CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter will describe the materials, tools and equipment used to generate energy harvester. This chapter also covered about the process or procedure on making the energy harvester simulation which is based on the vibration and electromagnetic using finite element method. This project involved the effort of embedded system design process, which involves designing the device and validate the modal parameter by using appropriate software. Hence, for device design, SOLIDWORK CAD software use to fabricate the design with full dimension an in a three dimension (3D) view. Meanwhile for simulation of the device design, ANSYS software are use to validate the modal parameter of electromagnetic-energy harvester using finite element method. The natural frequency then analyzes using experimental modal analysis. Finally, an electromagnetic energy harvester system is build for demonstration and simulation. It involves analytical solution and numerical analysis. The experimental data has been collected by the previous student and should be determined and analyzed to validate the simulation study.

The works begin with finding the motivation to do the project. This is where the research problems are identified. In this project, methods used based were FEA Simulation. FEA Simulation is the ANSYS Simulation software is used to generate the results of natural frequency and its mode shapes. Also to generate the results of energy harvester field intensity on the model and analyze the results. After obtaining results from FEA, the theoretical methods such as applying mathematical equation of electromagnetic field based on solenoid’s theory are carried out to obtain the data for this study. Comparisons are made between them so that to support each other. The works continues with the literature reviews on state of the art of electromagnetic energy harvester system and a study in simulation of the system to validate the modal parameter. The movement of the magnetic flux will be analyzed and the theories of the magnetic field by solenoid were used throughout this study. As a result of using the magnetostatic arrangement in ANSYS Simulation software, by inserting parameters and ANSYS will run an analysis desired and will produce the expected result. This is important for the researcher to understand the fundamental concept and operations carried out in the energy harvester system.

3.2 ELECTROMAGNETIC ENERGY HARVESTER SYSTEM

In particular, the size of beam and its material and coil parameters were investigated. The generator design is based upon a cantilever beam spring element. The electromagnetic principle of energy converter is used in the developed energy harvester and the used converter consists of an oscillating coil and a fixed magnets. Design of the system requires several tools and techniques that have to familiarized and mastered. This includes the 3D computer aided design (CAD) SolidWorks software in the designing development of the energy harvester.

3.2.1 Energy Harvester Design using Solidwork

The design of energy harvester device comprises two Neodymium Iron Boron (NdFeB) magnets that manually bonded together and mounted on the base at fix position. The magnets used were 10 mm in diameter and 12 mm height. These magnets are placed such that attractive and repulsive magnetic forces can be applied and this arrangement will be producing a concentrated flux gradient through the stationary magnets as the beam vibrates together with coils. The cantilever beam in this design is 100 mm long, 45 mm wide and 0.32 mm thick. Additionally, the coil has diameter of 1.03 mm. It is mounted on the free edge of the cantilever beam as shown in Figure 3.1.

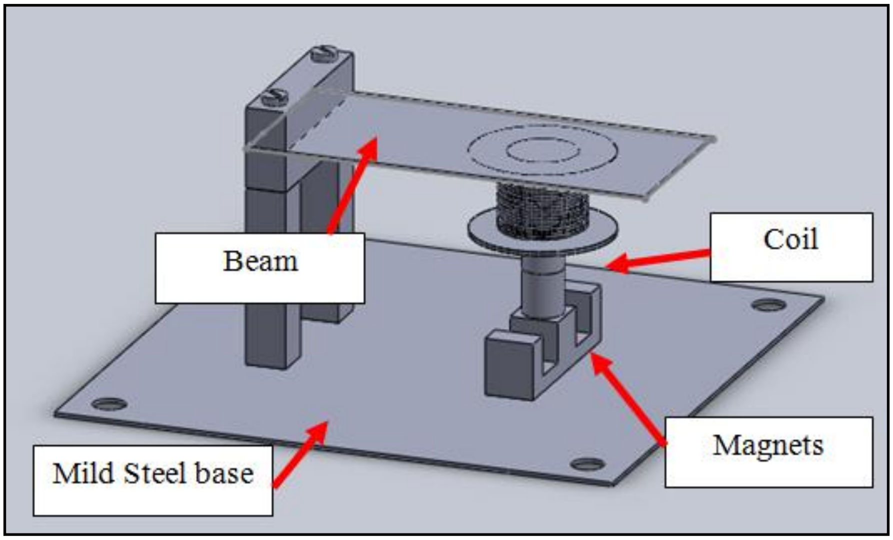

Figure 3.1: Energy Harvester Design

3.2.2 Design Materials

The design of this electromagnetic energy harvester consists of Neodymium Iron Boron (NdFeB) magnets. This magnet is known as rare earth magnets which is includes in a group of alloys of the Lanthanide group of elements. Rare earth magnets are the most advanced commercialized permanent magnet materials today. NdFeB magnets are available in a number of different grades that span a wide range of properties and application requirements. NdFeB magnets are brittle and machining operations should be performed prior to magnetization by using diamond tools. Table 3.1 shows the physical and thermal properties of NdFeB magnet.

Based on the basic operation of magnet and coils, an oscillation movement of the coils through the magnets provides a change in magnetic field and it induces voltage in the coil. Coils use for the design is Tinned Copper wire (MIL-W-3861 TYPE S) type. This tinned copper is electrolytic, soft drawn and annealed that allows to be easily formed. It improves corrosion resistance with the tin coating and makes soldering easier.