CHAPTER 1

INTRODUCTION

There are three main elements in avionics. They are electrical system, control system and navigation system including the design of antenna propagation and microwave. In order to obtain the characteristic of an antenna, high precision equipment (positioner) is needed to move the antenna to the specified and predefined location. This is essential in testing the antenna for antenna gain radiation pattern measurement. Precision positioning instruments are getting more important due to increasingly in demand in the application of high-end research and high-tech industry. There are two types of positioner required namely; rotational (azimuth) and linear positioner. This project concentrates on the linear z-transverse antenna positioner. Research is currently conducted on producing an accurate, portable, user friendly, and low cost linear positioner that could carry heavy load.

1.1 Overview

Developing a linear z-transverse antenna positioner require an integration of knowledge in mechanical system, electrical system, computer science and finally control system design. The purpose of this project is to design a suitable servomechanism. Servomechanism describes a closed-loop electromechanical control system that directs the accurate movement of a physical object such as in linear positioner. Normally, the output position is controlled. In this case, the controlled variable is the position of the antenna. The antenna will transverse in z-direction and it is rotated by a DC motor governed by the controller. The controller

will be located some distance away and the user could control direction of the movement by using preset modes to relocate the antenna to a specific position (Christopher T. Kilian, 2001).

Initially, a mechanical skeleton that can withstand the load of antenna and move the antenna to the required location has to be designed. From the mechanical system, an electrical system and control circuit are added. The hardware needs proper interfacing with software to achieve the purpose of controlling. All signals and commands from the user are interfaced through computer software (controller) that is designed in the form of graphical user interface (GUI). GUI is required to set the parameters of the control algorithm. GUI provides easy access to the necessary parameters and programming function. Bridging the software and the mechanical/electrical systems is through analog to digital or digital to analog converters (ADC/DAC) and data acquisition interface card. Software or controller will then need to be set appropriately by control algorithms to overcome problems regarding to control system. In other word, fine tuning will be done after the general system such as mechanical system, electrical system and computer system has shown to be working harmonically but does not possess the necessary accuracy.

The benefits of this project will be the localization of the knowledge in Malaysia in the area of antenna measurement technique and associated equipment.

1.2 Thesis Objectives

This thesis has identified several objectives that must be achieved as to fulfill the requirements of the research. They are:

i. To acquire the knowledge on antenna measurement instruments from theoretical application.

ii. To localize the knowledge on antenna measurement techniques and product in Malaysia.

iii. To study the precision methods to measure linear movement with accuracy equal or better than $50\,ppm$ over full scale and to apply the optimum method to an antenna positioner design.

iv. To develop mechanical, electrical and control system.
   a. To control the movement and the positioner by interfacing the mechanical and electrical system with computer.
   b. To fabricate and test the developed prototype system.
   c. Analyze to optimize and to achieve the desired controller settings to solve the problems such as overshoots, long settling times, unwanted oscillations and steady state error.

1.3 Antenna Positioner

Antenna Positioner is an instrument that is used in measurement and position adjustment applications. The main function of the instrument is to locate the RF (radio frequency) probe to the desired position. The design aims for this instrument are accuracy, simplicity, maintainability, portability, user friendly, low manufacturing/fabrication cost and safety. They are the basic guidance in the process of designing. Several instrumentation characteristics must be specified and considered. They are payload capacity and maneuverability, torque, rotary joints, ease of installation & alignment, and control system. All of which must be compatible with each others.

Positioner must also provide reacting against the payload and as a reference of the payload position and orientation to the coordinate system. In this thesis, the payload here means antenna under test (AUT). Most of the existing positioners use single mechanical skeleton for both purposes. They are optimized so that the instrument can act as reaction and measurement skeleton.

The antenna has its own weight and it is also subjected to gravity, payload acceleration, aerodynamics and other forces. Therefore, the mechanical structure of

positioner will provide reaction for the antenna. While the measurement system measure the payload position relative to a reference coordinate system (Dan Slater, 1991).