Design of a Framework for Indoor Location Based Service Systems

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Abstract. Location-Based Service (LBS) provides precious information to users based on the user's current location or the location designated by the user. Typical examples of LBS include vehicle navigation services, bus information services, fleet management services, and so on. As manmade structures are getting bigger and bigger, demand for indoor location based services (ILBS) has also been rapidly increased. It is well-known that frameworks make development of ILBS systems easier and more efficient. This paper introduces our design of a framework for ILBS systems.

Keywords: Location Based Service, Indoor Location Based Service, Framework.

1 Introduction

The definition of a location based service (LBS) says that 'this is a service that integrates a mobile device's location with other information to provide added value to a user' [1]. Typical examples of LBS include vehicle navigation services, bus information services, fleet management services, and so on. Thanks to GPS, we conveniently use location-based services. However, we spend most of the time in closed places where no satellite signals are available and there is not an alternative wide spread and well established positioning technology. Therefore, researchers have studied and developed different systems exploiting several positioning technologies [2].

In recent years mobile devices are equipped with more and more different sensor sources like receivers for Global Positioning System (GPS) and wireless local area network, for example [1]. Making use of these sensors, many researchers proposed quite accurate indoor positioning solutions.

As manmade structures are getting bigger and bigger, demand for indoor location based services (ILBS) has also been rapidly increased. It is well-known that frameworks make development of ILBS systems easier and more efficient. Therefore, this paper introduces our design of a framework for ILBS systems.
2 Related Works

In this section, we review a few solutions for indoor location based service proposed by other researchers. If we know the positions of stationary devices and ranges from these devices to the mobile device, then we can figure out the position of the mobile device with the triangular method. The authors of [3] developed WiFi middleware that determines the location of PDAs.

The authors of [4] introduced three methodology groups to determine an object location:

- Triangulation;
- Proximity: discovers the nearest reference to the object to be located
- Scene Analysis
  1) Image Analysis: Images from video cameras are analyzed and processed to determine object's relative position to the camera.
  2) Fingerprinting: Fingerprinting Scene Analysis is a localization methodology that consists of reading, in real-time, a given parameter of an electromagnetic signal, typically the RSS (Received Signal Strength) value, and compare it with a set of previously stored values, called the Fingerprinting Map (FM).

They developed a framework to build a Fingerprint Map and use it to locate users/objects correct coordinates. The functions consisting of the framework classified into four layers as follows [4]:

1) Data Acquisition Layer: A function to read reference/RSS pairs at a given point.
2) Data Layer
   - Data Registry: stores Reference/RSS pairs captured at each scene point along time.
   - Data Organization: obtains the scene FM (fingerprinting map)
   - Data Adaption: adapts the data from the Data Acquisition Layer before feeding it into the LEA(Location Estimation Algorithm)
3) LEA Layer: k-Nearest Neighbor and Weighted k-Nearest Neighbor are implemented
4) LBS Interface Layer
   - chooseLea (Algorithms lea) - allows to choose which LEA to use
   - chooseDriver (Driver driver) - Used to select the radio technology
   - getLocation() - Calculates the location estimation and returns the resulting point

The authors of [2] introduced the system that provides well-defined interfaces among the actors involved in the localization: the wireless technologies, the positioning algorithms and the applications. The server software components of the system is shown in Fig. 1. In order to enable the cooperation among the different radio technologies the Localization Manager is composed of many engines as shown in Fig. 1.

Map Manager allows users to upload and reference indoor maps. It has been foreseen the possibility to add point of interests and possible walking paths with Map Manager. The Request Manager routes the requested information from the client interface to the related component.
The authors of [5] presented the Global Positioning Module (GPM), a framework that seamlessly combines a multitude of approaches in order to supply mobile devices with indoor and outdoor positioning. In this framework, the following positioning methods are implemented:
- Barcode. Returns positions obtained using a barcode reader.
- Bluetooth. Uses fingerprinting
- Cell. Provides the location of the cell tower to which the device is attached.
- Dead reckoning. uses step counting based on the mobile device's sensors.

3 Design of our framework

The design principle of our framework is based on the following facts:
1) For every large scaled manmade structure, there exists electronic blueprints that are extremely accurate.
2) Almost everybody carries a smartphone all the time and smartphones are equipped with pretty accurate sensors.

The functions consisting of our framework are classified into two groups:
1) Open floor map repository provides
   - functions to upload, retrieve, delete, and update an electronic blueprint.
   - functions to upload, retrieve, delete, and update information of point of interests (POI)
2) Advanced functions
   - functions to draw images with electronic blueprints
   - functions to manipulate images
   - functions to draw tracks on the image
2) Indoor positioning provides
- function to determine the start anchor location referring to floor maps and information from the GPS receiver.
- functions to determine the current location with dead reckoning method.
- functions to adjust pedestrian's tracks with map matching methods.
- functions to update the anchor position referring to the information of POIs

4 Conclusions

The demand for indoor location based services (ILBS) is rapidly increasing and many ILBS applications are developed. Therefore, this paper introduced our design of a framework for ILBS systems. One of the distinguished features of our design is based on the fact that there exist extremely accurate electronic blueprints for every large structure. Making use of the information represented on electronic blueprints, we can perform the post process on the results of positioning. As a further research, we are implementing the framework discussed in the paper.

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