Nursing activities measurement technique of low introduction barriers

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1. Introduction

This paper reports on the development of human positioning method and the experiment in medical welfare facility using Bluetooth Low Energy, BLE, of ultra-low energy wireless communication technology.

Authors have been measuring the users' behaviors in the built environments1). While GPS has been popular in outdoor space, various indoor-positioning technologies are being invented, however, they are still in the development and each has both certain strengths and weaknesses. For example, high-precision positioning system requires high cost and installation efforts, which means high introduction barrier. Therefore, in order to measure the flow of staff at medical welfare facilities, authors have developed a low-introduction barrier positioning system using a generic terminal and BLE. However, the size and weight of the terminal used as the wearable receiver brings about a certain burden on the task, a sense of incompatibility, and trouble of desorption, so improvement was required. Therefore, we tried to newly develop a positioning system with BLE receivers on the building side and beacon transmitters with people. This flash report includes the experiments, the verification process and the analysis of acquired data.

The target is a night shift staff of a short-term residency care facility (Short Stay in Japanese). Many nursing home care facilities are in a severe situation, while domestic remarkable aging is progressing. To secure residents as well as care worker is an issue. With limited human resources and financial resources, technical development that effectively supports nursing care staff and residents is required. Because the night shift zone is operated only by two care workers, work burden and responsibility are particularly large. In spite of properly performing work, we have heard instances where inadequate nursing care is pointed out from the resident's family. The purpose of this paper is to show the actual condition of nursing care toward facilities, residents and their families through scientific measurements and records and to extract feature values of nursing care by analysis of aquired data.

2. Methods

2.1. Configuration of positioning system

①Beacon (Advertiser: Transmitter)

Radio waves of the 2.4 GHz band are transmitted at regular intervals. Technical considerations are made so as not to affect or receive existing wireless communications such as Wi-Fi. It operates with a coin type lithium battery and is small and lightweight as shown in Photo 1.

Photo 1. BLE beacon transmitter

Table 1. Specification of BLE

	Value
Frequency	2.400 - 2.4835GHz
Bit rate	1Mbps
Transmission power	10μW – 10mW
Transmission distance	Maximum 50m

Table 2. Specification of transmitter

	Value
Advertisement interval	1.28 seconds
Size	W65 x H35 x D10 mm
Weight including button battery	18g
Battery	CR2032 (3V)

Table 3. Acquired data

Name	Value
Time	yyyy/mm/dd hh:mm:ss
Room number	1 – 40
UUID	32 digits number
Major	1
Minor	1, 2
RSSI Received Signal Strength Indicator	[dBm]

②Single Board Computer (Receiver)

The positioning applications are developed and implemented on single board computers. They are operated using the AC power supply of each room. In experiments, we installed 40 single board computers at various places throughout the floor.

③Cloud server

A database on an external cloud server was used to store positioning data. By connecting to the database via the Internet, positioning information can be confirmed in real time.

④Graphical User Interface

Positioning information is visualized on the building plan as shown in Fig. 1 and can be viewed from a PC or smartphone connected to the Internet.

