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The Internet of Things system combined with the cloud platform is applied to the data collection and analysis of the elderly home life style

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Short resume

Bing-Hong Jiang

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Education

- M.S Master Program of Mechatronic Engineering, National Taipei University of Technology
- B.S. Department of Mechanical Engineering , National Taipei University of Technology, 2020

Research

- Big data analysis
- IoT
- Cloud Service

Outline

- Introduction
- System Architecture
- Method
- Result and Discussion
- Conclusion
- Future work
- Appendice

Introduction

- This study combines Google Cloud Platform (GCP), Google Assistant, Firebase and MongoDB for data streaming and storage through smart bracelets, smart amulets (9-axis IMU), and smart speakers (Google Home Next Mini), and the collected data changes are displayed on the webpage immediately to form a home care internet of things system for the elderly. The experiment visited five groups of families for actual testing, with ten people experimenting for one week, all wearing the smart bracelet and the smart amulet at the same time.

System Architecture

- IoT System Architecture Diagram

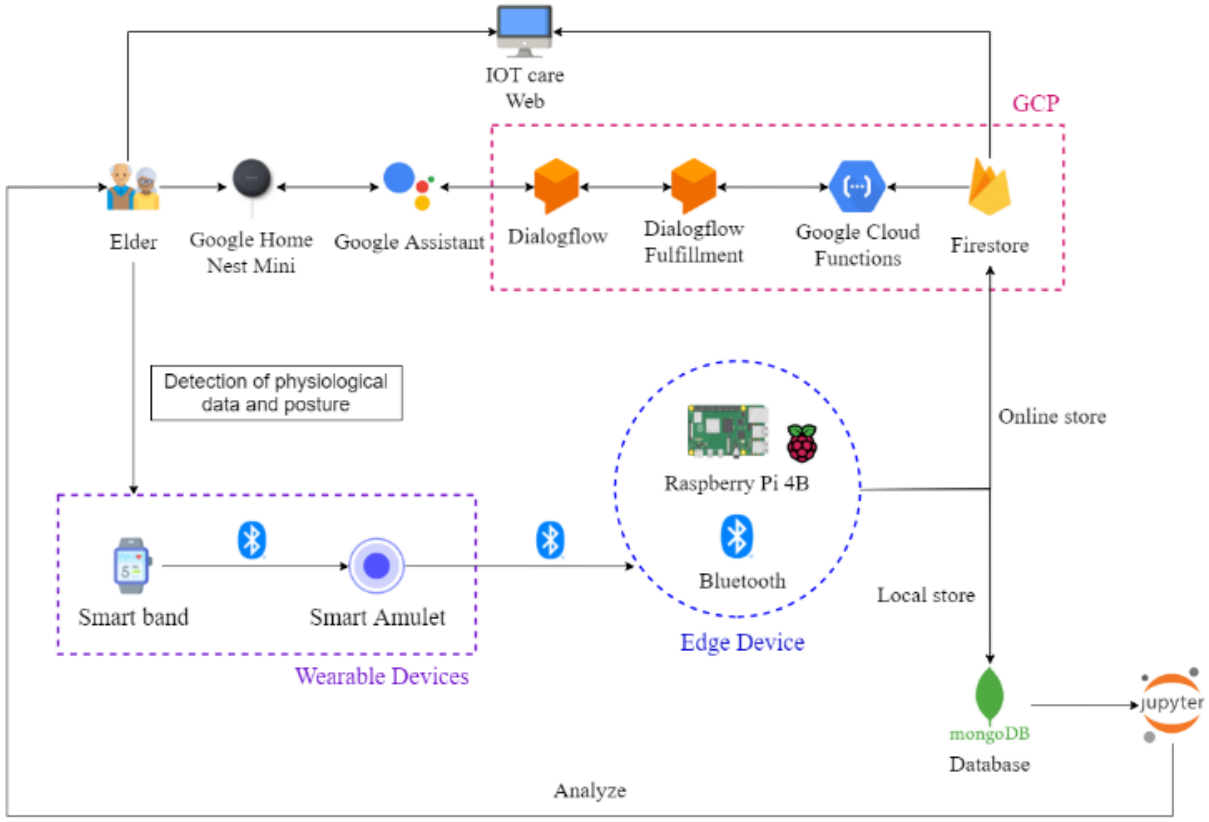


Figure 1.

