APPLICATION INDEPENDENT IN LOCATION TRACKING FRAMEWORK

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To beloved my Mother who always performs dowa for my success…

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ABSTRACT

Due to significant popularity of location-based services and multimedia communication over mobile devices, many researches have been conducted to extend the features of location tracking and make it cost effective to users. This research focuses on the performance of an indoor location tracking system on IPv6 network island with multiple real time applications that has location assisted session transfer feature for mobile users. Received signal strength Indicator mechanism has been used to locate the moving nodes. This research involved the development of location tracking server that monitors the dynamic and centralised MySQL database management system. Session initial protocols user agent has been used to deploy intercommunicating of multimedia data such as video and audio conference, text messaging among the moving nodes and users are able to transfer the multimedia sessions seamlessly to their nearest mobile nodes which will be determined by the location server. This study, thus, presents the variation of location tracking accuracy of triangulation system and fingerprint system on different indoor surroundings to compare the performance of their location tracking accuracy. Two indoor positioning systems, triangulation method (TM) and fingerprint method (FPM) were implemented and experiments were successfully conducted in different large area and small area scenarios of indoor environment. FPM experiments were examined into two sections: FPM database with data redundancy and FPM database without data redundancy. FPM database without data redundancy achieved 94.287% tracking accuracy which is the highest comparing to the FPM database with data redundancy and TM.

ABSTRAK

Disebabkan keperluan perkhidmatan yang berasakan lokasi dan komunikasi media untuk peranti mudah alih, banyak penyelidikan telah dijalankan untuk meluaskan penggunaan penjejakan lokasi dan membuat ianya lebih kos efektif kepada pengguna. Kajian ini memberi tumpuan kepada prestasi sistem penjejakan lokasi dalam bangunan (persekitaran tertutup) di rangkaian IPv6 dengan pelbagai aplikasi masa sebenar yang mempunyai ciri-ciri lokasi sesi perpindahan untuk membantu pengguna yang bergerak. Mekanisma petunjuk kekuatan isyarat yang diterima telah digunakan untuk mencari nod yang bergerak. Penyelidikan ini melibatkan pembangunan pelayan penjejakan lokasi akan memantau sistem pengurusan pangkalan data MySQL berpusat yang berada didalam rangkaian yang sama. Ejen pengguna untuk protokol permulaan sesi telah digunakan untuk menempatkan komunikasi data multimedia seperti video dan persidangan audio, mesej teks untuk nod yang bergerak dan pengguna dapat memindahkan sesi multimedia kepada nod terdekat yang ditentukan oleh pelayan lokasi. Dengan itu projek ini membincangkan beberapa variasi ketepatan oleh sistem triangulasi dan kaedah cap jari dalam beberapa persekitaran tertutup. Dua sistem lokasi persekitaran tertutup iaitu triangulasi (TM) dan kaedah cap jari (FPM) telah dijalankan dan experimentasi telah berjaya dilakukan dibeberapa kawasan besar dan kecil yang berbeza dalam persekitaran tertutup. Ujian FPM telah dibuat dalam dua bahagian: FPM pangkalan data dengan data pertindihan dan FPM pangkalan data tanpa data pertindihan. FPM pangkalan data tanpa pertindihan telah memberi kelebihan data mencapai 94.287% penjejakan lebih tepat berbanding dengan FPM pangkalan data dengan pertindihan data dan TM.

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LIST OF ABBREVIATIONS

ACK	-	Acknowledgment
ALSA	-	Advanced Linux Sound Architecture
AP	-	Access Point
API	-	Application Programming Interface
B2BUA	-	Back-to-back user agent
BS	-	Base Station
DHCPv6	-	Dynamic Host Configuration Protocol for IPv6
FPM	-	Fingerprint Method
GIS	-	Geographic information system
GNU	-	Free Unix style operating system
GPS	-	Global Positioning System
GSM	-	Global System for Mobile Communications
HTTP	-	Hypertext Transfer Protocol
IEEE	-	Institute of Electrical and Electronics Engineers
IETF	-	Internet Engineering Task Force
IM	-	Instant Messaging
IPng	-	Internet Protocol Next Generation
IPSec	-	Internet Protocol Security
IPv4	-	Internet Protocol version 4
IPv6	-	Internet Protocol version 6
LAMP	-	Linux, Apache, MySQL and PHP stack
LAN	-	Local Area Networ
LANDMARC	-	Indoor Location Sensing Using Active RFID
LBS	-	Location-Based Service
LS	-	Location Server
LTE	-	Long term Evolution

