Design of Auto Turning System Based on Sensor Network Using Ultrasonic Sound

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ABSTRACT

In a ubiquitous environment where real world and electronic space become one, a person's position information is very important. This is because the surrounding articles may provide automated responses and services may be provided with the person as the center, depending on a person's position. Services using position data can be very diverse depending on applications, making the systems related to each service diverse as well. The automated home appliance control system, which is an area of Intelligent home, is also operated in connection with the positioning system. The automated revolving system can be used in diverse applications in home appliances. This paper explains the automated revolving system design based on sensors using ultrasound. This sensor network-based automated revolving system using ultrasound is a system that makes home appliances turn automatically toward the user with the remote control, when the user with the remote control presses a button on the remote control, and offers the advantage of being used with diverse applications as one element technology of intelligent home.

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Keywords : Ubiquitous, Sensor Network, Intelligent Home, Ultrasonic Sound

1. Introduction

In a ubiquitous environment where real world and electronic space become one, a person's position information is very important. This is because the surrounding articles may provide automated responses and services may be provided with the person as the center, depending on a person's position. For instance, when a home owner moves from place to place in a house, room lights can automatically be switched on and off by identifying the person's position, and appropriate reaction can be taken on unauthorized intruders. As such, the use of position information is very important for improving quality of life for people.

Services using position data can be very diverse depending on applications, making the systems related to each service diverse as well. The automated home appliance control system, which is an area of Intelligent home, is also operated in connection with the positioning system. This is a system automatically controlling appliances surrounding the user depending on his/her position, and is currently studied quite extensively. In Korea, an intelligent home standardization forum has been opened, along with efforts to unify technological standards and create common standards for the industry.

This paper explains the automated revolving system

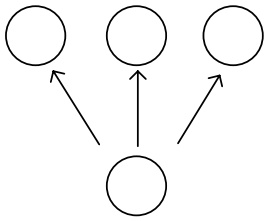
design based on sensors using ultrasound. Chapter 2 presents the WICHI, a related technology, which is a sensor network-based positioning system of the Korean Electronics Technology Institute. Chapter 3 examines applications of the sensor network-based automated revolving system. Chapter 4 describes the design for sensor network-based automatic revolving system using ultrasound, which is the key content of this paper, And finally, a description is made on the issues of the previously designed automated revolving system and directions for future studies.

2. Related Technology – WICHI System

WICHI, the positioning system of Korean Electronics Technology Institute, was designed based on sensor network as a low power indoor positioning system. As shown in Fig. 1, the hardware platform has two ultrasound sensors for positioning and is based on the mote platform. Wireless communication uses 915MHz band radio frequency and has a connector, so it is designed to attach additional sensor modules. Its size is 9.5cm x 5.5cm x 3cm.

(Fig. 1) Hardware platform of WICHI

The hardware platform of WIHCI uses the Tiny OS operation system. Therefore, the positioning application is also prepared with NesC, to enable operation in Tiny OS. The positioning application differs in movement mode depending on the set value. The movement mode decides whether to move as a fixed node, as a mobile node, or as a gateway node, and the WICHI system has the positioning scenario as shown in Fig. 2. This scenario has a very efficient feature in terms of power consumption because the fixed node only moves when the mobile node moves. Generally, nodes located on building ceiling or walls and cannot move are called fixed nodes and those that can move are called mobile nodes. In Fig. 2, F1 ~ F3 represents fixed nodes while M represents a mobile node.



(Fig. 2) Positioning scenario of WICHI

The mobile node transmits RF signals and ultrasound signals to the fixed node every 1 second. The fixed node measures the distance using the time difference between the two received signals, and this information is then transmitted as RF signal to the gateway node. Gateway node retransmits the distance data received from fixed nodes to the PC connected through a serial port. Finally, PC's positioning application uses the triangular measuring method to calculate the position coordinates of the mobile node. The precision variance of the WICHI system is 1cm~3cm, which is very accurate.

