EQUIPMENT TRACKING AND SECURITY SYSTEM FOR HOSPITAL ENVIRONMENT USING WLAN INDOOR LOCATION TRACKING SYSTEM

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To God the Almighty, without whom knowledge without faith is fruitless and to my parent, who have molded me into who I am.

ACKNOWLEDGMENT

In the name of Allah, Most Gracious, and Most Merciful

First, I would like to take this opportunity to express my sincere and utmost gratitude to my project supervisor Prof.Dr Tharek Bin Abdul Rahman for this vision, guidance and support throughout the duration that I undertook to complete this project successfully.

Secondly, I would like to convey my deepest gratitude to Mr. Chua Tien Han, for preparing the relevant groundwork for research in the field of indoor location tracking in the Wireless Communication centre, P15, Faculty of Electrical Engineering, UTM. His suggestions and comments on methodologies that I chose helped me avoid the common pitfalls in this filed of work

Also I would like to thank friends and stuff in (WCC) for their help facilities and for providing conductive working environment

I would like also to express my gratitude to Mr. Usman Ullah Sheikh, mentor friend and guru during software development phase utilizing Java. His tips and advice help quicken my learning curve in java programming.

Last but not least, I would like to thank my parents, my siblings and all my friends that have given their moral support during the ups and down of my project work life cycle.

ABSTRACT

Location tracking systems has brought tremendous benefits, especially to the medical field; one of its benefits is to help keeping track of critical equipment of the hospital which is a challenge in any hospitals. However hospital's equipment often scattered throughout the facility, forcing busy staff to waste precious time tracking down intravenous pumps, wheelchairs or other equipment. Furthermore, hospital also suffers the lost of the equipment due to thefts. Therefore, equipment management system using Wireless Location Area (WLAN) based indoor location tracking system is proposed to alleviate these problems. A simple measurement campaign will be conducted to study the properties of the Ekahau location tracking system and then the equipment management system which include real-time equipment tracking and security system. Ekahau WLAN-based indoor location tracking system will be applied in this project to provide real-time location estimation. Each equipment will equipped with Ekahau WLAN Tag, and its location will be calculated by the Ekahau engine server. The location is predicated through WLAN signal strength finger-printing technique. Requirements of basic equipment tracking and security will be developed and examined in Java platform. A test-bed would then be setup within the confines of the WCC (wireless Communication Centre) using the existing WLAN incorporating the IEEE 802.11g standard AP (Access Point) and adapters. The location of the equipment will be provided by Ekahau positioning engine software readily available at the WCC. At the end of the project, a system which is capable to provide real-time equipment's location to user will be developed. Besides that the system will be capable to give alert to the control centre if the hospital's equipment is brought out from the authorized area.

ABSTRAK

Sistem penjejak lokasi telah membawa manfaat yang sangat besar, terutamanya kepada bidang perubatan, salah satu manfaatnya ialah membantu menjejak peralatan kritikal hospital, dimana ia merupakan satu cabaran dimana-mana hospital. Walau bagaimanapun peralatan hospital sering bertempiaran di sekitar kemudahan hospital. Ini memaksa staf yang sibuk membazir masa yang berharga untuk menjejak pam intravena, kerusi beroda, atau peralatan lain. Tambahan lagi hospital juga mengalami kehilangan peralatan akibat pencuri. Oleh yang demikian, sistem pengurusan peralatan menggunakan sistem penjejak lokasi dalam bangunan berasaskan rangkaian kawasan setempat wayerles (WLAN) dicadangkan untuk meringankan masalah-masalah ini. Satu kempen pengukuran mudah akan dijalankan untuk mengkaji ciri-ciri sistem penjejak lokasi Ekahau dan kemudiannya sistem pengurusan peralatan yang merangkumi penjejakan peralatan masa-nyata dan sistem keselamatan. Sistem penjejak lokasi dalam bangunan Ekahau yang berasaskan WLAN akan digunakan dalam projek ini untuk membekalkan penganggaran lokasi masa-nyata. Setiap peralatan akan dilengkapi dengan tag WLAN Ekahau dan lokasinya akan dkira oleh pelayan enjin Ekahau. Lokasi diramal melalui teknik pencap-jarian kekuatan isyarat WLAN. Keperluan-keperluan asas penjejakan peralatan dan keselamatan akan dibangunkan dan diselidik dalam platform Java. Tapak pengujian kemudiannya akan dibentuk di pusat komunikasi wayarles (WCC) dengan menggunakan WLAN sedia ada yang menggabungkan titik capaian (AP) TEEE802.11g dan adapter. Lokasi peralatan akan diberi oleh perisian enjin lokasi Ekahau yang sedia ada di WCC. Di penghujung projek, sebuah sistem yang berupaya untuk memberi lokasi masa-nyata peralatan kepada pengguna akan dibangunkan. Disamping itu, sistem tersebut akan berupaya memberi amaran kepada pusat kawalan jika peralatan hospital dibawa keluar daripada kawasan yang dibenarkan.

