The Development of Localization Server System for Location-Awareness in Smart Home

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ABSTRACT

In this paper, we introduce localization server system calculated real location of objects using raw data of location-awareness from sensor node gateway. The software architecture of localization server system consists of location calculation and actuator control based on location. Also, this system supports for collecting raw data, calculating location of real objects using raw data, correcting error from external environment, and server for applications based on location.

Keywords : Localization server system, Location-Awareness, Smart Home, Sensor Node, Ubiquitous Computing

1. Introduction

In recent, we need to implement smart home to provide optimal services to track person's location to support for better life. Location-awareness in smart home is main researched issue in the world because location-awareness technology is core technology to extend further in smart home service [1][2]. We need to calculate distance for more accurate location-awareness and sensing technology of correcting error to provide user preferences at home and need to develop location-awareness system. We also need to gather users' life pattern, movement, and situation information to provide more intelligent information for resident and need to develop to process information [3].

In Section 2, we explain location server system to calculate real location of objects using raw data of location-awareness gathered from sensor node gateway in WICHI system to provide above services. In Section 3, we describe conclusion and future applications.

2. Localization Server System

WICHI system provides intelligent service based on location-awareness in smart home and consists of four components: WICHI_M, WICHI_B, WICHI_G, and localization server system. Overall system architecture for location-awareness prediction is following Figure 1.

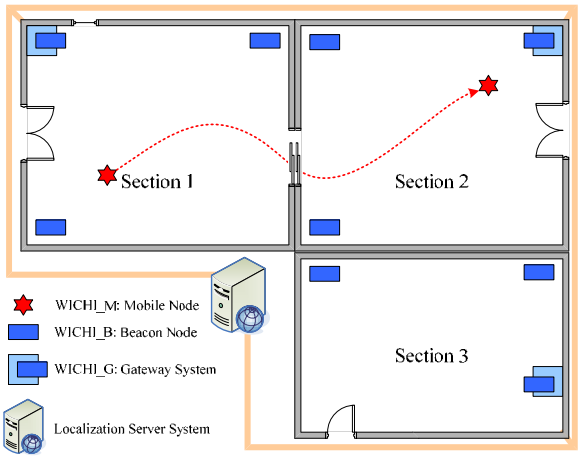

Figure 1: Overall System Architecture

WICHI_M is a sensor node attached to objects such as people/objects to know location information and sends RF/Ultrasonic signal periodically to calculate location-awareness. WICHI_B is a base node for WICHI_M's location-awareness and calculates distance between

WICHI_M and WICHI_B using DTOF (Difference Time of Flight) received RF/Ultrasonic. WICHI_G is a system to manage and separate sections as physical/logical context. In this paper, localization server system calculates real location used people/objects by collecting and calculating of raw data gathered by WICHI_M/WICHI_G. It provides three functions: collects raw data from WICHI_G, calculates real location of objects using raw data, and corrects error from external environment. It also provides a server of location information for applications based on location-awareness.

The software architecture of localization server system is following Figure 2.

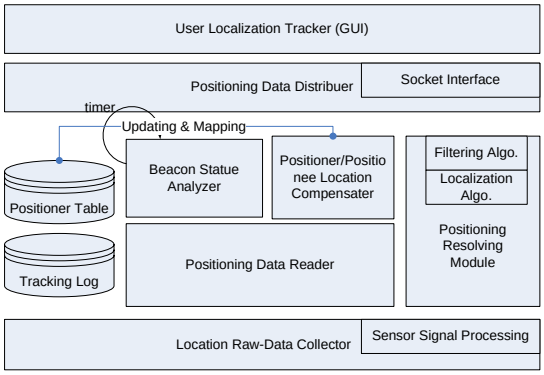

Figure 2: Localization server system software architecture

First, we will explain localization server system to calculate location using collected raw data of location-awareness. The localization server system calculates location per section separated physically/logically. There is a WICHI_G system to collect raw data in each section and localization server system to calculate location information filtering raw data gathered in section which is located within WICHI_M.

There are different amount of raw data gathered by WICHI_G per section depending on the number of WICHI_B/WICHI_M. We need three distance information from WICHI_B to calculate location of objects. Therefore, we have to filter capable distance information before we start to calculate location. Filtering process follows below rules:

- First, we filter distance information of WICHI_B in the same section as WICHI_M is in the same section-I ID.
- In distance information of WICHI_B received in random Time(t0) case, we get distance calculation by Best Choice. For Best Choice, we sort raw data.
- We select minimum three out of ordered raw data and apply them for calculating positions.

