

Orientation Tracking Exploiting ubiTrack

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ABSTRACT

In this paper, we propose the orientation tracking method exploiting ubiTrack developed by GIST. Location information is already used in various applications, and orientation information is also important to provide the appropriate services according to different situations. In order to recognize orientation we attach two IR receiver modules to ubiTrack receiver. We can obtain the orientation information of both a resident and a device by calculating locations of two IR receiver modules. The proposed method can be widely exploited for LBSs which require the orientation information.

Keywords

Ubiquitous computing, Location tracking, Orientation tracking, Device

1. INTRODUCTION

Ubiquitous computing environments can provide context-aware services according to various contexts which can be obtained from several sensors. Among various kinds of context information, location information is important to provide a variety of services from different locations. Many research organizations have studied about location tracking technologies. Especially the outdoor orientation tracking technologies have been already applied in many applications. For example, GPS and CDMA are used in several services. Recently, many researchers are conducting researches on indoor location tracking techniques. This trend implies that orientation information is required in

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order to provide more appropriate services to a user according to the different situation.

There are several indoor location tracking systems, such as the ubiSense [1], Active Badge [2], and ubiTrack [3]. They can track the orientation as well as location by subtracting current locations from previous locations. However, they cannot track orientation when orientation is dynamically changed in the same place. In addition, they cannot obtain the orientation in the right direction when a user steps backward.

In this paper, we propose reliable orientation tracking method exploiting ubiTrack. We use two IR receiver modules in order to get orientation while classic ubiTrack uses one IR receiver module. Each IR receiver module has an individual ID of right and left. So it can be aware of orientation of a user and a device by calculating locations of two IR receiver modules. By using the proposed method, we can obtain not just one-dimensional location as a point but two-dimensional location as a line, the physical length of a device, and orientation.

This paper is organized as follows. In chapter 2, we explain the motivation of the proposed method. Chapter 3 covers the orientation tracking method. In chapter 4, we will show the accuracy and performance through several experiments. Finally, in chapter 5, the summary and future works are presented.

2. MOTIVATION

Figure 1 shows the motivation of the proposed method. Classic location tracking systems cannot track changes of orientation in same position. When he exists in the annotation service area about exhibits, a visitor is provided multiple services as well as services about exhibits which he does not face on.

The environment provides specific services with consideration of a user's attention by comparing orientation of a user and an exhibit. In other words, the user is provided the service about the exhibit which he faces on. As shown in figure 1, visitor 1 is provided with services of

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an exhibit 1 because he watches the exhibit 1. The visitor 2 who watches an exhibit 2 is provided with the annotation service of exhibit 2 rather than the service of exhibit 1, even though he is technically in the service area of exhibit 1. Because the environment recognizes that he faces on exhibit 2 by his location and orientation from ubiTrack.

If ubiTrack couples the outdoor location tracking system, such as GPS, we expect that it can be used inside or outside of historical building or exhibition.

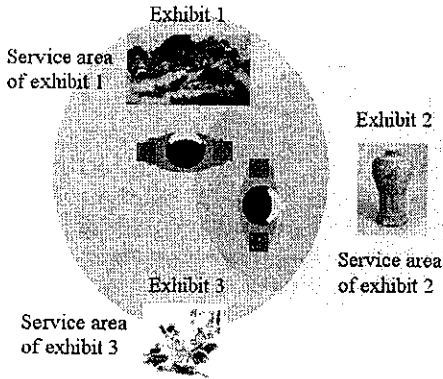


Figure 1. Motivation of proposed method

3. ORIENTATION TRACKING

We propose the orientation tracking method exploiting ubiTrack. In order to obtain the orientation of both a user and a device we attach two IR receiver modules to classic ubiTrack. Two IR receiver modules have individual IDs, such as right and left. Proposed method can obtain orientation of both a user and a device by calculating the different locations of two IR receiver modules. Proposed method can track the two dimensional location, length of a device, and orientation by using two IR receiver modules.

