OPEN ACCESS Freely available online

IJCMB
International Journal of Clinical Medicine and Bioengineering

ISSN 2737-534X
Volume 2, Issue 2
https://www.iikii.com.sg/journal/IJCMB
International Journal of Clinical Medicine and Bioengineering

Article

Care Assistance and Abnormal Activity Warning System by Bluetooth Positioning

Jia-Wen Wang [1], Hung-Wei Chang [2], Ai-Jia Hsieh [2] and Chun-Pin Chang [1,*]

[1] Department of Information Management, Chia Nan University of Pharmacy and Science, Taiwan; zxcv6990143@gmail.com
[2] Department of Multimedia and Game Development, Chia Nan University of Pharmacy and Science, Taiwan; b1130023@gm.cnu.edu.tw (H.-W. Chang); qajhsieh@mail.cnu.edu.tw (A.-J. Hsieh)
* Correspondence: cpchang@mail.cnu.edu.tw; Tel.: +886-937-665-727

Received: May 9, 2022; **Accepted:** Jun 9, 2022; **Published:** Jun 30, 2022

Abstract: At present, the domestic demand for long-term care is growing rapidly. However, the replenishment of related services has been slow. This leads to an imbalance in the proportion of nursing staff. The result was a shortage of manpower and a hectic work schedule. If there is a system to assist caregivers in their daily work processes, the burden on caregivers reduces. The constructed system in this research has the functions of Bluetooth indoor positioning, abnormal state judgment, early warning with processing flow control, active reminder, and recording of nursing work. Indoor positioning is used to instantly locate the elderly, know their activity statuses, and determine whether the activity is abnormal. In the event of possible abnormal conditions, active and passive alerts are issued. Through the combination of software and hardware, the processing flow is controlled to achieve the optimal allocation of manpower. In addition, proactively reminding the attendant and recording the care items before carrying out the care needs are conducted to avoid omission or duplication of care items.

Keywords: Bluetooth Positioning, Abnormal Activity Warning, Care Assistance

1. Introduction

1.1. Research Background

Today's medical standards have improved with the development of science and technology, and the average life expectancy of people has also increased. According to the World Health Organization, when the proportion of people over 65 years old in the country's total population was 14 and 20%, a country is defined as an "aged society" or "super-aged society". The National Development Council of the Republic of China (hereinafter referred to as the National Development Council, NDC) mentioned [1] that Taiwan officially entered the "aged society" in 2018. It is estimated that Taiwan enters a "super-aged society" by 2025. Thus, Taiwan is experiencing population aging rapidly. While the population ages seriously, Taiwan faces the problem of a low birth rate. This leads to a gradual increase in the dependency of young people in the future. According to statistics from the NDC [1], as of August 2020, Taiwan's total dependency ratio reached 40.2% (Fig. 1). On average, for every 100 people with working ability, about 40 dependent people (people aged 0–14 and over 65 years old) must be supported. With the increase in the dependency ratio, the burden of support for young people also increases. In addition, due to their busy lives, most family members do not have the extra time to take care of and accompany their elders. In the end, help from a long-term care facility is required. According to the statistics of the Ministry of Health and Welfare (hereinafter referred to as the Ministry of Health and Welfare, MOHW) [2] as of 2020, the number of people living in long-term care institutions was 52,261 in Taiwan. The Gender Equality Committee of the Executive Yuan also conducted a survey [3]. As of 2020, there was 5,400 nursing staff serving in long-term care facilities with 1,188 social workers and 18,185 service workers. According to the "Long-Term Care Ten-Year Plan 2.0" announced by MOHW in 2016 [4], 9,195 care workers and 3,485 social workers were needed in the long-term care sector in 2017. By 2021, 47,078 caregivers and 3,786 social workers were needed. However, according to the 2018 survey by Control Yuan commissioner Chen Xiaohong [5], there was a shortage of more than 5,000 care workers. In 2020, there was a shortage of nearly 8,000 care workers, and the actual employment rate of attendants after training was only 21%. This explains the slow replenishment of long-term care-related services.

To sum up, long-term care institutions have currently an unbalanced care ratio, resulting in one caregiver caring for multiple elders at the same time. Thus, "Smart Healthcare" is necessary to improve the situation. According to the World Health Organization, "Smart Healthcare" was defined as "the application of Information and Communication Technology (ICT) in the medical and health care fields, including medical care, disease management, public health surveillance, education and research" [6]. According to a

research report commissioned by the National Development Council (NDC), a survey conducted by the American Primary Care Physician found that nearly 75% of physicians said that the application of ICT reduced error of routine work. 70% believed that productivity increased, while 60% believed that ICT reduced costs [7]. As caregivers were usually busy, a system was needed to smoothen the entire nursing process and optimize human control.

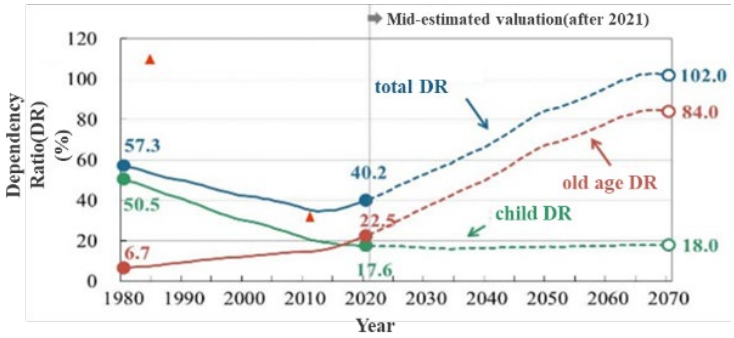

Fig. 1. Trend of dependency ratio change. [1]

