A Support System for Finding Lost Objects using Spotlight

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ABSTRACT

We propose a support system for finding lost objects indoors. The system employs active RFID and ultrasonic position detection to detect the position of a lost object. The system illuminates the position by using Movinglight, which is normally employed in stage lighting. From an experiment, the way of notification by light is better than that by sound in some situations.

Categories and Subject Descriptors: H.5.2 [User Interfaces]: Interaction styles; I.3.6 [Methodology and Techniques]: Interaction techniques

General Terms: Design, Human Factors, Measurement

Keywords: spotlight, particle filter, localization, bookshelf

1. INTRODUCTION

When searching for an object indoors, we often open/shut drawers, look under beds, etc. If GPS is used to search for a lost object, the building in which it is located might be found. However, it would not be possible to pinpoint the room in which it is located and its position in the room.

We propose a support system for finding lost objects indoors. There is related research such as SearchLight[2] that finds books in library by using camera. However, the system has no ability to find obstructed objects. We employ active RFID to find hidden objects; however the accuracy of detected position is low (From our preliminary experiments, the error between the true position and detected position is approximately 20-30 cm). In contrast, the accuracy by ultrasonic position detection is high (approximately 5 cm error); however, it cannot find objects obstructed by others. Therefore, we fuse these devices to find obstructed objects and enhance the accuracy. After finding the position, our system illuminates the position in real space. The user can know the position directly without the use of specific devices.

2. SYSTEM ARCHITECTURE

Figure 1 shows the hardware configuration of the system. Two position detection devices (Active RFID: RF Code Inc. and Ultrasonic position detection system: Furukawa Industrial Machinery Systems Co. Ltd) are used in order to enhance the accuracy of the detected position and find objects

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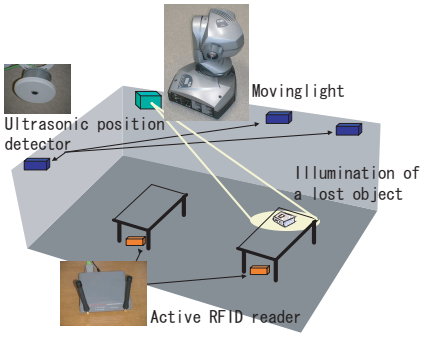

Figure 1: System overview

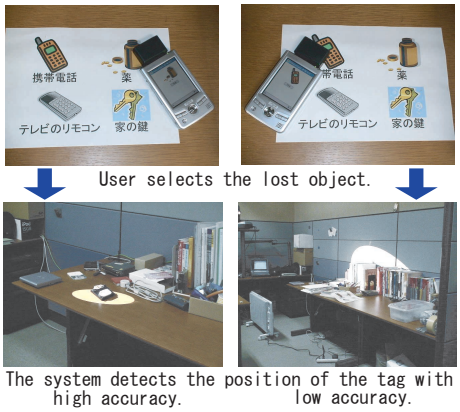

Figure 2: Pictures of the system in operation

obstructed by others. The measured values from the two devices are fused using a particle filter[1]. The particle filter is used not only to fuse two types of measured values (a tag adjoins the position and the position of the tag is measured as the 3D position) but also to enable the addition of new position detection devices to the system easily. Since active RFID detects a tag when it adjoins the position of the reader within a radius of approximately 20 cm, it is represented as an uniform distribution with 1/20 probability within a radius of 20 cm from the reader. Since the ultrasonic position detection system detects the position of a tag as a 3D position with an error of approximately 5 cm, it is represented as a normal distribution with $2\sigma = 5cm$.

The Movinglight (MiniMAC Maestro: Martin Inc.) is used for notifying the detected position to the user. This

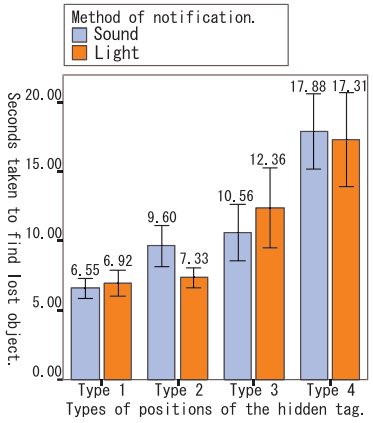

Figure 3: Seconds taken to find a lost object

device is normally used in stage lighting. The pan and tilt of the Movinglight are calculated backward by detecting the angle of each robot arm from the position of its hand. DMX512[1]–a standard protocol to control the Movinglight– is used in our system.

A paper with passive RFID that shows images or pictures of lost objects is used as the input device of our system. The user can select the desired object by holding the RFID reader against the paper.

Pictures of our system in operation are illustrated in Figure 2. The radius of the illuminated circle depends on the accuracy.

3. EVALUATION

The purpose of the evaluation is to show that notification by light is better than that by sound. We compared our system with a support tool that notifies by sound (Wireless Locator: The Sharper Image Inc.).

An experiment is performed in a general room with a dimension of approximately four meters. We tested the method through a task wherein the subjects have to find tags in the room. The followings are four different conditions of hidden tags.

Type 1 The whole of tag is visible.
Type 2 A part of the tag is visible.
Type 3 Other objects obstruct the view of the tag. The user can find it when he/she removes the other objects.
Type 4 The tag is inside a bag or box. The user can find it when he/she opens the bag or box.

The difficulty level of the task increases progressively from Type 1 to 4. The subjects are students at graduate school, and they have no information regarding the room. Three trials for each type of hidden tag are performed for each subject. Ten people participated in the experiment, and thirty values were obtained for each type of tag.

The result is shown in Figure 3. The error bar represents the 95% confidence interval. It was found from the two-sided t-test (significance level = 0.01) that notification by light in Type 2 is better than that by sound. The task of finding the tag in the Type 3 and 4 cases requires manual work because the subject cannot find the tag without removing objects that obstruct the tag. In contrast, the task in Type 1 and 2 cases does not require manual work because the user can view the entire tag or a part of it. Thus, it seems that notification by light has an advantage as compared with that by sound in the situation that the user has to complete the complicated task of finding a lost object by only using his/her eyes.

[1]http://www.usitt.org/standards/DMX512.html

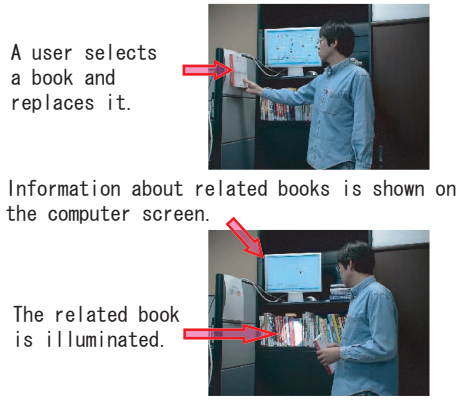

Figure 4: Finding related books

4. FINDING RELATED BOOKS ON A BOOKSHELF

In this section, we introduce another application based on our proposed system. In general, only the side of a book on a bookshelf is visible, however, it is not easy to find a book on a bookshelf. We consider this situation to be the example of adaptation of the advantage of our system.

Figure 4 shows an overview of the system. When a user standing in front of a bookshelf pulls out a book and replaces it, the system illuminates a book related to the replaced book. Data regarding related books are obtained through the Amazon.com web service[2].

5. CONCLUSION

We proposed a support system for finding lost objects by spotlight. From an experiment, notification by light has an advantage in the situation where the user completes the complicated task of finding a lost object only by using his/her eyes.

6. ACKNOWLEDGMENTS

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[2]http://www.amazon.com/gp/aws/sdk/