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LIST OF ABBREVIATIONS

AOA	-	Angle of Arrival
AP	-	Access Point
CID	-	Cell Identification
COO	-	Cell of Origin
EPE	-	Ekahau Positioning Engine
GPS	-	Global Positioning System
GSM	-	Global System
IEEE	-	Institution of Electrical and Electronic Engineering
LAN	-	Local Area Network
RSS	-	Received Signal Strength
SS	-	Signal Strength
WCC	-	Wireless Communication centre
WLAN	-	Wireless Local Area Network
Wi-Fi	-	Wireless Fidelity

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Wireless networks are becoming more and more popular in build environment such as in hospitals, universities, malls and so on, in build environment prefer to set up a wireless network rather than the traditionally wired network because the flexibility and freedom it can provided. Based on the wireless infrastructure, a great many new and promising applications are coming into our lives.

Now wireless local area network (WLAN) is not just a mere communications system, it can be used to locate people and objects Locations, based on signal strengths received from access points, this is called the WLAN Positioning System. To implement a successful location based application, the most important is to locate mobile devices accurately, at least within an acceptable range, to pin-point the user's positioning.

The problem of positioning and tracking has been tackled by many systems over the years, such as GPS, wide-area cellular-based system, infrared-based system, magnetic tracking system, physical contact systems and radio frequency based systems. Locating objects and people outdoors is becoming trivial by using technologies like Global Positioning System (GPS), GPS makes a big success in outdoor navigation, but fails in indoor due to the indoor channel characteristics,

accurately estimating location for indoors environment remains a difficult. There are actually various ways for determining and tracking position indoors, but to do so accurately remain very costly; deployment of sensors all around a building or the usage of expensive hardware might be required. Radio frequency-based tracking in WLAN has gained more and more attention in recent years, because it makes use of existing WLAN infrastructure, requires no extra hardware, and provides relatively large coverage [1].

Location tracking systems brings with it tremendous benefits, especially to the medical field, one of its benefits are to help track critical equipment of the hospital, keeping track of equipment is a challenge in any hospital, no matter how large or small are they. However, hospital's equipments are often scattered throughout the facility, forcing busy staff to waste precious time tracking down the equipments. If the equipment can not be found, hospitals unnecessarily purchase or rent replacements. However, in the emergence case the time lost because of the equipment unavailability, putting patient at risk. It can be expensive and can cost human life; in addition hospitals can loose a lot of money in medical equipment due to thefts.

For example, in-patient bedside medical equipment consists of an infusion pump and a physiological monitoring system that monitors most parameters such as ECG, heart rate, blood pressure, oxygen saturation and other parameters. An infusion pump is used to administer medicine or nutrient, often through a vein. These pumps, mounted on an IV (intravenous) cart, are highly mobile equipment that are allocated to General Service, thus making it difficult to locate a specific infusion pump prior to a repair. In addition, these pumps are often misplaced or stolen due to the nature of its use [2].

This project is proposed to design and develop a real time Equipment Tracking and Security System for Hospital environment based on WLAN indoor location tracking system to alleviate the problems which are mentioned above. A simple measurement campaign will be conducted to study the properties of the Ekahau [3] location tracking system, and then the equipment management system which include real-time equipment tracking and security system. The equipment

tracking system using WLAN-based indoor location tracking system will provide the physical location of the equipment at any time within the coverage of the hospital. The equipment security system will provide protection of the equipment from theft. Ekahau WLAN-based indoor location tracking system will be applied in this project to provide real-time location estimation. Each equipment will be equipped with an Ekahau WLAN Tag and its location will be calculated by the Ekahau engine server. The location is predicated through WLAN signal strength finger-printing technique. At the end of the project, a system which is capable to provide real-time equipment's location to user will be developed. Besides that the system will be capable to give alert to the control centre if the hospital's equipment is taken away from the authorized area.

1.2 Problem Statement

- The most current system used is manual.
- More time is wasted in search of equipments.
- In case of emergency time is an important constraint.
- Theft of equipments will cost the hospital in replacing them.

