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A Bluetooth User Positioning System for Locating, Informing, and Extracting Information Using Data Mining Techniques[1]

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ABSTRACT

Until now, user positioning systems were focused mainly on providing users with exact location information. This makes them computational heavy while often demanding specialized software and hardware from mobile devices. In this article we present a new user positioning system. The system is intended for use with m-commerce, by sending informative and advertising messages to users, after locating their position indoors. It is based exclusively on Bluetooth. The positioning method we use, while efficient is nevertheless simple. The m-commerce based messages, can be received without additional software or hardware installed. Moreover, the location data collected by our system are further processed using data mining techniques, in order to provide statistical information. After discussing the available technologies and methods for implementing indoor user positioning applications, we shall focus on implementation issues, as well as the evaluation of our system after testing it. Finally, conclusions are extracted. [Article copies are available for purchase from InfoSci-on-Demand.com]

Keywords: *Data Extraction; Data Mining; Data Processing; Mobile Technologies; Network Topology; Wireless Technologies*

INTRODUCTION

During the past few years, Bluetooth has become a very popular technology. Its low cost and low power consumption have made it ideal for use with small, low powered devices such as mobile phones and PDAs. Apart from forming wireless ad-hoc networks for sending and receiving data among Bluetooth enabled devices, wireless voice transferring, wireless printing, object exchange (such as business carts and messages) and many more applications, Bluetooth technology is also ideal for user location detection applications, mainly for two reasons: the first is that the technology itself provides ways for a variety of position-

ing methods to be efficiently implemented, like the triangulation and RX (Received X) power level methods (Kotanen, Hännikäinen, Leppäkoski & Hämäläinen, 2003). The second reason is that almost everyone possesses at least one Bluetooth device that can be used by a positioning application.

User positioning is the methodology used to detect the position of a user. This detection can be done according to some stationary points, which are usually called base stations. The position of a user arises when his distance from every base station becomes known. Two techniques can be followed: the first uses a central stationary point (server) that analyzes the data that come up from the base stations, resulting in the location of the user. The result is then sent to the user. The second technique, on the contrary, does not use any central stationary point. Instead, either the data that come up from the base stations are sent directly to the user's device to be processed there, or the user's device itself collects these data by detecting the base stations, and then processes them appropriately to find the desirable distances from the stations. This means that the user's device must be equipped with the necessary software to collect and process the data to find the users position, hence become software depended, something not desirable.

User positioning can be global or indoor. Global positioning is used to detect the geographic location of a user. GPS is a very well known and efficient global positioning system. Developed and maintained by the U.S. government, it was initially designed for military applications. Soon, civilian users have found numerous applications using this technology (Anonymous, 2007). GPS uses satellite links to detect the location of a GPS device worldwide. Indoor positioning on the other hand is used to locate a user inside a building. Despite the success of various well known global positioning technologies like the GPS, the Loran (LOng RAnge Navigation) (Proc, 2006b), the Decca navigation system (Proc, 2006a) and the Omega (Proc, 2006c), the need for indoor user positioning could not yet be satisfied. Using GPS to locate the position of a user inside a building will provide imprecise results, since a GPS receiver needs line-of-sight with a satellite, which is unachievable due to building walls.

According to Xiaojun, Junichi, & Sho (2004), the development of wireless technologies and mobile network has created a challenging research and application area, mobile commerce. They note that, as an independent business area, it has its own advantages and features as opposed to traditional e-commerce and that many unique features of m-commerce like easier information access in real-time, communication that is independent of the users' location, easier data reception and having accessibility anywhere and anytime make a widespread acceptance and deployment of its applications and services. Such services can be disposed to the public using wireless technologies. In this article we study the use of wireless technologies in informing the users by sending them m-commerce related messages.

Xiaojun, Junichi, & Sho (2004), also state that according to the market research firm Strategy Analytics, the global market for m-commerce is expected to reach $200 billion by 2004. Burger (2007) points out that while the U.S. and European Union markets are more crowded, closely regulated and contested, their size and technological infrastructure mean that they will be important proving grounds for m-commerce. According to Burger (2007), David Chamberlain, In-Stat's principal analyst for wireless technology, told the E-Commerce Times that there could be 10 million to 20 million m-commerce users in the U.S. by 2010. Indeed, the past few years there has been much interest in a variety of different applications regarding m-commerce. Varshney (2001) has identified several important classes of m-commerce, as well as examples within each class. Regarding mobile advertising applications, Varshney (2001) points out some important features of such applications: 1. advertisements sent to a user can be location-sensitive and can inform a user about various on-going specials (shops, malls, and restaurants) in surrounding areas, 2. depending on interests and the personality of