3.1 System architecture

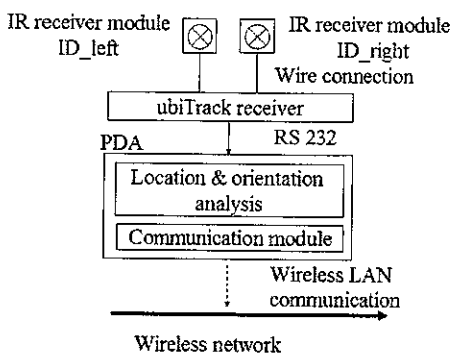


Figure 2 diagram of ubiTrack receiver

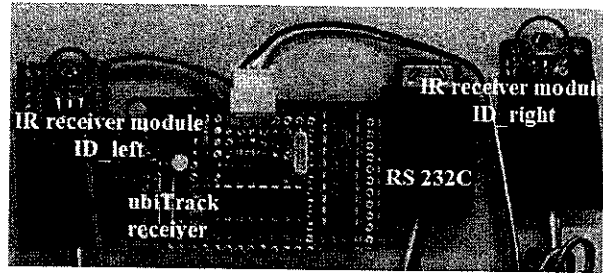


Figure 3 ubiTrack receiver

Figure 2 shows the diagram of ubiTrack receiver. Two IR receiver modules receive the individual IDs from IR transmitters attached on the ceiling. Two IR receiver modules have individual IDs of ID_right and ID_left. IDs received from two IR receiver modules are distinguished with each other in ubiTrack receiver. UbiTrack receiver transfers IDs to the PDA of both a user and a device. UbiTrack receiver connects with PDA through the serial communication (RS232C). In the PDA, location and orientation analysis part calculates the physical location and orientation from distinguished IDs according to the locations of two IR receiver modules. Then the communication module transfers the location and the orientation information to the wireless network by wireless LAN communication (IEEE 802.11b).

3.2 Orientation tracking method

We use two IR receiver modules in order to obtain the orientation. Two receiver modules have individual IDs of ID_right and ID_left. Two IR receiver modules recognize the orientation of a device using the each location information of two IR receiver modules. Figure 4 shows the method of the orientation tracking. Six circles represent IR sensing areas generated by IR transmitters attached on the ceiling. We attach two IR receiver modules to the each side end of a device which we want to know the location and the orientation. The device's location is presented as the center point (x, y) between two IR receiver modules. 'L' is the physical length of the device measured by proposed method,

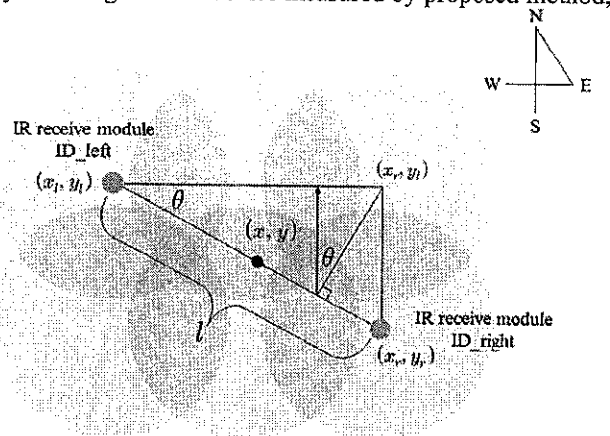


Figure 4 orientation tracking method

Location	$(x, y) = (\frac{x_l + x_r}{2}, \frac{y_l + y_r}{2})$
Length	$l = \sqrt{(x_l - x_r)^2 + (y_l - y_r)^2}$
Orientation	$\theta = \cos^{-1} \frac{ x_l - x_r }{\sqrt{(x_l - x_r)^2 + (y_l - y_r)^2}}$

Table 1 computation of location, length, and orientation

which is the distance between two IR receiver modules as shown table 1. The proposed method can recognize not one-dimensional location such as a point but two-dimensional location such as a line. It is more practical than conventional systems which can obtain only one-dimensional location such as a point. Then, it can obtain the orientation (θ) using each location of two IR receiver modules. If left and upside point is (0, 0), θ is an angle between the north direction and the forward direction of a device. Thus, if the forward direction of a device is headed north, orientation of this device is 0 degree. Table 1 shows the equation calculating location, the length, and the orientation of both a user and a device.

4. EXPERIMENT

We made various experiments in order to know the reliability of the proposed method. We measured the location and orientation of a resident in ubiHome which is smart environment developed in GIST [4]. We attached two IR receiver modules on the shoulders of a resident. While changing angle of his orientation from 0° to 360° per 30°, we measured the location and orientation as shown in figure 5. In order to increase the reliability we collected the 100 samples

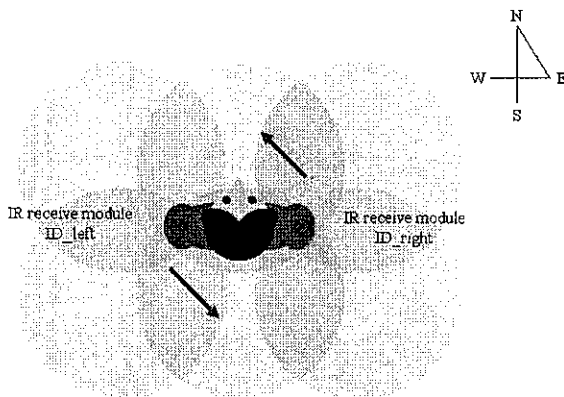
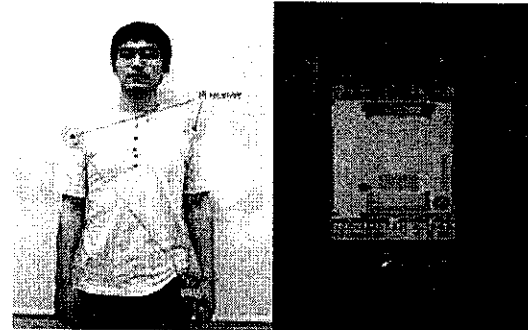