1.2. Research Motivation

Yang Zhiliang, president of Taiwan Active Aging Association pointed out that Taiwan has entered a super-aged society expecting 3.6 trillion business opportunitiesn [8]. Today, there were technology companies in Taiwan such as Foxconn, Quanta, Acer, and ASUS which invested in the research and development of smart medical-related fields [9]. Industrial Technology Research Institute also called on non-governmental long-term care institutions, medical resources, and technology industries to establish the first “Smart Long-term Care Alliance” in Taiwan [10]. The government and the public were optimistic about the development of smart medical care. According to the estimation (high estimation) of MOHW [4], in 2022, the number of moderate or severe physical and mental disabilities who need long-term care is close to 900,000 in Taiwan. With the rapid aging of Taiwan's population, it will exceed one million in four years (Fig. 2). Despite the rapid growth of the population in the need of long-term care, the replenishment of long-term care resources have been rather slow. As a result, the proportion of caregivers and care recipients in long-term care institutions was unbalanced. Taking the statistics of the Taipei City Government in 2019 as an example [11], in 2010, each care attendant needed to serve more than 5 people. However, according to Article 11 of the standards established by MOHW for the senior citizens’ welfare institutions, one care attendant is assigned only to five people during the day. The care ratio of long-term care institutions generally exceeds the ratio by the regulation, which causes busy work of nursing staff. According to the "Health Report" [12], when elders accidentally fall or have other accidents, if they cannot be rescued within the golden time, which may cause death or irreversible damage. In addition, when the caregivers are busy, they may miss the daily care items of the elderly. When the attendant wants to carry out the work of the care project, caregiver needs to know the current location of the elderly, but it is quite time-consuming to locate the elderly. If the above two problems can be solved, the workload of the attendant can be effectively reduced.

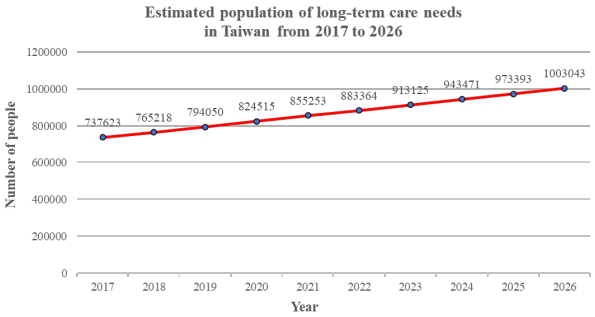

Fig. 2. Estimated number of people in need of long-term care from 2017 to 2026. [4]

1.3. Purpose

In order to improve the related problems (the imbalance of institutional care ratios leading to the busy workload of caregivers), a “Care Assistance and Abnormal Activity Warning System” was developed in this study. The following system features are achieved through location data analysis and push notification of care information.

(1) Proactive reminder of care items, record the details of care items and their execution status to avoid omission or duplication of care items;
(2) The system can determine whether the elders may have abnormal conditions and issue alerts, remind the cargivers to check the situation. Control the process through the combination of hardware and software to achieve optimal manpower deployment.

2. Methods

2.1. Research Questions

In this research, the location and activity of the elderly are necessary factors to remind the nursing procedure or to deal with the abnormal condition of the elderly. If the attendant locates the elderly easily, they can save time. When the attendant is busy, they may miss out on the implementation of elder care items (such as medication and daily care). If the status of nursing is not recorded immediately, repeated nursing happens probably. According to the "Health Report" [12], when the elderly had abnormal conditions, it leads to death or irreversible injuries if no one to deal with the condition in golden time. Considering these situations, it is necessary to understand the location and activities of the elderly. There are two methods to solve this problem: additional manpower or camera image recognition. The advantages and disadvantages of these two methods are as follows.

(1) Recruiting additional staff: Recruiting additional staff is a traditional practice, and this method improves the quality of care in the institution. When the additional staff effectively share the workload of each nursing staff, it reduces the occurrence of incidents of missing the daily practice for the elderly and improves the quality of nursing. However, the personnel cost greatly increased. According to the 2018 survey [5], the actual practice rate of attendants after training was only 21%. As a result, recruitment was slow, and the relevant personnel was difficult to hire.
(2) Camera image recognition: Image recognition is about the pixel and pattern analysis of an image to recognize the image as a particular object. Image recognition technology is applied to accurately capture the location and activity of the elderly. An abnormal situation of the elderly can be detected immediately. However, this method causes privacy problems and has blind spots of sight. Installment cost also needs to be considered for small institution.

For above two methods, the problem of financial burden arises. Therefore, a indoor positioning method of the elderly is proposed in this study. Owing to the rapid development of science, the technology of positioning can use Wi-Fi, infrared, UWB, Bluetooth, and so on. However, each technology has advantages and disadvantages when applied to indoor positioning (Table 1).

Table 1. Comparison of the advantages and disadvantages of indoor positioning. [13]

	Precision	Electricity consumption	Cost	Penetration	Integration of mobile device
Wi-Fi	★★☆☆☆	★☆☆☆☆	★★☆☆☆	★★★☆☆	★★★★★
Infrared	★★★★★	★★☆☆☆	★★★☆☆	★☆☆☆☆	★☆☆☆☆
Ultra-wideband	★★★★★	☆☆☆☆☆	☆☆☆☆☆	★★★★☆	★☆☆☆☆
Bluetooth Low Energy	★★★★★	★★★★☆	★★★☆☆	★★★☆☆	★★★★★

(1) Wi-Fi indoor positioning: Wi-Fi is a relatively mature and widely used technology. People go to any place (such as schools, office environments, and shopping malls) and access the Wi-Fi signals through their mobile devices. For Wi-Fi indoor positioning, nearby devices are scanned through wireless access point (WAP). Through the signal strength, the distance between the device and each WAP is calculated to obtain the position of the target. Using a hybrid approach of Wi-Fi location and image recognition, mobile devices lead user to a vehicle's parking spot[14]. In this application, surrounding traffic information is also provided. Wi-Fi indoor positioning can be used in long-term care facilities. However, for the elderly, the size and weight of the smartphone are relatively large to carry, and Wi-Fi consumes much power of portable devices [13]. If a coin battery is used for lighter devices, battery life can be shortened.
(2) Infrared indoor positioning: By installing multiple devices that emit infrared, the distance of the multi signal sources are calculated to locate the positioning object. This technology has high positioning accuracy [13]. Although the elderly do not need to carry

any positioning hardware, they can be located. However, Infrared is affected by the heat source and light, which reduces accuracy. For long-term care institutions, it is a burden to install a sufficient number of infrared devices.