System Architecture

- Flowchart of active broadcasting by speaker

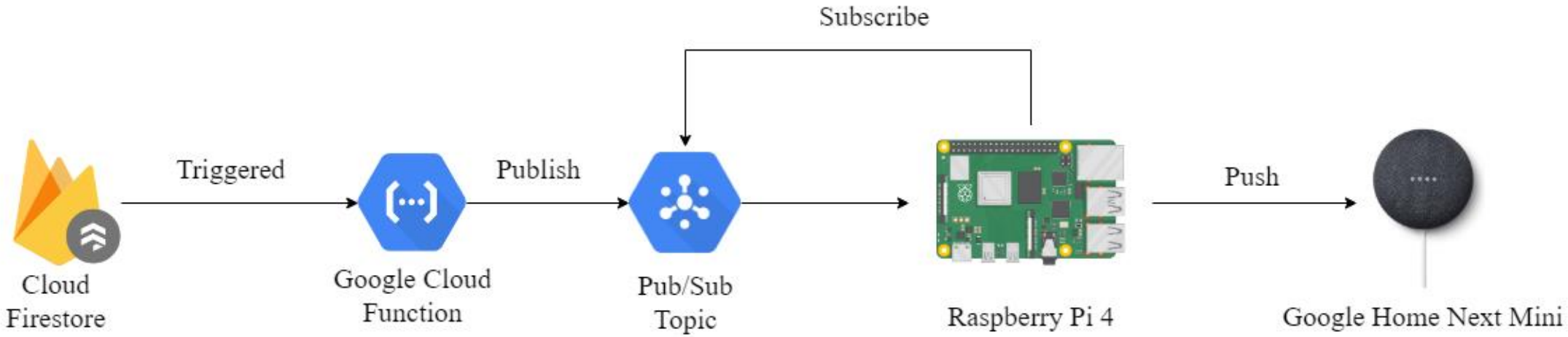


Figure 2.

System Architecture

- Devices used in IoT care systems

Device	Function	Advantage
Smart Bracelet	Blood pressure, Step, Mileage, Temperature, Heart rate and Calorie	with bracelet protocol, Cheap
Smart Amulet (9-axis IMU)	Attitude, Motion, Height monitoring, Fall monitoring, Emergency alert and indoor positioning	With 9-axis sensor, accurate identification
Smart Speaker (Google Home Nest Mini)	Notifications, Conversations, Sentence Collection and Care	Google has a series of services and functions
Beacon	Indoor positioning	Accurate positioning function
Edge Device (Raspberry Pi 4B)	Collect Bluetooth device data and store in database	Speed up data processing and response time

Table 1.

Method

➢ Subjects

The subjects were 10 people, 5 elderly people aged 70 to 80 years and 5 young people aged 24 to 26 years, and the system was set up in 5 households. The height and weight of the elderly were as shown in Table 2, and the height values shown in Table 2 were measured without hunchback.

Subjects (Elder)	Height(cm)	Weight (kg)	Humpbacked	Illness & Injury
Elder 1	158	62	No	Had ankle surgery
Elder 2	155	58	Yes	Bipolar disorder & Effusion of knee joint
Elder 3	155	45	Yes	Had knee surgery
Elder 4	157	58	Yes	Back sprain
Elder 5	168	65	No	None

Table 2.

Method

- Physiological State Data and Daily Posture Collection

  During the experiment, the subjects will be asked to wear the smart bracelet and the smart amulet for 7 days. Except for washing, they would wear them during the rest of the time.

- Experimental equipment wearing schematic diagram

Figure 3.

