SMART ANTENNA FOR HANDSET APPLICATION

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DECLARATION

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To my beloved parent and siblings

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ABSTRACT

Mobile communication technology has been developed rapidly in the past decade and it has been already dramatic impact in our life. In the last few years, the development of smart antenna systems represents one of the interested principles in the information and mobile communication field. Based on the previous works that had done before, there have a lot of researches and experimental in developing the smart antenna system. The smart antenna systems need to be designed with simple calculations, fast and in a small size. This can be done by develop the block set based on the value which is related for transmitted and received signal by using the Matlab Simulink software. The objective of the project is to study and understand the principles and characteristics of the smart antenna system. The block set that had been developed will be used to process the signal in both transmitter and receiver where this is applied to multiple antennas. This project is started with literature review on smart antenna in handset application. Then, the developing on block set of transmitter and receiver is done before it testing and modified again. The process will be end on the testing and modified the block set in Matlab Simulink software.

ABSTRAK

Teknologi komunikasi bergerak telah dibangunkan dengan pesat dalam beberapa puluh tahun yang lepas dan ia memberi impak yang besar kepada kehidupan kita. Beberapa tahun yang kebelakangan ini, kemajuan di dalam sistem alat pemancar pantas telah mewakili salah satu petunjuk yang begitu penting dalam bidang informasi dan komunikasi bergerak. Berdasarkan kepada kajian yang terdahulu, terdapat pelbagai eksperimen dan ujikaji dalam pembangunan system alat pemancar pantas. Di dalam projek ini, system alat pemancar pantas ini hendaklah direkabentuk berdasarkan nilai pengiraan yang mudah, rekabentuk yang bersaiz kecil dan berkeupayaan pantas. Projek ini boleh dijalankan dengan membina blok yang berdasarkan alat penerima dan alat pemancar. Blok ini boleh di hasilkan dengan menggunakan perisian Matlab Simulink. Objektif utama projek ini adalah untuk memahami ciri-ciri dan prinsip-prinsip yang digunakan dalam aplikasi telefon tangan. Blok yang dibina berdasarkan nilai-nilai tertentu akan digunakan dalam memproses isyarat di antara alat pemancar dan alat penerima untuk pelbagai pemancar (*antenna)*. Projek ini akan dimulai dengan kajian latar belakang untuk aplikasi telefon tangan di mana selepas itu blok-blok untuk alat pemancar dan alat penerima akan dibina dengan menggunakan perisian Matlab Simulink. Akhir sekali, kerja-kerja pengujian dan penambahbaikan akan dijalankan ke atas blok-blok yang telah dibina.

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ASK	-	Amplitude Shift Keying
AWGN	-	Add White Gaussian Noise
BER	-	Bit Error Rate
BPSK	-	Binary Phase Shift Keying
CDMA	-	Code Division Multiple Access
FDMA	-	Frequency Division Multiple Access
FSK	-	Frequency Shift Keying
PN	-	Pseudo Noise
PSK	-	Phase Shift Keying
QPSK	-	Quadrate Phase Shift Keying
SDMA	-	Space Division Multiple Access
SIR	-	Signal to Interference Ratio
SNR	-	Signal to Noise Ratio
TDMA	-	Time Division Multiple Access

CHAPTER 1

INTRODUCTION

1.1 Introduction

In nowadays technology, the cellular communications systems have speedily grown up. One of the part technologies used in this system is smart antenna technology for handset. A smart antenna or an adaptive array antenna consists of multiple antenna elements at the transmitting and receiving part. By using an appropriate set of antenna weights which are provided in software, the desired beam from the antenna can be programmed. The concept of spatial diversity has been expanded to use some digital signaling processing (DSP) block set and dynamically generate the binary input pattern based on the positions of transmitter and receivers itself. This smart antenna can use a technique of multiple-input multiple-output (MIMO) which can provided multiple signals in the antenna that give the better performance.

Smart antenna technology contains many advantages to telecommunication system such as can greatly reduce the interference; increase the system capacity in communications channels and to enlarge the radio link quality. It can be seen that smart antenna system has much better performance. This project will deals with

develop the block set in Simulink to generate the signal beam, testing and modifying the block set using CDMA block set.

