CHAPTER 1
INTRODUCTION

1.1 Background

Respiration is one of a sign for monitoring human activities. It can diagnose disease by monitoring respiration rates. The human breathing can be categorized as a shortness and longness of breath. One of the caused of shortness of breath which occurs suddenly is problems with heart or lung. It can be diagnosis as an asthma, anemia, heart attack, or lungs problem. The shortness or the longness of breath can be knwon by the how much the breathing occured (up-and-down chest wall). To determine in how much the respiration is recorded, it uses a medical device. Electrical sensors using electrocardiograph (ECG) and spirometer are widely use [1] which operates as contacting devices. These are an existing technology to determine in respiration activity (as it is known).

A contacting devices which is used to record the respiration activity test results provide an information about the pattern of heart rate, speed, and rhythm in a given time sample. This test in the hospital, as we know, do not cause pain, and do not involve the process of inserting unknown-objects to the body (non-invasive). This medical devices usually make patient is uncomfortable, because they do not know much about this procedure. They assume this procedure is getting scary and involve electricity to their body. Actually, this contacting devices work by reading the activity of electrical energy in the heart. The electrodes is taped on the human chest wall as shown in Figure 1.1 and Figure 1.2. Figure 1.1 is one of the example of a contacting devices. This device is for monitoring and recording human respiration rate, speed, and its rhythm. An electrode is taped to the human chest wall (a), then the displacement of electrical signal caused by the human rate is displayed in (b), so that it produces the results of the human's rate record (c). This result next is processed by the doctor or nurse for their consideration. Figure 1.2 is one of the example of contacting devices also. In the (a), the mask on the human's face has a sensor for detecting respiration activity. After that, the result is displayed in (b) to become considered. These devices do not lead of electrical energy. Therefore, this condition about the psychology of human while is getting a sample of human rate and the test are become a considered as this thesis' topic.

The pulmonary volumes and capacities of human respiration vary which de-

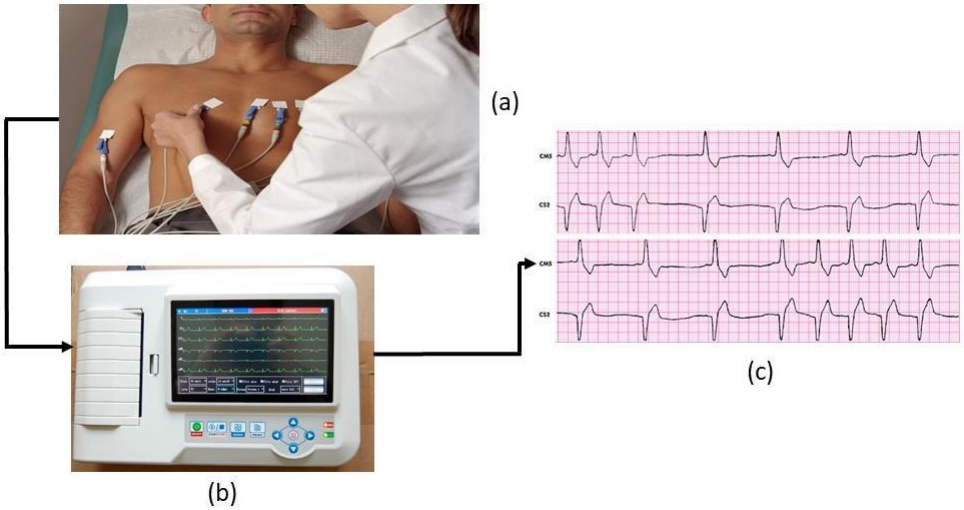

Figure 1.1 A figure shows that one of the example of contacting-devices existed of human respira-tion; Electrocardiograph (ECG).

pends on the size of the lungs, the power of breathing, and the way of breathing. The longer activities the higher breathing frequency are caused by the strong body movements which are using a lot of oxygen in the muscles that energize the activity, it will guide to an increase in the amount carbon dioxide in the blood. Therefore, it becomes enlarged lung ventilation lungs, so that the impulse stimulates the respira-tory center [2].