Smart Watch

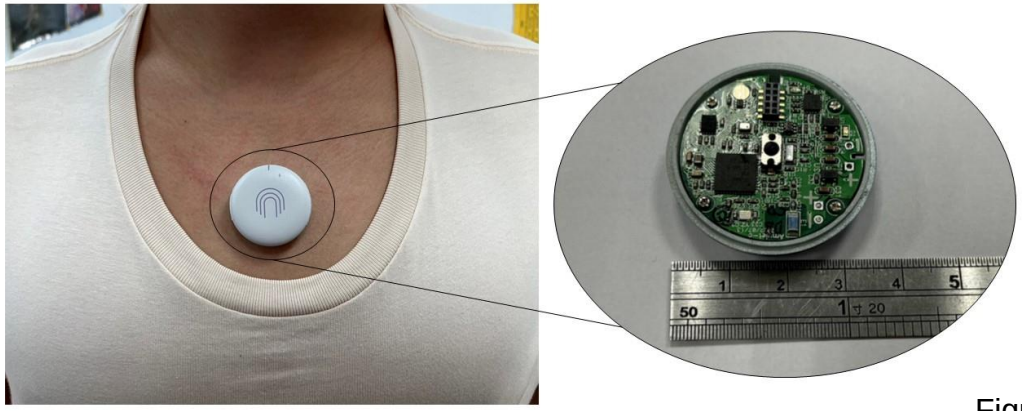


Figure 4.

Smart Amulet

Method

- Timed Up and Go Test (TUG)

The Timed Up and Go Test (TUG) frailty assessment standard was conducted to check the movement changes of the subject and to determine whether the subject had frailty symptoms. Time Up and Go Test uses the standard TUG protocol and starts from the center of the foot and goes forward 3m, using tape at the 3m mark and turning around the cross mark. The TUG experiment was conducted using a chair with no back rest.

Result and Discussion

➢ Physiological Information and Daily Posture Collection Results

The data collected during the experiment will be uploaded and stored to the cloud database through the edge device, and the current posture changes will be displayed through the webpage for the subjects to view in real time.

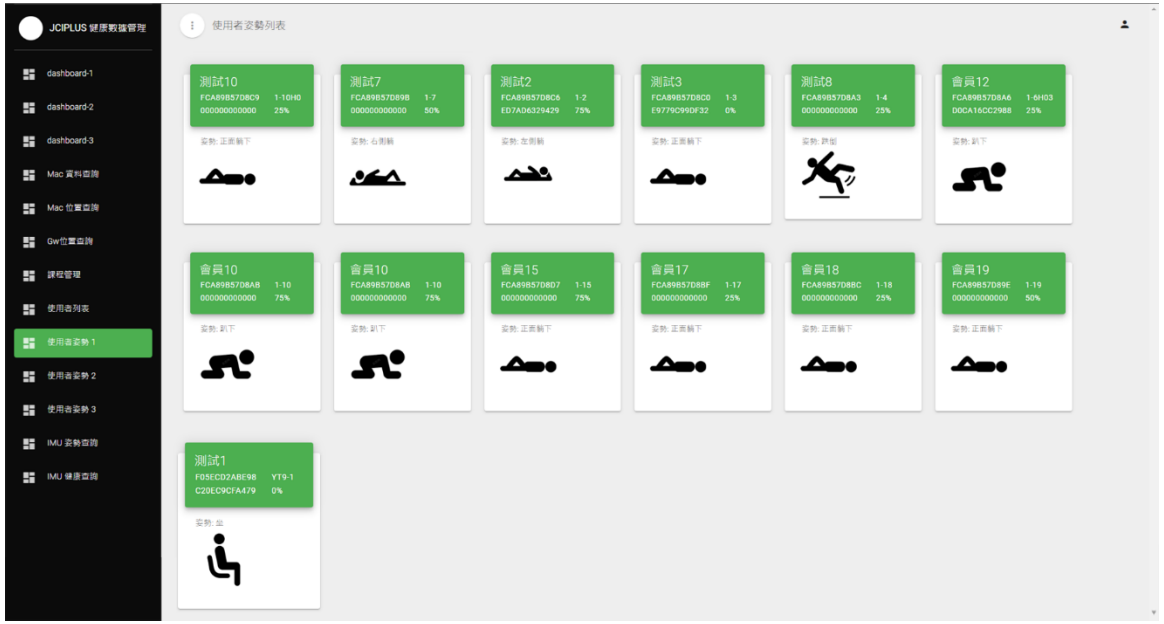


Figure 5.

