Automation in Construction 20 (2011) 3–13

Contents lists available at ScienceDirect

Automation in Construction

journal homepage: www.elsevier.com/locate/autcon

Application of WiFi-based indoor positioning system for labor tracking at construction sites: A case study in Guangzhou MTR

Sunkyu Woo [a], Seongsu Jeong [a], Esmond Mok [b], Linyuan Xia [c], Changsu Choi [d], Muwook Pyeon [e], Joon Heo [a,*]

[a] Department of Civil and Environmental Engineering, Yonsei University, Seoul 120-749, Republic of Korea
[b] Department of Land Surveying and Geo-Informatics, The Hong Kong Polytechnic University, Hong Kong, PR China
[c] School of Geographical Science and Planning, Sun Yat-sen University, Guangzhou, PR China
[d] Communication LAB., Central R&D Center, LS Industrial System Co., Ltd., Republic of Korea
[e] School of Civil Engineering, Konkuk University, Seoul, Republic of Korea

ARTICLE INFO

Article history:
Accepted 3 May 2010

Keywords:
WLAN
WiFi
Positioning system
Tunnel
Indoor
Construction
Labor tracking

ABSTRACT

For construction management, tracking the locations of construction resources such as labor, materials machinery, and vehicles is important. Some alternative form of location monitoring system is necessary for indoor environments such as tunnels and buildings under construction, because of systematic limitations of the Global Positioning System (GPS). This study investigated the feasibility of a WiFi-based indoor positioning system for construction sites. The system was developed using the fingerprint method of Received Signal Strength Indication (RSSI) from each Access Point (AP). A series of experiments were conducted at a shield tunnel construction site in Guangzhou, China. The results showed that the WiFi-based indoor positioning system was accurate within 5 m of error for that site, thus proving the utility of the system for tracking the approximate locations of labor at construction sites. Additionally, this system could be used for monitoring the locations of other construction resources such as vehicles and materials.

1. Introduction

Positioning of construction resources is an important issue for construction management. Location information offers significant potential for enhancing manual processes and supporting decision making tasks in the field [9]. Indoor positioning, specifically, offers promise as an especially useful construction site tool in such areas as safety and risk inspection, asset management and maintenance, and time and payroll management. Whereas materials, machinery and vehicles can be controlled and moved by computers or drivers, labor moves mostly according to non-fixed patterns. For the reason, the location and movement of labor need to be monitored in a more purposeful manner.

The Global Positioning System (GPS) is a well known means of obtaining locations in outdoor areas. However, this technique cannot be utilized in indoor environments as buildings and tunnels and congested metropolitan areas because of its reliance on satellite visibility [12]. There have been many efforts made to equip the GPS for indoor environments, efforts, for example, involving augmentation with an inertial navigation system (INS) or ["pseudo-satellite"] system [3,6]. Also, many researchers have proposed alternate systems for indoor areas.

A WLAN-based system is used to calculate positions by measuring the received signal strength of a radio frequency (RF). RADAR [1] (Microsoft) and Place Lab (Intel) are WLAN-based positioning systems. Alternatively, the infrared-based method finds positions using sensors that recognize the unique ID codes of infrared devices. Although the structure of this system is simple and the cost is low, a limited visibility range and line-of-sight (LOS) obstructions are its weak points. One such system is the "Active badge system" [16] (AT&T Lab.). Another, ultrasonic-based system uses the difference in the transfer speed between RF and ultrasonic signals. This system has the advantages of 3D position recognition, low-power, and low cost. The Cricket system [14] (MIT) and the Active bat system [13] (AT&T Lab.) both use ultrasonic technology. The radio frequency identification (RFID) system utilizes a tag-and-reader scheme. There are two types of readers, the receiver and the decoder. A transmitter in an RFID reader sends an activation signal to a tag, and the tag replies to the reader, sending its unique ID. This system, in the guise of SpotON [6], is available for use as a proximity location sensor. Ultra Wide Band (UWB) is a wireless technology for the low-power transferring of large amounts of digital data through a wide

* Corresponding author. Tel.: +82 2 2123 5797; fax: +82 2 364 5300.
E-mail addresses: wsk0419@yonsei.ac.kr (S. Woo), Seoungsu@yonsei.ac.kr (S. Jeong), lsemok@inet.polyu.edu.hk (E. Mok), xialiny@mail.sysu.edu.cn (L. Xia), cschoi2@lsis.biz (C. Choi), Neptune@konkuk.ac.kr (M. Pyeon), jheo@yonsei.ac.kr (J. Heo).

0926-5805/$ – see front matter © 2010 Elsevier B.V. All rights reserved.
doi:10.1016/j.autcon.2010.07.009