ENHANCED MOBILE LOCATION ESTIMATION WITH A SINGLE BASE STATION

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Dedicated to my dearest dad and mum who supported me all the time and my friends who always by my side.

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ABSTRACT

Wireless telecommunication technology is getting more and more advance these days. Localization technology like mobile phone tracking has a lot space for expansion. In order to localize mobile station (MS), non-line of sight (NLOS) propagation of signal is one of the major problems faced during estimation. Positioning techniques like angle of arrival (AOA), angle of departure (AOD) and time of arrival (TOA) are used to reduce the error occurred. Besides, the conventional single input single output (SISO) technology can be replaced by multiple input multiple output (MIMO) technology to improve efficiency. This leads to the idea to develop algorithm by extending virtual base stations concept for a single MIMO base station (SMBS). The methods used in this project is only MIMO and it is applied with different number of antenna at both transmitter and receiver sides. This project only covered the software part by using powerful simulation tool. MIMO with higher number of antenna will perform better location and position estimation.

ABSTRAK

Teknologi telekomunikasi tanpa wayar menjadi semakin maju pada masa kini. Teknologi penyetempatan seperti pengesanan tempat telefon bimbit mempunyai banyak ruang untuk perkembangan. Untuk mengetahui posisi stesen bergerak (MS), garis bukan penglihatan (NLOS) perambatan isyarat adalah salah satu masalah utama yang dihadapi semasa anggaran. Teknik kedudukan seperti sudut ketibaan (AOA), sudut berlepas (AOD) dan masa ketibaan (TOA) digunakan untuk mengurangkan peluang berlakunya kesalahan anggaran. Selain itu, konvensional teknologi input tunggal keluaran tunggal (SISO) boleh digantikan dengan teknologi pelbagai input pelbagai output (MIMO) untuk meningkatkan kecekapan. Perkara ini membawa kepada idea untuk membangunkan algoritma dengan meluaskan konsep stesen pangkalan maya untuk stesen pangkalan tunggal yang menggunakan sistem MIMO (SMBS). Kaedah-kaedah yang digunakan dalam projek ini hanya MIMO dan ia digunakan dengan nombor antena berbeza di kedua-dua antena pemancar dan antena penerima. Projek ini hanya meliputi bahagian perisian dengan menggunakan alat simulasi. MIMO dengan bilangan antena yang lebih tinggi antena akan memberi keputusan lokasi dan anggaran kedudukan yang lebih baik.

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LIST OF ABBREVIATIONS

AOA	-	Angle of Arrival
AOD	-	Angle of Departure
AMC	-	Adaptive Modulation and Coding
AWGN	-	Addictive White Gaussian Noise
BS	-	Base Station
CDF	-	Cumulative Distribution Function
CPE	-	Customer-Provided Equipment
DOA	-	Direction of Arrival
DOP	-	Dilution of Precision
GDOP	-	Geometric Dilution of Precision
IEEE	-	Institute of Electrical and Electronics Engineers
ISDN	-	Integrated Service Digital Network
IMT	-	International Mobile Telecommunications
LAN	-	Local Area Network
LLS	-	Linear Least Square
LS	-	Least Square
LOB	-	Line of Bearing
LOS	-	Line of Sight

L&P	-	Localization and Positioning
MAN	-	Metropolitan Area Network
MIMO	-	Multiple Input Multiple Output
MS	-	Mobile Station
NLOS	-	Non-Line of Sight
PAN	-	Personal Area Network
PC	-	Personal Computer
QOS	-	Quality-of-Service
RF	-	Radio Frequency
RMSE	-	Root-Mean-Square Error
ROS	-	Ring of Scatterer
RSS	-	Received Signal Strength
RSSI	-	Received Signal Strength Indication
SBM	-	Single Bounce Macrocell Model
SD	-	Sequential Derivation
SINR	-	Signal-to-Noise-Plus-Interference Ratio
SISO	-	Single Input Singe Output
SMBS	-	Single MIMO Base Station
SMVirBS	-	Single MIMO with Virtual Base Station
SVD	-	Singular Value Decomposition
TA	-	Timing Advanced

TDOA	-	Time Difference of Arrival
TOA	-	Time of Arrival
TOF	-	Time of Flight
VirBS	-	Virtual Base Station
WAN	-	Wide Area Network
WiMAX	-	Worldwide Interoperability for Microwave Access
WLAN	-	Wireless Local Area Network
WMAN	-	Wireless Metropolitan Area Network
3G	-	Third Generation
3GPP	-	Third Generation Partnership Project

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CHAPTER 1

INTRODUCTION

1.1 Introduction

In this globalization era, communications by using internet play a vital role by linking people around the world. About 10 years ago, internet is used by using cable modem, dial-up connection or ISDN (Integrated Service Digital Network) [1]. For easing people, wireless broadband or wireless internet connections have been created and implemented in telecommunication sector. By having wireless internet connection, people can use internet at anywhere and anytime.