(3) UWB indoor positioning: UWB is an emerging technology in recent years, and its operation mode is similar to Wi-Fi. By arranging four base stations with known coordinates, the positioning object with a responding device measures the distance to the four base stations at a certain position. The location is then calculated through an algorithm. Products using UWB technology are easy to find on the market. Apple's AirTags and Samsung's SmartTag+ are well-known products. The user installs the device on a frequently lost item, and when the item cannot be found, the user uses the help of mobile device to find the lost item. UWB has the advantage of high positioning accuracy [13] but has the problem of high construction and maintenance costs.

(4) Bluetooth indoor positioning: The Bluetooth Low Energy (BLE) has the characteristics of low power consumption. BLE is used to only obtain the relative position of the elderly, so it don't need high accuracy in this study. The cost of Bluetooth technology for indoor positioning is lower than that of other technologies [13].

In this study, indoor positioning was carried out by BLE technology. The developed system has two main functions: care assistance and abnormal warning. Fig. 3 shows the process of indoor positioning. The elderly carry Beacon devices (the following abbreviated IDTag) that send Bluetooth signals in various areas (such as rooms, bathrooms, and public areas). When the elderly enter the positioning area with the IDTag, the positioning device in that area sends the information of location and activity status to Wi-Fi Mesh. Wi-Fi Mesh Bridge uploads the data to server.

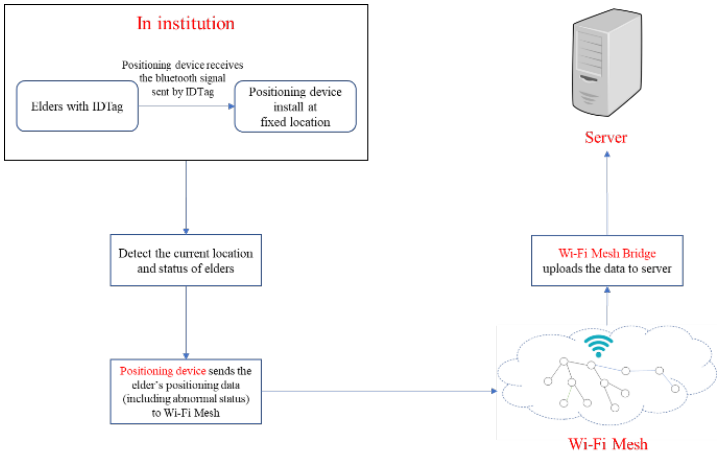

Fig. 3. Flow of indoor positioning.

2.1.1. Care Assistance

In the process of the "care assistance" function (Fig. 4), the caregiver needs to know the elderly's location for daily care. The APP developed from our system will enable them to check the current positions of the elderly. The system reduces the time to find the elderly and smooth the nursing process. The system also records the daily care of the elderly, and the caregiver sees the detailed information and status of the care items through the APP. Before nursing is required, the system notifies the on duty staff and operations that be performed through a push message. After the caregiver completes the daily care, the APP updates the care status. This function avoides the omission and duplication of nursing tasks.

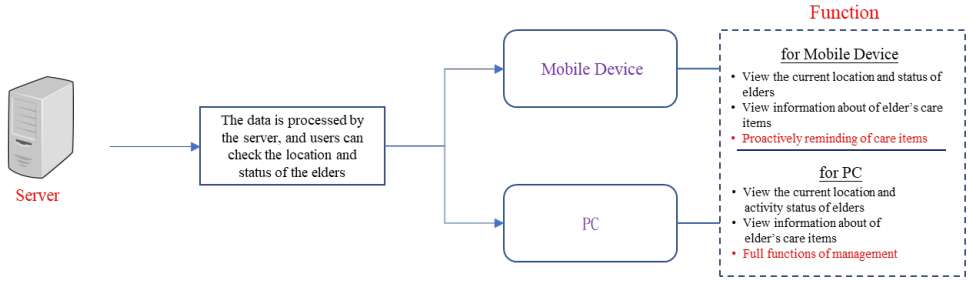

Fig. 4. Flow of Care Assistence.

2.1.2. Abnormal Warning

In the process of the "abnormal warning" (Fig. 5), the positioning device locates the elderly and judges if there is an abnormal condition in the elders (staying too long in a certain place or entering a specific area). When the abnormal condition of the elderly is determined, the positioning device sends the information to the Wi-Fi Mesh. Pre-installed warning panel and screen module in a prominent of the application area will receive related data from Wi-Fi Mesh. The warning panel shows the location, indicates the degree of urgency of conditions through the color of the light, and plays the corresponding level of warning sound. This provides a more intuitive way for caregivers to receive information. The screen module provides more detailed information, such as who and where the condition occurred. Other than the location and status, the camera module also performs photo-taking actions. The system will send the images and messages to the caregivers through the mobile device by push notification. When the caregiver receives such an emergency message, they immediately goes to the location to check. When the caregiver visits the site, their will return information by using the Abnormal Warning Reporting Device (AWRD) pre-installed at the site according to the actual situation of the elders. Before using the AWRD, the caregiver must tap the mobile device to the device for authentication. When the caregiver after inspection, elders do have abnormal conditions, but the current manpower is not enough to deal with, caregiver can press the red button, the warning panel will light up the red light and play the high risk warning sound. If the current manpower is sufficient, the caregiver can press the yellow button on the AWRD and the warning panel will light up with a yellow light and play a dangerous warning sound. Yellow and red buttons are used for calling for more help and warning about the worse situation. When the condition is finished, the caregiver can press the green button on the AWRD and the system will release the abnormal condition, the warning panel will light up green and stop playing the warning sound, and send the condition release message to the caregiver by push notificetion. In addition, when the caregiver finds no abnormal condition after inspection, he / she can press the blue button of the AWRD and the system will release the abnormal condition directly. Using this function of the system helps the attendants to respond to any situations in golden time, not delaying medical treatment and preventing the elderly from being worse.

