Assets Location Management Solution Based on the Combination of SmartLocator and RFID

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Abstract

This paper introduces the "SmartLocator," a highly accurate indoor location management system using IR-signals, and an assets location management solution based on combination of the SmartLocator and RFID. The solution is expected to improve warehouse input/output operation efficiency and it enables the effective utilization of storage spaces when it is applied to the logistics, physical distribution and manufacturing industries. In the future, at the same time as expanding marketing of the solution more widely, commercialization of an lighting tag that makes electrical works unnecessary will be advanced in order to help to further reduce the costs of these industries.

Keywords

RFID, SmartLocator, assets location management, lighting tag, fluorescent lamp

1. Introduction

Assets management solutions based on RFID are studied and introduced aiming at improvements in job efficiency in various businesses such as the logistics, distribution and manufacturing industries. The introduction of RFID-based assets management improves the efficiency of input/output and production management in warehouses and factories. The management of asset locations is regarded as a factor that can improve efficiency even further. This paper introduces the "SmartLocator," a highly accurate indoor location management system using IR (Infra-Red) signals, together with an assets location management solution linking the SmartLocator and RFID.

2. Needs and Market Trends of Assets Location Management

Previously, the management of assets stored in warehouses and factories has been troubled by the following problems.

(1) Problems with the Storage Location Registration Operation

① As the assets storage locations are kept only in the memories of workers or recorded only after the completion of daily work, problems such as forgetting, uncertain memory and incorrect notification of location information to other workers tend to occur.

② Even when the location information is recorded every time assets are stored, the input of the shelf numbers and addresses is troublesome for some workers.

(2) Problems in the Picking up of Assets from Their Storage Locations

① Troublesome labor of searching for assets based on the memory of workers or ambiguous assets location information.

② When designated assets are not found, the same kinds of assets that are stored after the designated ones may be picked up by mistake, leaving the designated ones. In this case, the older assets may become unusable due to the expiration of their consumption limit period (shelf life).

These problems have led to a rise in the need for assets location management systems that support easy and accurate management. According to a survey by the ESP Research Institute, Inc., the market for indoor location management is expected to grow from about 1.2 billion yen in FY2004 to 38 billion yen in FY2008. In particular, the assets location management sector is expected to expand rapidly to reach a market scale of nearly 20 billion yen in FY2008[1)].

Based on these market needs, many solution providers have recently been proposing assets location management solutions by linking RFID- or bar code-based assets management systems with location management systems. These solutions can roughly be divided into two types; 1) those which manage the assets locations directly, and; 2) those which manage the locations of the workers or the forklifts conveying the assets and thereby indirectly manage the assets locations. The assets location management solution based on the combination of the SmartLocator and RFID, introduced in this paper, belongs to the latter type.

3. Indoor Location Management System "SmartLocator"

This section describes the issues of the positioning technologies that are expected to be applied to the assets location management systems of various solution providers and also the configuration and features of our indoor location management solution using IR signals, the "SmartLocator."

3.1 Indoor Positioning Technologies

Table shows the major indoor positioning technologies.

Table Comparison of indoor positioning technologies (Compiled by NEC).

Technology	Accuracy	Note
Wireless LAN multi-base station	3 - 5m	Accuracy is dependent on the surrounding environment.
Active RFID	5 - 7m	Accuracy is dependent on the surrounding environment.
Ultrasound	3 - 30cm	Accuracy is dependent on the surrounding environment.
Passive RFID	10 - 30cm	Accuracy is affected by RFID readout errors and simultaneous readout of multiple tags.
IR tag (SmartLocator)	0.7 - 2.5m	A clear view should be reserved between the IR transmitters and the IR receivers.

The technologies determining locations according to the radio wave propagation time between multiple wireless LAN base stations and the terminals[2-4] make it necessary to reserve a clear line of sight between each terminal and the base station in order to improve the positioning accuracy. However, as it is often difficult to reserve a clear view due to other stored assets and machinery in warehouses and factory workshops, the positioning accuracy in these places often becomes considerably degraded. We actually simulated the location detection accuracy of the wireless LAN positioning technologies by using a computer[5]. The results of the computer simulation are shown in **Fig. 1**. The left hand figure shows the plan of the assessed floor area, and the gray squares in it represent metallic shelves. The ceiling height is 2.5 meters and the shelf height is 2 meters. When six wireless LAN base stations are installed on this floor, communications are available in approximately 95% of the floor, but the area that can meet the indoor positioning accuracy requirement of no more than 5 meters[6] is only about 16% of the floor. As shown by these results, the effective application of wireless LAN-based positioning technologies seems to be difficult to achieve in warehouses and factories where clear views cannot be reserved between the base stations and terminals.

