Image Systems Using RFID Tag Positioning Information

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Abstract

We have developed a system that automatically selects images from particular cameras based on RFID (radio frequency identification) tags that identify individual persons or objects, thus enabling each user to receive desired images via IP networks. For example, if an RFID tag is inserted in the nametag of a kindergarten child and several cameras are installed in the kindergarten, the system automatically switches the transmitted images according to the child's movements so that the parents can watch their own child from home or the office.

1. Introduction

ADSL and other broadband services are proliferating at an increasingly rapid pace, and the distribution of stored image contents has now begun. Users can obtain network cameras at an affordable price, and we can expect to see a steady increase in the types of images that can be used, including live images sent by video phone. We expect that there will be an increase in demand for simpler selection of images that are of interest to users from among the huge number of available images.

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There are various methods for obtaining positioning information such as PHS (personal handy-phone system), GPS (global positioning system) and RFID (radio frequency identification) tags. RFID tags come in active (with built-in battery) and also passive types. Table 1 shows a simple comparison of these four methods. RFID tags can be used outdoors, but the installation of receivers has not yet reached the point of being a true infrastructure, and applications are limited to spot usage in the immediate vicinity of the receivers. Passive RFID tags can only be used in close proximity to the receiver, while active RFID tags have a limited battery life. PHS is basically designed for outdoor use, but antennas are now being installed indoors, mainly in public facilities, providing a broad scope of applications. Even so, the positioning accu-

Table 1. Comparison of position identification methods.

	Position identification accuracy, etc.	Indoor use	Notes
Active RFID tag	Can be used within approx. 10 m dia.	Good	Requires internal battery in tag. Can be used for several years, depending on transmission intervals.
Passive RFID tag	Operates at close range (1 m or less)	Good	Powered by external radio waves, so frequency and distance between tag and receiver are limited.
PHS*	Position identification accuracy: about 100 m	Fair	Positioning accuracy is rough. Can be used indoors in some cases, depending on antenna installation conditions.
GPS	Position identification accuracy: about 10 m	Poor	Cannot be used indoors. Good positioning accuracy when corrected using map information.

*When using NTT DoCoMo's Imadoko service (fee required) racy is around 100 meters. GPS can only be used outdoors. Each of these methods thus has limitations, so methods must either be selected according to the service content, or combined so as to complement one another.

Our developed system is unique in the sense of being a combination of image systems and RFID systems.

2. Image systems using RFID tag positioning information

Existing image systems cannot identify the subject in images. Our system can identify the subject among several dozen people. It enables users to select camera images of the subject, who is identified by an active RFID tag placed on him or her, and to view the images via the Internet on suitable terminals. In the system introduced here, we chose the active RFID tag system as the most appropriate method for use in indoor facilities and within the range of the cameras being used (approximately 10 meters in diameter). Here we explain the functions for use in a kindergarten as a typical application.

2.1 Image selection

Figure 1 shows an example of a specific application of how this system handles images in a kindergarten. Cameras, receivers, and management servers are installed in the kindergarten classrooms and other locations. The children are given RFID tags, which might be installed in their nametags. The RFID tags transmit radio signals at regular intervals, including an ID code known as RFID. The signals are picked up by receivers installed throughout the kindergarten, and the RFID is sent from the receiver to the management server. The receiver picking up the radio signal changes as the child moves around the kindergarten, so the management server can track which child (RFID) is in which area. Parents can watch their children by logging into the system via the network using an account and password issued in advance, using the browser on their PC at home or at work.

A parent can view his or her child from the nearest camera. Figure 2 shows a screen for the server administrator managing cameras installed in four locations,

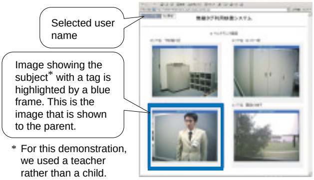

Fig. 2. Example of management screen.

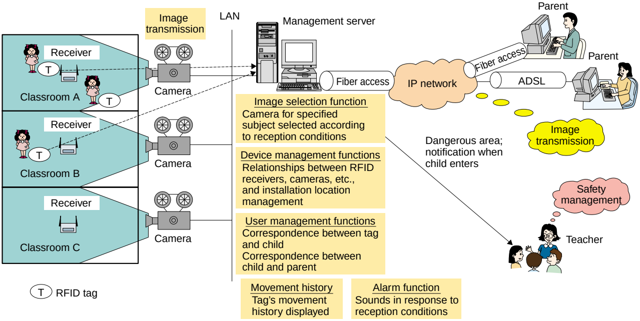

Fig. 1. Typical system configuration in kindergarten.

such as the shoeboxes and the lockers. Parents see only one image (in this case the bottom left one), which is automatically highlighted with a blue frame on their screen. (For this demonstration, we used a teacher rather than a child.)