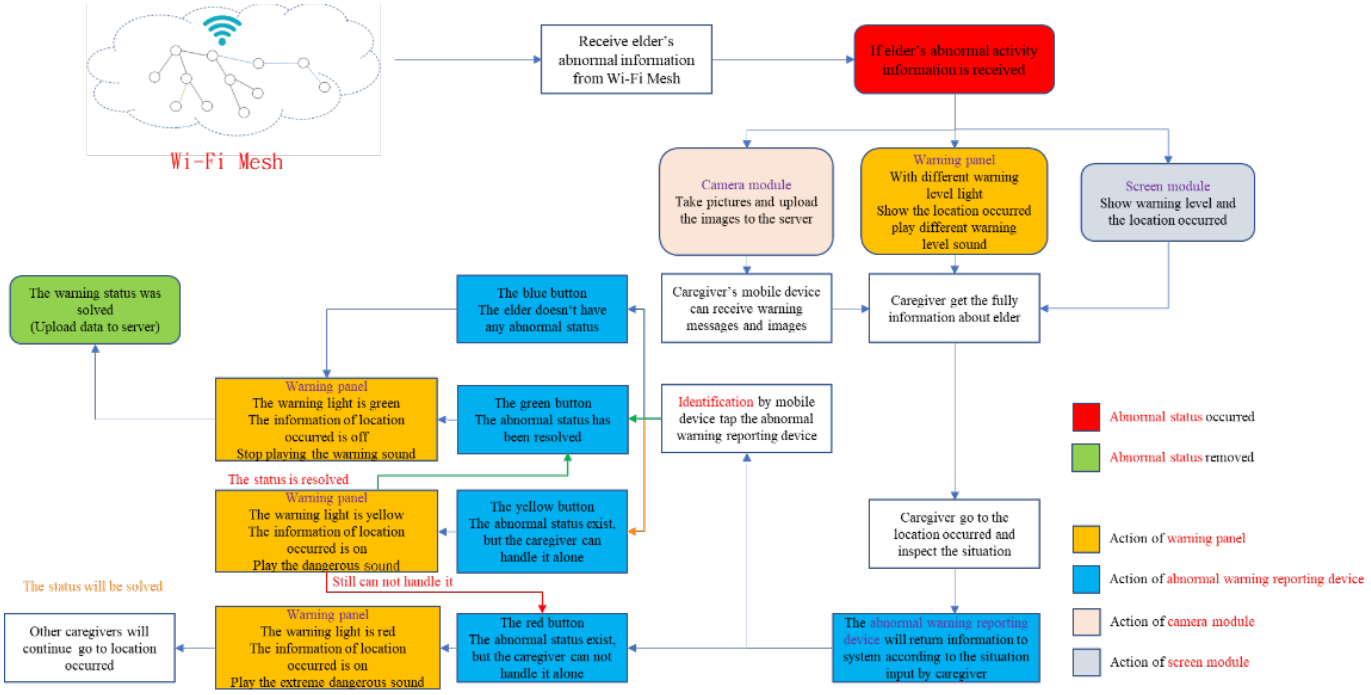

Fig. 5. Flow chart of the abnormal warning function.

2.2. Research Process

The system is developed based on key factors for finding the location and monitoring the activity of the elderly. The system is tested and the results are shown in Fig. 6.

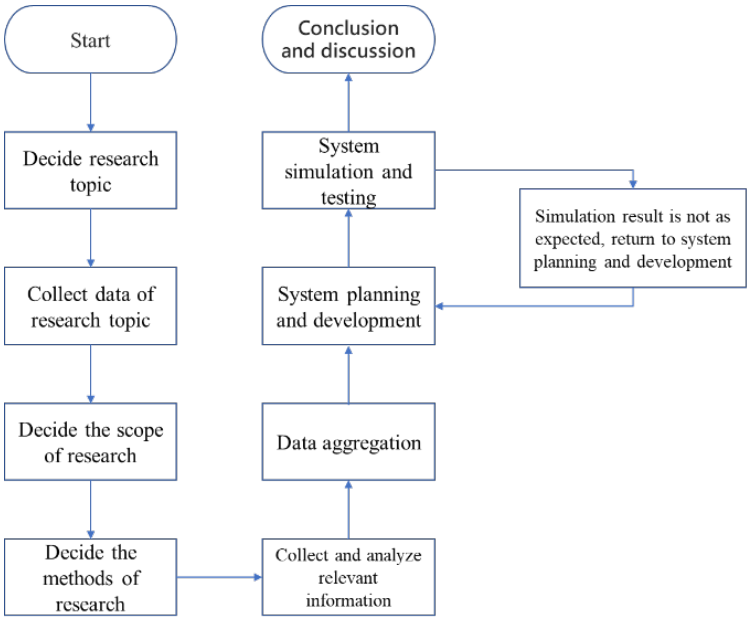

Fig. 6. Research flowchart.

2.3. System Architecture

This study uses BLE as the indoor positioning technology, the network structure uses Wi-Fi Mesh, and each node is processed by edge computing. The system includes an automatic reorganization function, customizable data format (JSON), and edge computing.

2.3.1. Automatic Reorganization Function

The network architecture used in this system is Wi-Fi Mesh. When a node is damaged or disconnected, the network structure is automatically reorganized (Fig. 7). Unlike a ring network, the failure of any node causes the entire network to be paralyzed (Fig. 8). As the Wi-Fi Mesh is decentralized, node devices automatically are connected to other devices. Not like a star topology (the current mainstream intranet architecture), all data are transmitted through the central node. When the central node fails, data is not transmitted, and the network paralyzes as shown in Fig. 9. If the above ring or star network is applied to the system, when any node fails may result in the abnormal warning of the elderly is not transmitted correctly, which causes the failure to know the abnormal condition of the elderly and misses the golden rescue time. In installing the system, multiple devices are required. In the Wi-Fi Mesh, each node needs to use the same wireless network name, password, and communication port to automatically form an interconnected internal network. This is more convenient when the system requires additional equipment (Fig. 10). As no external connection is required, there is no hacked data. In summary, the system with the Wi-Fi Mesh has automatic reorganization, a decentralized structure, good scalability, and high information security.

