Design of efficient location system for multiple mobile nodes in the wireless sensor network

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Abstract – Various design schemes for network using wireless sensor nodes have been widely studied on the several application areas ranging from the real world information collection to environmental monitor. Currently, the schemes are focused on the design of sensor network for low power consumption, power–aware routing protocol, micro miniature operating system and sensor network middleware. The indoor localization system that identifies the location of the distributed nodes in a wireless sensor network requires features dealing with mobility, plurality and other environmental constraints of a sensor node. In this paper, we present an efficient location system to cope with mobility of multiple mobile nodes by designing a location handler that processes location information selectively depending on the nodes' density in a specific region. In order to resolve plurality of multiple mobile nodes, a routing method for the location system is also proposed to avoid the occurrence of overlapped location data.

Keywords: Wireless Sensor Network, localization system, location data handler, network routing, sesnor node

1 Introduction

M2M technology is a burgeon field of study in ubiquitous computing environment. Among them, the study of wireless sensor network that use light-weight sensor node being progressed in many fields. It includes several factors that node platform design [1] to customize power consumption, microminiature operating system [2] to mange hardware resource of the node, and application[3] to apply real world.

Location-aware technology is a basis technique for high-precision shipping and car navigation industry. When we apply this ability to sensor network in the building, we will expect to provide various consumer oriented service such as guidance and information providing about building and to make sysetm to serve upper case so fast.

Till now, many studies have been progressed to apply location base technology to indoor environment using received signal strength indicator of radio frequency, 802.11 signal, infrared ray and ultrasonic wave sensor, and vision recognition [4]. These technologies, however, have several limitations of natural factor such as sunlight and temperature that increase error of estimated distance, structural factor between location data and its client, and variational factor such as dynamic change of service area due to increment of network traffic load. These bring about lots of problems in the real environment which huge amounts of mobile objects resides in.

This paper describes the solution for recognition error of the node that expected critical factor when applied this scheme to real environment. And we proposed the location system for multiple mobile nodes to serve manifold application.

To solve this matter, we proposed two solutions : *orderly routing algorithm, determining data direction.* The former makes recognition very smart that transmitted a location data at the given time. And the latter supports multiple demander nodes by passive beacon.

In this paper, we evaluate new efficient location system that consists of three major elements : nodes to receive and send the location data, mobile terminal to display location information and service, service server to provide various practical application, previously stated.

The paper is structured as in the following : in the second section, several related works introduced. In the third section, the proposed technique is defined in the implemental way; showing whole system composition and discussing algorithm to solve plurality character on indoor environment. In the fourth section, we implemented new location system using proposed scheme and evaluated performance. In the fifth section, conclusions and work in progress are discussed.

2 Related work

Currently, the study of indoor location system using sensor node focused on fixed beacon node's role that transmit and acquire the location data. Some related works introduced below.

Active badge[5] measures location by recognize infrared signal contained unique number per 10 sec. Active bat system uses short pulse of ultrasound to determine three-dimensional position. RADAR[6] uses received signal strength of 802.11 radio frequency by multiple receiver. Easy living[7] computes mobile object's position by analyze acquired vision data through real-time three-dimensional camera. Cricket[8] calculates location using TDoA of Radio frequency and ultrasonic wave.

Since progressed work had some limitation as previously stated. Furthermore, they gave no consideration to multiple nodes. Cricket system similar with our work focused on the single node mobility too. We expected beacon node's heavy load to transmit location data to multiple nodes, and needed thinking over to plurality character

3 Location system for multiple mobile node

3.1 System overview

Whole system consisted of three parts as shown figure 1. First of all, wireless node divided two function blocks. One is beacon node to transmit location data to object. It had been placed to ceiling and executed multiple object handling and orderly routing algorithm. Another one is sink node to acquire location data from beacon node. It had been attached to mobile terminal and executed multiple location data handler.

Mobile terminal contained two major elements : web browser to search the information about building, module switcher to perform path guiding in building.

Likewise, service server to provide variety building information to user and administrator needed to our system.

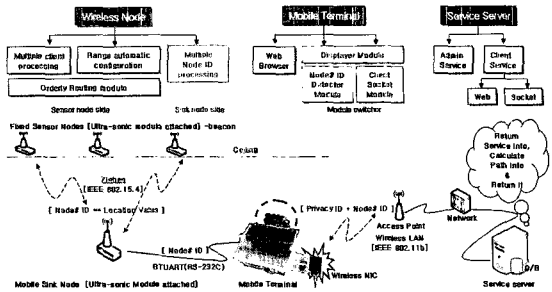

Figure 1. System overview

3.2 System platform for implementation

We designed this system to debug and modify so easily through modulation technique. Beacon and sink node had Radio frequency communication module and ported microminiature operating system by ETRI for efficiency resource management. Mobile terminal and service server was organized by open source to apply some practical free software.