MAN	-	Metropolitan Area Network
MBONE	-	Multicast Backbone
MICE	-	Multimedia Application Tool
MN	-	Mobile Node
NAT	-	Network Address Translation
NNTP	-	Network News Transfer Protocol
OSS	-	Open Sound System
PDA	-	Personal digital assistant
QoS	-	Quality of Service
RadioMAP	-	RSS mapping with the location of Access Points's coverage
RFC	-	Request for Comments
RFID	-	Radio Frequency Identification
RITS	-	RSS-based Indoor Tracking System
RSS	-	Real Simple Syndication
RSSI	-	Received signal strength indication
RTP	-	Real-time Transport Protocol
SA	-	Service Agent
SDP	-	Session Description Protocol
SIP	-	Session Initiation Protocol
SIP-RTLS	-	RFID Location Tracking System Based on SIP
SMTP	-	Simple Mail Transfer Protocol
SRTP	-	Secure Real-time Transport Protocol
S-SIP	-	SIP-based Seamless-handoff
STP	-	Signaling Transfer Point
STUN	-	Session Traversal Utilities for NAT
UA	-	User Agent
UDP	-	User Datagram Protocol
URI	-	Uniform Resource Identifier
URL	-	Uniform Resource Locator
V2I	-	Vehicle-to-Infrastructure
V2V	-	Vehicle to Vehicle
VIC	-	Video Conference Tool

VoIP	-	Voice over IP
WBD	-	eBeam Whiteboard software
WiFi	-	Mechanism for Wirelessly Connecting Electronic Devices
WiMax	-	Worldwide Interoperability for Microwave Access
WLAN	-	Wireless Local Area Network
WSN	-	Wireless Sensor Network
WWW	-	World Wide Web

LIST OF SYMBOLS

α	-	The Angle between *a* and *d*
X_{mn}	-	X-coordinates distance of P1
Y_{mn}	-	Y-coordinates distance of P1
d_0	-	Reference distance
$P_r(d)$	-	Received power
$Pr(d_0)$	-	Received power at the reference distance d_0
X_σ	-	Gaussian random
WAF	-	Wall Attenuation Factor
T	-	Number of walls between transmitter and receiver.

LIST OF PUBLICATIONS

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3. Sazzad Hossain, Sharifah H. S. Ariffin, Norsheila Fisal, Norhidayu Shahila Abu Hassan, Liza Abdul Latiff, Choong Khong Neng, "Seamless SIP Multimedia Session Transfer on IPv6 Network Via Device Switching", International

Conference on Modeling, Simulation and Applied Optimization (ICMSAO-2011), pp. 1-7 Kuala Lumpur, Malaysia, April 19-21, 2011.

CHAPTER 1

INTRODUCTION

1.1 Overview

Modern researches on the location tracking are not only focusing on the calculating distance but also seeking to developed communications between the moving nodes [1] [2]. Nowadays, indoor location tracking in wireless networks is a leading area of research. The ability to determine and track the physical location of mobile wireless nodes in the wireless local area networks (WLANs) leads to many interesting applications, particularly with regard to the tracking of people, vehicles, and robots [3-8]. There are several softwares and methods have been used to enhance the performance and usability of indoor location tracking system. The location tracking of wireless multimedia application for users is an important feature, considered as remarkable progress in location base service.