1.2 Objectives

The objectives of this project are:

1. To understand the principles and characteristics of the smart antenna for handset application.
2. To study the Simulink Block set and CDMA technology in process the signal at the transmitter and receiver.
3. To develop the block set of downlink and uplink in Simulink for smart antenna applications.

1.3 Problem Statement

Nowadays telecommunication technology required the fast, simple and small antenna that can be able to give the best performance. In order to propose the small and smart antenna, the work of design and develop the smart antenna for handset applications consist of big challenges as the limited size compare to actual handset. Therefore the suitable smart antenna should have very compatible design and architecture. Besides that, there is a challenge to develop the suitable simulation methodology and the accurate modeling of channel characteristics, interference and implementation losses. To overcome this problem, the block set for process the signal at the transmitter and receiver has to be fast and simple.

1.4 Scope Of Work

The scope of work for this project can be divided into three parts; the first is the literature review. This work can be done by analyzed and study the principles of smart antenna in Simulink in order to get the better results. For the example, in Simulink there are a lots of types of block set can be used in order to analyze the signal in input of binary number, such as the binary phase shift keying (BPSK), quadrature phase shift keying (QPSK), and others. Then, the second part is developing the transmitter and receiver by using the block set in Simulink. The developing of this will be done by using Matlab Simulink for transmitter and receiver. Lastly, for the final part is testing the block set. By this, the setting will be change in order to get the output signal. If there any improvement can be made, then the setting of the block set will be modified.

1.5 Methodology

This project will start with the background study of smart antenna in handset application. This is done by find out all the journal, articles and books that related to this project either in website or any materials. After understanding all concepts which is relating, the study of software is done. In this project, developing of the block set of transmitter and receiver is done by using the Matlab Simulink 7.1 software. All of these block set is develop by appropriate block set that relate with the transmitter and receiver before both of it will be combined together as a system. After the entire block set for transmitter and receiver is done, the testing and modification can be made if there any improvements need to be made.

CHAPTER 2

BACKGROUND STUDY

2.1 Antenna History

Antennas have become increasingly play an important role in our life and society until now they are indispensable since the era of Hertz and Marconi [1]. They are everywhere; at our homes and workplaces, on our cars and aircraft, while in ships, satellite and even as pedestrian we are carrying them. Although antennas may seem to have bewildering, almost infinite variety, all operate in the same basic principle of electromagnetics.

Antennas are our electronic eyes and ears on the world. They are our links with space. They are important and integral part of our evolution. Antennas have been around for a long time, millions of years ago. But in last 100 years ago, they have acquired a new important as the connecting between radio system link and the world outside. The first radio antenna was created by Heinrich Hertz, a professor at the Technical Institute in Karlsruhe, Germany. In 1886, he assembled apparatus of a complete radio system operating at meter wavelengths with an end-loaded dipole as the transmitting antenna and a resonant square loop antenna as a receiver.

Although Hertz was the leader and father of radio, his invention remained a laboratory curiosity until 20 years old Guglielmo Marconi of Bologna, Italy went on to add tuning circuits, add with big antenna and ground system for longer wavelength, and lastly was able to signal over longer distances. On mid December 1901, from the transmitting station that he had constructed at Poldhu in Cornwall, England, he shocked the world by receiving the signals at St. Johns, Newfoundland. Then, the next year he started with regular transatlantic message service in spite of a suit by the Cable Company for infringing on its monopoly of transatlantic messaging.

At the beginning of the 20th century there is an invention that captured the public imagination as Marconi's wireless creation. After its value at sea had been dramatized by the S.S. Republic and S.S. Titanic disaster, Marconi was regarded with universal fate and admiration seldom matched. Before wireless, complete isolation enshrouded a ship at sea. Disaster could strike everything without being aware that anything had happened. Then, Marconi became the Wizard of Wireless.

During World War II, the advent of radar which named centimeter wavelengths become famous and the entire radio spectrum opened up to wide usage. Thousands of communication satellites bristling with antennas now circle the earth in low, medium and geostationary orbits. The geostationary satellites form a ring around the earth similar to the ring around Saturn. Your hand held Global Position Satellite (GPS) receiver give your latitude, longitude and elevation to centimeter accuracy anywhere on or above the earth day or night, cloudy or clear.