Wireless technology used radio frequency (RF) to transmit the data from one point[1] to another. The typical RF range is from 3 kHz to 300 GHz, and the frequency range used by each country for wireless technology is different. Wireless network can be divided into a few types, according to their coverage area, which are Personal Area Network (PAN), Local Area Network (LAN), Metropolitan Area Network (MAN) and Wide Area Network (WAN) [2]. There are many standard for each of the network, for example the commonly known standard like Wi-Fi (LAN), 3G (WAN) and WIMAX (MAN).

The wireless technology is getting popular, wider and advanced since there are many competitors who try to provide better network coverage and performance. One of the wireless famous standards is WIMAX (Worldwide Interoperability for Microwave Access). This standard provides high-speed data rates and it has wide coverage area.

Location and positioning technology also have great interest to explore in aspects of navigation, tracking, security and monitoring movement of the mobile devices. This technology helps a lot in determining the location and position of mobile phones since most of the emergency calls received is from mobile phones. Thus in this situation, the accurate location information should be delivered by using wireless technology.

There are many kinds of localization and positioning technique like received signal strength (RSS), angel of arrival (AOA), time of arrival (TOA) and so on. To achieve satisfactory location estimation accuracy, at least three base stations (BS) is required for most of the location estimation algorithms.

In this project, we are using a single base station with MIMO system to approximate the location of mobile station (MS) by using method of AOA, AOD and distance of the propagation path of multipath signals. With the assist of virtual base station, the estimation of MS location by using a single MIMO base station is enhanced. Thus, the single MIMO base station (SMBS) algorithm with virtual base station for simulation is required to be developed.

1.2 Objectives

The development of this project comes with several objectives. The objectives include:

To develop hybrid algorithm that utilizing a single MIMO Base Station by extending the virtual BS concept to further improve the accuracy of location estimation

To develop algorithm for simulation of the proposed L&P technique

To incorporate the developed algorithm into WiMAX specification and evaluate the performance of the algorithm

1.3 Problem Statement

To achieve a satisfactory level of location and positioning of a mobile device, at least three base stations are needed. This means that the location of mobile device cannot be accurately estimate if there are not enough base stations around it. This project is about to localize user's position and to enhance the accuracy of the estimation location and position of a WiMAX user by using a single base station.

One of the major problems that affect the accuracy of the estimation is the non-line of sight (NLOS) propagation, which is the absence of line of sight (LOS) between base stations (BS) and mobile stations (MS). Thus, hybrid positioning technique like the combination of angle of departure (AOD), angle of arrival (AOA), and time of arrival (TOA) are used to decrease the error of position estimation due to NLOS propagation.

Besides, estimation of location and position of the user by using only a single base station will decrease the accuracy and precision of the actual location of the user. Most of base stations implemented single input single output (SISO) technology which consist one transmitter antenna and one receiver antenna at each base station respectively. In this case, multiple input multiple output (MIMO) technology is proposed to be used in to solve this problem.

1.4 Scope of Project

The aim of this project is to develop algorithm of location and positioning enhancement by using a single base station for WiMAX. The existing algorithms for SMBS are reviewed and developed. Then, the SMBS algorithm with virtual base station is developed and proposed.

The proposed algorithm with virtual base station consider the hybrid location and positioning technique that consist of time of arrival (TOA), angle of departure (AOD), and angle of arrival (AOA).

This project will not cover the hardware part. The software part of this project will be done mainly by using MATLAB software.

1.5 Brief Explanation on Methodology

Antenna technology includes single input single output (SISO), multiple input multiple output (MIMO), relay station, beam forming and adaptive modulation and coding (AMC). However, the project is limited to one method which is MIMO.

There are several positioning technique can be used. They include received signal strength (RSS), time of arrival (TOA), time difference of arrival (TDOA), direction of arrival (DOA), angle of departure (AOD), angle of arrival (AOA), and others. The technique used in this project is TOA, AOA and AOD since it only uses a single base station.

Before developing the SMBS algorithm, the fundamental information about WiMAX, MIMO and the existing algorithm are reviewed. Then, the existing SMBS algorithm is further developed and verifies it with powerful simulation tool. The proposed algorithm with virtual base station is developed and validates its enhancement efficiency by using simulation tool. The performances of the existing and proposed algorithm are evaluated.

1.6 Project Report Structure

WiMAX, location and positioning techniques and MIMO will be discussed in Chapter 2. The methodology of this project will be showed in Chapter 3. Chapter 4 includes the software development of the SMBS algorithm. The results obtained will be

discussed in Chapter 5. Chapter 6 consists of the conclusions of this project and recommendation.