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A Novel, Affective & Automatic Tracking System for an SPV power plant as a part of Green drive

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Abstract: A solar tracker is a device that assists the solar panel to track the Sun light. This is done by either single axis or dual axis trackers. Solar tracker gives 10 to 20% more energy than conventional fixed solar system. The modeling and simulation of solar power plant is done in MATLAB software. The hardware is designed and tested for fixed and tracking type for different radiations/insolation and inclination angles. The movement of solar panels is done by a linear actuator and controlling is done with microcontroller.

Keywords: *Microcontroller, Single axis tracker, PV Panel, linear actuator, charge controller.*

I INTRODUCTION

A solar tracker is a gadget that arranges a payload toward the Sun. Payloads are normally sun based boards, explanatory troughs, fresnel reflectors, focal points or the reflections of a heliostat. For level board photovoltaic frameworks, trackers are utilized to limit the edge of frequency between the approaching daylight and a photovoltaic board. This expands the measure of vitality delivered from a settled measure of introduced control producing limit. The amount sunlight depends on the cosine angle of edge. The motivation behind a following system is to take after the Sun as it moves over the sky by considering its every day east-west movement independently from its yearly north-south variety with the periods of the year. Trackers are of two types, Single axis tracker and Dual axis tracker. Tracking can be done with reflectors, MPPT with reflectors, algorithm based single axis tracker, DC motor, stepper motor etc. In this paper, the hardware of 1kW SPV plant with single axis tracker has been designed and tested for fixed and tracking type for different radiations/insolation and inclination angles. The movement of solar panels is done by linear actuator. The ratings of the linear actuator vary on the number of solar panels connected. Initially prototype of the tracker system is done and later it is be scaled up to 1kW. A microcontroller is used for sensing the position of the Sun and controlling of DC motor/linear actuator. The simulation of 250W PV panel is done in MATLAB with MPPT (Maximum Power Point Tracking) Incremental Conductance technique.

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II EXPERIMNTAL SETUP

A 1kW PV plant has been designed with four 250W PV panels. The main idea of the hardware is to power supply domestic appliances.

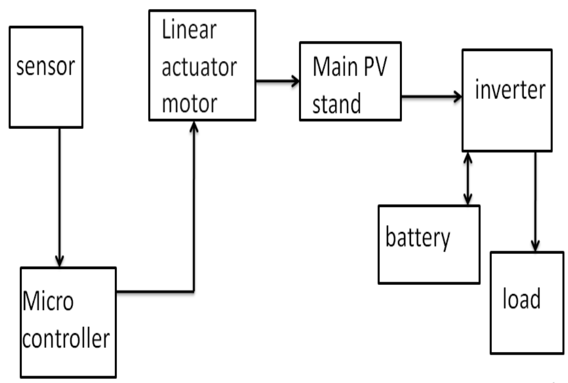

Figure1 :Main block diagram

From the above block diagram we can say that the sensor will give signal to micro controller which in turn sends the singal to linear actuator such that motor will tilt the main four panels in the direction of sun in order to receive the maximum power . So the intial singal is given by the sensors only which makes the main panels to maximum power input to inverter such that which can be converted to AC from DC solar power. The load can be normal home appliances and battery is just back up to store or send power depending on requirement.

Figure 2: Main solar PV panels setup

The main 250W panels are polycrystalline panels and linear actuator is 50W. The linear actuator is fed from another 60W PV panel insted of feeding back from main panels. The 7805 volatge regulator has been used in order to provide constant power supply to micro controller. Below is the figure of voltage regulator used with capacitors.