Antennas are the essential communication link for every part such as air craft, and ships. Besides that, antennas for cellular phones and all types of wireless devices link us to everyone and everything. With mankind's activities, which expanding into space, the needs for antennas will grow to an unprecedented degree. Antennas will provide the vital links to and from everything out there. The future of antennas reaches to the stars.

2.2 Smart Antenna Analogy

The functionality of many engineering systems is mostly can be understood and easier when it is correlated with our human being body system [5]. Thus, to give a more understanding on how a smart antenna systems work, let us imagine a conversation between two person in a dark room [refer to Figure 2.1]. The listener among the two persons can determine the location of the speaker when he makes any movement because the voice of the speaker arrives at the ear, the acoustic sensor come at different time. Then the brain, the human signal processor will compute the direction of the speaker at the different time or delay of the voice received by the two ears. Afterward, the brains will add the strength of the signals from each ear so as to focus on the sound of the computed direction. In addition, if another speaker connects in the conversation, the brain can tune out unnecessary interferers and concentrate only on one conversation at a time. In opposition, the listener will respond back to the same direction of the preferred speaker by orienting the transmitter which is act as mouth, towards the speaker.

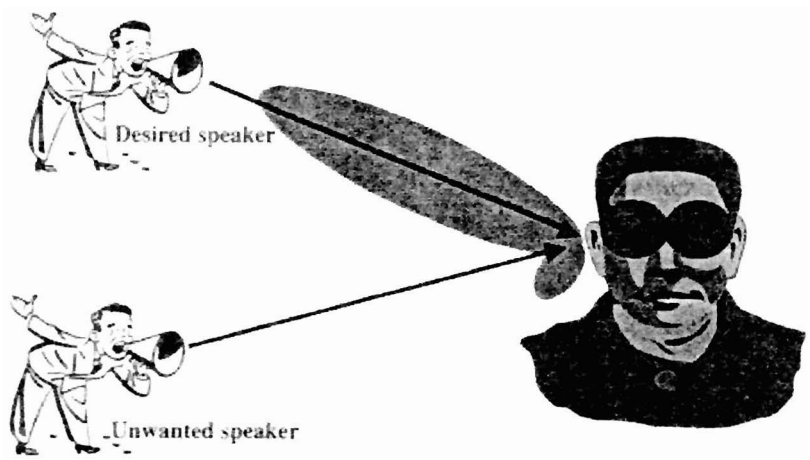

Figure 2.1: Human Analogy

The same way is used for electrical smart antenna systems by using two antennas instead of the two ears and a digital signal processor instead of a brain. This can be referred to Figure 2.2 below. Therefore, after the digital signal processor measures the time delays from each antenna elements, it will compute the direction of arrival of the signal of interest, and then it is adjusts the excitations (the gains and phases of the signals) to produce a radiation pattern that focuses on the signal of interest while, ideally, tuning out any signal not of interest.

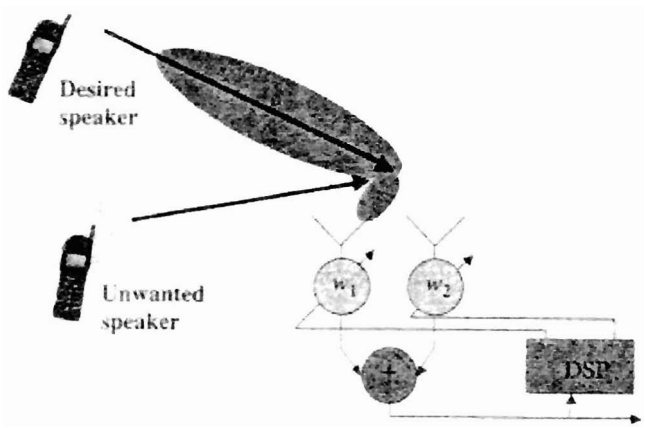

Figure 2.2: Electrical Equivalent

2.3 Categories of Smart Antenna Systems

The idea behind a smart antenna is not new but it was started at early sixties when it was the first time planned for electronic warfare as a counter measure to jamming. At that time, varying degree of costly antennas systems had used in defense systems and for satellite communications. This is excluding diversity arrays that were considered, there are primarily three other categories of smart antenna systems.

