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Use of Fuzzy Logic Controller for Abstraction of Maximum Power from Solar Panel with Stepper Motor Drive – A Review

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***Abstract*— The main objective of this project is to develop and implement a prototype of a controller scheme using latest control algorithms and drives technology to capture maximum sun energy from sun through solar panel in day time. The efficiency of a solar panel is related to the amount of solar energy it absorbed, so it is necessary to track the sun's position for the panel accurately. A new approach to implement a control unit so that the position of the panel is always kept perpendicular to the sun so as to capture maximum amount of energy. In this control unit a new tracking system is proposed, which comprises of a sensor (position), a microcontroller, and a stepper motor. The position sensor (pyranometer) always detects the position of the sensor. This sensor also detects the radiation from the sun. The fuzzy logic control approach is developed in the microcontroller to design a drive unit for stepper motor as well as to detect the sun position. By implementing this tracking system, the solar panel can be perpendicular to the sun at any moment in day time to obtain maximum solar radiation. The resulting structure has high efficiency, low cost and can be easily modified. This improves the performance of regular tracker nearby 30-40%.**

***Index Terms*— Fuzzy logic controller, stepper motor, pyranometer, solar tracking system, MATLAB/SIMULINK.**

I. INTRODUCTION

Solar tracker has been continuously developed by many scholars with the aim to improve the efficiency of solar energy captured during day time. The position of the solar panel is the most important factor that ensures the optimum capture of solar energy. Solar panel is normally placed and fixed at open area for long period of time with minimum supervision. It is manned for robust application and should not frequently breakdown which may interrupt the power generated by the solar panel. A solar panel receives the most sunlight when it is perpendicular to the sun's rays, but the sunlight direction changes regularly with changing seasons and weather. Currently, most solar panels are fixed, i.e., the solar array has a fixed orientation to the sky and does not turn to follow the sun. This may contribute that the energy captured is not always maximized as the static placement of the panel limits their area of exposure from the sun. The efficiency with solar tracking methodology is 6.7 percentages higher than that with fixed angle on a horizontal surface. The oriented solar panels in the way of sun tracking would lead to the maximum power and increase the output by 30%-40%; significant enough to make tracking a viable preposition in spite of the enhancement in system cost. The active tracker use motors and gear trains to direct the tracker commanded by a controller responding to the solar direction which typically indicate by real time clock and a sensor. In this proposed unit a sensor always detects the position n of the panel and relevant parameters induced by the sun which are transferred to the controller to manipulate the panel, and then yield the maximum energy. So the proposes a closed loop type.

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II. METHODOLOGY:

The system structure comprises of three modules, the sensor module, the driver module and the control module. The sensor module aims to convert the received sun light to some kind of signal, and then obtain the position of the sun. The control module generates the operating command depending on the sensor signals and motor as well as solar panel position. The driver module drives the solar panel through the stepper motor to track the sun light.

The sensor Module **:**

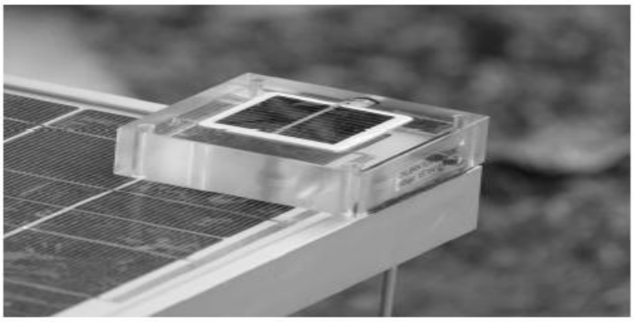

Fig 2: Pyranometer Sensor

Since in many number of sun tracking systems the LDR or photodiode have been used as a sensor to detect light radiations. But these sensors are unable to detect the cloudy weather conditions, so it is difficult to the sensor to access the exact solar radiation. In such case the controller is unable to take the proper decision. To avoid such uncertain condition the pyranometer sensor has been utilized. This sensor is a position sensor as well as weather detecting sensor. This sensor is the prominent tool of the proposed scheme so as to capture the exact position of sun with respect to solar panel , which must be perpendicular and it also detect the weather condition so as to monitor the cloudy atmosphere.