Once filtering raw data to calculate positions, we perform position calculation using *x*, *y*, and *z* of WICHI_B and distance information. Theoretically, we can know positions by distance between two different known points and the other point on one dimension. On two dimensions, we can get location by distance among three different positions not on the same straight line. In three dimensions, we can know location by positions and distance of among four different positions not on the same planes. But, localization server system in this paper is able to track position of WICHI_M using only three beacons because every beacon is on the same plane. The reason is that *z* position of beacon is located on the same plane and *z* position of WICHI_M is always greater than zero or equal to zero.

It can happen that two cross points are theoretically on three beacons on the same plane. One of positions is greater than zero and the other has less than zero. Here, *z* position of beacon is equal to zero and it located on ceiling. WICHI_M located under *z* position, that is, *z* value has greater than zero. It means that we choose *z* position which is greater than zero among two calculated position values.

The localization server system software architecture consists of four parts. First, we turn on sever system and register locations of WICHI_G and WICHI_B. It connects to WICHI_G in TRACKER ANALYZER and receives raw data. After it checks whether received raw data is error, it transfers to TRACKER DAEMON module using port 5003.

TRACKER DAEMON received raw data from TRACKER ANALYZER module performs position calculation and it sends calculated result value as called *callback function* once it finished calculating. We need to communicate system to receive calculated location information. CLIENT LIBRARY module supports above functions.

In the result, calculated position information represents GUI type by TRACKER VIEWER & EDITOR module.

Figure 3 is overall localization server system software block diagram.

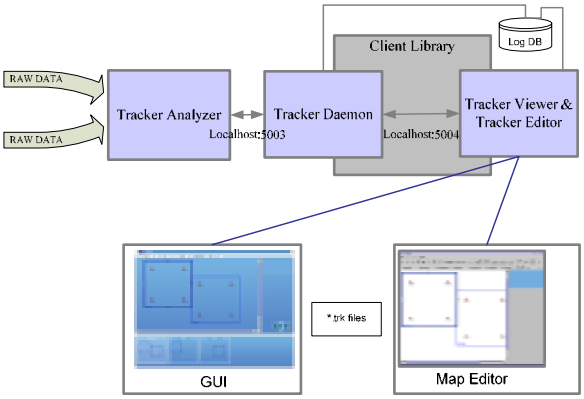

Figure 3: Localization Server Software Block Diagram

We explain each module.

(1) TRACKER ANALYZER

TRACKER ANALYZER connects to WICHI_G. It receives raw data, checks raw data error, saves in Log DB, and transfers raw data to several TRACKER DAEMONs. TRACKER ANALYZER consists of three functions: Receiver (connects WICH_G, gathers raw data, and checks if raw data has error), Log Process (records raw data received by Receiver into Log DB), and Sender (transfers raw data to registered TRACKER DAEMON using port 5003).

(2) TRACKER DAEMON

TRACKER DAEMON calculates positions and provides calculated position information to CLIENT LIBRARY. TRACKER DAEMON consists of two functions: First, Raw Receiver receives raw data from TRACKER ANALYZER and sends to Position Estimator. Second, it generates Position Estimator as much as the number of Sections and manages sections. Here, Position Estimator filters beacon raw data located within itself section and provides calculated location information to CLIENT LIBRARY.

(3) CLIENT LIBRARY

CLIENT LIBRARY divides by section and provides interface to register daemon. Also, it provides callback interface to provide location information easily to GUI programmer. CLIENT LIBRARY consists of three functions: Section Register (adds Position Estimator and is ready to calculate location when command to register section is arrived from Server Broker), Position Sender (sends callback to call once location calculation has done), and Server Broker (communicates server and registers per WICHI_B).

(4) TRACKER VIEWER & EDITOR

TRACKER EDITOR is an editor to draw physical/logical environment of WICHI_B such as home map and a GUI to provide environment viewing user's moving location information based on home map. TRACKER VIEWER & EDITOR provide following five functions: (i) Image Panel (provides interface to set picture files as background) (ii) Construction (provides drawing function by architecture material wall or door) (iii) Section (divides into section drawn plane) (iv) Beacon (inserts/registers ID of WICHI_B and position) (v) Actuator (registers location of setting Actuator).

3. Conclusion

In this paper, we explained detail WICHI system provided intelligent service based on location-awareness in smart home and localization server system calculated real location of objects using raw data collected from sensor node gateway. The localization server system also provides GUI for convenient application of location-awareness technology. Location-awareness technology in smart home is based on ubiquitous home service and it is a hot topic to research and develop in the world.

Localization server system proposed in this paper can be applied for diverse application services such as home security based on location-awareness, automation, health care, information and explanation based on user's location in exhibition/museum, etc.

References

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