2.3.1 Switched Beam Antennas

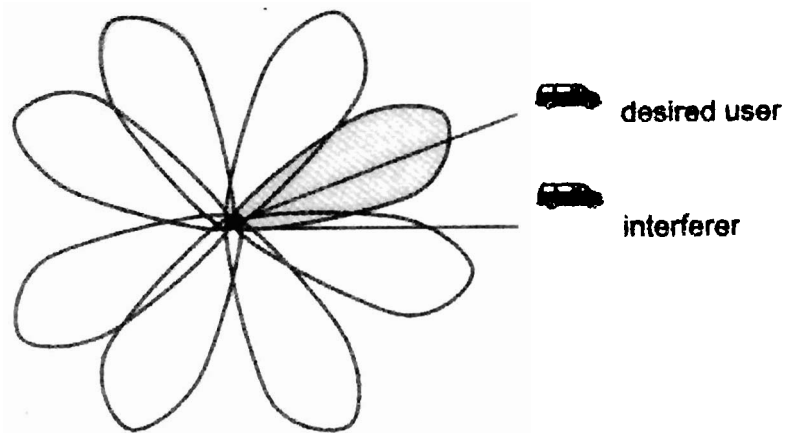

Figure 2.3: Switched Beam Antennas

A switched beam antenna system consists of several highly directive, fixed, pre defined beams, formed usually with an arrays by referring to the Figure 2.3 above. In practice, multiple beams from an array can be formed by means of beamforming network that consists of an interwoven feed system and multiple input ports. An example of beam forming network is the Butler matrix which consists of power splitters and phase splitters. The system detects signal strength and chooses one of the best beams that give the better signal performance, typically in conditions of the maximum received power as the mobile moves throughout the cell.

Beam switching can be performed by means of semiconductor switches. In a sense, a switched beam antenna is an extension of the conventional sector beam in that it divides a sector into several micro-sectors. If there are no direction of arrival information of the desired user is assumed, the desired user may not fall on the maximum of the chosen beam. Switches beam antennas are effective in low to moderate co channel interfering environments owing to their lack of ability to distinguish a desired user from an interferer. If a strong interfering signal is at the selected beam and the desired user is away from the center of the selected beam, the

interfering signal can be enhanced far more than the desired signal with low quality of service to the intended user.

2.3.2 Dynamic Phase Arrays

For dynamic phase arrays, it is make use of the direction of arrival information from the desired user and steer a beam maximum towards the desired user, this consequently improving upon the capabilities of a switched beam antenna [4]. Some sort of tracking in dynamic phase arrays is required to constantly turn the beam towards the desired user.

2.3.3 Adaptive Antennas

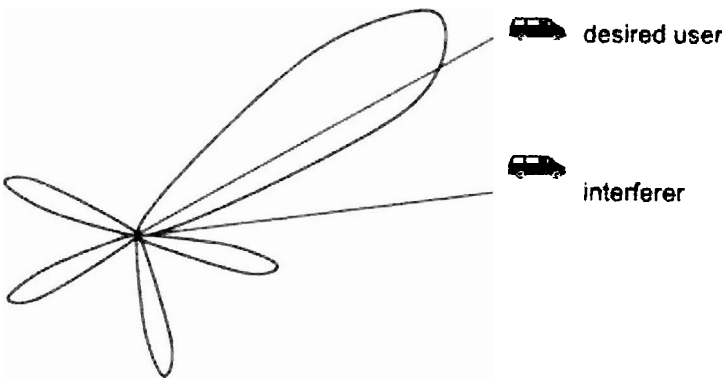

Figure 2.4: Adaptive Antenna

In an adaptive array, the weights are adjusted to maximize the signal-to interference-plus-noise power ratio and provide the maximum discrimination against interfering signals as referred to Figure 2.4 above [4]. An adaptive antennas will maximize the signal to noise ratio if there occur an interferers and noise, this consequently act as maximal ratio combiner. By using a variety of signal processing