Client-Server Based LBS Architecture: A Novel Positioning Module for Improved Positioning Performance

Mohammad AL Nabhan, Jerash Private University, Jordan
Suleiman Almasri, Anglia Ruskin University, UK
Vanja Garaj, Brunel University, UK
Wamadeva Balachandran, Brunel University, UK
Ziad Hunaiti, Anglia Ruskin University, UK

ABSTRACT

This work presents a new efficient positioning module that operates over client-server LBS architectures. The aim of the proposed module is to fulfill the position information requirements for LBS pedestrian applications by ensuring the availability of reliable, highly accurate and precise position solutions based on GPS single frequency (L1) positioning service. The positioning module operates at both LBS architecture sides; the client (mobile device), and the server (positioning server). At the server side, the positioning module is responsible for correcting user’s location information based on WADGPS corrections. In addition, at the mobile side, the positioning module is continually in charge for monitoring the integrity and available of the position solutions as well as managing the communication with the server. The integrity monitoring was based on EGNOS integrity methods. A prototype of the proposed module was developed and used in experimental trials to evaluate the efficiency of the module in terms of the achieved positioning performance. The positioning module was capable of achieving a horizontal accuracy of less than 2 meters with a 95% confidence level with integrity improvement of more than 30% from existing GPS/EGNOS services.

Keywords: Accuracy and Integrity, EGNOS, GPS, LBS, Positioning Module

INTRODUCTION

Location-Based Services (LBS) are information services providing position-related content to mobile users. LBS represent integration between position determination technologies, mobile communication and location related contents. LBS are currently being deployed for different civilian applications such as contextual advertising, user warning and alerting, transport, gaming, dynamic objects tracking and

DOI: 10.4018/jhcr.2010070101
mobile guidance (Rapera et al., 2007; Filjar et al., 2008). Mainly LBS can be implemented in two architectures, one as stand-alone, where the mobile unit is equipped with on board positioning devices, maps and geographical information, which are used to provide the user with required service locally. The second architecture is described as client-server based, in which services are remotely delivered to users either on demand or consecutive dependent on the application type being implemented.

LBS application’s performance mainly depends on the capability and reliability of its components. This includes the positioning technology performance in terms of the achieved service availability, position accuracy and integrity. Also, the mobile network’s latency, available bandwidth, and data rates along with the mobile handsets memory capacity and processing power plays an important role in delivering the required service to the user. LBS applications require up-to-date and accurate location related information, such as maps, images, voice and video records, transport and weather updates, and so forth (Tsalgatidou et al., 2003; Aredo et al., 2003).

Generally, LBS applications deliver sensitive information services related to the user’s location. Therefore, a critical aspect of LBS implementation is identifying a suitable positioning technology that is capable of efficiently determining where (user accurate location) and when the required services are delivered. Currently, there are several positioning technologies available for navigation purposes in different LBS applications. However, this work focuses on the Global Positioning System (GPS) as the most widely deployed positioning technology.

**POSITIONING TECHNOLOGIES BACKGROUND**

Generally, the positioning technologies are divided into two major categories. The first one is described as network-based which involves different types of implementations such as mobile network positioning, in which mobile signals and the network infrastructure are used to locate the mobile device utilising several methods such as Angle of Arrival (AoA), Time of Arrival (ToA) and Enhanced Observed Time Difference (E-OTD). Also, this category includes wireless local network (Wi-Fi) and Radio Frequency Identification (RFID) based positioning, these methods are mainly used for position determination in local scales and indoor environments (Esmond, 2007). However, the network based positioning techniques are still not widely implemented as stand alone solutions because of its accuracy limitations. In addition, network operators still are not considering that LBS applications are typically to be utilised by all mobile phone users.

The second main category is known as satellite-based positioning, in which satellite signals are received by handheld receivers and used to position the mobile device based on a triangulation process of three or more different signals. This technology is known as the Global Navigation Satellite Systems (GNSS) such as GPS which has been widely utilised for a variety of air, land and sea applications. GPS is considered as the cornerstone of positioning in LBS applications because of its simplicity of use, inexpensive implementation, and global availability (Filjar, 2003). However, the positioning performance provided by a single frequency GPS receiver has proved to be insufficient for some precision and accuracy demanding applications (Kaplan & Hegarty, 2006).

The performance degradation of GPS is due to several error sources such as poor satellite geometry, satellite orbital shifting, clock errors, multipath effects, atmospheric delays and GPS receiver internal processing errors. These limitations escalate in urban environments and densely areas as there is a significant possibility for the signals to be jammed and blocked due to high obstructing buildings and difficult landscapes. A considerable attention has been carried out during the last decades trying to augment GPS positioning services among multiple signal error sources. As a result, different methods have emerged such
Mobile Agents Security Protocols

Open Source Digital Camera on Field Programmable Gate Arrays