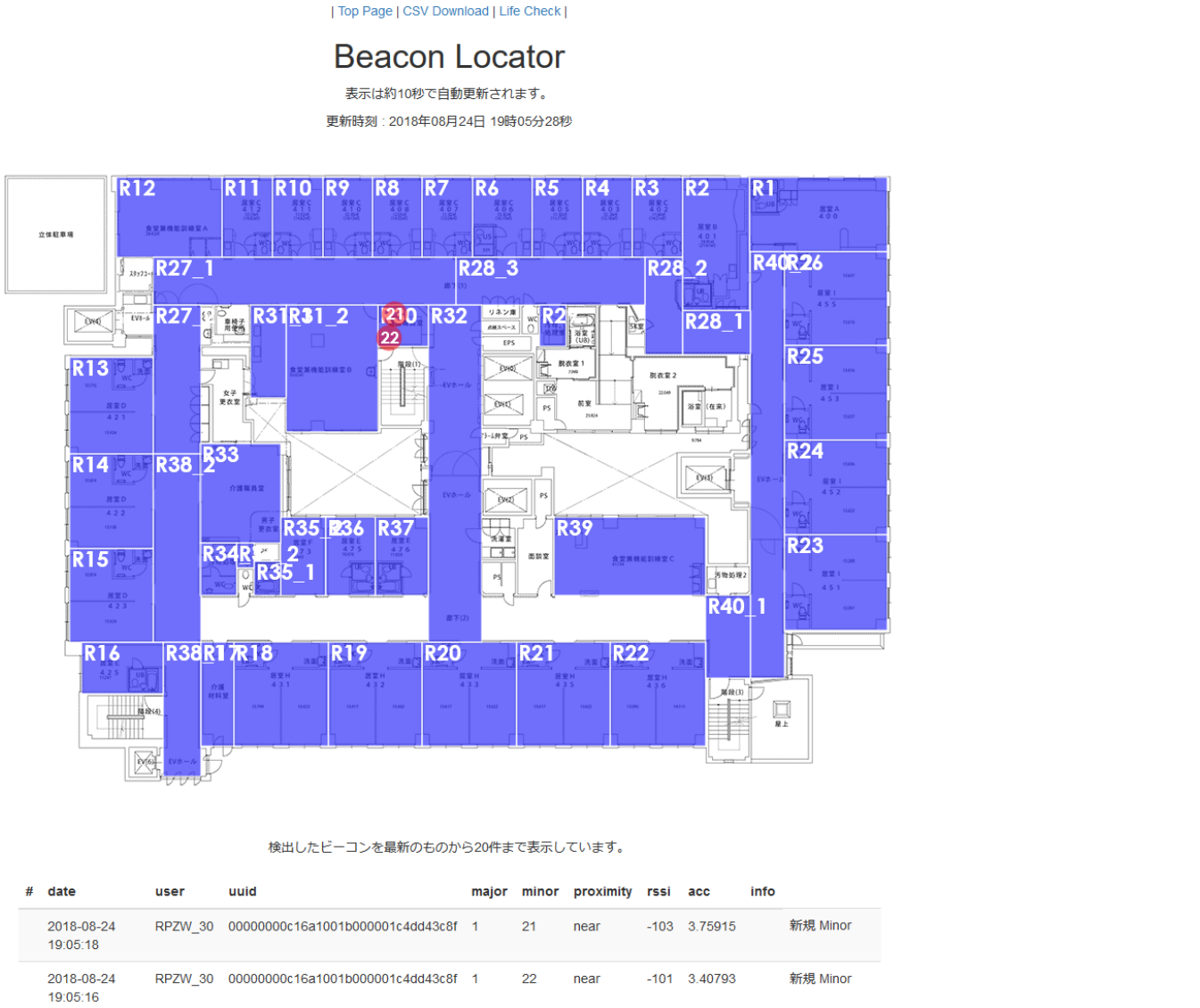

Fig.1. Screenshot of GUI within a browser

2.2. Installation of positioning system

We initially installed 10 single board computers in a part of the floor and grasped the behavior of the positioning system. Thereafter, 40 single board computers were installed throughout the floor and verified. In confirming the positioning data, we found that there were places Wi-Fi had not reached, so additional Wi-Fi station and extenders were installed accordingly. In addition, we implemented an additional function to monitor the communication of single board computers as shown in Fig. 2.

Fig.2. Monitoring function of Wi-Fi communication

2.3. Survey target and period

Two short-stay night-shift staff in two weeks were targeted.

Table 4. Target facility outline

Name	Value
Capacity	78 people/day
Room configuration	Multi bed rooms: 12 Private rooms: 12 Special rooms: 2
Night shift time	16:00 – 9:30
Number of night shift staff	2

Table 5. Care staff's attributes

ID	Age	Experience [Year]
1	20	2
2	19	1
3	35	9
4	41	10
5	21	3
6	21	3
7	22	4
8	44	1
9	21	3
10	38	4