Figure 5 measurement method of a sofa's orientation



(a) a resident who attached receiver (b) PDA display

Figure 6 experimental set-up



Figure 7 ubiTrack transmitters

in each angle. Figure 6 shows the experimental set up. Figure 6 (a) shows a resident who attached the receiver on the shoulders. Figure 6 (b) is the PDA which shows the map and the resident's location.

Figure 8 and 9 show the results of this experiment. Figure 8 shows the measured location of a resident, whereas the practical location of the resident is (140, 130). Figure 9 shows a resident's orientation in each 30° degree sections and shows that all errors exist within 30°. In this experiment we can see that ubiTrack recognizes eight directions. It is enough to apply this technique to ubiHome to find the attention of multiple residents by using several ubiTracks.

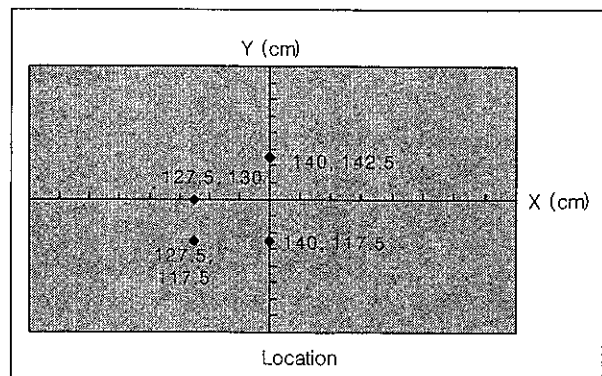


Figure 8 Location of a resident

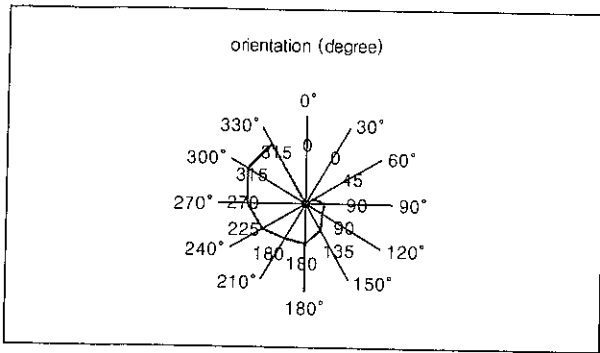


Figure 9 Orientation of a resident

Figure 10 shows the cause of errors. Although the locations of two IR receiver modules are different, if they exist in the same sensing area, two IR receiver modules are aware of the same location, because ubiTrack uses the proximity method for location tracking [5]. For example in figure 9, there are two IR receiver modules, a and b. Their locations are physically different, but they exist in the same IR sensing area. Thus, the locations of both a and b are recognized as c. This is the reason why there are errors in

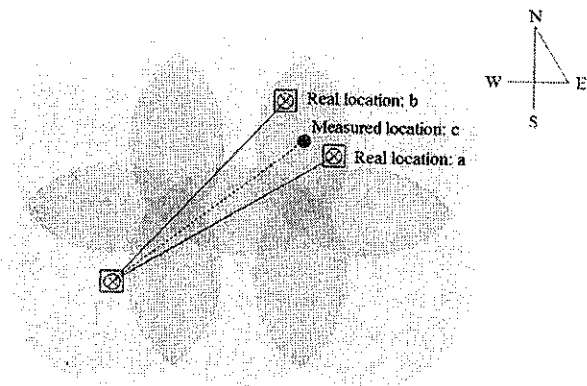


Figure 10 cause of error

location tracking using the proximity method. By using location with these built-in errors, there also exist errors in length and orientation.

5. CONCLUSION & FUTURE WORK

We proposed the orientation tracking method exploiting ubiTrack. The proposed method attaches two IR receiver modules to classic ubiTrack which is infrared-based location tracking system. By using two IR receiver modules, the proposed method can obtain the location, which is not one-dimensional location such as a point but two-dimensional location such as a line, the physical length, and the orientation of a user and a device.

For high accuracy, IR sensing area should be more accurate and dense than current state because ubiTrack used the proximity method.

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