Design and Simulation of an Intelligent Maximum Power Point Solar Tracking System

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Abstract - This paper accentuates the enhancement of modulation and simulation in real time projects. Different kind of simulations can be done to authenticate and predict the results of any hardware model. Different approaches are being discussed which can be helpful in the design and implementation of any hardware model. For the study a very common model of Solar tracker is chosen. Pro-E was being used for the 3D modeling and analysis of the tracker. Furthermore, MATLAB Simulink was used to verify the results obtained in the first step. In the last conversion of Simulink block diagram into hardware model of Pro-E is also discussed.

Keywords - component; Simulation, MATLAB, PRO-E

I. INTRODUCTION

One of the most important problems facing the world today is the energy crisis [1], [2]. To meet the growing demands of the world, with limited fossil fuels, research on methods of enhancing renewable energy sources are the need of the hour. The amazing thing about solar power is that it is easy to install and maintain. The major problem, however, lies in the low efficiencies of solar power systems. This inefficiency results in higher cost of solar solutions thus making solar solution mostly redundant in comparison to fossil fuel based energy resources.

The efficiency of a solar panel can be increased by a tracking system which can keep the panels oriented to get maximum power at the given instant.

A Maximum Power Point (MPP) tracking system can boost power output by 25-30%. This increase in output of a solar panel because of tracking has been shown in Fig. 1.

In order to increase the efficiency of photovoltaic panels, solar tracking systems have been developed. Regular mounted solar arrays do not optimally collect sunlight and arrays with tracking systems have been shown to increase power output by an average of 30%. Due to the expense and space required for solar arrays, this increase in power is extremely desirable.

A solar tracker is a device for orienting an array towards the sun. The sun's position in the sky varies both with the seasons and time of day as the sun moves across the sky. Solar powered equipment works best when pointed at or near the sun, so a solar tracker can increase the effectiveness of such equipment over any fixed position, at the cost of additional system complexity. There are many types of solar trackers, of varying costs, sophistication and performance.

In this paper, the software used that helped in deciding critical electronics and programming decisions are MATLAB, Pro Engineer and Simulink. The Pro E model has been linked to MATLAB and important force/movement relationships have made it possible to determine the current requirements. This allows from a programming point of view to determine how much movement in one step is permissible in order to determine the best orientation which gives the maximum power.

II. BASIC PARAMETERS OF TRACKER

The basic parameters of a tracker are closely associated with the mechanical structure of a particular tracker. A list of such parameters includes

- Payload (up to 450 kg)
- Mobility (single axis with 0.1-degree accuracy)
- Workspace
- Agility
- Accuracy and repeatability of positioning in various degrees of freedom
- Structural stiff-nesses, masses, damping coefficients and natural frequencies
- Economics
III. THE PRO ENGINEER DESIGN

Complete solar tracker was designed and simulated in the Pro Engineer environment. Here the tracker was subjected to forces which it would face in the real world and a structural study was carried out. A dynamic study was also carried out on the tracker simultaneously to find out the torques on different parts.

Finished design of tracker from different views is shown in figures. 2, 3, 4.

A. Mechanical Analysis

Mechanical analysis of different parts of tracker was being done by applying expected force over them in Pro-Mechanica application. Following are the figures of test results of hinge and beam where maximum stress was expected.
IV. SIMULINK

Simulink is a tool for modeling, simulating and analyzing multi domain dynamic systems [3]. Its primary interface is a graphical block diagramming tool and a customizable set of block libraries. It offers integration with the rest of the MATLAB environment and can either drive MATLAB or be scripted from it. Simulink is widely used in control theory and digital signal processing for multi domain simulation and design.

A. Simulink Control Design

Simulink of basic scanning technique P&O were implemented in MATLAB to simulate the power comparisons of different angles. The model is shown in the following Figure 7.

Figure 7. Simulink design of P&O

Figure 8. Comparison graph for different IV values
B. SimMechanics

SimMechanics software gives a complete set of block libraries for modeling machine parts and connecting them into a Simulink block diagram [4]. Actuator and DC motor are implemented in SimMechanics to simulate results of both in different power and force conditions.

C. SimMechanics of Actuator

Block diagram of SimMechanics of actuator is shown in fig. 9. Comparison graph is shown in fig. 10 showing that applied force is acting in only one direction.

If the change is applied a signal, then actuator reaction is also changes. This behavior is shown in graph of fig. 11 and fig. 12.
V. INTERFACING BETWEEN MATLAB AND PRO-ENGINEER

The designed mechanical model in pro-Engineer software has been imported into MATLAB with the help of “SmLink 31” software [5]. It allows the Pro-Engineer model to be exported as an .XML file. This file is then imported into MATLAB, where a Sim mechanics model can be generated.

In addition, analysis can be done on the model and force-movement relationship helps us in determining the power consumption from the battery. So, in this manner this integration helps determine the amount of movement that is permissible under the given ambient conditions.

SimMechanics model generated for our model in Pro-E is shown in fig.12, 13 and 14.
With the help of this SimMechanics model we have generated the machine model which is shown in fig 16.

By adding scopes with SimMechanics model graph for forces of bodies and their motion-force relationship can be obtained.

VI. CONCLUSION AND FUTURE WORK

The main reason of doing this study was to design a stable mechanical system which can support the weight of solar panels and all the electronic equipment required to track the sunlight for the production of electricity.

As a future work a structure can be designed mathematically in some other programming language and transferred into PRO-E to generate 3D model for stress and strain analysis.

REFERENCES