Handsfree Entrance/Exit Management System

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Abstract

Market introduction of entrance/exit management systems is accelerating in order to meet the requirements of the personal information protection law and to improve enterprise internal schemes. In Japan, the non-contact IC card is main stream for entrance/exit management systems. However, the method has disadvantages, such as complicated operations and it is a cause of queuing at gates. The present development of a handsfree entrance/exit management system employs a semi-active system that solves such disadvantages. The new system also enables the control of personal air conditioners and lighting by linking with an indoor central monitoring system. We expect that the present system will also be of interest to the owners of offices and buildings that are aiming to introduce further more effective energy saving countermeasures.

Keywords

handsfree, RFID tag, semi-active tag system
attendance management, personal air conditioner/lighting

1. Introduction

Since the early stages of the introduction to the market of entrance/exit management systems they have been developed as prevention systems used to stop non-registered persons entering university laboratories or company buildings. However, recently there have been introductions of more functions aimed at preventing the leakage of confidential company information and of personal information by managing the attendance and location of staff and visitors. This trend also contributes to the enhancement of company social responsibility by dealing positively with the personal information protection laws and the internal control of enterprises.

The main stream application of the entrance/exit management system in Japan at the present time is provided via non-contact IC cards such as the “FeliCa.” However, with a non-contact IC card, you must hold the card over a card reader before passing through a gate, which is a rather bothersome task that sometimes causes a long queue to form at the gate. The present handsfree entrance/exit management system that is developed in cooperation with the Obayashi Corporation (hereinafter referred to as “this system”) has solved such issues as well as enabling the control of air conditioners and lighting facilities by linking such systems with a central building monitoring system, hereinafter referred to as the BA (Building Automation) system. In future, this system will be introduced not only to offices and buildings that are required to meet the revisions of the Rationalization in Energy Use Law but also in fields such as at logistics sites, for medical services and in food processing factories, where strict hygiene control is obligatory.

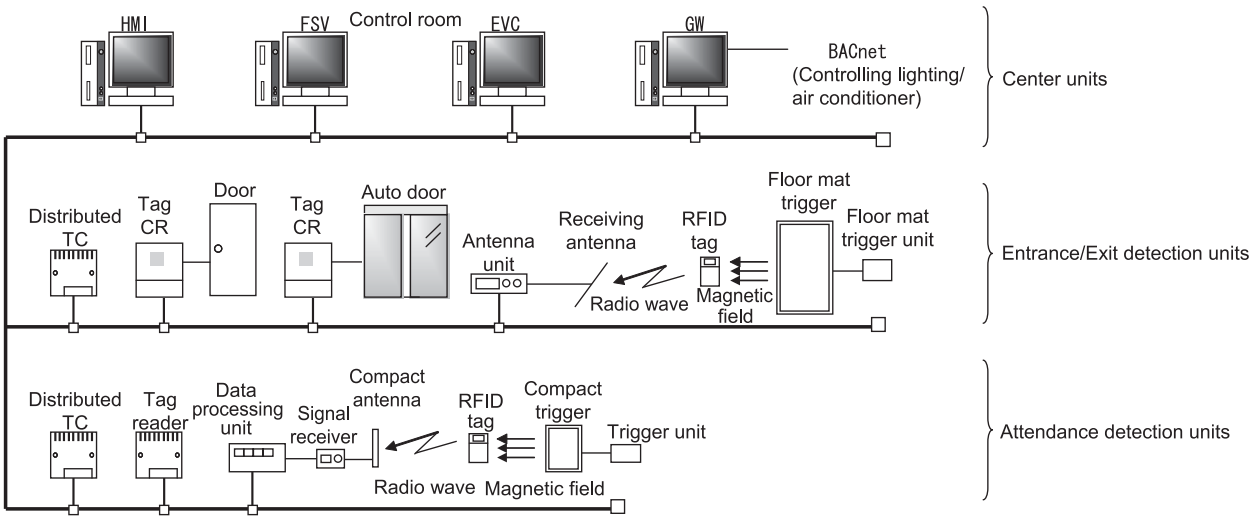
2. System Features

This system features the functions described below.

(1) By carrying an RFID tag, smooth entry and exit at a gate becomes possible. When a person tries to pass through a gate, the door is automatically locked or opened. Multiple persons are also enabled to pass through a gate at the same time thus preventing the formation of queues.

(2) Entry/exit and staff attendance information are automatically detected. The detected information is sent to the BA system in order to activate the automatically controlled personal air conditioner and lighting units. This procedure results in a saving of energy.