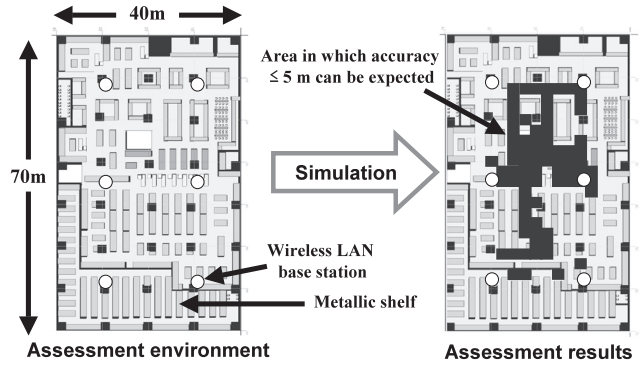

Fig. 1 Assessment of expected accuracy of wireless LAN multi-based station positioning technology.

On the other hand, to provide high positioning accuracy for a positioning technology using active RFID tags[7], it is necessary to install a large number of RFID readers in the relevant environment. This necessitates high installation costs because it is also necessary to install a backbone network for each RFID reader. For a positioning technology using ultrasound waves[8], clear views should also be reserved and the area in which high positioning accuracy is available is limited as with the wireless LAN-based technologies. In addition, the necessities of the ultrasound sensors and the backbone networks connection to the sensors lead to an increase in the installation costs just as with the active RFID-based technology. For the positioning technology using passive RFID tags[9], a degradation of the positioning accuracy due to errors in passive RFID tag readout and simultaneous readouts of multiple tags is the problem.

As shown above, the positioning accuracy and installation costs were the major problems with the traditional indoor location detection technologies. The SmartLocator described in the next section is a new, IR ray-based indoor location management technology that can solve the above problems.

3.2 Configuration of the SmartLocator System

The SmartLocator is a system that allows mobile devices incorporating IR receivers, such as PDAs and mobile terminals, to detect their own locations by receiving the location ID signals from IR transmitters installed on the ceiling, etc. As shown in **Fig. 2**, the SmartLocator is composed of IR transmitters, mobile devices incorporating IR receivers, and the location management server.

The SmartLocator detects the locations as described in the following: Each IR transmitter transmits an IR signal carrying

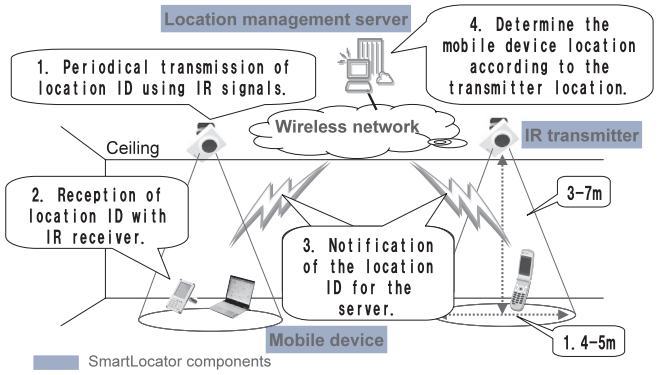

Fig. 2 Configuration of SmartLocator.

the location ID periodically (1 in Fig. 2). The area in which the location ID can be received is determined like an area illuminated by a spotlight; it is a circle with a diameter of about 1.4 to 5 meters at a height of about 3 to 7 meters, so the positioning accuracy of this area becomes between 0.7 and 2.5 meters. When a mobile device comes into this area, it automatically receives the location ID (2 in Fig. 2) and notifies the location management server of the received location ID through the wireless network (3 in Fig. 2). Finally, the location management server detects the location of the mobile device according to the installation location data of the IR transmitter with the received location ID (4 in Fig. 2)

3.3 Features of the SmartLocator system

The use of IR signals provides the SmartLocator with the following advantages compared to the wireless systems using wireless LAN or RFID.

- Each reception area has a clearly defined boundary like a spotlighted area so two adjacent areas can be distinguished clearly.
- Since the IR signals do not permeate through walls, the area of interest can be distinguished clearly from adjacent passages or rooms that are partitioned by a wall or shelf.
- The positioning accuracy is little deteriorated by surrounding articles or environmental changes such as a relocation of structures so stable location detection is possible.

The system is accompanied by the constraint that a clear view should be reserved between the transmitters and receivers due to the use of IR signals. However, despite this fact the system is still advantageous because accurate location detection is possible whenever unimpeded IR signals can be received as described above. The preservation of lines of sight between transmitters and receivers is relatively easy if the transmitters are installed on the ceiling.

Another advantage of this system is that the IR transmitters do not need backbone networks to be installed.

The above advantages allow the SmartLocator to detect locations at lower costs and a higher accuracy than other positioning technologies.

4. Assets Location Management Solution Based on Combination of SmartLocator and RFID

4.1 Outline of the Assets Location Management Solution

The assets location management solution combining the SmartLocator and RFID locates the position of assets by linking the RFID information and SmartLocator information obtained when the assets are placed in their storage locations.