The Stepper motor :

Stepper motors are commonly used for precision positioning control applications. There are three types of stepper motors: permanent magnet, variable reluctance, and hybrid. The sun tracking system used two 2-phase hybrid stepper motors to monitor the rotation of the panel in west east axes and north-south axes separately. A driver circuit was developed to driver these stepper motors.

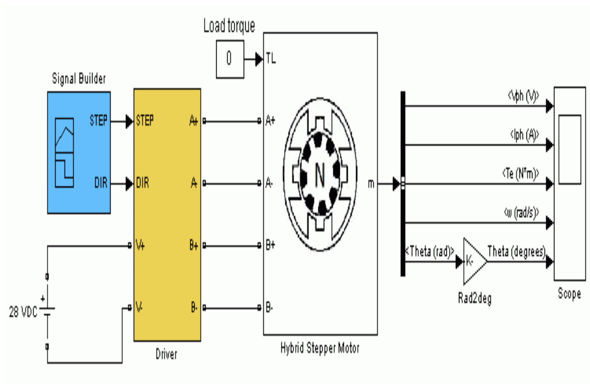

Fig 2: MATLAB/SIMULINK Model of stepper motor.

III. THE CONTROL MODULE :

The control module comprises of the fuzzy logic control used nine fuzzy rule bases to check the position of the panel and to determine the calculation of radiation of sun. Accordingly the fuzzy logic controller take the decision to rotate the panel through stepper motor. The advantage of the FLC that it acts as smart controller having some sort of human sense. So the FLC is the powerful tool of the proposed system as it can take the decision on the basis of fuzzy rule base. The basic structure of FLC is shown below in which it follows the three basic function namely fuzzification, inference engine and defuzzification which is shown in the following n schematic. In fuzzification the controller converts the actual input which is in the form of crisp set to the fuzzy membership grade . In the inference mechanism it will apply the rule base (in present case there are nine rule base). And in defuzzification the fuzzy set is converted into crisp set which actually fed to the rotator.

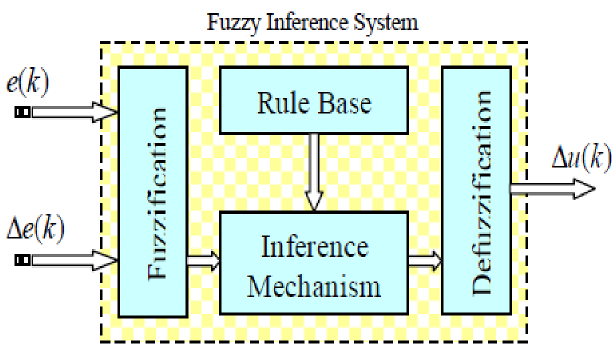

Fig 3:Basic structure of FLC

The control schematic in MATLAB environment in shown below.

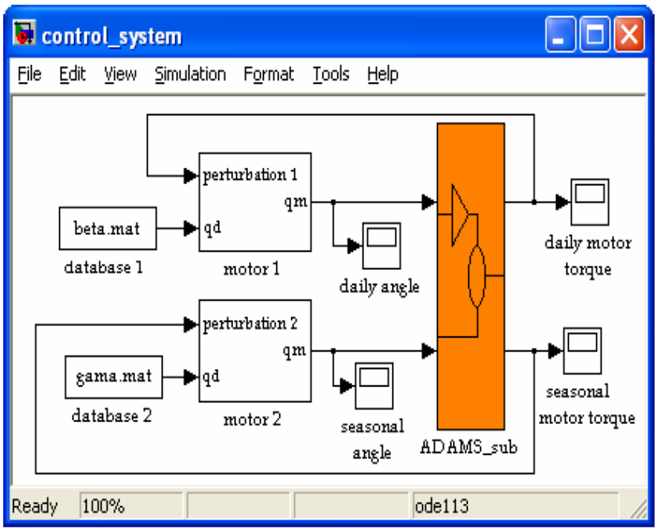

Fig 4 : Control Schematic of Solar tracker in MATLAB.