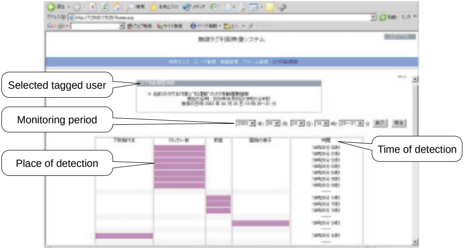

Fig. 3. Movement history.

2.2 Movement history

Other functions besides the automatic selection of the live camera are "Movement History Display" and "Alarm Function". The information received from the RFID tag is stored in the system in a log. Figure 3 shows a screen image of how this information is displayed in chronological order (Movement History). This log shows movement behavior at a glance; for example, which RFID tags (i.e., which children) have been in which area and for how long, as well as how many times a subject went to each area. If a data analysis function is added to this system, it will be possible to use this data in a wide variety of applications, including analyses of correlations between tags and statistical analysis of the time spent in each receiver area or the number of entries and exits. Some of these applications are described below.

2.3 Alarm function

It is possible to have an alarm sound according to the reception conditions of a given RFID tag. For example, the alarm could sound if the tag is detected by a specified receiver or when the tag cannot be detected by any of the receivers. Figure 4 shows an example of this system (alarm settings). For a kindergarten, the alarm could be set to sound when any child approaches one of the exits or the stairs to the roof. However, the RFID tag system itself is not designed for applications where lives may be at risk. Such applications of this system should be confined to use as a complementary function.

3. Potential fields of application

The system itself is a general-purpose system and can be applied to a wide range of fields besides kindergarten and daycare settings. Table 2 shows several specific examples.

Fig. 4. Alarm settings.

(1) Home monitoring (pets, perimeter of house): An RFID tag can be attached to the collar of a cat or other indoor pet, and a camera and receiver installed inside the house, so that the owner can watch the pet while away from home. An RFID tag can also be attached to the family's key-holders, and receivers can be installed in the living room and other locations and cameras can be installed in the front hall and other parts of the house. When no signals are received from the RFID tags — that is, when nobody is home — the home owner or a security company can remotely watch images of the perimeter of the house.

(2) Social welfare facilities: Residents have RFID tags, so relatives and others can watch an elderly person there. Secondary applications by the facilities themselves are also possible, for example detecting residents who have wandered off the premises based on locations of the RFID tag signals. Depending on the requirements of the viewers, the range of camera images can be adjusted, or a power switch can be added to the RFID tag itself, so if the person being monitored wants some priva-

Table 2. Typical applications.

	Application	RFID tag subject	Receiver, camera installation locations	Image viewing location and viewer	System application conditions
Live Images	Home security	Pet	Home	Outside the home	Can be used
	Home security	Keyholder	Perimeter of house (camera)	Security company or outside the home	
	Building monitoring	Visitor	Restricted areas	Security personnel	
Stored images	Shared object management	Shared object	Management or usage location	Shared object manager or user	Requires additional function for processing stored images
	Commemorative video production	Visitors	Entertainment facilities, attractions, etc.	Person entering	
	Efficiency Improvement	Employee	Shops and workplaces	Manager or head office employee	Requires additional function related to analysis process

cy, he or she can switch it off.

(3) In public facilities: RFID tags can be incorporated into ID badges for visitors, enabling security personnel to detect accidental entry by visitors into restricted areas in real time and to monitor images from a safety management perspective.

As an extension of these applications, in addition to monitoring live images, these images can be stored for a period of time, enabling the following types of applications by matching the images against the RFID tag reception logs.

(4) Management of shared objects: An RFID tag can be attached to a shopping cart or other shared object and a receiver and camera installed in the management location, so that when a change in the signal status of the RFID tag—that is, movement of the shared object—is detected, it is possible to access images for the time when movement took place.

(5) Entertainment facilities: Cameras and receivers are installed at attractions in indoor facilities, and visitors have RFID tags. A commemorative video for each visitor can then be created by gathering relevant RFID images from the images stored throughout the day. These images could be edited in combination with images from parades and other events.

(6) Shops and workplaces: Cameras and receivers can be installed in shops and workplaces and the employees given RFID tags. In addition to managing the attendance of each employee, by storing images and recording movement of the RFID tags, it is possible to analyze the time required to complete tasks or the variation in required time among various employees. This information can also be used as basic data for increasing work efficiency or for designing more efficient office layouts.

4. Further study

To adapt the systems to handle a large number of users, we will reconsider how to distribute the server load, or which users connect to which servers, and how to manage the total load. If the systems are to be applicable to security services, they should be more reliable and fault tolerant.

5. Conclusion

We have developed image systems combined with positioning systems. These enable us to create new services for broadband users. The number of live images is expected to increase even more in the future, with mass media images of interest to many people and individual images targeting a small number of users (e.g., images from cameras installed in kindergartens and daycare centers). The provision of attractive images as well as convenient and easy-to-use services holds the key to the future proliferation of broadband. The RFID tag image system introduced here will contribute to the further popularization of broadband applications, though it needs to be improved.

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