Result and Discussion

➢ Physiological Information and Daily Posture Collection Results

The physiological data and postural changes collected daily were plotted for analysis. The graphs were used to clearly analyze the physiological data and postural distribution of the subjects during one hour at a point in time, as shown in Figure. 6 and 7.

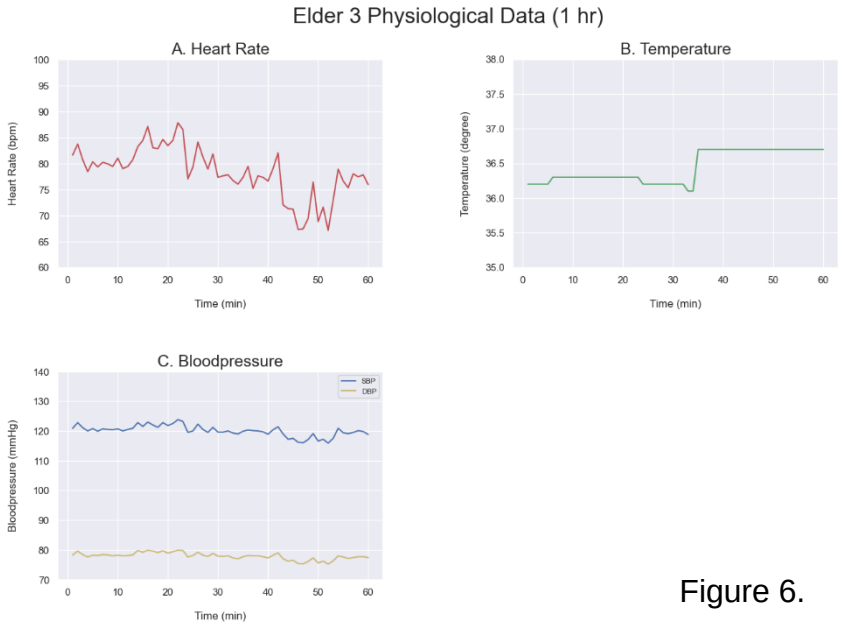


Figure 6.

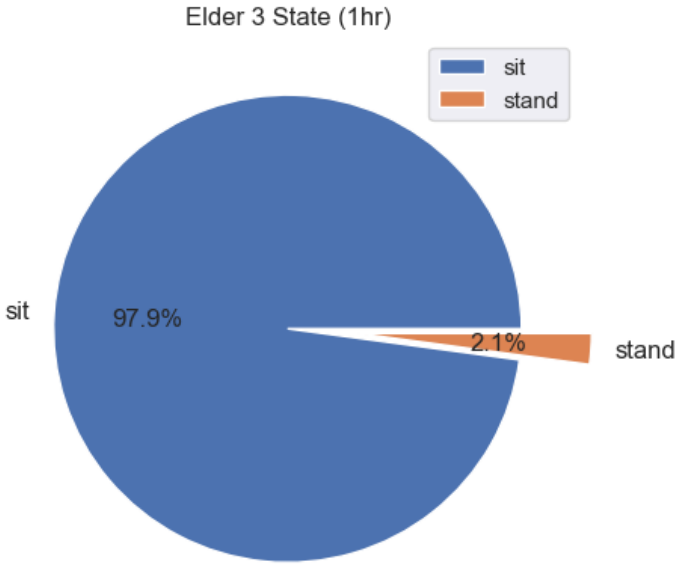


Figure 7.

