



# Estimation of Person Existence in Room Using BLE Beacon and Its Platform

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**Abstract.** In this research, estimation of person existence in room using BLE beacon and that propose application method. Create a platform for that. For estimating of person existence, BLE beacons are used as individual identifiers. Install a receiver in the room. By doing this, we can estimation with high degrees of freedom not dependent on Devices. Acquire Information on estimation of person from the platform we created. Based on this information, we disclose real-time person's stay information and person's stay information history. We also propose applications such as notification systems and visit promotion systems.

**Keywords:** BLE beacon · Room estimation · Platform

## 1 Introduction

Various uses can be considered for person staying information. Approach becomes easier if person know whereabouts. Also, if you know the number of users in the room and the time zone to be used, it will be an index of the improvement of the environment including the temperature adjustment of the room.

There are several ways to estimate a person staying in the room. It is a method using an IC card or a live camera. The former method is to use IC card and card reader. It is a detection method based on the voluntary action of the user [1]. Therefore, it is labor when entering or leaving the room. In the latter case, the user need not act voluntarily However, taking permanent indoor photography requires privacy consideration for users [2]. In this research, We estimate with a device that do not require user's voluntary actions and do not inspect precise behavior, so focus on BLE beacon.

In recent years, tracking of people using BLE and BLE beacons has been done [3,4]. Among them, there are many attendance management systems using smartphones and BLE beacons [5]. These are methods of installing a BLE beacon in a room using an individual's smartphone as a device. From the viewpoint that many users have smartphones, it is an advantage that operation costs are reduced. However, person's who do not have a smartphone can not use it. In addition, there are problems such as requiring user's voluntary operation for

application operation. In this research, priority is given to a method need not voluntary action without limiting users. As a method, the user owns the BLE beacon and Install a receiver in the room.

With this approach, The user only has to hold a small beacon. For example, put it in a wallet or Attach to the key holder. It is possible to estimate people simply by attaching BLE beacon to items that are always carried around. There is no need for the user to pay attention. There is no worry that the user will make an operation mistake.

We think person's stay information can used in various places such as university lecture room and office. In this research, we aim to promote smooth communication and promote visit to university laboratories.

We create a platform so that person's stay information can be obtained from various applications. Applications can refer to the person's stay information from the API created by us. We think that referencing information of person's in the room from various programs leads to improvement of accessibility of users.

The rest of this paper is structured as follows. In Sect. 2, we explain related research. Section 3 we explain about the stay management system. Section 4 make a simple visualization system using API and propose methods for promoting visits. Section 5 Consider improvement of user's accessibility by concrete application development. Section 6 summarizes and discusses future issues.

## 2 Related Research

Information on occupants is very useful. There are several studies to investigate occupancy situation of buildings [6–8]. For example, if you know the building's occupancy situation, you can effectively use vacant conference rooms [7] and conserving energy in buildings [8]. It is important to create an estimated platform for passengers to use for such applications. In this research, we will create a platform that can be applied in various situations.

In recent years attendance management using BLE beacon is flourishing. For example, attendance management method in lecture room of university [9] and Smart Building Management [10]. This research, a beacon is installed in the room and the corresponding application is downloaded to the smartphone owned by the individual. Attendance management is possible with reduced cost because beacon detection is carried out using smartphones owned by individuals. Applications are required to perform actions such as voluntary startup, so in some cases it is possible to forget to launch applications. Also, person's who do not have smartphones can not use the system, they will need separate teacher's cope. We think that the method that the user possesses BLE beacon can solve such a problem.

There is an estimation method that places no burden on users. It is a method of using environmental sensors [11]. It measures human occupancy by environmental indicators such as CO2 concentration. The drawback of this problem is that we can not identify individuals. There is no problem if you want to know only whether there are people or not. However, in this research, we use information on people in the room to promote communication. Therefore, it must be a

method that can identify individuals. A BLE beacon has a unique identifier. We can identify individuals by using this.

### 3 Stay Management System

An overview of the entire system is shown in Fig. 1. Users carry small beacons. Beacon used MAMORIO sold by MAMORIO Corporation<sup>1</sup>. Install raspberry pie in the room as a receiver for BLE reception. The device constantly monitors the radio waves of BLE, makes a determination on entry and exit, and sends it to the server if there is a change. Refer to the data on the server using the API created independently. You can refer to personal or multiple current stay information, past stay information history, etc.

#### 3.1 Linking Beacons and Individuals

Beacons have UUID, major, minor identifiers. Save this beacon specific identifier and personal name in the database. We are also considering adding attributes in addition to individual names when linking beacons and individuals. For example, it is the name of the laboratory to which you belong, the team that belongs to it, the grade, etc. These information facilitate identification of individuals in the visualization system. Also in the visit promotion system, we think that grouping such as laboratory or grade can stimulate solidarity and competitiveness.

