CHAPTER 1

INTRODUCTION

1.1 Background

Through the wall radar (TWR) is a technology to detect objects behind the wall [1]. TWR is commonly used for military, security and to help people who are trapped in a room by emergencies [2]. To detect the objects requires a fast and high accuracy to minimize errors [3]. The conventional TWR can only be used for one object and now need to be upgraded to detect more than one object. Meanwhile, when there are two objects that near one another, the detection progress will be more difficult to interfere which should be two objects but detected as one. Multi-object requires high resolution for radar imaging applications [3] [4].

One of the conventional methods in TWR is SISO antenna. Lately, MIMO antenna that consists of M transmit elements and N receive elements was developed for radar applications [5][6]. MIMO antennas resulted in a faster scanning process with higher resolution [7]. MIMO antennas also have better detection of two close objects compared to SISO antennas [4].

There are several studies related to this thesis. The first paper [3] detects multi-targets rarely close to one another. The target is three plywood dihedrals with a thickness of 2.5 cm measuring 30 cm x 170 cm. This study uses a constant false alarm rate (CFAR) detection algorithm. The result of this research is that CFAR produces a good trade-off between high sensitivity and low false detection rate. The second paper [4] MIMO radar is used to improve the detection results of multiple stationary humans with an automatic constant false alarm rate (CFAR) algorithm to detect clutters and shadow effects. Research-based on the paper [3] and [4] more focus on the TWR application detection algorithm that pays more attention to signal processing on the resulting image. This method is quite difficult because it requires a high level of detail in compiling the algorithm.

The main problem in this thesis is to prove that MIMO antennas have better detection results to split the interference of two close objects. To compare the B-scan image resulted from a single input single output (SISO) antenna with a multiple-input multiple-output

(MIMO), this thesis proves that MIMO antenna increased the resolution of detection results and also split the interference of two close objects. It is also proven that with the same SNR, the detection ability of MIMO antenna is better than SISO antenna. MIMO radar antenna is applied to TWR applications modeled by 2-dimensional finite-difference time-domain (FDTD) TWR and simulated by MATLAB.

1.2 Problem Identification

Problem identification of this research are:

1. Limitations of SISO to detect two close objects.
2. MIMO is able to set up the antennas with various configurations.

1.3 Objective

The main objective of this research are :

1. Identify the performance improvement of multi-target detection resolution in the TWR application.
2. Improved detection capabilities with MIMO antennas.

1.4 Scope of Work

The scope of work of this thesis is modeling SISO antenna and MIMO antenna in the TWR application using 2D FDTD simulation by James Irving. The frequency used is 1 GHz. In the simulation, it detects 2 close objects behind a wall of a room-sized of 2m x 2m. The object detected is made of aluminum block. The parameter is the distance between objects (10cm, 30cm, and 70cm). The distance from the antenna to object is 60cm.

1.5 Limitation of Work

The limitations of this thesis are:

1. Experiments are simulated by using FDTD modeling applied to TWR application using SISO and MIMO antennas.

2. The antenna distance is assumed as the same as one another so the antenna is relatively independent. When the antenna is relatively independent, the combination process of the antenna with the convolution method can be used.
3. Improve performance by comparing detection results between SISO and MIMO antennas
4. The final data process using MATLAB resulted in B-Scan image.

1.6 Research Method

This research start from identify the size of objects and the wall, permittivity, permeability, and conductivity for the wall and objects. All the data analyzed for the simulation. Developed the TWR SISO simulation using the numerical FDTD method by James Irving [8]. Simulate the problem of detecting the 2 close objects. And then, simulate the application of TWR MIMO to detect close objects and test its performance in improving the ability to distinguish close objects. This research focus on the position between two objects (10 cm, 30 cm, 70 cm). Analyze and compare the result of simulation with SISO and MIMO configuration. And the last step is SNR analysis between SISO and MIMO.

1.7 Structure of the Thesis

The rest of this thesis is organized as follows:

CHAPTER 2: Basic Concept

This chapter describes the basic concept of TWR with MIMO configurations. FDTD modeling theory mentioned here.

CHAPTER 3: Experiment Method

This chapter discusses the scenario of this thesis to set up the simulation.

CHAPTER 4: Result and Analysis

This chapter provides the preliminary result performance of SISO and MIMO to improve the ability to distinguish close objects.

CHAPTER 5: Conclusion

This chapter sums up all works done in this thesis.