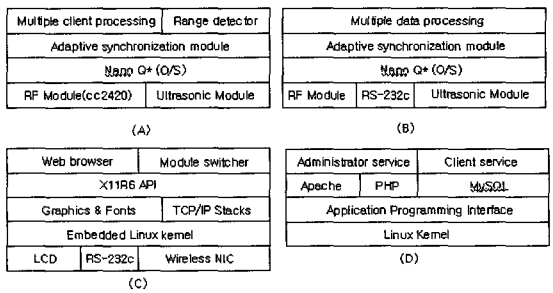

Figure 2. (A) beacon (B) sink (C) mobile terminal (D) server

3.3 System operation

The System is operated as in the following. Fixed beacon node transmit RF carrier that contained own ID with ultrasonic wave same time. Mobile node computes distance using TDoA of RF and Ultrasonic wave, and send data to server. Server records location data to client's database, and provide path guidance according to client's request. As well, it serves building information via web pages.

3.4 The plurality character

Our location system depends on RF signal, previously stated. So, mobile terminals within the RF reception boundary had the possibility of acquiring same location data wherever terminal is located in another

place. Also, when the beacon node transmitted location data at the same time, mobile terminals within the overlapping RF reception boundary had the possibility of acquiring multiple location data.

This paper describes several methods to solve the matter. Above all, beacon node oriented transmission scheme, selection mechanism for max closer beacon node and orderly routing algorithm. Beacon node oriented transmission scheme support multiple node by transmits RF signal and ultrasonic wave absolutely Selection mechanism used ultrasonic wave to cut off the recognition range. Orderly routing algorithm made beacon node to transmit their data when their turn. Flow chart inter nodes are shown below.

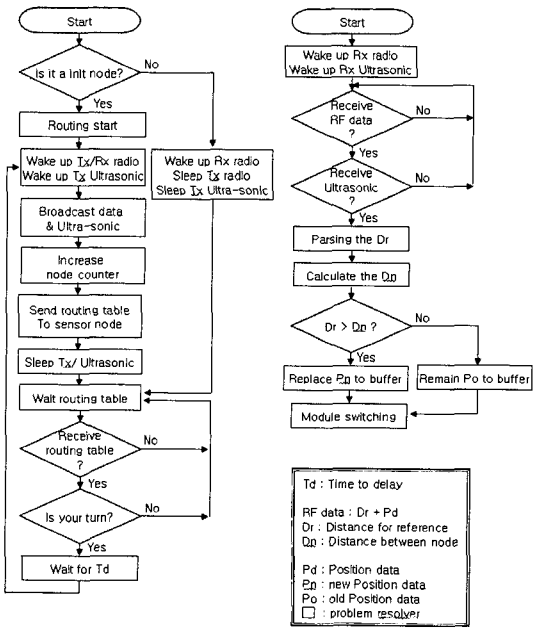

Figure 3. flow chart of nodes

Delay time(Td) must be " Time to reach to node < Delay time for next RF signal generation", the shade temperature 15℃, speed of ultrasonic wave is 340m/s,

$$1 : 340 = Td` : 3,\ Td` = 0.008 \qquad (1)$$

We found a default time delay (Td`), and added processing speed of MCU on node. We used ATmega128L at 16MIPS, so processing time for one instruction had 1/16us sec.

Finally, we found real time delay(Td) shown 2.

$$Td = 0.008 + ((1/16us) * X) \qquad (2)$$

4 performance evaluation

We analyzed recognition accuracy of the node by measuring the location data. We deployed six beacon node s at regular interval about 3m, and move 1m on the opposite side of another.

Table 1. Hardware platform specification

Component	Names of goods	manufacturer
Sensor node	Nano-24	Octacomm
Mobile terminal	Xhyper255B	Hybus
Wireless NIC	Acro LAN 11M	Acrowave system

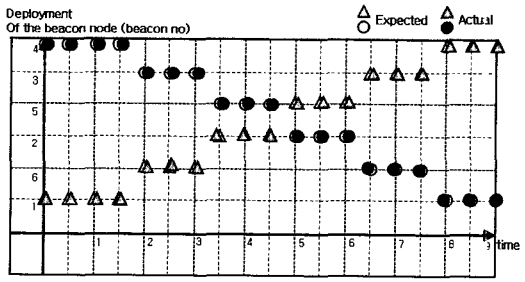

Figure 4. experimental result

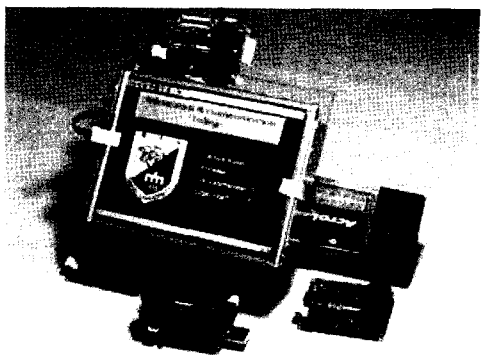

Figure 5. Mobile terminal and beacon nodes

5 Conclusions

Indoor location system has essential consideration such as plurality character for multiple mobile nodes. In this paper, we proposed new location scheme to solve former matters. A sequential routing algorithm is proposed to solve the data ambiguity problem in the in-door location system. Beacon nodes blocks generation of its location information by using a sequential routing algorithm to resolve data ambiguity problem. It is anticipated that the proposed in-door location system is implement for practical applications.

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