Hybrid Vibration and Solar Power Generation System using Piezoelectric Sensors and Fuzzy Logic based Sun Tracking Solar Panels

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Abstract

Now a day, with increasing concern of depletion of fossil fuel reserves and global warming, there is a great demand of using sustainable energy as alternative to preserve and save the earth for future generations. Hydro and wind power are some alternative power source which have a great potential to meet our energy demands, but they need a lot of space and a huge initial investment, whereas vibration and solar power can also meet our energy demands and also needs less space and initial investment is also low. We will be generating power from vibration energy by using piezoelectric sensors and from solar energy by using solar panels. To get maximum efficiency we have designed 1-D fuzzy logic based sun tracking solar panels.

Keywords: Hybrid Power Generation, Vibration and Solar, Piezoelectric sensors, Fuzzy Logic, Sun Tracking

I. INTRODUCTION

Energy is present everywhere in our surrounding, it totally depends on us that we utilize this energy for constructive or destructive purpose. Energy can be classified as conventional and non-conventional energy.

The conventional sources of energy are generally non-renewable sources of energy, which are being used since a long time. These sources of energy are being used extensively in such a way that their known reserves have been depleted to a great extent. These conventional sources are usually fossil fuels. Their use leads to increased greenhouse gas emissions and other environmental damage.

Energy generated by using wind, tides, solar, geothermal heat, and biomass including farm and animal waste as well as human excreta is known as non-conventional energy. All these sources are renewable or inexhaustible and do not cause environmental pollution. Moreover they do not require heavy expenditure.

So In our Project we are trying to harness Vibration and solar energy and further use them to generate power. Since both the sources have their own disadvantages so we make it a combination of both the energies so as to remove the limitations and increase the efficiency.

II. RELATED WORK

Ms. Bhusari Priya Govind *et al.* [1] proposed an efficient way to power generation system, using hybrid piezoelectric solar power. Solar energy system is used to collect maximum power from sun. this proposal is to use the solar panels implemented in this project more efficiently and to carry out a realistic experimental approach to enhance the solar output power to a significant level and piezoelectric energy harvesting circuit.

S.Sathiyamoorthy et al. [2] in their paper they proposed an excellent way for power generation system using wind, vibration and solar energy harvesting.

Md. Habibur Rahman et al[3] Showed us about using the vibration energy to produce power.

Kazi Saiful Alam et al. [4] have modelled Solar-Piezoelectric Hybrid Power Plant for Railway Station. Which Gives us an Idea about the application of such kind of Systems.

III. PROPOSED BLOCK DIAGRAM

A. Process Description:

In this system, when sun rays are incident on phototransistor then the signal is given to the fuzzy logic controller. 12V dc supply is also given to fuzzy logic controller. The output of fuzzy logic controller is given to the DC motor and through this motor photovoltaic panel will rotate. The output of the PV panel is given to the charge controller and at the same time charge controller is taken the output from piezoelectric sensor. The output of the charge controller is given to the battery and battery gives dc supply. It is necessary to convert the dc supply into ac so here inverter is used.

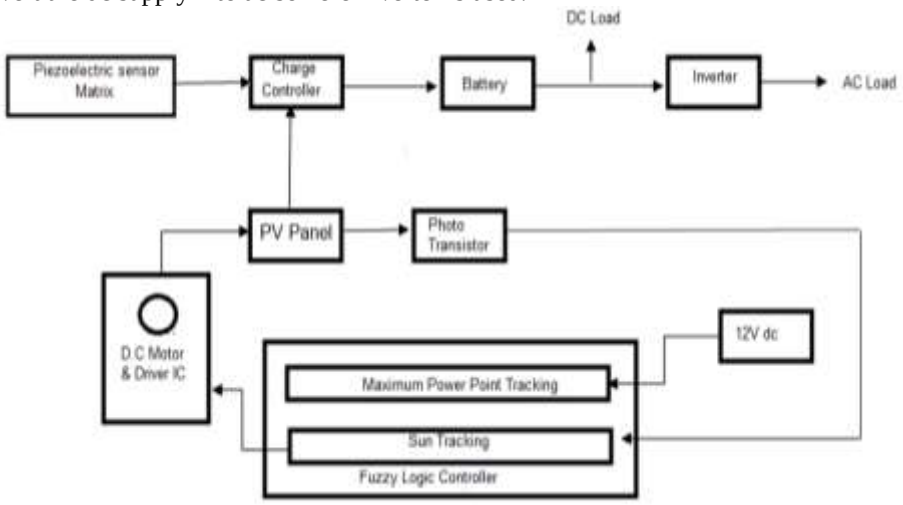


Fig. 1: Block Diagram of implemented System.

