CHAPTER I
INTRODUCTION

1.1 Background of the Problem

Natural disasters such as tsunamis and earthquakes have caused numerous casualties and damage to buildings, resulting in both material and immaterial losses. The advancement of technology for search and rescue missions to evacuate victims as quickly as possible has become crucial. The highest priority after a disaster is to search for and rescue survivors in the affected areas. Survivors may be trapped under ruins, and hazardous terrain often hinders Search and Rescue (SAR) teams from reaching these areas. Rapid, accurate, and safe victim detection is necessary to prevent further losses that may arise from natural disasters.

Heart rate or respiratory rate detection is a common parameter for measuring human vital signs. Vital sign detection has been the subject of research in recent years, particularly in non-contact measurements [1], [2], [3]. Vital sign detection using drones has also received attention [4].

Radar *Frequency Modulated Continuous Wave* (FMCW) [4] is an example of a radar system used to detect the distance and information of a target. FMCW is a type of radar that uses continuous signals with a sinusoidal signal modulated by frequency [5].

The presence of obstacles in vital sign detection using radar systems can cause signal attenuation, phase shift in radar signals, and result in beat frequencies from the target [6], [7]. When the FMCW radar system detects the peak spectrum of signals as beat frequency, it leads to detection errors, and vital signs such as respiration may go undetected.

In previous research [6], the development of FMCW Radar system to detect living victims based on vital signs from small chest movements under ruins has been conducted. The ruins are composed of several layer and a method has been devised to

identify resistive responses or obstacle objects to be reduced. Subsequently, this method is combined with phase detection. The applied method aims to extract doppler responses related to the vital signs of the target from small chest movement.

In this research, the addition of a drone to place the radar in areas with extreme terrain is proposed. The drone will be programmed automatically to detect the designated areas for data collection. In the processing stage, in addition to the method for detecting the doppler effect of the victim's lung movements, a method will be added to reduce the doppler effect caused by drone fluctuations [8][9], [10].

The radar detection height on the drone can be adjusted using a barometer or LiDAR (Light Detection and Ranging). LiDAR is a method of object detection that uses the principle of laser beam reflection to measure the distance of objects on the earth's surface [9].

1.2 Problem Formulation

Based on the background presented, the problem formulation of this research is as follows:

1. How does obstacle effect the detection method?
2. What is the effect of drone movement on the detection method?
3. What techniques or methods can be used to reduce the effects of drone movement?

1.3 Objectives and Benefits

The objectives and benefits of this research are to design methods or techniques to reduce the doppler effect caused by drone height fluctuations and to detect the doppler effect from chest movements as vital signs of the target.

1.4 Problem Limitations

The following are the limitations of this final project: *First*, the testing will be conducted in the scope of laboratory experiments and simulations. The testing will use the FMCW radar system model with a frequency of 24 GHz. *Second*, the testing will also involve the use of a drone system. *Third*, the ruins will be modeled using concrete

brick. *Fourth*, the radar system is directly above the obstacle. *Fifth*, this research only considers the fluctuations in the drone's movement along the vertical axis. Movements in the horizontal or transverse directions are not considered.

1.5 Research Contribution

The contribution of this research is to provide an initial study and proof of concept for a method or technique to reduce the doppler effect caused by drone movement, thus improving the accuracy of vital sign detection from chest movements behind ruins.

1.6 Research Method

The research methodology used in this research consists of the following steps:

1. Literature Review

Understanding the fundamental concepts and theories related to radar systems for detecting vital signs of victims under ruins, as well as FMCW, through relevant references such as books, articles, and journals that support the research.

2. System Analysis and Design

Designing a radar system that emits electromagnetic waves to penetrate obstacles or ruins based on FMCW.

3. Measurement

Conducting measurements after the design process. Measurements are performed to prepare for several aspects before conducting experiments.

4. Experiment

Conducting experiments to determine the characteristics of vital signs and drone fluctuations and their respective impacts. The radar emits and receives reflected signals, and the data is processed using MATLAB.

5. Analisis

Analyzing the results obtained from the previous steps. The detection results of vital signs under ruins, after being processed into reconstructed signals,

can be analyzed for their characteristics. The processed data is then observed for vital sign results and drone fluctuation effects, leading to conclusions.

6. Report

Compiling the results of the preceding stages into a written thesis format.

1.7 Research Methodology

The next step is to perform theoretical analysis and numerical simulations to prove the scientific validity of the proposed concept. Subsequently, laboratory/field experimental tests will be designed for data collection.