Locating objects is becoming prominent by using technologies such as global positioning system (GPS) [9], but due to indoor channel characteristics, estimating location indoors accuracy remains a difficult problem. GPS system appears with scalable, efficient and cost effective location services that are available to the large public. However, the satellite emitted signals cannot be oppressed indoor to effectively determine the location. Due to different environmental characteristics and high price of technology, widespread availability of indoor location tracking system remains in doubt. There are actually various ways for determining and tracking position indoors, but to do so accurately remain very expensive. Sometimes it is quite

difficult to measure the accurate positions of the moving nodes. However, due to the maturity in the wireless technology, location-tracking of objects and people in indoor or outdoor environments has received ample attention from researchers lately. There are various methods for identifying and tracking user position such as Cricket [10], Active Badge [11], LANDMARC [12] and Mote Track [13]. Hence, accurate estimation of location in both environments remains a longstanding difficult task.

Different indoor location tracking have their own ways to determine the position or the location of moving objects [14] [15] [16] [17].Using location tracking mechanism, it is possible to calculate the current location of a user or an indoor object. For some applications it is sufficient to estimate the user's location in a room. Providing more accuracy opens up an opportunity for more specific services, such as real time application. Nowadays, location tracking services provide many other application for instance; audio alarm, location images, instant messaging among the moving nodes within the same range. In this research, Session Initiation Protocol (SIP) is integrated with the triangulation method to provide different multimedia communication between the mobile nodes within the range. SIP protocol is a signaling protocol which is widely used in the transport layer for controlling multimedia communication sessions such as voice and video calls over Internet Protocol (IP) [18]. The Session Initiation Protocol is a protocol to establish, maintain, and tear down multimedia sessions. Most operational experience with SIP to date has been over the IPv4 network; however, SIP implementations that support IPv6 are starting to emerge. In SIP, IPv6 support needs to be provided not only by the host on which a SIP element is executing on, but support is also expected from the application itself [19].

IPv6 is the next generation protocol for the Internet. It's designed to provide several advantages over current Internet Protocol Version 4 (IPv4). Both IPv6 and IPv4 define network layer protocol that sends from one computer to another computer over packet-switched networks such as the Internet. IPv6 deals with the main problem of IPv4, that is, the exhaustion of addresses to connect computers or host in a packet-switched network. IPv6 has a very large address space and consists

of 128 bits as compared to 32 bits in IPv4 [20]. IPv6 brings quality of service that is required for several new applications such as IP telephony, video/audio, interactive games or ecommerce. Whereas IPv4 is a best effort service, IPv6 ensures Quality of Service (QoS), a set of service requirements to deliver performance guarantee while transporting traffic over the network.

A Wireless Local Area Network (WLAN) typically extends an existing wired local area network. WLANs are built by attaching a device called the Access Point (AP) to the edge of the wired network. Nodes communicate with the AP using a wireless network adapter with same in function as a traditional Ethernet adapter. The signal from the nodes or the APs that use WLAN can be read or calculated using Received Signal Strength Indication (RSSI) method. RSSI is a measurement of the present power in a received radio signal. RSSI is generic radio receiver technology metric, which is usually invisible to the user of device containing the receiver, but is directly known to users of wireless networking of IEEE 802.11 protocol family [21] [22]. Most of the previous researches on RSSI are done by utilizing existing WLAN infrastructure. This approach is no doubt a cost effective solution, however, the uses for this WLAN suffers from the elimination of rays. Some signals are too weak to contribute in the calculation of distance and therefore, they must be eliminated from the system.

The research focuses on two indoor positioning methods and their performance on a specific architecture of indoor environment. The positioning methods are; Triangulation and Fingerprinting location tracking method. The developed location tracking server has a dynamic database system which saves each data retrieved by the positioning methods and its further uses. SIP session protocol has been applied to create communication between the mobile nodes. Developed location sever has the extended feature to let the mobile node know its nearest neighbor, so that the mobile nodes can transfer their session to their nearest neighboring nodes. Entire system has been developed on Ubuntu (Linux) platform and IPv6 network has been used in the WLAN.