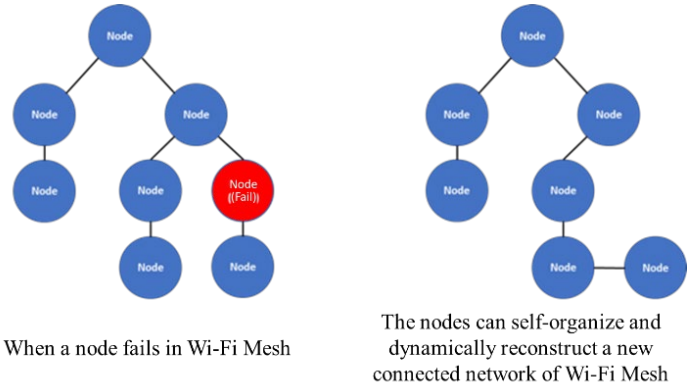

Fig. 7. Automatic reorganization when any node in Wi-Fi Mesh fails.

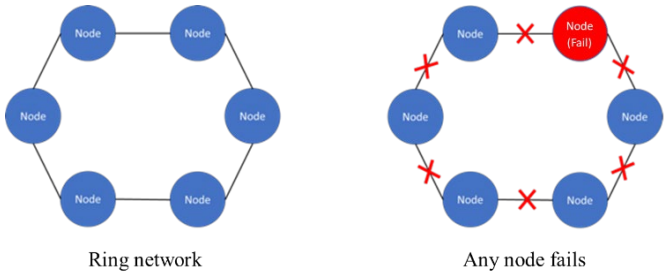

Fig. 8. Overview of the ring network structure and the failure of any node.

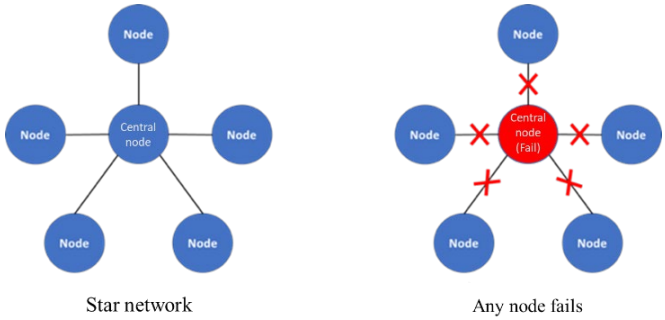

Fig. 9. Overview of the star network structure and the failure of the central node.

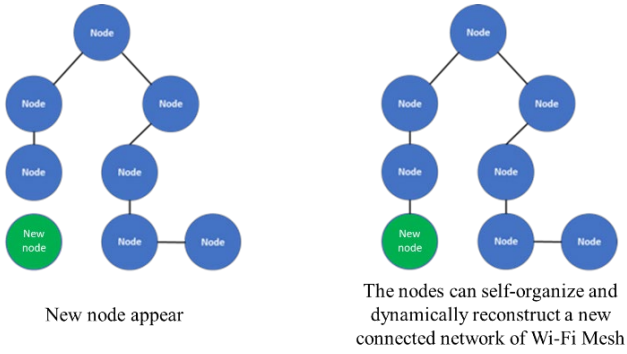

Fig. 10. Wi-Fi Mesh automatically reorganizes when new nodes are added.

2.3.2. Customized Data Format (JSON)

The system transmits data at each node in Wi-Fi Mesh. This architecture is easy to expand. Traditional IoT devices need to communicate with each other with their own set of specific data formats, and if the system need to communicate some different devices, it is necessary to customize a variety of different data formats, so it is not easy to expand devices. The data format of this system adopts JSON (JavaScript Object Notation). JSON is a standard format for presenting structured data as JavaScript objects. It has the characteristics of high compatibility, easy-to-understand format, and convenient reading and modification. With JSON, the system adds equipment or modifies the data structure easily. Table 2 shows an example of the JSON data structure of the system.

{"TYP":"STATUS","CID":7874300,"NID":846735100,"NAME":"ESP32" , "LOC":101 , "EID":10001}

Table 2. JSON custom format description.

Key	Value
TYP	Data type
CID	Unique ID of device
NID	Unique ID of device in Wi-Fi Mesh
NAME	Name of device type
LOC	Location number of positioning device
EID	Elder's ID

2.3.3. Edge Computing

Edge computing is distributed computing that integrates intelligence into edge nodes, allowing timely processing and analysis of data at data collection. In edge computing, data is not uploaded directly to the network or a centralized data processing system. Common IoT devices on the market, the data is uploaded to the server for unified processing. After processing, the server sends the data back and controls the device. However, if the server fails or the network is abnormal, the device becomes unusable. To improve the situation, each node of the system adopts edge computing. The edge computing of this system is for the node to receive JSON information through Wi-Fi Mesh. The node automatically parses the relevant information by JSON and handles the related work that the node is responsible for. Therefore, there is no need to process and calculate data through the server, which reduces the burden of the server, improves the response time, and provides higher bandwidth availability.

3. Results

The system architecture is shown in Fig. 11. The system includes Wi-Fi Mesh, related equipment, and user interface. The following is a detailed description of the implementation.

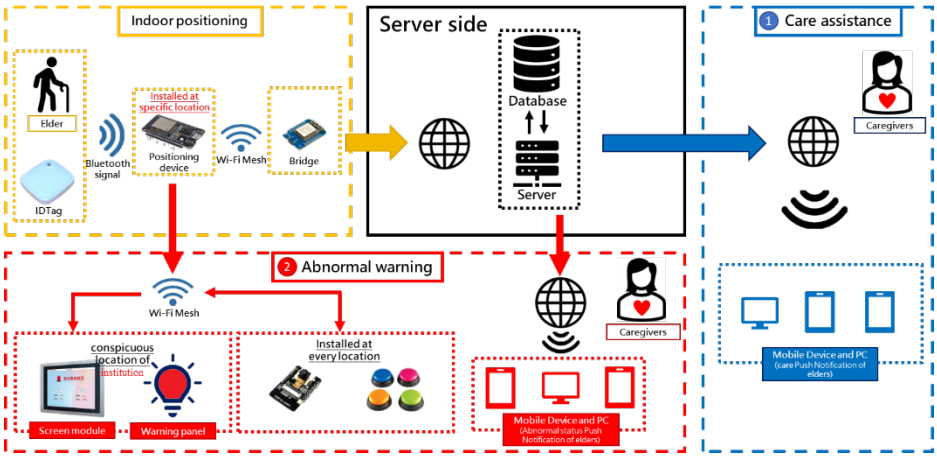

Fig. 11. System architecture.