Table 6. Staff shift of investigation period

ID	Exp.	Start time	End time	Duration	ID	Exp.	Start time	End time	Duration
1	2	2018/4/3 16:00	2018/4/4 9:50	17:50	2	1	2018/4/3 16:00	2018/4/4 10:00	18:00
3	9	2018/4/4 15:40	2018/4/5 7:15	15:35	4	10	2018/4/4 15:40	2018/4/5 8:50	17:10
6	3	2018/4/5 16:00	2018/4/6 9:30	17:30	5	3	2018/4/5 16:00	2018/4/6 7:00	15:00
7	4	2018/4/6 15:35	2018/4/7 9:30	17:55	8	1	2018/4/6 16:20	2018/4/7 9:30	17:10
4	10	2018/4/7 16:00	2018/4/8 9:30	17:30	9	3	2018/4/7 15:30	2018/4/8 7:20	15:50
1	2	2018/4/8 16:00	2018/4/9 9:30	17:30	10	4	2018/4/8 16:00	2018/4/9 9:30	17:30
2	1	2018/4/9 15:10	2018/4/10 10:30	19:20	3	9	2018/4/9 15:10	2018/4/10 10:30	19:20
8	1	2018/4/10 15:23	2018/4/11 9:23	18:00	5	3	2018/4/10 15:30	2018/4/11 6:00	14:30
1	2	2018/4/11 16:00	2018/4/12 9:30	17:30	6	3	2018/4/11 16:00	2018/4/12 9:30	17:30
7	4	2018/4/12 16:00	2018/4/13 9:20	17:20	2	1	2018/4/12 16:00	2018/4/13 9:30	17:30
1	2	2018/4/13 16:00	2018/4/14 9:30	17:30	10	4	2018/4/13 16:00	2018/4/14 9:30	17:30
9	3	2018/4/14 15:30	2018/4/15 9:20	17:50	4	10	2018/4/14 15:30	2018/4/15 9:20	17:50
5	3	2018/4/15 15:15	2018/4/16 5:30	14:15	2	1	2018/4/15 15:30	2018/4/16 10:00	18:30
9	3	2018/4/16 15:30	2018/4/17 9:00	17:30	6	3	2018/4/16 15:15	2018/4/17 9:10	17:55
7	4	2018/4/17 16:00	2018/4/18 9:00	17:00	10	4	2018/4/17 16:00	2018/4/18 9:00	17:00

3. Result

3.1. Overall staying time in each room

The percentage of stay time in each room during the entire investigation period of the staff was totaled. Data was divided according to the staff mainly responsible for the north side of the floor and the staff mainly responsible for the south side of the floor.

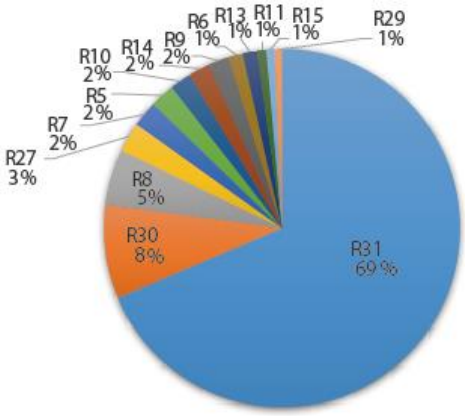

Fig.3. North-side staff's Percentage of stay time in each room

Both R31 and R39 are "Dining and Function Training Rooms". The staff's station is also attached there. Staying in these rooms accounted for nearly 70% of the total.

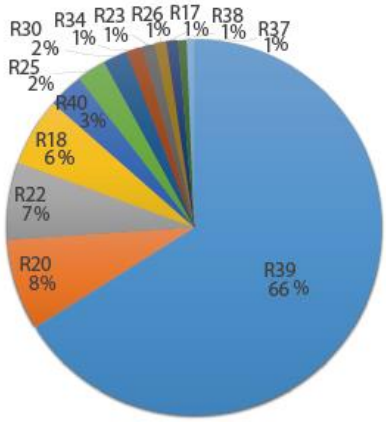

Fig.4. South-side staff's Percentage of stay time in each room

3.2. Visiting rooms

The number of visits to each room was counted. We here attempted to compare the experienced staff with the unexperienced staff as shown in Table 6 of bold characters. By using the network analysis inter-room movements were shown in Fig.5-Fig.9. Experienced staff tend to visit more rooms than inexperienced staff.