1.3 Objective

- To design and develop a real time hospital equipment management system which will includes equipment tracking and security system, using WLAN indoor location tracking system.
- To study the properties of WLAN signal strength (SS) for indoor location tracking application.
- To study the properties of WLAN-based indoor location tracking system.

1.4 Scope of Work

The equipment management system would be developed and examined into an electronic version based on the Java platform. The Implementation of WLAN-based indoor location for real time tracking will be done by utilizing Ekahau Positioning Engine [3] (Mapping, Fingerprinting and calibration), as well as this project will involve building Database for all equipments available in the hospital for security and management purposes.

A test-bed would then be setup within the confines of the wireless Communication Centre **(WCC),** Block P15 Faculty of Electrical Engineering, using the existing WLAN incorporating the **IEEE 802.11g** standard Access Point **(AP),** Tags which are attached to the hospital equipments will be use in order to emulate the location of the equipment. A two-dimensional map covering the entire ground floor building of WCC is covered in the system saved into the positioning engine and scaled accordingly. The received signal strength intensity **(RSSI)** index of the test-bed would be obtained from the calibration run of the positioning engine using the propriety software on the previously stored scaled map. This commonly, known as the ***finger printing technique***. The location of the equipment will be calculated by using the positioning engine software from the RSSI obtains during the calibration process.

An interface would then be developed into the equipment management recorder application, to extract the location of the equipment. This will be done by obtaining the received signal strength which is emitted by the tag, and comparing it with the recorded RSSI which obtained from the calibration process.

Equipment tracking and security system using WLAN indoor location tracking system is does not involve any hardware development as the existing hardware are readily available off-the shelf. It only consists of the software development cycle in a Java. WCC has been chosen as the perfect test-bed to run simulated test of the software as the existing access point are sufficiently installed and EPE server is deployed within the confines of building itself.

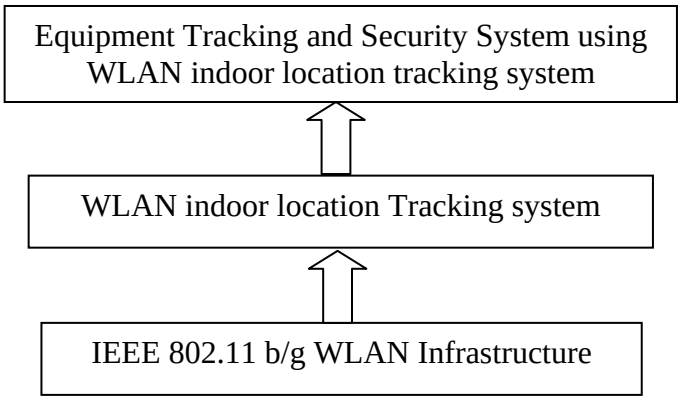

Figure 1.1: Tree Diagram of Location –A Ware Equipment Tracking and Security System Using WLAN Indoor Location Tracking System

From the tree diagram as shown from figure 1 the lowest hierarchical level is the physical WLAN infrastructure, which involve access points, WLAN PCMCIA cards, laptops and Ekahau WLAN Tag. One layer above the WLAN indoor location tracking system consist of Ekahau Position Engine 3.0 (EPE) is the only software based real time location system currently in market. The top of the diagram is the Equipment tracking and security system using WLAN indoor location tracking system.

Moreover this project will include a proper study of the properties of the WLAN-based indoor location tracking system; this will include examining of the WLAN signal strength **(SS**), at different time and locations, in order to prove the stability and reliability of location tracking using WLAN **SS** finger-printing technique. The measurement of SS will be obtained using NetworkStumbler software. Besides that, the effects of number of access points, and calibration nodes on the location estimation accuracy will be investigated by using Ekahau manager accuracy analysis.

1.5 Thesis Organization

The first chapter the provides readers, glimpse at the basic aspects of the research undertaken such as problem statement objectives, and scope of work,.

The second chapter gives an overview of available positioning techniques. And among the topics that are discussed, Classification of Positioning system, Global Positioning System; Cell of Origin /Cell ID Positioning, system, and finally Indoor Positioning System.

The third chapter, reports on the methods employed to develop the positioning system and the methodology, in which the methods employed and the soft wares needed for this project are explained.

The fourth chapter presents the result and discussion of implementation of equipment tracking and security system based on WLAN indoor location tracking. The topics discussed are positioning system program requirement, program functionality and finally program implementation.

The fifth chapter, studies the properties of WLAN based-Indoor location tracking system in terms of accuracy based on the signal strength of the wireless network.

In the sixth chapter, are the conclusion and discussion of future works that can be carried out is presented.