APPLICATION INDEPENDENT IN LOCATION TRACKING FRAMEWORK

SAZZAD HOSSAIN

A thesis submitted in fulfilment of the requirements for the award of the degree of Master of Engineering (Electrical)

Faculty of Electrical Engineering
Universiti Teknologi Malaysia

MARCH 2013
To beloved my Mother who always performs dowa for my success…
ACKNOWLEDGEMENT

I would like to thank my supervisor and my Alma mater, Dr. Sharifah Hafizah Syed Ariffin for her willingness and kindness to guide and teach me until this research has been completed successfully. I would like to take this opportunity to deliver and extend my heartfelt gratitude to whom have made possible to complete my thesis.

I would also like to thank the Head of the MIMOS-CoE lab Prof. Norsheila Fisal for granting me to work on MIMOS-CoE Lab. I would also thank my co-supervisors Dr. Choong Neng and Dr. Liza Abdul Latif for their help to review my paper and giving me innovative ideas. I would also like to thank MIMOS for providing the equipments and fund for this research. I would also like to appreciate ministry of Higher Education for providing grants for this research

Last but not least, I thank my family: my parents Abed Hossain and Jahanara Begum, for giving me life in the first place, for educating me in respect to both arts and science, for unconditional support and encouragement to pursue my interests. My siblings; Ezaz Hossain, Asmia Hossain and Asif Hossain, always encourage me to be confident. My thank goes to all of my colleagues and friends for their encouragement. They were always beside me and accompanying me. And to Almighty Allah, who made all things possible.

I am very much appreciative and proud to be able to have this opportunity to finish my Master by Research at Universiti Teknologi Malaysia.
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 berasaskan 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.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DECLARATION</td>
<td></td>
<td>ii</td>
</tr>
<tr>
<td>DEDICATION</td>
<td></td>
<td>iii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENT</td>
<td></td>
<td>iv</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td></td>
<td>v</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td></td>
<td>vi</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td></td>
<td>xi</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td></td>
<td>xii</td>
</tr>
<tr>
<td>LIST OF ABBREVIATION</td>
<td></td>
<td>xvii</td>
</tr>
<tr>
<td>LIST OF SYMBOLS</td>
<td></td>
<td>xviii</td>
</tr>
<tr>
<td>LIST OF PUBLICATIONS</td>
<td></td>
<td>xix</td>
</tr>
</tbody>
</table>

1 INTRODUCTION

1.1 Overview 1
1.2 Problem Statement 4
1.3 Objectives 5
1.4 Scope 5
1.5 Significant Contribution of Research 6
1.6 Thesis Organization 7
2 LITERATURE REVIEW

2.1 Overview 8
2.2 Location Tracking Technology 9
2.3 Session Initial Protocol Overview 11
2.4 SIP User Agent 13
2.5 Seamless Connectivity 15
2.6 Related Works 17
  2.6.1 SIP Based Location Services 17
    2.6.1.1 RFID Location Tracking System Based on SIP (SIP-RLTS) 17
    2.6.1.2 SIP-based Seamless-handoff (S-SIP) 19
    2.6.1.3 An Indoor Tracking-based Handoff Mechanism for VoIP Applications in IEEE 802.11 WLANs 21
  2.6.2 Location Tracking Mechanism 23
    2.6.2.1 Cricket Location Tracking 23
    2.6.2.2 LANDMARC Tracking Algorithm 24
    2.6.2.3 Fingerprint Position Error Estimation 25
  2.7 IEEE 802.11 Standard 28
  2.8 Internet Protocol version 6 (IPv6) Network 29
  2.9 MySql Database Management Systems 30
  2.10 Summary 32

3 TRIANGULATION TRACKING SYSTEM AND SIP SESSION TESTBED

3.1 Overview 33
3.2 Triangulation Tracking System Architectural 34
Design

3.3 Flow of Overall System
   3.3.1 Location Server Work Flow
   3.3.2 SIP Session Connectivity

3.4 Triangulation Method Algorithm

3.5 Work flow of SIP Session Handover
   3.5.1 SIP Peer to Peer Activity
   3.5.2 SIP Session Handover Flow

3.6 Setup and Configuration
   3.6.1 Location Server Setup
   3.6.2 Mobile Node Setup

3.7 Hardware Requirements

3.8 Summary

4 TRIANGULATION AND SIP SESSION
RESULTS

4.1 Introduction

4.2 Triangulation Location Tracking Analysis
   4.2.1 Experiment without Wall Interference: Small Area
   4.2.2 Experiments without Wall Interference: Large Area
   4.2.3 Experiment with X-Axis Wall Interference: Small Area
   4.2.4 Experiment with X-Axis Wall Interference: Large Area
   4.2.5 Experiment with Y-Axis Wall Interference: Small Area
   4.2.6 Experiment with Y-Axis Wall Interference: Large Area