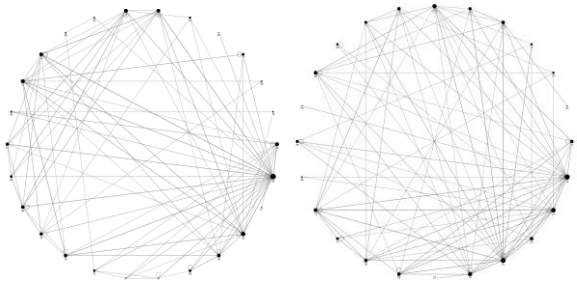

Fig. 5. 2018/4/6
Left: Experienced Right:inexperienced

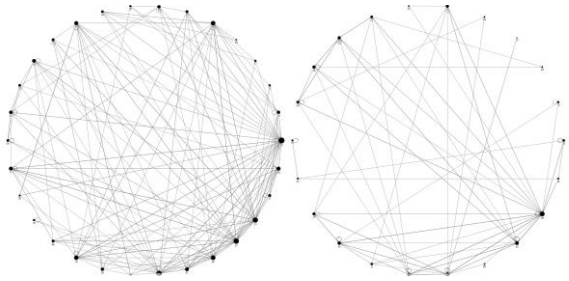

Fig. 6. 2018/4/7

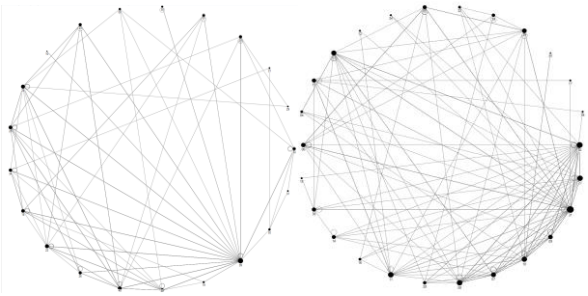

Fig. 7. 2018/4/9

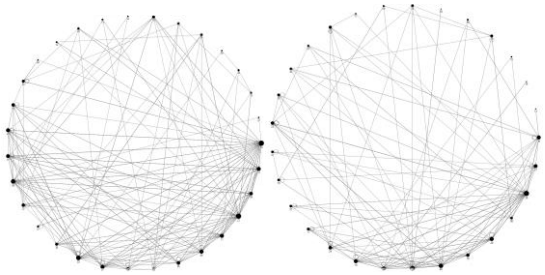

Fig. 8. 2018/4/10

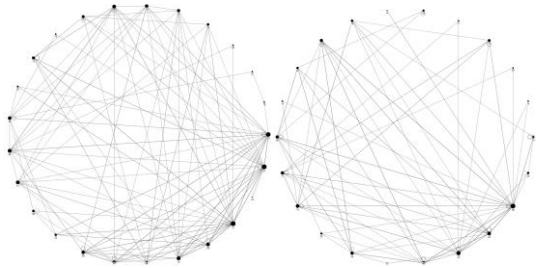

Fig. 9. 2018/4/12

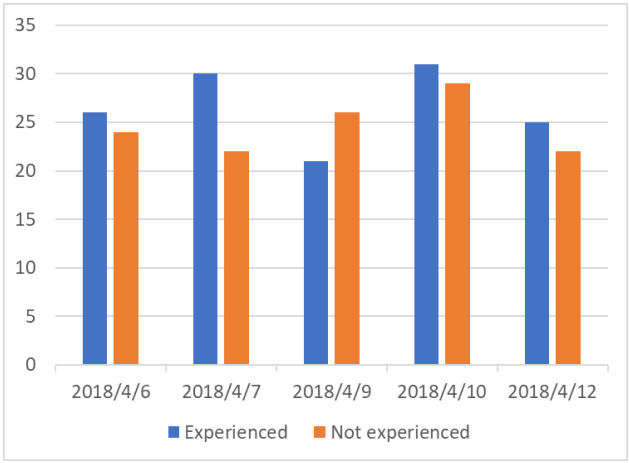

Fig.10. Number of visiting rooms of experienced and inexperienced staff

4.Conclusion

The main achievements of this paper can be summarized as follows.

1) The BLE positioning system of small introduction barrier was developed and operated without problems.

2) The behavior of the staff was continuously measured, and objective data was obtained.

3) One of the characteristics of experienced and inexperienced staff's nursing behaviors was found.

5. Acknowledgement

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References

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