After conducting theoretical analysis and numerical simulations to validate the basic concept of the FMCW radar and the extraction method for detecting vital signs of victims under ruins using a drone, including the effect of drone fluctuations, laboratory/field experimental tests will be conducted to validate the concept. The next step involves developing an algorithm for data processing using the method to reduce the effect of drone fluctuations in detecting vital signs of survivors under ruins using the FMCW drone radar. The overall research methodology is depicted in Figure 1.1.

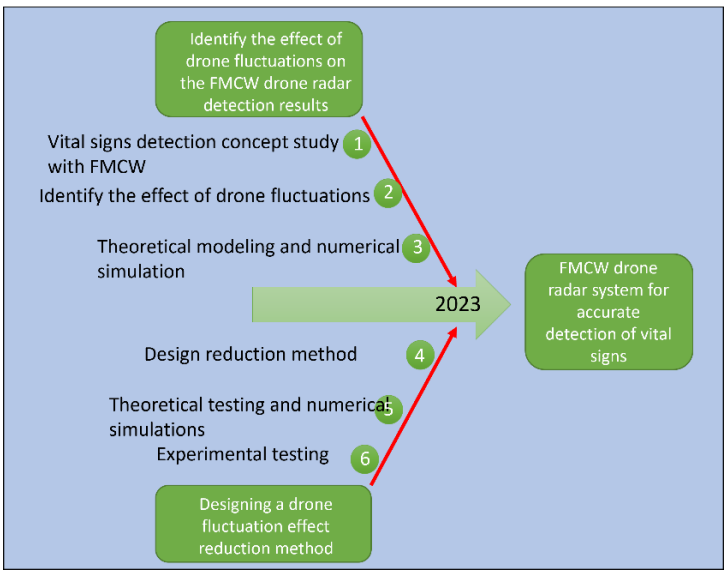

Figure 1.1 Research methodology

For a more comprehensive explanation of the activities and milestones for each step, refer to Table 1.1.

Table 1.1 Stages, activities, and achievement indicators

No.	Stages	Activities	Achievement Indicators
1.	Study Literature in formulating the basic concept of detecting vital signs of survivors under ruins using FMCW drone radar.	Formulating the research problem includes the principles of FMCW radar to be used, the detection target, as well as the methodology and projected requirements.	The concept of detecting vital signs of survivors under ruins using FMCW drone radar and its extraction method.
2.	Identifying the influence of drone fluctuations	Identifying the influence of drone fluctuations during detection using the drone radar system.	Understanding the effect of drone fluctuations
3.	Theoretical modeling and numerical simulation.	Performing theoretical modeling and numerical analysis of the effect of drone fluctuations on the detection of vital signs of survivors under ruins using the drone radar system.	Designing a model of drone fluctuation effects on the detection of vital signs of survivors under ruins using the drone radar system.
4.	Reduction method design	Designing a method to reduce the effect of drone fluctuations on the detection of vital signs of survivors under ruins using FMCW drone radar.	Designing a method to reduce the effect of drone fluctuation on the detection of vital signs of survivors under ruins using FMCW drone radar

5.	Theoretical modeling and numerical simulation	Performing theoretical modeling and numerical analysis of the reduction method's effectiveness in reducing the effect of drone fluctuations on the detection of vital signs of survivors under ruins using the drone radar system.	Designing a model of the reduction method's effectiveness in reducing the effect of drone fluctuations on the detection of vital signs of survivors under ruins using FMCW drone radar
6.	Experimental testing	Conducting data collection for vital signs of survivors under ruins, with and without drone fluctuations.	Documenting the results of the experimental testing.

1.8 Thesis Structure

The systematics for writing this thesis is as follows:

1. Chapter 1 INTRODUCTION

   This chapter contains the background, problems formulation, objectives and benefits, problem limitations, research contribution and methods, research methodology, and systematic writing.

2. Chapter 2 BASIC CONCEPT

   This chapter contains an explanation of the theory, tools, and equipment used.

3. Chapter 3 PROPOSED METHOD

   This chapter discusses the proposed method to overcome drone fluctuations in vital sign detection. The proposed method explains in detail its concepts so that vital signs behind the debris can be better detected with the influence of drone fluctuations.

4. Chapter 4 RESEARCH METHODOLOGY

This chapter describes what will be done in developing the proposed method and proving its scientific validity.

5. Chapter 4 RESULTS AND ANALYSIS

   This chapter contains the steps of test results, and an analysis of the test results obtained.

6. Chapter 5 CONCLUSION

   This chapter contains the conclusions and suggestions of this thesis.