(3) By employing a semi-active system for the RFID tag, it enables the accurate location of management and of extending the service life of batteries (a period of over three years is suggested).



◆Tag reader : A device to read tag information
◆Tag CR : Tag reader + card reader
◆FSV : A server to manage user information and to control various events
◆HMI : A monitoring terminal enabling the browsing, registration and management of various data by a system operator
◆EVC : An event controller that performs various functions, including anti passback, etc.
◆GW : A gateway (BACnet) that functions as an interface between the system and the BA system
◆Distributed TC : A terminal controller that controls communications and operations among the card readers, HMI, FSV and EVC

Fig. 1 Standard configuration scheme of a handsfree entrance/exit and attendance management system.

3. System Configuration and its Operation

The standard system configuration is shown in **Fig. 1** .

This system is configured with a center units section, an entrance/exit detection units section and an attendance detection units section.

(1) Control Units Section

A monitoring terminal (hereinafter referred to as the HMI: Human Machine Interface) is a man-machine interface for registering, browsing and controlling various information. A file server (hereinafter referred to as the FSV: File SerVer) controls various accumulated data and systems. An event controller (hereinafter referred to as the EVC: EVent Controller) controls various events such as an anti-passback [*1] function, etc. It also outputs control signals to the gateway (hereinafter referred to as the GW). These control signals are generated from detected signals based on entrance/exit and staff attendance information. The GW converts the control signals, to be sent to the BA system, into BACnet [*2] protocols in order to communicate with the BA system. The distributed TC (Terminal Controller) controls communications and operations linking the tag card reader (hereinafter referred to as "tag CR"), HMI, FSV and EVC.

(2) Entrance/Exit Detection Units Section

An entrance/exit detection image of this system is illustrated in **Fig. 2** .

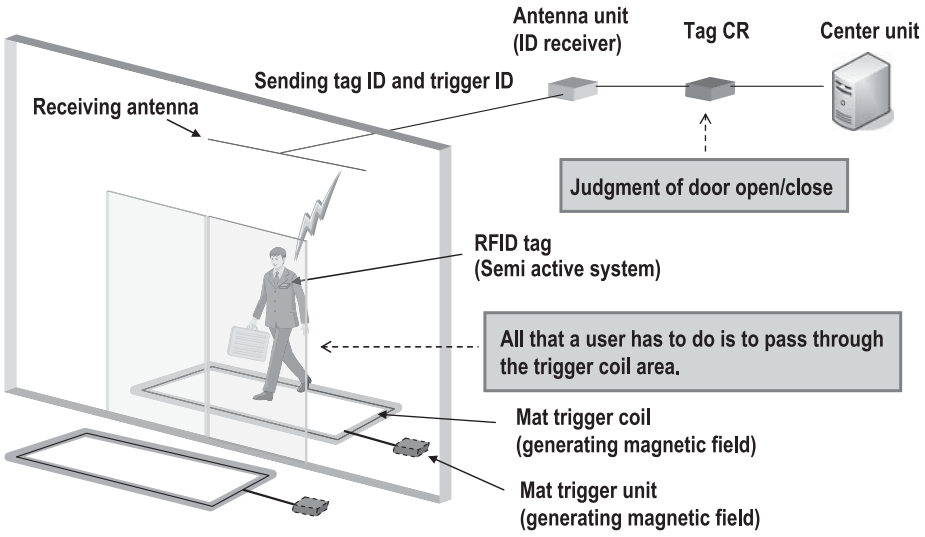
A floor mat trigger coil is generally placed on the floor and

[*1] Anti-passback function detects mismatched information at an entrance or exit, such as when a person without an entry record tries to exit the gate. This function is effective in preventing tailgating.

[*2] BACnet is a data communications protocol for building automation and control networks. BACnet is the standard protocol of ASHRAE, ANSI and ISO.