3.1. Wi-Fi Mesh

Devices in the Wi-Fi Mesh network include bridges, positioning devices, warning panels, screen modules, camera modules, and Abnormal Warning Reporting Device (AWRD). The data of each node is in JSON format and customized by the system. The data is exchanged and control is conducted through the Wi-Fi Mesh. The bridge of this system is the ESP8266 D1 mini development board (Fig. 12) which uses the Wi-Fi function to connect peripheral devices and upload the data to the server. The location and activity status of the elderly are transmitted to each node through the Wi-Fi Mesh. When an abnormality is detected, a warning message is displayed immediately. At the same time, the camera takes and sends pictures. In addition, when the caregiver presses the button on the AWRD, the device will also send the reporting data to the server.

Fig. 12. ESP8266 D1 mini development board.

3.2. Related Equipment

There are six type of devices in the system, including IDTag, positioning device, warning panel, screen module, camera module, and abnormal warning reporting device.

(1) IDTag: The system uses a Beacon that emits Bluetooth signals as the IDTag. The unique MAC address (Media Access Control Address) of the Beacon device is used to bind to the personal information of the elders as the identity of the elders. The device is small in size (Fig. 13) and light and consumes less power to be used for a long time.

Fig. 13. Beacon device.

(2) Positioning device: The positioning device of this system is composed of the ESP32 single-chip development board (Fig. 14). The ESP32 supports Wi-Fi and Bluetooth technology. Bluetooth is mainly used for indoor positioning, receiving Bluetooth signals from IDTag, and judging the current location and activity of elders based on the strength of the signal with IDTag. Wi-Fi is mainly used for data transmission, and it forms a Wi-Fi Mesh network with other related devices to send information about the location and activity status of elders through Wi-Fi Mesh. The automatic reorganization of the mesh Wi-Fi Mesh has high stability in data transmission (Fig. 15).

Fig. 14. ESP32 single-chip development board.

Fig. 15. Positioning device.

(3) Warning panel: A warning panel is installed in a conspicuous place in the application area to provide a more intuitive way for the caregiver to receive information by means of lights and sounds . This panel is controlled by the ESP8266 D1 Mini development board (Fig. 12). Through the Wi-Fi function of this development board, it can form a Wi-Fi Mesh network with other related devices and receive the data related to the abnormal condition of elders sent from any node. According to the received data, the

control warning panel lights up the corresponding lights and displays the location of the abnormal situation. The warning panel is mainly divided into two blocks: the emergency light signal of abnormal condition and the information of the place of occurrence (Fig. 16). The emergency signal part, through the different color of the signal, indicates the degree of emergency of the abnormal condition, the color of the signal is divided into red, orange, yellow, green four kinds. For the situation to check and confirm, a orange light is seen. For abnormal conditions and needs for help, a red light is up. A yellow light is for the situation to be settled down. A green light is for the normal situation.

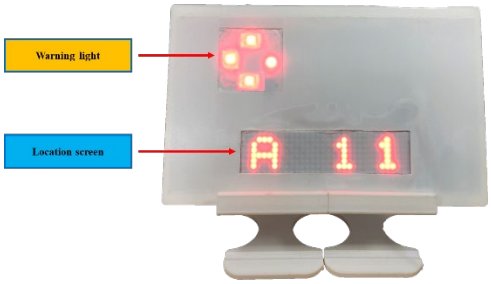

Fig. 16. Warning panel.

(4) Screen module: The screen module is installed under the warning panel (Fig. 17) and provides detailed information to the attendant. This module has an ESP8266 D1 mini development board to control the USART HMI screen. Through the Wi-Fi Mesh, the screen receives data related to abnormal conditions of elders sent from positioning device. Detailed information about the object and location of the abnormal condition also be displayed. (Fig. 18).

Fig. 17. Screen module.

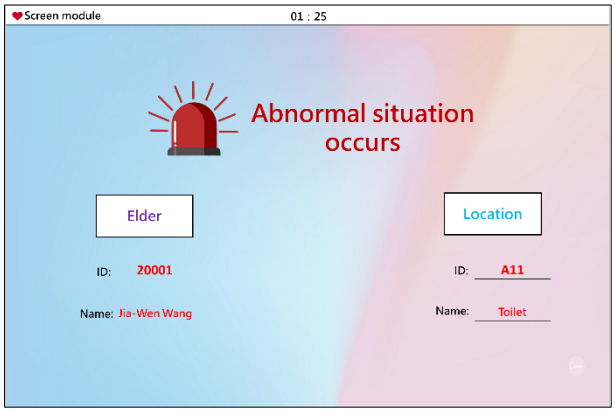

Fig. 18. Screenshot of Screen module.

(5) Camera module: Camera modules are installed at various locations to take images of abnormal conditions. This module contains an ESP32 CAM single-chip development board (Fig. 19). When the elderly with an abnormal condition is located, the module

takes pictures and uploads them to the server. The pictures are sent to the mobile device of the attendant in real-time by push notifications.

Fig. 19. ESP32 CAM single chip development board.

(6) Abnormal Warning Reporting Device (AWRD): AWRD is shown in Fig. 20. When the attendant receives the warning message and visits the location, the attendant uses this device to report the situation. The device has 4 buttons of different colors to show the different statuses of the elderly. To avoid accidental touches, the attendant must authenticate before using the device. To touch the mobile device on the warning report device, the attendant can use the device. (the flow as Fig. 5)

Fig. 20. Abnormal warning reporting device

3.3. User Interface

The user interface of this system is divided into two parts, the application and the push notification.

(1) Application: This study developed a set of applications for mobile devices and computers for this system. The application allows the caregiver to view the location and activity status of the elderly in detail. In the APP for mobile devices, the staff number and password of the attendant need to be input (Fig. 21). Caregivers can check the current relative position of each senior (Fig. 23). The caregiver can view the daily care needs of elders on the system screen, including the items and the time to be executed. When the caregiver has completed the daily care needs of the elders, "Finish" is clicked (Fig. 22). The system records completed items, and other caregivers can also see which items have been completed or not. The function prevents the attendant from omitting and repeating the same care item. The computer APP retains the functions of the mobile device APP and provides a complete management features (Fig. 24), including personnel management, nursing project management, hardware data setting, etc.