1.2 Problem Statement

By using RSSI, it is possible to calculate the current location or position of an indoor object. For some applications, it is even sufficient to estimate user's location in a room. Providing more accuracy opens up an opportunity for more specific services. Usually, indoor location tracking has been used to establish an ubiquitous environment to track the motion of the moving nodes or objects. These objects are such as artificial robots, tiny devices, mobiles, laptops, or monitoring children activity. It is important to calculate the proximity position of the mobile objects and store them for future records. However, several multimedia applications can be used to enhance the usability of location tracking system during tracking the devices. Some of the problems have been identified on existing systems which are given below;

- Different methods have been used, but accuracy of indoor positioning remains a hitch.
- Installations difficulties and lack of user-friendliness of the system is considered as a big issue.
- Most of the recent technologies in Location Tracking System are very expensive and less effective when it comes to use of dynamic applications which has been discussed in chapter 2.
- Applications of current location tracking system can be enhanced by adding different other software with the location tracking system.

1.3 Objectives

The objectives of the research are mentioned as follows:

- To develop a framework that can support the existing Triangulation Location Tracking System with compatible centralized database system.
- To implement Seamless Multimedia Sessions between the moving nodes over IPv6 network on the top of existing Triangulation Location Tracking System.
- To implement Fingerprint Location Tracking System and compare the tracking result with the Triangulation Location Tracking System.

1.4 Scope

The scope of this research is to develop seamless multimedia communication between the moving nodes. SER (SIP Express Router) is used as the SIP Server. SIP protocol has been used to create communication between the moving nodes over IPv6 network. Kphone SIP open source user agent is modified to create seamless SIP session. IPv6 Island Network using Ubuntu (Linux) operating system or platform which had been previously setup in UTM MIMOS CoE. All the experiments and the entire setup of this research have been implemented inside UTM MIMOS CoE laboratory. Ubuntu 9.04 is used as operating system for the Location Server and Mobile Nodes. The software called as Quagga which comes up with Ubuntu is used to set up this IPv6 network. To further enhance the operation of the Location Server, MySql database server 2005 have been deployed. The location tracking mechanism using RSSI methods has been exercised to implement Triangulation and Fingerprinting Method.

1.5 Significant Contribution of Research

This research has been conducted to improve the accuracy of the location tracking mechanism concentration in a particular indoor environment and to increase the efficiency of overall system. Extended literature review has assisted to generate new concepts in the applications on location tracking system. The contributions are being listed below;

- Seamless multimedia communication has been successfully deployed on the moving nodes over IPv6 network. SIP protocol has been applied to reduce the high traffic data during video or audio session.
- Existing Triangulation Tracking System has been improved by add centralized database and SIP session (for example; audio session, video session and text messaging session) between the moving nodes.
- Fingerprint Tracking System is developed to improve the accuracy to improve the accuracy of the tracking system. Fingerprint Tracking System has been divided into two phases; With Data Redundancy and Without Data Redundancy. Fingerprint Without Data Redundancy experiment has achieved 94.287% tracking accuracy which the highest comparing to other experiments.
- Triangulation and Fingerprint tracking program's source code has been developed from the scratch. The codes are well documented for its further uses.
- Triangulation and Fingerprint experiments have been conducted on different scenarios of an indoor environment to observe the variation error of their tracking results.
- In this research, Ubuntu is used as a platform and MySql is used as Database which provides to users a cost effective solutions.
- This kind of system can be fruitful to child-care services or health-care industries. The management can monitor their patient and patient can communicate with nearest doctor or nurse available within the same network.

1.6 Thesis Organization

This thesis is organized as follows;

Chapter 2 presents the literature review of the research, the IPv6 Network, the features of IPv6 introduction in a brief, overview of SIP protocol, Database Management System, IEEE 802.11 network and Location Tracking mechanism using RSSI. Some of the similar recent works to this research has been discussed as well.

Chapter 3 and Chapter 4 present the methodology and implementation of Triangulation method and the multimedia Seamless Session transference mechanism on moving over IPv6 network. The flow of the overall system and the implementation of database system have also discussed in this chapter. The experimented results of Triangulation method on different scenarios and Seamless connectivity of SIP sessions over IPv6 network have been briefed in Chapter 4.

Chapter 5 presents the implementation of Fingerprint method and analyzes the experimental results which have achieved on indoor environment.

The Conclusion and some new ideas proposed as future work have been discussed in the Chapter 6.

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