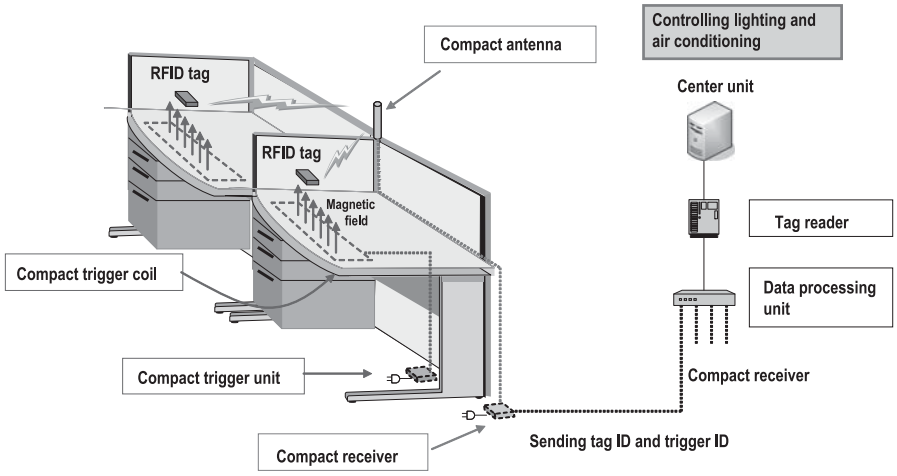
generates a weak magnetic field by applying an electric current from the mat trigger unit. Trigger ID information is superimposed in the generated weak magnetic fields. When a person carrying an RFID tag steps over the trigger coils, his/her RFID tag detects the weak magnetic field and generates a radio wave that transmits the ID information containing the triggered ID information (location information) together with his/her tag ID information (personal identification information). An antenna unit receives the radio wave from the RFID tag and converts them into digital information to send as ID information to a tag CR (card reader) via LAN. The tag CR verifies the ID information with the reference ID information received in advance, and the door will open when the ID information is verified. By placing floor mat triggers both inside and outside of a door, the direction of a person going through the door can also be detected (entry and exit information). Detected entrance/exit information is sent to the EVC. The EVC sends the entrance/exit information to the BA system via the GW and a personal air conditioning control system will be activated.
Moreover, the tag CR contains a function that is capable of reading non-contact IC card information so that the combination usage of the RFID and IC cards is available.

(3) Attendance Detection Unit Section
An attendance detection image of this system is illustrated in **Fig. 3** .
The system works with the same mechanism as the one for the entrance/exit detection system described in the previous section. A compact trigger coil is generally installed to the rear of the desk top plate that generates a weak magnetic field in which the trigger ID information is superimposed. When a person who carries an RFID tag approaches his/her desk, the RFID tag detects a weak magnetic field and sends ID information (a trigger ID and a tag ID) by radio wave. A compact antenna unit converts the ID information received from the various RFID tags into digital information in order to send them to the data processing unit. The data processing unit deletes any unnecessary information (such as overlapped ID information, non-registered information, etc.) and sends the processed ID information to the tag reader via LAN. The tag reader verifies the ID information with the reference ID information received in advance and it then sends the attendance information to the EVC when the ID information has been verified. The EVC sends the attendance information to the BA system via the GW in order to activate a personal lighting control system.



(1) RFID tag automatically starts communication with the receiving antenna when it enters a trigger coil area.
(2) RFID tag information is sent to the tag CR and the door will open when the information is verified.

Fig. 2 Illustration of the entrance/exit detection system image.



(1) The RFID tag detects the magnetic field and sends ID information (trigger ID + tag ID)
(2) The compact receiver receives ID information from the various tags and sends them to the data processing unit.
(3) The data processing unit receives attendance information from the various compact receivers and processes the information to send them to the tag reader.
(4) Attendance information is sent to the entrance/exit management system. The lighting and air conditioning controls will be started via the BACnet.

Fig. 3 Illustration of the attendance detection system image.

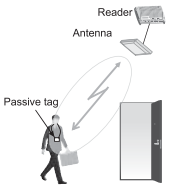
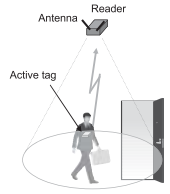
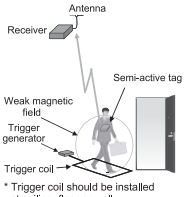
4. RFID Tag as an Attendance Detection Tool

4.1 Semi–active System

The RFID tag performances classified by different tag systems are described in **Table 1** .

There are two types of RFID tags that are commonly available in the market. One of them employs an active system and the other employs a passive system. While a passive system does not incorporate built-in batteries and transmits ID information by using carrier waves generated by an antenna, an active system incorporates built-in batteries and transmits ID information without intervals. An active system employs a simple configuration so that smaller numbers of components are required to be incorporated into the system, which tends to make the system easier for users to introduce. However, its communications area at approximately 10 m wide is too great to perform highly accurate location detections. Moreover, it continuously transmits ID information so that the battery service life is short. On the other hand, a passive system does not require batteries, so that the tag service life lasts longer. However, the detection accuracy is influenced by the relative angle of the antenna and the tag. When this angle is not appropriate, detection failures are sometimes caused. The passive system also has a quite wide communication area (approx. 4 m) so that it also cannot be expected to always perform highly accurate location detections.

