CHAPTER 1
INTRODUCTION

1.1 Background

Various fields such as civil, mining, agriculture, and environment deem information about soil water content is important [1]. There are many methods that can be conducted to determine the content of water in subsurface soil. One of its method is Ground Penetrating Radar(GPR) [2][3][4].

GPR is a method for detecting objects under the soil surface by transmitting and receiving electromagnetic wave, the method are shown in Figure 1.1. This method uses the electromagnetic radiation in the microwave band (UHF/VHF frequencies) of the radio spectrum, and it detects the reflected signals from subsurface structures. GPR uses high-frequency (polarized) radio waves, in the frequency of 10 MHz to 2.6 GHz. The GPR transmitter and the antenna encounters a buried object or a boundary between a materials having different permittivities, the signal then can be refracted, reflected or scattered back to the surface. A receiver antenna then can record the variations in the return signal. This principles are similar to seismology, except GPR methods uses electromagnetic energy rather than acoustic energy.

The electrical conductivity of the ground, transmitted center frequency, and the radiated power all may limit the range of the effective depth range of GPR investigation. Increasing value in electrical conductivity will attenuate the electromagnetic wave, and thus it can increase the penetration depth. Frequency-dependent attenuation mechanisms make lower frequencies will penetrate farther than higher frequencies, however higher frequencies can improve the resolution. The mechanism then create a trade-off between the resolution and penetration. GPR antennas are generally placed in contact with the ground to achieve strongest signal strength; however, there also a method to place the antenna above the ground.

In this thesis, GPR with antenna placed above the ground is used as a method for mapping the water content of the soil especially at the top layer. Several studies on the GPR field have been conducted to study the effects of soil conditions on the detection results and a high amount of water in the soil will lead to losses in detection result [5][6].The condition of soil affect the GPR antenna performance and several methods have been studied for improving the GPR performance related to the problem [7][8][9]. Researches on how soil water content affects the electrical

properties of the soil has also been carried out and the results show that increase of water content in the soil will cause increased permittivity and conductivity of the soil [10][11][12].

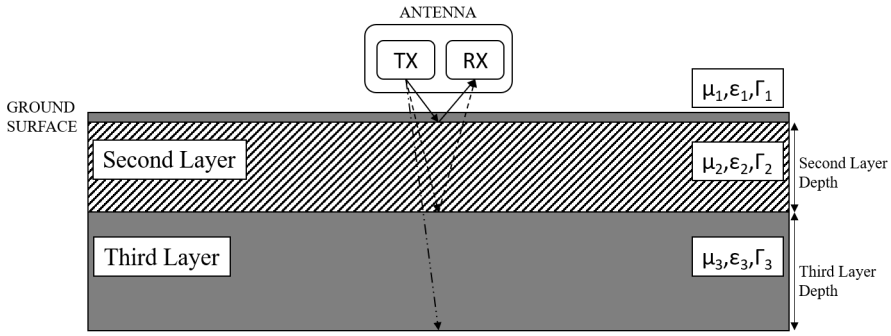

Figure 1.1 GPR signal model for measuring the water content

In previous research, extraction model based on Least Square method has proposed in obtaining the soil water content information from GPR data [13], the research obtain the result of the water contain information by processing the data manually, this method take much time to process the data. This method are elaborated in developing the post-processing that proposed in this thesis.

In this thesis, MATLAB is used to design a post-processing tools for GPR data to obtain the soil water content information. By using post-processing that proposed, the data are processed by computer so it increase the time and cost efficiency to mapping the soil water content in large area.

1.2 Objectives and Benefits

For mapping the soil water content at large area, extracting information of soil water content is needed from the GPR output, thus advanced post-processing method then will be needed. The post-processing method then are expected to improve the time and cost efficiency for mapping the soil water content at large area.

1.3 Problem Formulation

The data that are obtained from the GPR experiment will not directly show information of soil water content, thus advanced post-processing of the data will be needed for extracting the soil water content information from the GPR output. The performance of the post-processing method that are proposed also needed to be analysed to find it accuracy and acceptance to be used.

1.4 Problem Boundary

The boundary of problem that this final project is:

1. The possible noise and clutter problems that may rise in GPR have not been considered yet in this thesis.
2. The experimental study is conducted by laboratory experiment using VNA measurement.
3. Gravimetry method is used to validate the proposed post-processing method result.

1.5 Research Method

The research method that conducted are experimental with steps such as:

1. Study of Literature

   This step decide references from journals, papers, and books related to soil water content, GPR, Least Square extraction model, and the post-processing method.

2. Designing Post-Processing

   This step are designing an algorithm to processed the data of GPR to obtain the soil water content information.

3. Simulation

   This step are conducted using computer simulation tool for electromagnetic to obtain the GPR data by computer.

4. Measurement

   This step are conducted using VNA to obtain the GPR data by laboratory experiment.

1.6 Structure of This Thesis

The rest of this thesis described as follows:

- Chapter 2 LITERATURE REVIEW
  This chapter decribes the theories, tools and equipment related in this research.

- Chapter 3 SYSTEM DESIGN AND EXPERIMENTAL SETUP
  This chapters describe system design and experimental setup

- Chapter 4 RESULT AND ANALYSIS
  This chapters describe the result and analysis of the proposed post-processing method

- Chapter 5 CONCLUSION AND SUGGESTION
  This chapters describe suggestion on how to improve the proposed post-processing method

1.7 Time Schedule

This subsection contains the implementation schedule of this thesis work. It is important to set several milestones to determine the achievement of the job. The implementation schedule is used as a reference to evaluate the stages of work as set forth in the established milestone.

Table 1.1 A time Schedule for this proposal

Description	Duration	Due Date	Milestone
Study of literature	1 month	February 2018	block diagram
Designing Post-Processing	1 month	March 2018	Designing the post-processing method on Matlab
Simulation	2 months	Aug 2018 - Sep 2018	Conducting simulation of GPR using computer simulation tool for electromagnetic
Measurement	2 months	Aug 2018 - Sep 2018	Conducting laboratory experiment of GPR using VNA
Performance evaluation	4 months	Aug 2018 - Dec 2018	Thesis finish