According to the latest data published in the medical journal of British Medical Journal (BMJ), the medical error is the three major which causes of death in the country [3], much higher than lower respiratory tract disease or under heart disease and cancer. The increase in critically ill patients, it will increase the complexity of the technology, the elderly population, the ethical dilemmas, the cost pressures and changes in service delivery systems including nursing are problems faced by paramedics and doctors [4].

There are several concerns in choosing medical measurement devices. It is not only related to accuracy, but also patient comfort (especially for long term mon-itoring), minimizing distress and re-coding hygienically. In the hospital, human respiration is mostly detected by medical devices. Respiratory monitoring can be categorized as contact and non-contact method. A non-contact method is potentially satisfied all above mention concerns. Today, a number of non-contact method for respiratory has been investigated and developed, such as optical, thermal imaging, and radio detection and ranging (radar) system [5, 6]. This thesis studies on radar system as a non-contact method for human respiratory monitoring.

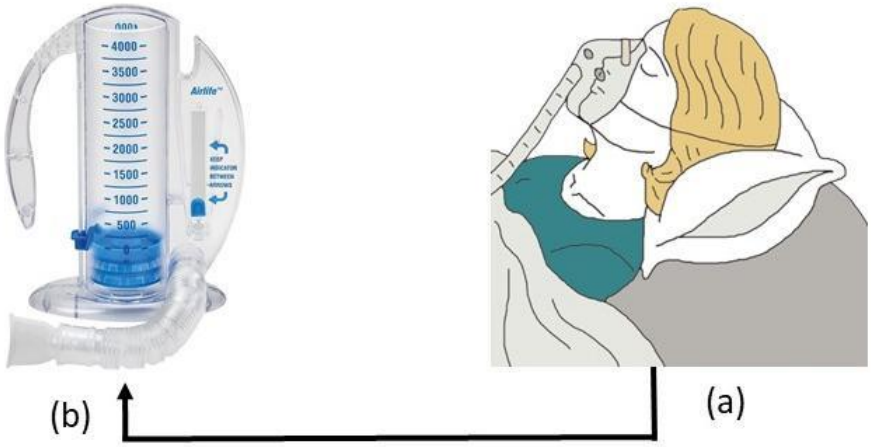

Figure 1.2 A figure shows that one of the example of contacting-devices existed of human respira-tion; Spirometer.

When there is relative motion between the radar and the target as shown in Figure 1.3, the center frequency of the radar shifts, a phenomenon known as the Doppler shift. Doppler shift can provide information about the target motion [7]. The Doppler shift is observed whenever the source of waves is moving with respect to an observer.

The Doppler shift can be measured based on frequency mixer that mixes the transmitted wave with its Doppler shifted signal as shown in Figure 1.3. The Doppler shifted signal originates from moving target that reflected the transmitted wave [8]. Transmitted signal can be used as reference to mix with received signal by using a mixer or multiplier (direct down-conversion), the output base-band signal contains the vital sign signal in its phase.

As described in Figure 1.3, the chest wall movement related to human respira-tory is detected as a periodic phase shift that occur on Doppler radar signal. When the Doppler radar is applied to detect human respiratory, the information about res-piratory rate potentially extracted from the phase data of Doppler radar signal that reflected from chest wall [9].

Several previous researchers have investigated the implementation of radar sys-tem to detect human vital signs including respiratory and heartbeat [10–14]. The experiment results in [10] show that continuous wave (CW) radar systems enable contact-less measurements of respiration activity. Otherwise, in [11] and [14] show that contact-less respiration monitoring using Ultra-Wide Band (UWB) array radar with adaptive beam-forming technique. Also, in [12] shows that the approaching of Frequency Modulation Continuous Wave (FMCW) can to calculates a small dis-