Table 1 Performances of RFID tags classified by different RFID tag systems.Performances of RFID tags classified by different RFID tag systems.

	Passive system (UHF waveband communication system)	Active system	Semi-active system
Configuration example	Tag is initiated by the carrier wave from the antenna to send data. 	Tag incorporates built-in batteries in order to enable data transmission. 	Tag transmits data only when it stays in the trigger coil magnetic field.  * Trigger coil should be installed at ceiling, floor or wall.
Performance	- Detection failure: Many (several %) - Multiple identification: Available - Directionality: Narrow (Approx. 30°) - Transmission distance: Up to 4 m approx. - Service life (in continuous use): Up to 10 years approx.	- Detection failure: Rare - Multiple identification: Available - Directionality: Wide (360°) - Transmission distance: Up to 10 m approx. - Service life (in continuous use): 1 year approx. (depending on the usage condition)	- Detection failure: Rare - Multiple identification: Available - Directionality: Wide (360°) - Transmission distance: Up to several meters - Service life (in continuous use): 3 year approx. (depending on the usage conditions)

In order to solve these issues, our system employs a semi-active system for the RFID tag that makes it possible to carry out both entrance/exit management and attendance management simultaneously.

(1) Highly Accurate Location Detection

RFID tag compatibilities classified by different tag systems are described in **Table 2** .

The semi-active RFID tag enables the provision of highly accurate location detection and of specifying the user location. This function becomes available because the RFID tag reads the trigger ID information (location information) from the weak magnetic field generated by the trigger coil.

Moreover, it can also detect multiple RFID tags so that detection failures do not occur, even when multiple persons pass through a gate simultaneously. For example, when an automatic door is left open and multiple people go through the door, the semi-active RFID tag system will certainly detect and identify those persons that have entered and those that have exited from the door. Because each person who enters the door is identified, it is possible to find out immediately which person goes to which room and stays there. This information becomes available because all RFID tags passing over the trigger coil transmit their ID information to the receiving antenna, which can receive multiple ID information. Data collision countermeasures are also provided to the receiving antenna, so that approximately ten people per second can enter or exit a gate without causing detection failures.

Table 2 RFID tag compatibilities classified by different tag systems.

	Passive system (UHF waveband communication system)	Active system	Semi-active system
Advantage (relative)	- Batteries not required - Long service life, low cost	- Simple configuration	- Arbitrary setting of detection range is available. - Detection range variation is small.
Disadvantage (relative)	- Reading range greatly varies according to people's movement. - Guidelines should be provided to protect people against electricity waves.	- Batteries required - Communications range is wide and detection accuracy varies greatly. - Delay of verification results transmission may occur due to communications intervals. - Battery service life is short.	- Batteries required - More components required - Transmission is carried out continuously as long as it stays in the magnetic field.
Entrance/exit management compatibility	x: Detection accuracy is influenced by the relative angle between the antenna and the tag. △: Judgment of persons' movement direction (entering or exiting) is difficult.	x: Misreading or fault reading may occur depending on the ambient conditions. △: Judgment of persons' movement direction (entering or exiting) is difficult.	○: Judgment of persons' movement direction (entering or exiting) is available.
Attendance management compatibility	x: Detection failure may occur depending on the relative angle between the antenna and the tag. △: Communications range is relatively wide so that highly accurate location detection is not available.	△: Communications range is too wide to carry out highly accurate location detection.	○: Accurate location detection and location identification are available by specifying the trigger magnetic field generating area.

(2) Battery Service Life

Semi-active RFID tags only transmit signals when a magnetic field is detected, therefore battery consumption is reduced. Moreover, when a tag is used for attendance detection to detect a person sitting at a desk that is covered by a magnetic field all the time, it is possible to set a longer transmission interval. This makes the service life more than three years longer under the usage condition of a normal office hour working cycle. Commercial thin button type batteries (two of them) are employed so that replacing batteries by a user as necessary is available.

An alarm function is provided to alert when the remaining battery life becomes low. RFID tags that need to replace their batteries are indicated on the screen of the HMI unit.