B. Piezoelectric Sensor Matrix:

It is an arrangement of number of piezoelectric sensors in series and parallel so that when weight is applied we get a proper voltage so as to charge the Battery.

Solar Panel (PV Panel): In our prototype we have used a 12V, 30W rating solar panel to charge the battery in presence of sun.

C. Charge Controller:

A charge controller, charge regulator or battery regulator limits the rate at which electric current is added to or drawn from electric batteries. It prevents overcharging and may protect against overvoltage, which can reduce battery performance or lifespan, and may pose a safety risk. It may also prevent completely draining ("deep discharging") a battery, or perform controlled discharges, depending on the battery technology, to protect battery life. The terms "charge controller" or "charge regulator" may refer to either a stand-alone device, or to control circuitry integrated within a battery pack, battery-powered device, or battery charger. Input to the charge controller will be given by the solar panels and piezoelectric sensor matrix, and the regulated and controlled voltage will be used to charge a 12V Lead acid battery.

D. Lead Acid Battery:

In our Prototype we use a 12V, 7Ah rechargeable Lead acid Battery, To store electrical energy in form of chemical energy so as to use it further to power up DC loads.

E. Inverter (Optional):

We can use a Sine wave inverter if we need to power up AC loads we can convert this 12V DC to 220V AC 50HZ by adding a inverter to the system if required.

F. Photo Transistors:

In this Project we have used two L14G2 photo transistors to track the direction of the sun from East to west the signals of this photo transistors is further given to the controller so as to take proper action.

G. Controller:

We have designed our project using a Fuzzy Logic Control to track the Sun, using the Concept of Maximum power point tracking. In this method the sensors continuously tracks or compares the inputs from both the sensors increasing its accuracy.

H. Motor and Driver circuit:

Usually a stepper motor is used for the Sun tracking System but after comparing the specification, working, efficiency, user friendly nature and maintenance we come to conclusion use of DC motor would be more preferable as there is less maintenance and is user friendly and also suitable for rough environmental conditions.
For driving DC motor we have used a L293D Dual H Bridge Motor Driver IC.

Fig. 2: Schematic representation of working model of Power Generation using Vibration and Solar Individually.

IV. MODELING AND LOGIC

A. Mechanical Modelling of Sun Tracking Solar panel:

First we select the centre of an edge of the panel and we calculate the torque of the motor required by the formula:

$$\Im = F.d \ldots\ldots\ldots \text{ eq.1}$$

Where; $\Im$= Torque
F= force= mass x Acceleration= 2.5kg*0.5m/s^2 =1.25N
d= Distance from the centre= 35/2= 170.5cm
So the Torque of the motor should atleast be 21.9Ncm

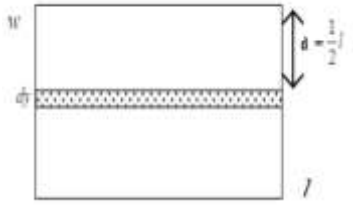


Fig. 3: The Rotary axis of solar panel.

B. Fuzzy Logic Implementation:

The main control unit of the whole tracking system is micro controller, and the control strategy used in this system is fuzzy logic control. Fuzzy Logic control has five membership functions that are defined as NVS(negative very small), NS(negative small), ZE(zero), PS(positive small) and PVS(positive very small). While the fuzzy outputs consists of CCW FAST, CCW SLOW, STOP, CW SLOW, CW FAST.