Result and Discussion

- Physiological Information and Daily Posture Collection Results

1. Figure. 6C shows that the blood pressure changes during the first 30 minutes implied a trend of pre-hypertension. According to the criteria for hypertension published by the American Heart Association, a diastolic blood pressure between 120 mmHg and 129 mmHg and a systolic blood pressure below 80 mmHg are the criteria for prehypertension.
2. The posture distribution in Figure. 7 showed a prolonged sedentary state, which was verified with the experimental activity records, and the subject was watching a movie at that time, which was presumed to be caused by the tension of the drama.

Result and Discussion

- Daily Behavior Analysis

The results of the TUG experiment with the same conditions for young person 1 and elder 1 are shown in Figure. 8

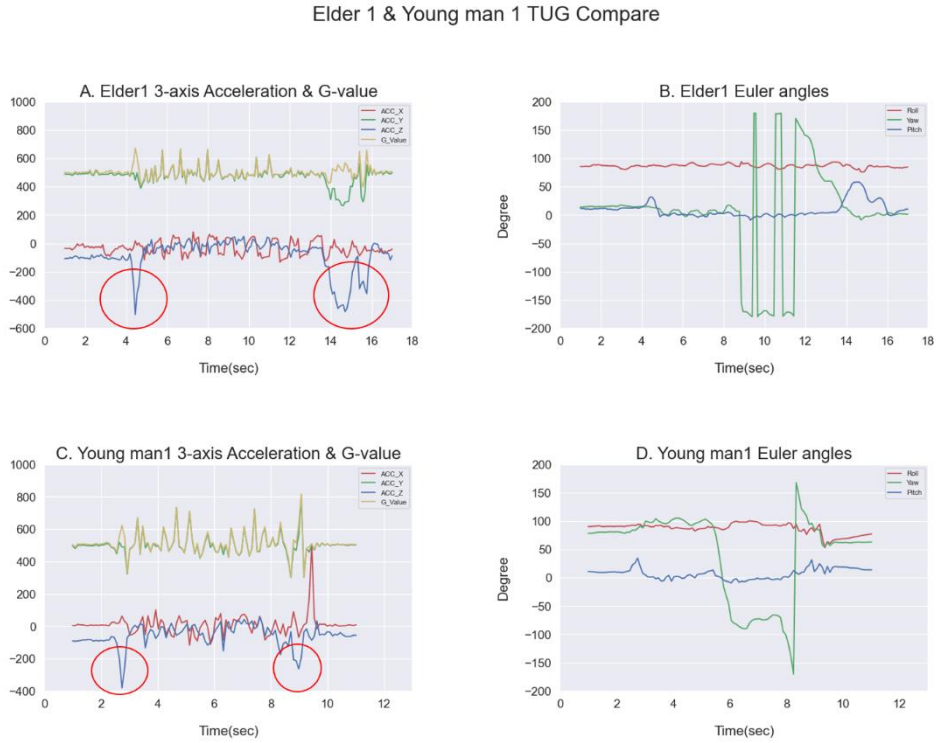


Figure 8.