There is also a comparison between the fixed panel and rotating panel, from this comparison it has been observed that the rotating panel has high resolution than the fixed one .

IV. CONCLUSION :

From the above methodology of the sun tracking system developed in MATLAB/SIMULINK environment. The study and certain experimental results came to the conclusion that the rotating panel gives better result than the fixed panel Also the FLC is a powerful control scheme to establish the above solar tracking system. The main aim of the research work is to implement the enhanced solar tracking system with new approach of control algorithm and best position control device with latest technical inputs. In order to perform accurate and reliable analysis of the proposed system, an experimental set up is designed that can accurately repeat the measurements of the system. In the present research work, MATLAB/SIMULINK environment is used to implement and analyze the proposed system. The contributions of this research are summarized as follows:

1. Survey in following areas has been performed:
   - Various methodologies used in solar tracking systems.
   - Details of the various control algorithm used in the present scenario.
   - Study and analysis of the use of various motor for such systems.
   - Comparison of the features of various motors.
   - Detail of parameters of the solar panel.
2. Common types of the solar tracking systems using different tools.
3. Motor analysis based on the requirement of the proposed system.
4. The various methods for detection and absorption of energy from the sun rays.
5. An experimental study of fuzzy logic controller for different inputs.

6. An experimental study of various conventional controllers for different inputs.

7. Detail analysis has been made about the rotation of the panel (which decides the angle of rotation of stepper motor).

- For small panels – Nearby five degrees.
- For medium panels _ Nearby ten degrees.
- For big panels _ Nearby twenty degrees.

The panel size depends upon the power rating of the panel.

8. Application of the proposed tracking scheme to the panel will show the detail comparison for power output from the panel. (It is taken from study analysis) which is shown the following table. The detail study analysis of the various panel output after the application of the proposed scheme is shown in the following table (table 4.1).

Table 4.1Comparison for power output from both controllers.

P_{out}	P_{max}	By FLC	By PIC
10 W	9 W	Nearby 7.8-8.2W	Nearby 7-7.2W
20 W	18 W	Nearby 16-16.2W	Nearby 14.4-14.6W
40 W	37.5 W	Nearby 34W	Nearby 30-31W
60 W	58 W	Nearby 52W	Nearby 46-47W
120 W	114 W	Nearby 102W	Nearby 93-94W
240 W	228 W	Nearby 205W	Nearby 185W

V. REFERENCES :

[1] M. Amir Abas IEEE Member, M. Hilmi Fadzil,,Samsudin A.Kadir, A. Khusairy Azim, "Improved Structure of Solar Tracker with Microcontroller based Control", Second International Conference on Advances in Computing, Control, and Telecommunication Technologies, 2010, pp 55-59.

[2] Weiping Luo, Yurong Wu, "A Servo System of Tracking Automatically for Solar Cell Based on Fuzzy Controller", 978-1-42445326-9/IEEE 2010.

[3] Zhou Yan, Zhu Jiaxing, "Application of Fuzzy Logic Control Approach in A Microcontroller- Based Sun Tracking System", WASE International Conference on Information Engineering,2010 pp160-163.

[4] A.Lay-Ekuakille, G.Vendramin1, A. Fedele, L. Vasanelli1, A. Trotta , "PV Maximum Power Point Tracking Through Pyranometric ensor: Modeling and Characterization" International Journal On Smart Sensing And Intelligent Systems, Vol. 1, No. 3, September 2008,pp659-678.

[5] Usta M.A., Akyazi O. and Altas I.H., " Design and Performance of Solar Tracking System With Fuzzy Logic Controller", Sixth International Symposium (IAT'S11), 2011,Turkey, pp. 331-336.

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