#### 3.2 Method for Estimation of Person

Refers to the beacon information of the corresponding room periodically detected by the device and the registrant information stored in the database to determine the person's stay. If the information of the corresponding beacon is not included in the periodically detected, it is assumed that it does not already exist in the room. With this, it is possible for a user to detect a person in the room without carrying out voluntary action just by having the beacon by the user. Record the name of the room in which the device is installed in the device. As a result, it is possible to estimate the person in multiple rooms.

#### 3.3 Stay Information Management Server

The stay information estimated by the device is sent to the server. It is recorded in the database together with the date and the room name in which person is present. The stay information can also be used from other programs through the API. For example, we are thinking about systems such as visualization of stay information, visitors notice, promotion of visitors to the laboratory.

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<sup>1</sup> <http://company.mamorio.jp>.

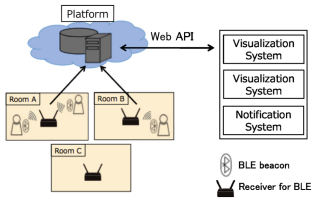


Fig. 1. Outline of the system

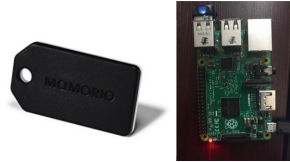


Fig. 2. MAMORIO (BLE beacon) and Raspberry Pi (Receive for BLE)

## 4 Smooth Communication and Promotion of Visit

The stay information of the person in the room is useful information for both the user and the administrator. It is important to know where that person is in order to communicate directly with other person’s. Also, for administrators too, such information is important for improving the indoor environment. In this research, we focus on improving the convenience of users by using the information of person’s in the room. The stay information of the person in the room is divided into the present stay situation and the past stay situation. The display of the person staying present serves as an aid for smooth communication at the present time. In the display of the past stay status, future prediction can be made from the tendency of the visiting place.

It is important that users increase in public rooms such as laboratories. It leads to an increase in information exchange and communication opportunities. In addition to the name of the information of the person in the room, attribute such as grade or team is given. We think that segmentation of user information strengthens individual recognition and increases sense of solidarity. In addition to that, We think that we can measure the total staying time and increase the competitiveness by ranking overall, every grade or team.

### 4.1 Visibility of Stay History Information

Examples of visualization of stay information history information is as follows. Information is displayed as shown in Left of Fig. 3. If you know the current person’s location, it will be easier to contact with the target person. The figure to the right of Fig. 3 shows information on stay information history. If you can grasp the past stay information, you can grasp the trend and usage situation of the visiting place. We think this will lead to smooth promotion of communication as above. Also, we can know the time zone when users use the room. Therefore, we believe that it will be able to assist the maintenance of the environment such as the temperature adjustment of the room.

### 4.2 Total Staying Time and Grouping

Examples of display of total staying time and an grouping are shown below. Display the total staying time as shown in Left of Fig. 4. We think that the promotion of visit can be aimed at by setting compensation based on cumulative points and competition by ranking. Also, compare this total staying time even within the group as shown in to the right of Fig. 4. We think this will stimulate the competition by competition among groups like all laboratories and grade and will lead to promotion of visit.

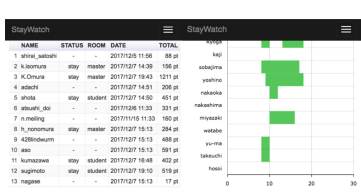


Fig. 3. Stay history information

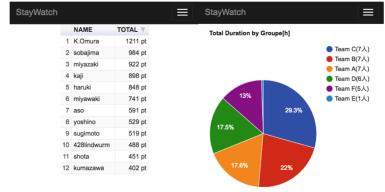


Fig. 4. Total stay time and grouping

## 5 Application Deployment

Use stay information by other program through API. We think this will lead to an increase in the opportunity for users to browse information. For example, as shown in Left of Fig. 5, a display is set at an eye-catching place and the stay status of a specific person is always displayed. Displaying information on stays on SNS as shown in to the right of Fig. 5. Collaboration with other applications frequently used and encouraging surrounding environment will improve accessibility of users to this system.



Fig. 5. Teacher’s stay status display monitor

## 6 Conclusion

In this research, the user possessed the BLE beacon and installed the receiver in the room. As a result, we can only the stay information was detected without restriction of the user, voluntary action. Also, in order to increase the opportunity to view the information of persons stay in the room, we also made it possible to reference from an external program through the API.

We classified information on stays into two occupancy situations. One is the indication of real-time staying information. The other is a display of the stay histories. Regarding the visit promotion system, we set compensation and ranking about stay time and proposed as one method for promoting visit. Also, as application development, we constantly displayed the stay information of a specific person, and proposed proposals to increase the number of browsing opportunities through cooperation with LINE.

In the future we will evaluate the proposed visit promotion. Also, consider other approaches to promoting visits. On that basis, we will consider visualization of information on stay history more effective than now.

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