An outline of this solution is described in the following. Firstly, the workers or forklifts should carry the mobile devices incorporating an IR receiver and RFID reader. In addition, the RFID tags in which the assets IDs are recorded are attached to the assets, and IR transmitters are installed on the ceiling above the areas where management of the assets locations is required. Then, assets that are conveyed by a worker or forklift are identified based on the RFID, the location of the worker or forklift conveying the assets is detected with the SmartLocator. When the assets are placed in a storage location, the two kinds of information are linked for the assets location management.

4.2 Example of Solution Application

An example of the application of the assets location management solution can be seen in the warehouse input process in a warehouse without determined assets storage locations (free-location warehouse) as shown in **Fig. 3**.

When a worker conveys assets on a hand truck and places them in an unoccupied space, the worker reads the assets ID recorded in the RFID tags attached to the assets using a PDA, as the last step in the warehouse input process. At this time, when the worker takes out the PDA for reading the RFID, a view is reserved between the IR receiver on the PDA and the IR transmitter on the ceiling and the PDA receives the location ID (1 in Fig. 3). The PDA then associates the assets ID it read (2 in Fig.3) with the location ID it received from the transmitter, and notifies the assets location management server of the associated information for registration (3 in Fig. 3). The notification to the assets location management server for registration is performed by means of the wireless LAN when real-

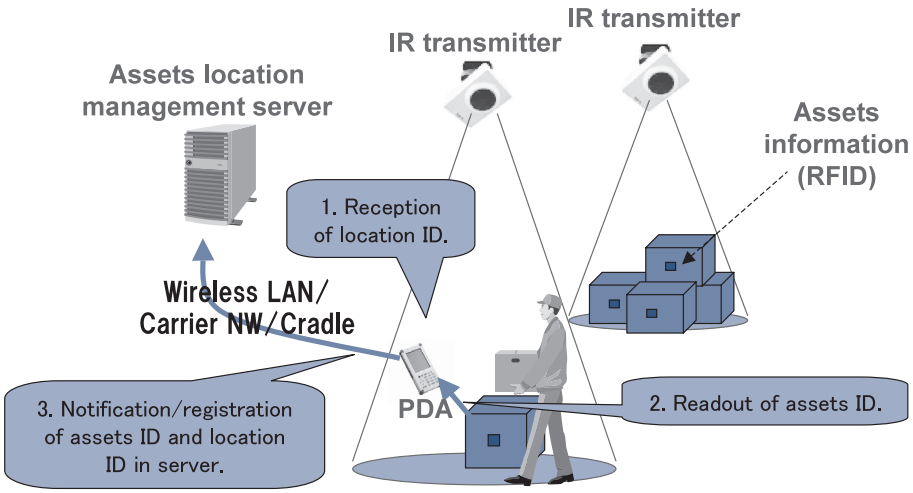

Fig. 3 Assets location management linking the SmartLocator and RFID.

time management is required. Or, it is done by the batch registration using a cradle, etc. after completion of the warehouse work when real-time management is not important.

5. Future Plans

The SmartLocator and the assets location management solution described above are commercialized by NEC Engineering, Ltd.[10)]

In supporting the future development of the SmartLocator, we are currently conducting research into the "Lighting tag," a system in which the power supply for the IR transmitter is obtained from fluorescent lamp[11)]. The power supply can be obtained from the fluorescent lamp either by electromagnetic induction from an inverter type fluorescent lamp or by tapping off from a rapid-start type fluorescent lamp (**Fig. 4**). Either technology makes it possible to introduce the assets location management solution in various indoor environments equipped with fluorescent lamp illumination without the need of power supply installation work at the floor level. The lighting tags are currently under development aiming at commercialization in the not too distant future.

6. Conclusion

In this paper, we have introduced the assets location management solution based on the combination of the SmartLocator and RFID. In the future, we intend to promote commercialization of this solution and will also develop the lighting tag system that will make power supply installation work unnecessary.

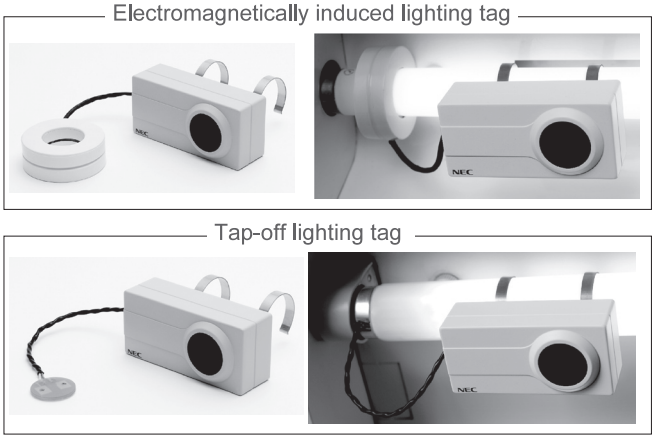

Fig. 4 Lighting tags.

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