CHAPTER 1
INTRODUCTION

1.1 Background

Lots of activities require information about conditions below the ground surface such as military, civil engineering, and geophysics. In this era, engineers developed a Ground Penetrating Radar (GPR) to complete those activities with a non-destructive method for ground surface. Several functions of GPR are including pipes and landmines detection, concrete thickness, void detection, and corrosion [1][2]. GPR is the one of radar using a non-destructive method. A non-destructive method is the method that offers non-contact testing, fast scanning speed, deep penetration and also not damage the surface of the land. GPR also provides the mechanism to detect the reflected signal from subsurface object [1].

GPR system consists of the antenna transmitter connected to the signal generator and the antenna receiver. The electromagnetic pulse that comes from the antenna transmitter has a fast duration when penetrating the subsurface. During the electromagnetic wave transmitted to the underground, that makes several signals will come back to antenna transmitter and several signals will be forwarded to antenna receiver. The data from that system will process in signal processing and will display in the display layer as an output. The output of the data is the information about the condition of the subsurface object [3][4].

Signal processing is an important part of GPR system to find clear information about the object under the ground [5]. In signal processing, there are many forms one of them is A-scan, B-scan and C-scan. A-scan to detect the signal and the output is the one-dimensional image, while B-scan is constructed by stacking multiple A-scan data for detected the data in two-dimensional. While C-scan is constructed by B-scan data in three-dimensional [1].

In previous research [6], clutter was the most problem at GPR. Another problem is that weak target signals will be hidden in stronger background clutter signals. The backscattering signal when the target is buried deep in the ground is easily distinguished from the target. The scattering signal when the target is buried near the surface will arrive almost at the same time that makes the target difficult to know. By using likelihood method, the process of reducing clutter as measured using Received Operating Characteristics (ROC). The results obtained are the closer

to one area under the ROC is the better performance of the clutter reduction. For PMN type of mines buried in depth of 3 cm and 5 cm, the ROC value after reduction process is in the area of 0.74. While, mines buried at the depth of 10 cm, the ROC value after reduction process is in the area of 0.80.

In the [7] study, the GPR uses the principle of electromagnetic wave scattering to determine the location of buried targets. When the GPR emits electromagnetic waves to the ground, the feedback signal will be a signal from the target and a signal of clutter from the ground surface. This paper aims to develop signal processing techniques for background subtraction in the spatial domain. Three types of filter that are implemented are averaging, thresholding, and localization filter. These three filters are simple and easy to use implementations, but these three filters still have shortcomings in removing clutter. Therefore, the cascaded filter method was chosen because this method is proven to be able to eliminate all clutter obtained during detection. This method can be implemented as an independent system for GPR data processing.

In previous research [8], clutter consisted of crosstalk antennas, ground bounces, and reflected signals. This paper aims to reduce clutter caused by undulated ground bounce and soil roughness scattering by using the average subtraction method, SaS method, two-dimensional digital filter. However, these three methods still leave a lot of clutter after reducing the clutter process. Therefore, symmetry filtering method is proposed which is more effective in reducing asymmetrical clutter. The SCR results after calculating performance are 3.85 dB, 3.42 dB, 8.8 dB and 15.57 dB for average subtraction, SaS method, two-dimensional digital filter and symmetry filter, respectively. From the SCR results, it was concluded that the higher the SCR value the better the results of the process of reducing clutter. Therefore, symmetry filtering is chosen as a good method of removing clutter.

In previous research [9], the Fast Synthetic Aperture Imaging (SAI) method was used to obtain highly effective data processing results. The effects produced by fast synthetic aperture imaging are easily adjusted by the general synthetic aperture imaging method. In research [10], the purpose is to solve the problem that shallow will detect clutter signal more stringer than the target signal. Furthermore, differentiating the target echo and surface echo on the shallow surface target is not easy to do. Distinguishing target echo and surface echo on the shallow surface target is not easy. In this paper, the method used to remove the clutter is PCA and SVD method to remove the direct wave. The conclusion of the two methods is PCA-SVD used to improve the performance of the clutter suppression effectively 6 dB signal to noise ratio. This undergraduate thesis focuses on reducing surface clutter by using the

averaging method. Tests on this undergraduate thesis were carried out on the detection of cans which were buried two inside, namely 3 cm and 10 cm. Testing is done by modelling GPR using VNA.

1.2 Problem Formulation

Disturbances (clutter) obtained during the detection process as well as interference from heterogeneous soil distortion can cause less precise images received after signal processing. To show a good target on a B-scan, clutter needs to be reduced using certain techniques or methods.

1.3 Objective and Benefit

The objective of this undergraduate thesis is to reduce the clutter signal using averaging method. Providing a benefit of reducing the surface clutter. The results of the hyperbolic signal obtained will be seen more clearly and the surface clutter signal does not interfere the performance of GPR. Averaging of the clutter signal is carried out to clarify the hyperbolic signal coming from the reflection of the detected object. This can be seen if the clutter signal is close to the object signal. It is difficult to distinguish the surface clutter with object signal and if for long distance the clutter signal can interfere with hyperbolic signals so the result are less clear.

1.4 Scope of Problem

Based on the problem formulation, there are scope of the problem in this undergraduate thesis:

1. The research focus on process signal until B-scan.
2. The experimental data collection was performed using VNA as GPR modelling.
3. The type of the ground in this research is heterogeneous.
4. The condition of the ground is dry soil.
5. The research does not discuss about noise.
6. Research used depth of the object are 3 cm and 10 cm from surface ground.
7. The data processing using software.

1.5 Research Method

The method in the completion process of this undergraduate thesis consist of several stages, namely:

1. Literature Study
   The purposes of this step are to collecting and identify some journals, paper, books, and the previous research about Ground Penetrating Radar (GPR) system, signal processing in GPR, the method to reduce the surface clutter in GPR to support the preparing this undergraduate thesis.

2. Experiment
   This step aims to collect data from VNA experiments. Before that, preparations were made for the tools used for the experiment, one of which was a sandbox, VNA, bistatic antenna and objects that had conductive properties.

3. Simulation
   Data obtained from the VNA experiment are in the form of real imaginary which are processed into A-scan and B-scan using the software.

4. Analysis
   Analyzing the data is done so that the data taken in the experiment is the same as expected.

5. Conclusion
   After analyzing the results obtained, the last step taken is to conclude from the results and analysis.

1.6 Writing Systematics

This undergraduate thesis research is divided into several discussion topics as follows:

1. CHAPTER I INTRODUCTION
   This chapter explains the background, objectives and benefit, problem formulation, scope of problem, research methods, and writing systematics.

2. CHAPTER II BASIC THEORY
   Explains the basic theories about Ground Penetrating Radar (GPR), signal processing, modelling using VNA and SFCW.

3. CHAPTER III MODELLING SYSTEM AND SIMULATION
   Explains about the framework, experiment design, collecting data, and implementation of VNA experiment of this undergraduate thesis.

4. CHAPTER IV ANALYSIS AND RESULT
   Explains result and analysis obtained from the simulation stages of the system.

5. CHAPTER V CONCLUSIONS AND SUGGESTIONS
   This chapter describes the conclusion of the process and analysis in this undergraduate thesis. Suggestions for next research development.