Result and Discussion

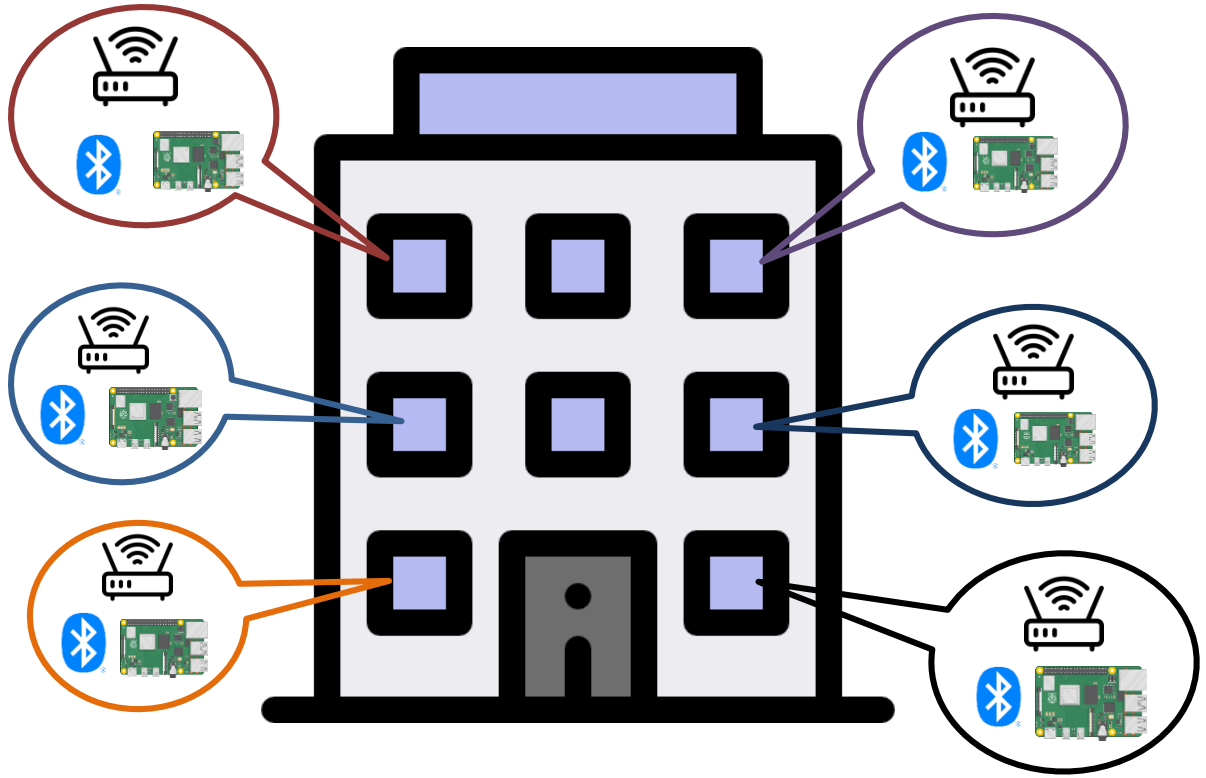
- Daily Behavior Analysis
  1. From Figure. 8A and 8C for comparison of the difference in 3-axis acceleration changes, we can observe that the amplitude of G-value of young person 1 is larger than that of elder 1.
  2. comparing the difference of Z-axis acceleration, the maximum amplitude of Z-axis acceleration reached -400 as shown in the red circles in Figure. 8A and 8C, indicating that elder 1 was leaning forward than young person 1 in getting up, which could be inferred from observing the experimental procedure that elder 1's leg muscles were relatively weak and needed to be guided to stand by body strength.
  3. the TUG test time of elder 1 was greater than 12 seconds, and it is presumed that there may be a risk of falling.

Conclusion

- More effective care for the elderly at home
- Real-time display of physiological data of the elderly for easy viewing
- Low equipment costs
- No discomfort when worn
- Smart speakers help to solve the difficulties encountered by the elderly in their lives

Future work

- Access to more homes for experiments
  1. Expansion of experimental population
  2. conduct more realistic and long-term experiments
  3. Create a more comprehensive and complete personalized care system



Appendice

- The American Heart Association

BLOOD PRESSURE CATEGORY	SYSTOLIC mm Hg (upper number)	and/or	DIASTOLIC mm Hg (lower number)
NORMAL	LESS THAN 120	and	LESS THAN 80
ELEVATED	120 – 129	and	LESS THAN 80
HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 1	130 – 139	or	80 – 89
HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 2	140 OR HIGHER	or	90 OR HIGHER
HYPERTENSIVE CRISIS (consult your doctor immediately)	HIGHER THAN 180	and/or	HIGHER THAN 120

Source：https://www.heart.org/en/health-topics/high-blood-pressure/understanding-blood-pressure-readings

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