4.2 Card Holder–type Model

This type of RFID tag employs a card holder type that enables a conventional IC card to be inserted in the holder and also the operation of conventional IC card functions. This means that users can carry the RFID tag together with their conventional company ID card without changing the size or shape of the holder. Even if authentication systems for both IC cards and handsfree RFID tags are installed at a gate, person may pass smoothly through the gate.

Photo shows the newly developed RFID tag appearance. Its dimensions are 58 mm × 97 mm × 9 mm, the weight is approx. 40 g and the material is polycarbonate.

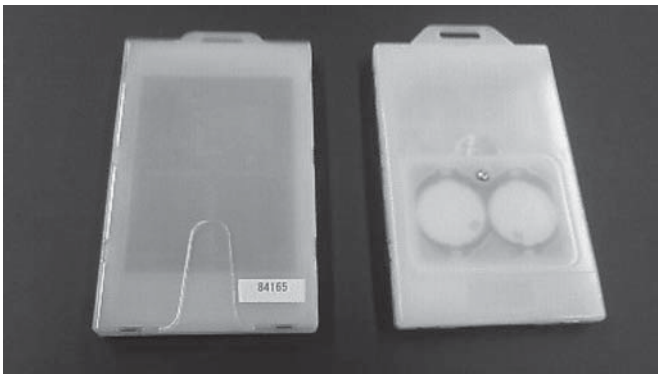


Photo Card holder type RFID tag.

5. An Authentication System Least Influenced by Network Faults

The entrance/exit management system employed for this system was developed based on the technologies used for "Safeware" which has already been delivered to NEC head office and has had its performance proven. As a result of the mechanism provided from "Safeware," each authentication device (tag CR) is able to continue operation, even if a fault occurs at a higher level network system.

First of all, the ID information to be verified for authentication is sent in advance to each tag CR (card reader) from the FSV via LAN in order to store it in the tag CR. When a person carrying an RFID tag passes through the door, his/her ID information received by the antenna unit is transmitted to the tag CR. The tag CR performs authentication and opens the door. This means that a tag CR does not send a query to the FSV (file server) for authentication, so that it can control the door open/close operation even if a fault occurs in a higher level network system. If a fault occurs in a higher level network system, the entrance/exit log information is stored temporarily in the tag CR (up to 10,000 events) until the higher level network system resumes. After the higher level network system is resumed, the stored log information is sent to the control units. This process is designed to prevent the loss of any entrance/exit log information detected for the authentication.

6. An RFID Tag as a Vital Tool for Energy–Saving Systems

This system transmits the entrance/exit information and also attendance information to the BA system via BACnet to control ON and OFF operations of the personal air conditioners and lighting at each staff desk. This system linkage has the possibility of being developed for further automatic energy saving control systems that satisfy more specific control demands. For example, entire building air conditioners can be controlled depending on the numbers of people entering a building, or the lighting of a space with no attendance can be switched off. In future, buildings and offices will be required to meet the revisions of the Rationalization in Energy Use Law. Consequently, we expect more market demands to introduce such a system in the future.

7. Future Issues

(1) Detection of Tailgating

The most critical issue that the RFID entrance/exit management system is facing is to detect a person trying to enter without carrying an RFID tag.

This is the so-call "tailgating detection issue". In order to solve this issue, a linkage arrangement between our hands-free entrance/exit system and a monitoring camera would be effective. A monitoring camera is able to count the numbers of people entering a building, facilities, rooms etc.

(2) Reducing the Price of Units

The semi-active tag system employed for this system enables highly accurate location detection. However, its configuration requires more components compared to the non-contact IC card systems such as "FeliCa." This results in a higher cost per door to introduce the system. In order to remedy this disadvantage, we intend to promote a reduction in the cost per unit and will also enhance our system by ensuring a good cost performance.

8. Conclusion

As described above, the performance of a semi-active RFID tag enables superior location detection accuracy thus making it appropriate for an entrance/exit management system. Moreover, when a semi-active RFID tag is linked with the BA system, more specific automatic controls can be available for saving energy, therefore we expect to introduce to BA market more. The system is therefore expected to be introduced in the future, we are also promoting introduction of this system for new markets such as at logistics sites, for medical services and in food processing factories where strict hygiene control is demanded, and also to offices and buildings that are required to meet the revisions of the Rationalization in Energy Use Law.

Finally, we would also like to take this opportunity to express our gratitude to the Obayashi Corporation for their helpful cooperation throughout this project.

*FeliCa is a registered trademark of Sony Corporation.

Access control system

Handsfree Entrance/Exit Management System

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