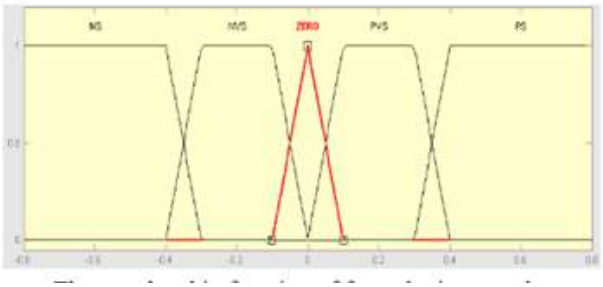


Fig. 4(a): The Membership function of FLC input.

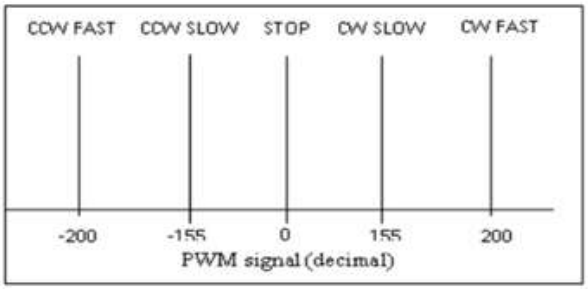


Fig. 4(b): The fuzzy output set (DC motor speed)

Table – 1
Rule Base of Fuzzy Logic Control.

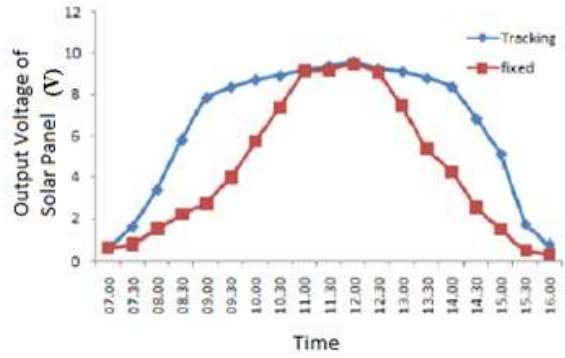
Input	Output
NS	CCW FAST
NVS	CCW SLOW
ZE	STOP
PVS	CW SLOW
PS	CW FAST

V. RESULTS

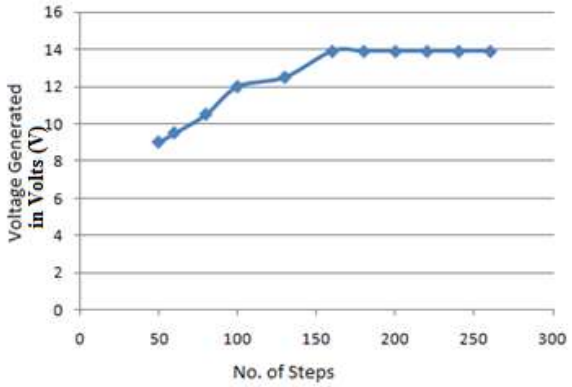
After completing our entire project we have taken the power generation reading individually from both the sources viz. from sun tracking solar panel and piezoelectric sensor matrix individually and here we have given the graphical representation as Graph 1. Shows the difference between the output voltage of a fixed and tracking solar panel. So this exactly shows how the efficiency of the solar panel increases as we switch on to sun tracking mode.

Graph 2. Shows the rise in the voltage generated by the piezoelectric sensors matrix after different no. of steps on the piezoelectric sensor Matrix.

So we can assume that how the entire hybrid system will be efficient by seeing the graphs.



Graph 1:



Graph 2:

VI. CONCLUSION AND FUTURE WORK

In today's world it has become very important to harness and use renewable source of energies so as to protect the environment. So this paper comes up with an idea of using vibration and solar energy together and generates electricity for our needs. Hybrid vibration and solar power generation system is one of its kind which is low maintenance and also economy to use. And this system is also very efficient. To get maximum efficiency this kind of systems should be installed in busy crowd places such as railway stations, malls, bus stops and busy footpaths. In future we can also improve this system by making it dual sun tracking solar panels or if the area or geographical conditions allow we will also be able to add other power generation systems to increase the output.

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