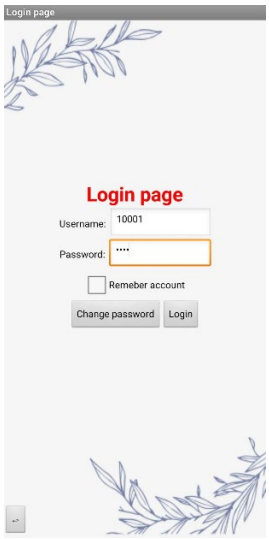

Fig. 21. APP login screen.

Fig. 22. Elder care items.

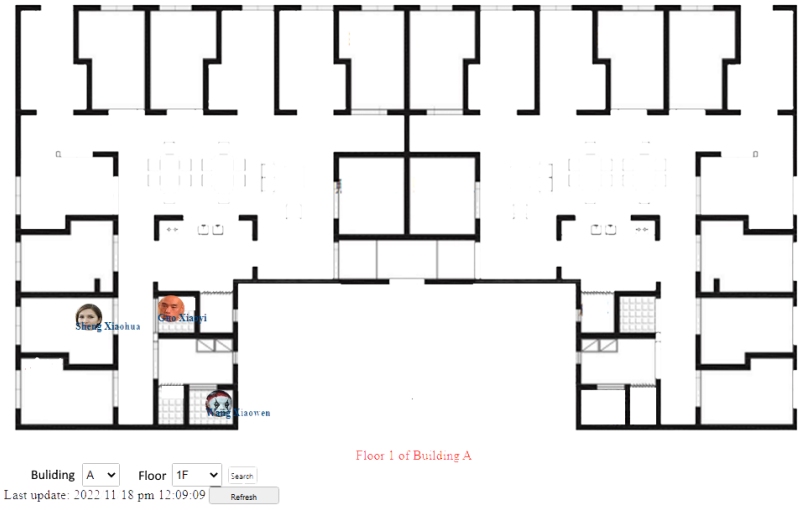

Fig. 23. The location information of the elders.

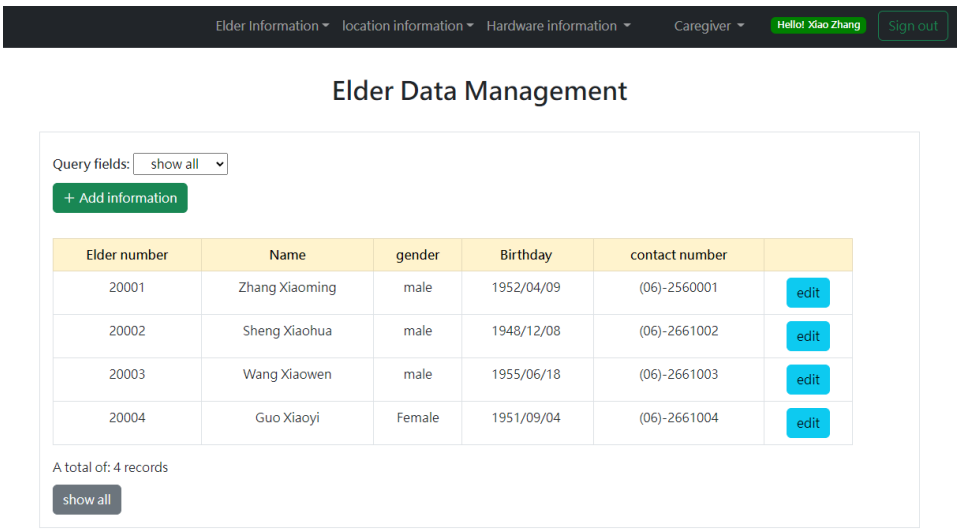

Fig. 24. APP management page for computer.

(2) Push notification: The broadcast of information is realized by Line Notify. Line Notify provides an API with push notifications and is the most popular message service. According to a survey, Line has about 21 million users in Taiwan [15]. In the push message function, it only need to add a specific Line Bot account and caregivers to the same Line group. When one message is sent by system, all attendants receive it at the same time. The information pushed by this system is on care need notification and abnormal condition warnings. The system reminds the person on duty in time. To avoid omitting elder care needs, the notification includes the execution time, objects, and pre-preparation-related materials (Fig. 25). The abnormal warning part, when the positioning device determines that the elders have abnormal conditions, the system automatically sends a message through the device to notify the caregiver to check (Fig. 26).

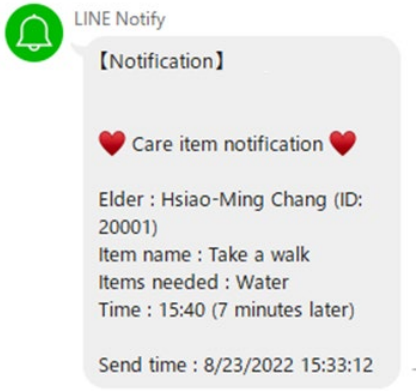

Fig. 25. Elder care needs reminder.

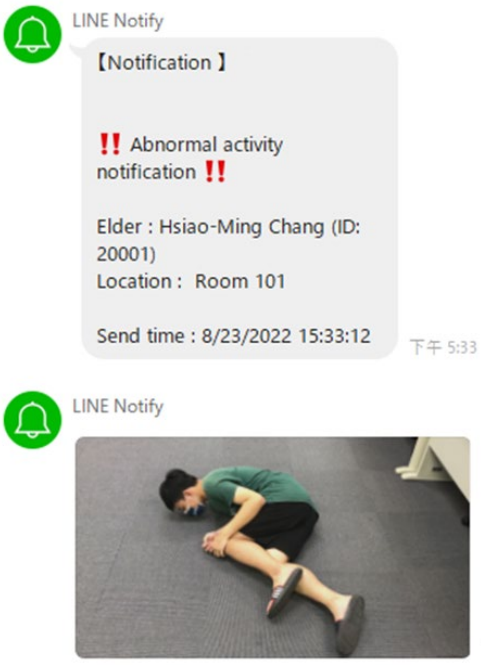

Fig. 26. Notification of abnormal conditions of elders.