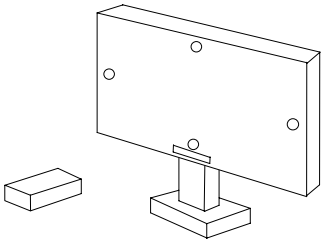
3. Application of Automatic Revolution

The automated revolving system can be used in diverse applications in home appliances. For instance, when a viewer with a television remote control presses a button on the remote control, the TV screen can be made to automatically revolve towards the viewer with the remote control, and when fan remote control button is pressed, the fan can be made to revolve toward the user with the remote control. In addition to this, specific person's position can be tracked to revolve the monitoring camera's direction. As such, the automatic revolving system can be used effectively in an actual environment.

4. Realization and Design

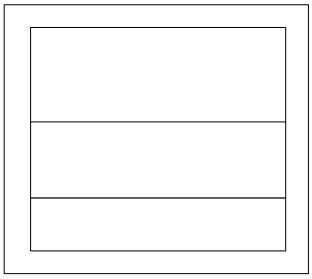
The sensor network-based automated revolving system using ultrasound in this paper uses the WICHI system as the

basis. As shown in Fig. 3, the platform consists mainly of a remote control device that can transmit RF message and ultrasound signals, and a revolving system that can receive RF message and ultrasound signals. When the user presses a button on the remote control, the remote control transmits the RF message and ultrasound signal to the revolving system, and when the revolving system receives this, it turns the revolving body to make the remote control and the revolving body face each other..



(Fig. 3) Automatic revolving system platform

As shown in Fig. 4, the revolving system structure consists of a remote control signal processing part that receives RF messages and ultrasound signals, a positioning processing part that calculates the angle of the revolving body and the remote control, and the revolving body control part that turns the revolving body to the desired angle. RF message receiving module is located at the front lower part of the revolving body, and the ultrasound signal receiving module is placed in four places, upper, lower, left, and right parts of the revolving body. The revolving body control part is in charge of mechanical functions like motor control..



(Fig. 4) Revolving system structure

As explained earlier, the positioning processing part calculates the angle of the revolving body and the remote control. The revolving angle of the revolving body can be calculated using the formula for measuring the area of a triangle. The area of a triangle can be measured when the length of two sides and the angle in between are known, and when the length of the three sides are known, the area can be calculated (Heron's Formula).

The two formulas take two of the four ultrasound signal reception modules placed in the front of the revolving body, either upper and lower or left and right modules, as two points of a triangle, and when the remote control is applied as the other point, creating a triangle, the revolving angle of the revolving body can be calculated.

Referring to Fig. 5 and expressing this in the form of a formula, the triangle's area S with sides a, b, and c becomes

$$S = \sqrt{s(s-a)(s-b)(s-c)}$$

$$\text{when, } s = \frac{a+b+c}{2}$$

and therefore, the area of the triangle having sides a, b, and d becomes $\frac{S}{2}$.

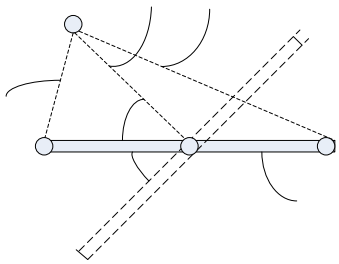
Here, again, when formulas ① and ② are applied to the area of the two types of triangles, it becomes

$$① \ \frac{S}{2} = \sqrt{s(s-a)(s-b)(s-d)}$$

$$\text{when, } s = \frac{a+b+d}{2}$$

$$② \ \frac{S}{2} = \frac{1}{2}(\frac{c}{2})d\sin\theta$$

and the angle θ created by c and d can be obtained. Therefore, the revolving angle α becomes $\alpha = 90 - \theta$.



(Fig. 5) Triangle created by the revolving body and the remote control

5. Conclusion and Study Directions

This sensor network-based automated revolving system using ultrasound is a system that makes home appliances turn automatically toward the user with the remote control, when the user with the remote control presses a button on the remote control, and offers the advantage of being used with diverse applications as one element technology of intelligent home.

Currently, the time difference between the RF message and ultrasound signals is used to obtain the revolving angle, but the difference would not be great even if infrared signals used commonly in appliance remote controls were used in stead of RF messages. And although this hasn't been applied to actual appliances since the control part of the revolving body has not yet been realized, there shouldn't be any major issues in creating it. It is anticipated that the appliances applying the automatic revolving system in this paper will be used in an actual environment.

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