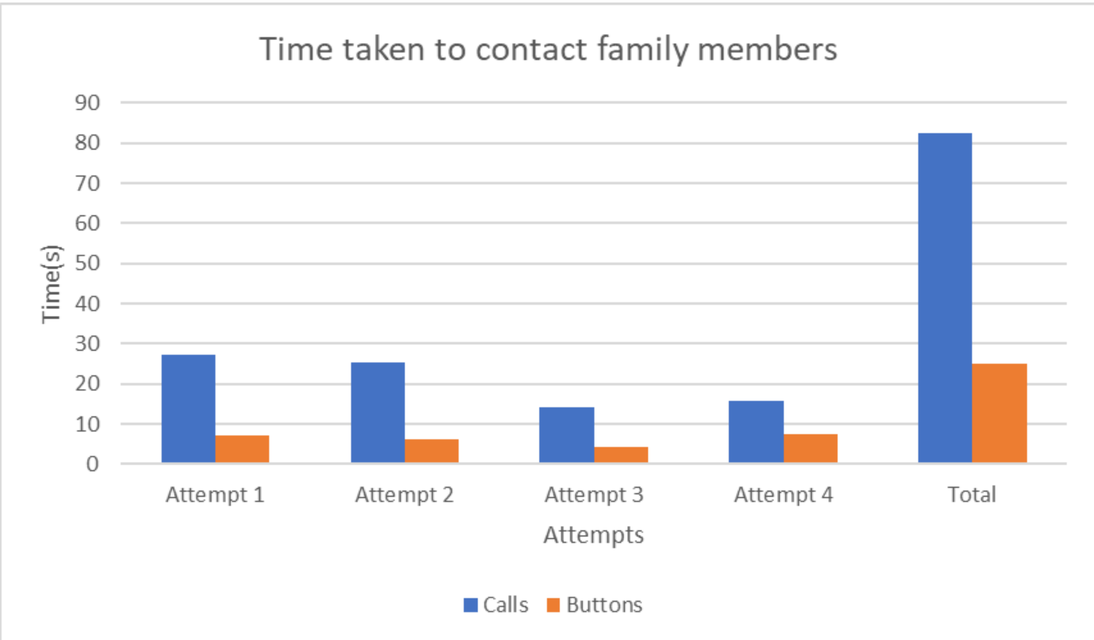


Fig. 6: Comparison of time taken to contact family members between Smartphone calls and button

4. Conclusion

This study provides significant insights into the development of a cost-effective IoT-based elderly surveillance system aimed at addressing the challenges faced by Malaysia's aging population. All objectives were successfully achieved, including the design of an IoT solution that integrates ESP32-CAM, ESP32, and ESP32-C3 devices, enabling the transmission of live image and environmental data to monitor elderly individuals effectively. The system was thoroughly evaluated for latency, speed, and accuracy to ensure timely detection of distress signals and accurate data transfers.

Despite demonstrating improvements in response time compared to traditional phone-based assistance, challenges remain in ensuring seamless performance under varying environmental conditions. Validation processes highlighted the importance of secure data transmission and access controls to maintain user privacy and data integrity. While this study addressed several critical aspects, further work is needed to refine the system for wider implementation.

This research emphasizes the need for robust and user-friendly monitoring systems to enhance the safety of elderly individuals living independently. It provides a solid foundation for future advancements in IoT-based eldercare technologies, offering valuable guidelines to improve the well-being of visually impaired elderly individuals while addressing key concerns of privacy, accessibility, and affordability.

Acknowledgement

The authors would like to thank the Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia for their support along the way.

Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

References

[1] Sahril N, Shahein NA, Yoep N, et al. Prevalence and factors associated with falls among older persons in Malaysia. *Geriatr. Gerontol. Int*. 2020; 20: 33–37. https://doi.org/10.1111/ggi.13980

[2] Mahmud A, Jaffar W, Hashim W, Mohammad AH, Ishak I, Sapri M, et al. Report on Key Findings Fifth Malaysian Population and Family Survey (MPFS-5) 2014. (2016).

[3] Paul Prabhakar Abhilash, Kundavaram & Sivanandan, A. (2020). Early management of trauma: The golden hour. Current Medical Issues. 18. 36. 10.4103/cmi.cmi_61_19.

[4] The Straits Times. (2023, September 30). *Home alone, ill or in distress? Just press the button*

[Press release]. https://www.straitstimes.com/singapore/home-alone-ill-or-in-distress-just-press-the-button

[5] Nakamura, K., Otomo, A., Maeda, A. *et al.* Evaluation of complex activities in daily living of elderly Japanese with visual impairment. *Aging Clin Exp Res* **11**, 123–129 (1999). https://doi.org/10.1007/BF03399651

[6] E J-Y, Li T, McInally L, Thomson K, Shahani U, Gray L, Howe TE, Skelton DA. Environmental and behavioural interventions for reducing physical activity limitation and preventing falls in older people with visual impairment. Cochrane Database of Systematic Reviews 2020, Issue 9.

[7] Robert J Teunisse, Johan R Cruysberg, Willibrord H Hoefnagels, Yolanda Kuin, Andre L Verbeek, Frans G Zitman, Social and psychological characteristics of elderly visually handicapped patients with the Charles Bonnet Syndrome, Comprehensive Psychiatry, Volume 40, Issue 4, 1999.

[8] Fisher, K., Sanders, C., & Stanmore, E. (2023). Impact of Charles Bonnet Syndrome on visually impaired older adults' ability to engage in physical activity: A scoping review. British Journal of Visual Impairment, 41(4), 910-924.

[9] Malmquist, A., Hjerpe, M., Glaas, E., Karlsson-Larsson, H., & Lassi, T. (2022). Elderly People's Perceptions of Heat Stress and Adaptation to Heat: An Interview Study. *International Journal of Environmental Research and Public Health*, *19*(7), 3775. https://doi.org/10.3390/ijerph19073775

[10] Han Q, Liu Z, Jia J, Anderson BT, Xu W, Shi P. Web-Based Data to Quantify Meteorological and Geographical Effects on Heat Stroke: Case Study in China. Geohealth. 2022 Au.