4. Conclusions

The system is developed to solve problems in long-term care institutions due to the increase in the aging population, the imbalance of institutional care ratio, and busy care workers. Indoor positioning is enabled through Bluetooth low-energy to obtain the location and activity status of the elderly. Wi-Fi Mesh is used to form an internal network, enabling each node to transfer data within the network environment. Each node uses edge computing to significantly reduce server load. Mobile devices and computer APPs are developed for relevant use. The system is divided into two major functions of care assistance and abnormal warning. In the care assistance function, the system provides the current location of the elders, so that when the caregiver needs to carry out the

care items, the time required to find the elders is eliminated and the care process is smoothed. When the caregivers are required to care for the elderly, the system notifies the need and time. The system also reminds the on-duty staff to care for the elderly through the mobile device and records the execution status. Then, omission or repeated execution of caring is prevented. The system determines whether the elderly have abnormal conditions to be cared for according to the indoor positioning and sent pictures. When the system determines an abnormal situation, a warning notice is issued immediately for the attendant to check. According to the actual situation, the system sends the abnormal warning report for efficient caring service (Table 3).

Due to the current impact of Covid-19, it becomes difficult to go to a long-term care facility for an actual test. In a future study, the test is necessary to be performed with the cooperation of relevant institutions to evaluate the system. According to the evaluation results, the system needs to be optimized to be more suitable for long-term care institutions and the actual needs. To solve the problems of the heavy workload of the attendants caused by the imbalance of care ratios, this system will be improved and implemented based on the result of this study.

Table 3. Summary of the two functions.

1 Care assistance	• Provide the location of elder, reduce the finding time. Smoothen nursing process • Remind nursing item of elder by push notification, record nursing status. Avoid omission and duplication of nursing item
2 Abnormal warning	• Receive elder information of indoor activity. Detect the happen of abnormal situation • Accord input of caregiver on the abnormal warning reporting device. guide of optimize manpower will provide by system

Author Contributions: Conceptualization, C.P. Chang; methodology, C.P. Chang and J.W. Wang; software, J.W. Wang, A.J. Hsieh, and H.W. Chang; formal analysis, C.P. Chang and J.W. Wang; investigation, C.P. Chang and J.W. Wang; resources, A.J. Hsieh and H.W; writing—original draft preparation, C.P. Chang, J.W. Wang, A.J. Hsieh, and H.W. Chang; writing—review and editing, C.P. Chang and J.W. Wang; supervision, C.P. Chang. All authors have read and agreed to the published version of the manuscript.

Funding: This research did not receive external funding.

Informed Consent Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. National Development Council of the Republic of China. Population Estimates for the Republic of China (2020-2070). 08.2020, last revised August 2020. https://reurl.cc/vW6V3A.
2. Ministry of Health and Welfare. The Actual Number of Residents in Long-Term Care and Nursing Institutions for the Elderly. last revised December 2022. https://reurl.cc/gQY04Q.
3. Ministry of Health and Welfare. The Number of Staff in Long-Term Care, Nursing and Caring institutions for the elderly. last revised December 2020. https://reurl.cc/VRWDNA.
4. Ministry of Health and Welfare. Long-Term Care Ten Year Plan 2.0 (Years 106-115). 12.2016. https://www.mohw.gov.tw/dl-46355-2d5102fb-23c8-49c8-9462-c4bfeb376d92.html.
5. Chen, X.-H. 107 to 0028. Control Yuan. 0v.2018. https://www.cy.gov.tw/CyBsBoxContent.aspx?n=133&s=6035.
6. Lin, C.-C; Liang, W.-L. Potential Applications and Business Considerations of Smart Healthcare. Institute of Industrial Technology. July 5, 2019. https://jictcms.itri.org.tw/xcdoc/cont?xsmsid=0M208578644085020215&sid=0M266526814490812079.
7. Research commissioned by the National Development Council. Research on Key Issues and Countermeasures of Smart Healthcare. 04.2017. https://reurl.cc/0XZ7XA.
8. Yin, T. [Silver Haired Market] New Business Opportunities for The Silver Hair Industry: Do You Know What Is The Ageless Age? Great college. January 13, 2020. https://www.smartm.com.tw/article/36323339cea3.
9. Chen, F.-Y; Ko, W.-L; Wu, P.-H; Lin, Z.-Y. Smart Medical Lazy Pack Contains Eight Pictures to Understand The Definition and Application of Smart Medical Care and The Challenges in Taiwan at One Time. Futuristic City. March 16, 2021. https://futurecity.cw.com.tw/article/1916.

10. Industrial Technology Research Institute. The Industrial Technology Research Institute, Together With The Smart Long-Term Care Alliance of The Industry-Government-University-Research-Medical Group, Uses Technology to Add Value to Care and Create Business Opportunities for The "Heart" of The Elderly in The Orange Generation. August 3, 2020. https://reurl.cc/91nGej.
11. Wang, Y.-X. Estimation of The Population and Care Needs of Persons with Dementia and Disabilities in Taipei City. Accounting Office of Taipei City Government. December 2020. https://reurl.cc/O4G7mr.
12. Kangjian. What Should I Do If My Elder Falls? Don't Miss The Golden Time for Rescue. April 8, 2019. https://www.commonhealth.com.tw/article/79186.
13. Chen, Z.-Y. Communications Industry Key Report. New Communications Elements Magazine. February 5, 2018.https://www.2cm.com.tw/2cm/SpecialProductDetails.aspx?id=F731C54FD4B2431CBC3F1E01CE10ABFF.
14. Lo, Z.-H. Stay Close To Your Guests with Wi-Fi. iThome. August 23, 2013. https://www.ithome.com.tw/tech/82239.
15. Huang, X.-Q. LINE Taiwan Users' Annual List of Favorite Features Released! The Scanning Function Won The Championship. United Daily News. December 9, 2021. https://udn.com/news/story/7088/5948801.