CHAPTER I
INTRODUCTION

1.1 Background

A Radio Detecting and Ranging (radar) is a device that transmits out electromagnetic waves to detect a variety of targets, including people, animals, birds, insects, rain, the ground, planes, etc. Radar also has the ability to detect targets at both close and far distances that are impermeable to infrared and optical sensors [1]. Therefore, radar is very beneficial to human life. One of the vital signs that are crucial to determining the state of a person's health is breathing [2]. Currently, vital signs are measured using a device that makes contact with the body, which can make patients uncomfortable, especially those with skin infections. Along with causing discomfort for the patient, devices that come into contact with them have the potential to carry infectious viruses. The chest's up-and-down motion during breathing is picked up by the radar when it detects human breathing. There are several radar systems that can detect it, including the Impulse Radar Ultra-Wide Band (IR-UWB) [3], the Continuous Wave [4], the Stepped Frequency Continuous Wave [5], the Multi-Frequency Continuous Wave [6], and the Frequency Modulated Continuous Wave [7].

In this research [3], the detection method used was the Impulse Radio Ultra-Wide Band radar sensor (IR-UWB). Based on radar-to-UWB fusion technology, IR-UWB sensors have an excellent temporal resolution, and penetrability, and emit non-ionizing electromagnetic waves. However, the IR-UWB radar has a very wide bandwidth and a rather complex architectural design. While in the [4] research, a homodyne transceiver architecture CW radar system was used due to its simplicity. However, the target range of this radar system has not been able to be revealed. Utilizing SFCW radar in research [5] because it can be used in a variety of situations. A high-resolution SFCW radar will be used in this study to find multiple targets. However, processing respiration data is a bit complicated because quite a lot of data is taken.

Low power and bandwidth operation use MFCW radar to detect breathing in the [6] because it can determine how far away the target is. The MFCW radar system has the ability to determine target distances, making multi-target detection possible. While in the research [7], the respiration detection capability is used for a variety of tasks like clutter removal and the development of multi-target features. To detect minute breathing movements, such as those of the chest or abdomen during inhalation or exhalation, a radar system with high resolution and a wide text bandwidth is required. The respiratory amplitude peak spectrum for the FMCW system is 1.5 cm higher than the respiratory amplitude peak spectrum for the same system. The suggested FMCW system achieves successful results and enables multi-target detection.

Since each MFCW and FMCW radar system has unique advantages and disadvantages, the two radar systems are contrasted in research [8]. Both systems use Software Defined Radio as their technology (SDR). The MFCW radar performs well, but its frequency cannot be adjusted. The radar system needed for this thesis must be able to adjust its frequency because it will be detecting multiple targets. The frequency will be divided because there are multiple people, necessitating frequency optimization. In order to detect multiple targets, the FMCW radar system will be implemented.

The research [9] describes multi-subject detection using FMCW automotive radar with a working frequency of 76–81 GHz. This research uses a beam-steering technique to isolate respiratory signs for each subject at a distance of approximately 0.5–1 meter from the radar. The result obtained in this research is that the accuracy for calculating breathing rate is 93% compared to medical professional recordings. The results obtained in this research can be used to measure cardiorespiratory vital signs. But this research does not explain in detail the respiration rate of each subject and its error.

In this research [10], multi-target research using an FMCW radar system using an IQ demodulator technique has been conducted. The results obtained from the comparison of bandwidths of 80, 120, and 150 MHz show that each target can be identified and that the noise in the measurement does not really affect human respiration activities. Although the detection results shown are quite satisfactory, the targets detected are only simulations, not real breathing targets.

Research [11] describes the detection of multi-person vital signs using FMCW radar with an operating frequency of 77 GHz. This research proposes an adaptive digital beamforming (ADBF) algorithm for multi-target vital signs. In addition, the 3-dimensional fast fourier transform (3D-FFT) is used for multi-target separation. The results obtained in this paper can distinguish the respiration rate of each target, but there is no proof of whether the results are accurate or not.

This thesis discusses multi-target measurements of breathing rate in comparison to oximeter measurements. The measurements presented in this thesis have been tested at a range of distances between the radar and the breathing target. The proposed method in this thesis employs a two-step FFT, with the first FFT being used to pinpoint the target's position and the second FFT being used to pinpoint the target's breathing rate.

1.2 Formulation of Problem

Respiratory multi-target detection is important. One potential for multi-targeting is detecting disaster victims buried under rubble. Multi-target detection makes finding disaster victims easier and more efficient. Before researching that deeply, this research serves as an initial approach to multi-target concept verification. In the proof of concept, the focus is on whether the detected target is breathing or not. In this thesis, the fundamental problem in multi-target detection is distinguishing between the targets. In addition, there must be a respiration rate match between the oximeter measurement and the proposed method result.

1.3 Research Purposes

The aim of this research is to measure human breathing by detecting movement in the chest or abdomen. Breathing monitoring is not only done for one target but with multi-targets. This research has the main objective of classifying multi-target breathing.

1.4 Scope of Work

The limitation of the problem from this thesis are:

1. Data was collected indoors with laboratory experiments
2. The target position is in front of the radar
3. The maximum limit for radar detection range is 110 cm.

1.5 Research Methodology

The research methodology in this research has five steps there are carried out as follows:

1. Study of Literature

The purpose of this stage is to explore the existing problem of multi-target respiration. The data is collected from books, conferences, and previous research journals.

2. Experiment

   Experiments were conducted by setting static targets and breathing targets in front of the radar until they were easily detected.

3. Simulation

   If there is unsatisfactory data from the experiment, data collection will be carried out by conducting experiments again. If the data from the experiment is satisfied, data processing will continue using the software.

4. Analyze the Data

   After the data has been finalized and simulated, then the data will be analyzed. Data analysis taken from the theoretical basis that has been obtained will be compared with the results of simulations that have been carried out.

5. Make The Conclusion

   After analyzing the simulation data, conclusions will be drawn. Conclusions will be drawn from the analysis that has been done, from manual or original measurements, and measurements from simulations.

1.6 Thesis Structure

The research methodology in this research has five steps there are:

1. CHAPTER I INTRODUCTION

   This chapter describes the background, objectives and benefits, problem formulation, scope of the problem, research methods, and writing structure of this thesis.

2. CHAPTER II BASIC CONCEPT

   This chapter explains the theories of multi-target breathing used in this thesis.

3. CHAPTER III RESEARCH METODOLOGY

   This chapter contains the proposed method and experimental scheme used in this thesis.

4. CHAPTER IV RESULT AND ANALYSIS

   This chapter contains the test results and analysis of the test results obtained for this thesis.

5. CHAPTER V CONCLUSION AND SUGGESTION

   This chapter contains conclusions from the entire thesis process that has been undertaken and suggestions for future research.