4.3 SIP Session Implementation

4.4 SIP Seamless Session Handover
5 FINGERPRINT METHOD IMPLEMENTATION AND RESULTS

5.1 Introduction 86
5.2 Fingerprint Method 87
5.3 Fingerprint Algorithm Design and Deployment 89
5.4 Fingerprint Testbed Setup 92
5.5 Fingerprint Experiments 95

5.5.1 FPM Experiments with RSSI Data 95
Redundancy
  5.5.1.1 FPM Experiment with RSSI Data 97
    Redundancy: Small Area
  5.5.1.2 FPM Experiment with RSSI Data 92
    Redundancy: Large Area
5.5.2 FPM Experiments without RSSI Data 101
Redundancy
  5.5.2.1 FPM Experiment without RSSI 101
    Data Redundancy: Small Area
  5.5.2.2 FPM Experiment Without RSSI 103
    Data Redundancy: Large Area

5.6 Summary 105

6 CONCLUSION

6.1 Introduction 106
6.2 Recommendations and Future Works 109

REFERENCES 111

Appendices A-B 118-128
## LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE NO.</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Recent location tracking technologies</td>
<td>9</td>
</tr>
<tr>
<td>3.1</td>
<td>List of required hardware and software</td>
<td>56</td>
</tr>
<tr>
<td>4.1</td>
<td>Small area experiment without wall interference</td>
<td>62</td>
</tr>
<tr>
<td>4.2</td>
<td>Large area experiment without wall interference</td>
<td>64</td>
</tr>
<tr>
<td>4.3</td>
<td>X-Axis wall barrier on small area</td>
<td>68</td>
</tr>
<tr>
<td>4.4</td>
<td>X-Axis wall barrier on large area</td>
<td>70</td>
</tr>
<tr>
<td>4.5</td>
<td>Y-Axis with wall barrier on small area</td>
<td>73</td>
</tr>
<tr>
<td>4.6</td>
<td>Y-Axis wall barrier on large area</td>
<td>75</td>
</tr>
<tr>
<td>5.1</td>
<td>FPM small area experiment with RSSI data redundancy results</td>
<td>97</td>
</tr>
<tr>
<td>5.2</td>
<td>FPM large area experiment with RSSI data redundancy results</td>
<td>99</td>
</tr>
<tr>
<td>5.3</td>
<td>FPM small area experiment without RSSI data redundancy results</td>
<td>102</td>
</tr>
<tr>
<td>5.4</td>
<td>FPM large area experiment without RSSI data redundancy results</td>
<td>103</td>
</tr>
<tr>
<td>6.1</td>
<td>Average error of triangulation and fingerprint experiments on different scenarios</td>
<td>108</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>FIGURE NO.</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Session Initial Protocol flow of work</td>
<td>12</td>
</tr>
<tr>
<td>2.2</td>
<td>Kphone SIP user agent</td>
<td>14</td>
</tr>
<tr>
<td>2.3</td>
<td>Greenpacket’s Intouch connection manager for android</td>
<td>16</td>
</tr>
<tr>
<td>2.4</td>
<td>RFID location tracking system based on SIP architecture</td>
<td>18</td>
</tr>
<tr>
<td>2.5</td>
<td>SIP-based seamless-handoff (S-SIP) network architecture</td>
<td>20</td>
</tr>
<tr>
<td>2.6</td>
<td>Indoor tracking-based handoff mechanism for VoIP applications in IEEE 802.11 WLANs architectural design</td>
<td>22</td>
</tr>
<tr>
<td>2.7</td>
<td>Cricket location tracking experimental setup</td>
<td>24</td>
</tr>
<tr>
<td>2.8</td>
<td>LANDMARC testbed environment</td>
<td>25</td>
</tr>
<tr>
<td>2.9</td>
<td>Fingerprint position error estimation</td>
<td>27</td>
</tr>
<tr>
<td>2.10</td>
<td>Wi-Fi networks</td>
<td>28</td>
</tr>
<tr>
<td>3.1</td>
<td>Overall testbed design of the system</td>
<td>34</td>
</tr>
<tr>
<td>3.2</td>
<td>a) Flow of location server on IPv6 network b) Flow of SIP session connectivity</td>
<td>36-37</td>
</tr>
<tr>
<td>3.3</td>
<td>Triangulation method</td>
<td>39</td>
</tr>
<tr>
<td>3.4</td>
<td>SIP activity diagram</td>
<td>42</td>
</tr>
<tr>
<td>3.5</td>
<td>Sequence diagram of SIP session transference</td>
<td>44</td>
</tr>
<tr>
<td>3.6</td>
<td>Start up SIP server</td>
<td>44</td>
</tr>
<tr>
<td>3.7</td>
<td>Location sever program</td>
<td>45</td>
</tr>
<tr>
<td>3.8</td>
<td>Results on MySQL database</td>
<td>46</td>
</tr>
<tr>
<td>3.9</td>
<td>Quagga application on Ubuntu</td>
<td>47</td>
</tr>
<tr>
<td>3.10</td>
<td>Zebra configuration file</td>
<td>48</td>
</tr>
</tbody>
</table>
3.11 Mysql database configuration file
3.12 Kphone SIP user agent
3.13 Client program
3.14 SIP user agent Kphone call invitation
3.15 Kphone text messaging
3.16 Video conference
3.17 SIP session transfer
3.18 Kphone audio session configurations