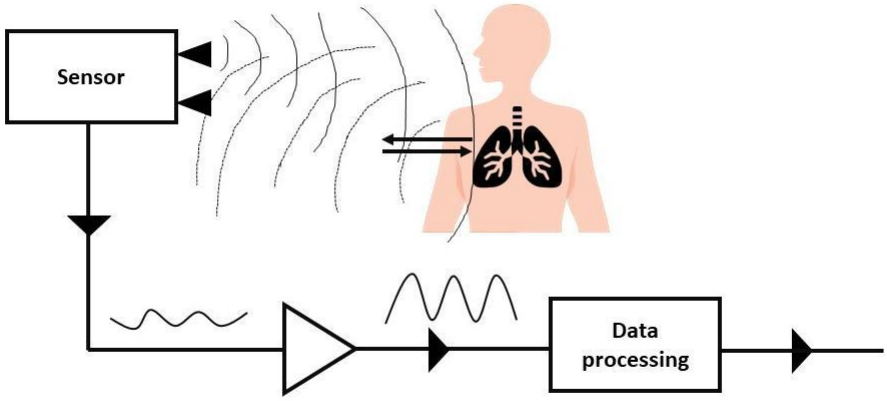

Figure 1.3 A prototype simulation for detecting human respiratory rate.

placement analytically. Meanwhile, in [13] the experiment shows that the body motion is developed using only one method of non-contact CW Doppler radar vi-tal sign detection system. There are many references substantially discuss related to this thesis. Consider a CW system with a smaller bandwidth, to develop non-contact method for human respiratory detection based on CW radar system is become this thesis' topic.

1.2 Problems Formulation

The output signal of CW Doppler radar is a Direct Current (DC) signal contain-ing small displacement data. Chest wall or body movement relates to the respiration activities can be formulated as a time-varying or CW radar of small displacement. It causes the output as a time varying also. Moreover, the respiration parameter, such as rate and amplitude, lead to be extracted from the output signal.

In detecting respiration parameter by using CW radar system is such of a post-processing of output signal. It needs to be determined in order to extracted the rare and amplitude of respiration. Unfortunately, the phase data is should be extracted from the DC signal.

In developing a non-contact method for human respiratory monitoring, post-processing improvement on CW radar is needed to extract the human respiratory information from the phase data of CW radar output signal. The post-processing method that suitable for extracting the respiratory information from CW Doppler

radar system is not yet known.

Furthermore, development of the post-processing for CW radar to extract the human respiratory information is limited. This thesis is trying to solve this problem using Single-Tone Doppler radar system.

1.3 Objective

The objective of this thesis is to design and to implement a method which de-termines the rate of human respiratory using the Doppler shift method and radar system. This thesis also looking for what parameters affect the result of the sys-tem accuracy. Furthermore, this thesis also analyzes the performance results of the system for practical applications.

1.4 Scope and Limitations

To simplify the analysis, this thesis assumes the following points:

1. The developed method is only for human especially the human respiratory. However, this thesis only designs a single human respiration.
2. The radar system identifies the frequency of respiration, the amplitude of res-piration, and the output wave signal from CW radar.
3. This thesis assumes that the position of human is static so the distance be-tween radar and object or target of the radar system range detection are ap-propriate to the detected objects.

1.5 Research Methodology

1. Study Literature
   This step determines references from journals, papers, internet, and books related with the topic.
2. System Development
   This step evaluates the related theory to the single-tone Doppler radar system suitable for human respiratory.
3. Simulation
   This step makes a computer simulation with MATLAB(R) and module of HB100 for detecting respiration rate of human body with the specified pa-rameters.

1.6 Structure of The Thesis

The rest of this thesis is described as follows:

Chapter 2 BASIC CONCEPTS

This chapter describes the theories, tools, and equipment considered.

Chapter 3 THE PROPOSED TECHNIQUE AND RESEARCH METHOD-OLOGY

This chapter discusses the proposed technique and research methodology in-cluding the specification of the system.

Chapter 4 RESULT AND ANALYSIS

This chapter provides result and analysis of the proposed technique.

Chapter 5 CONCLUSION AND SUGGESTION

This chapter concludes this thesis and provides the suggestion for the future research.