3.19 Kphone external application tools
4.1 The indoor experiment layout
4.2 Small area experiments without wall interference
4.3 Small area experiment for fixed position without wall interference
4.4 Large area experiments without wall interference
4.5 Large area experiment for fixed position without wall interference
4.6 Triangulation scenario on X-Axis wall interference
4.7 X-axis with wall interference experiment in small area
4.8 X-Axis with wall interference experiment on large area
4.9 Triangulation scenario on Y-Axis wall interference
4.10 Y-Axis interference experiment on small area
4.11 Y-Axis interference experiment on large area
4.12 Bob handover session to Sally
4.13 Bob audio sessions
4.14 Marry audio session
4.15 Bob video sessions
4.16 Marry video session
4.17 Bob text message session
4.18 Marry text message session
5.1 Fingerprint coordinate structure
5.2 Flow of fingerprint method program
5.3 Pseudo code to find the closest match
5.4 Fingerprint location tracking testbed
5.5 FPM location tracking program 94
5.6 FPM database with redundant RSSI data 96
5.7 FPM small area experiments with RSSI data redundancy 98
5.8 FPM Large area experiments with RSSI data redundancy 100
5.9 FPM small area experiments without RSSI data redundancy 102
5.10 FPM large area experiments without RSSI data redundancy 104
6.1 Accuracy comparison of location tracking 108
# LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACK</td>
<td>Acknowledgment</td>
</tr>
<tr>
<td>ALSA</td>
<td>Advanced Linux Sound Architecture</td>
</tr>
<tr>
<td>AP</td>
<td>Access Point</td>
</tr>
<tr>
<td>API</td>
<td>Application Programming Interface</td>
</tr>
<tr>
<td>B2BUA</td>
<td>Back-to-back user agent</td>
</tr>
<tr>
<td>BS</td>
<td>Base Station</td>
</tr>
<tr>
<td>DHCPv6</td>
<td>Dynamic Host Configuration Protocol for IPv6</td>
</tr>
<tr>
<td>FPM</td>
<td>Fingerprint Method</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographic information system</td>
</tr>
<tr>
<td>GNU</td>
<td>Free Unix style operating system</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>GSM</td>
<td>Global System for Mobile Communications</td>
</tr>
<tr>
<td>HTTP</td>
<td>Hypertext Transfer Protocol</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
</tr>
<tr>
<td>IETF</td>
<td>Internet Engineering Task Force</td>
</tr>
<tr>
<td>IM</td>
<td>Instant Messaging</td>
</tr>
<tr>
<td>IPng</td>
<td>Internet Protocol Next Generation</td>
</tr>
<tr>
<td>IPSec</td>
<td>Internet Protocol Security</td>
</tr>
<tr>
<td>IPv4</td>
<td>Internet Protocol version 4</td>
</tr>
<tr>
<td>IPv6</td>
<td>Internet Protocol version 6</td>
</tr>
<tr>
<td>LAMP</td>
<td>Linux, Apache, MySQL and PHP stack</td>
</tr>
<tr>
<td>LAN</td>
<td>Local Area Network</td>
</tr>
<tr>
<td>LANDMARC</td>
<td>Indoor Location Sensing Using Active RFID</td>
</tr>
<tr>
<td>LBS</td>
<td>Location-Based Service</td>
</tr>
<tr>
<td>LS</td>
<td>Location Server</td>
</tr>
<tr>
<td>LTE</td>
<td>Long term Evolution</td>
</tr>
</tbody>
</table>
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
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VoIP</td>
<td>Voice over IP</td>
</tr>
<tr>
<td>WBD</td>
<td>eBeam Whiteboard software</td>
</tr>
<tr>
<td>WiFi</td>
<td>Mechanism for Wirelessly Connecting Electronic Devices</td>
</tr>
<tr>
<td>WiMax</td>
<td>Worldwide Interoperability for Microwave Access</td>
</tr>
<tr>
<td>WLAN</td>
<td>Wireless Local Area Network</td>
</tr>
<tr>
<td>WSN</td>
<td>Wireless Sensor Network</td>
</tr>
<tr>
<td>WWW</td>
<td>World Wide Web</td>
</tr>
</tbody>
</table>
LIST OF SYMBOLS

\( \alpha \) - The angle between \( a \) and \( d \)

\( X_{\text{mn}} \) - X-coordinates distance of P1

\( Y_{\text{mn}} \) - Y-coordinates distance of P1

\( d_0 \) - Reference distance

\( P_r(d) \) - Received power

\( P_r(d_0) \) - Received power at the reference distance \( d_0 \)

\( X_\sigma \) - Gaussian random

\( WAF \) - Wall Attenuation Factor

\( \tau \) - Number of walls between transmitter and receiver.
LIST OF PUBLICATIONS

Journals:


Conferences:


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.
REFERENCES