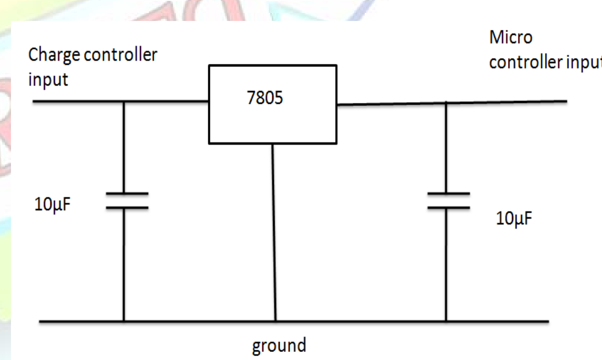

Figure 3: Voltage regulator

The charge controller is used in order control power outflow of battery and also to ensure reverse current protection. The speed and rotation direction of motor is controlled by motor driver. This motor driver is in turn conncted to microcontroller and motor for its operation. The figure below shows the relation

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among charge controller , micro controller and motor.

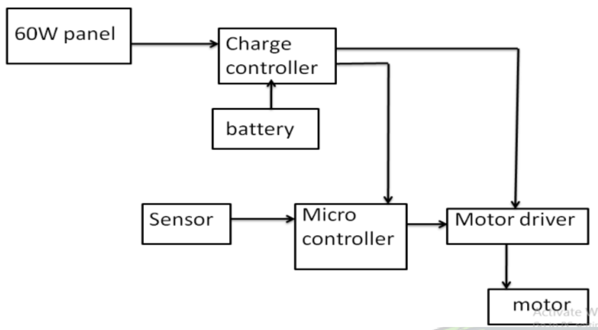

Figure 4: Internal block diagram

The inverter needs one positive and negative , that can be achieved by parallel connection of all main 2050W PV panels with the help of juction box. The junction box made as 4input and one output . The accelerometer is also been used in order to protect the main tarcking PV panels .

The load connected is of 400W , just for example four filament bulds are conncted with inverter. The below figure shows the connections among power output of main PV stand , batteries, load and inverter.

Figure 5: Connected load with inverter

III SIMULINK MODELS

The simulation has been done in MATLAB software with the same rating parameters of 250W PV panels. Open circuit voltage(Voc) is 37.98V , short circuit current(Isc) is 8.67A. Simulink model of complete circuit is shown below. It includes PV module with MPPT & PWM (Pulse width Modulation) control . It also includes normal boost converter. In the below figure insolation & temperature are inputs to get power as output.

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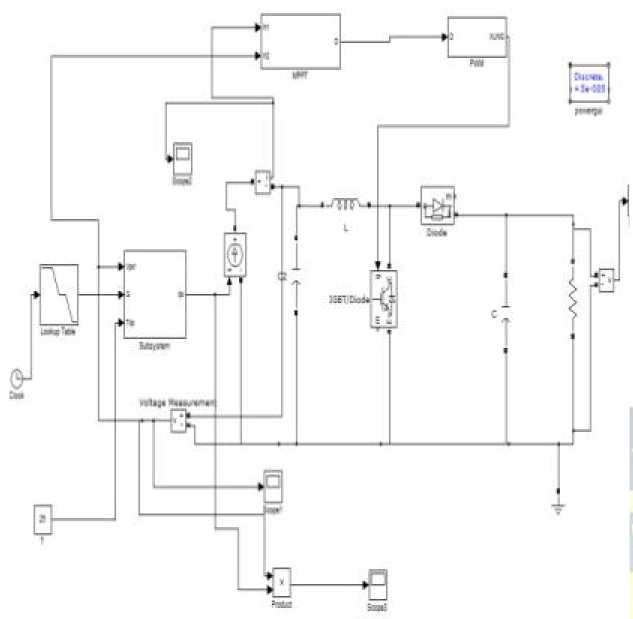

Figure 6: Main simulink model of MPPT PV system

Below are the constant parameters that are used in the designing of simulink model and the parameters include Boltzman constant, charge of electron etc.

Table 1: Constant parameters of simulink model

Parameter	values
K_i	0.0017
K	1.38* 10^{-23}
Q	1.602*10^{-19}
A	1.3
E_g	1.1

The below figure shows the internal circuit of PV model with reverse saturation current, phase current, saturation current and output current of PV panel.

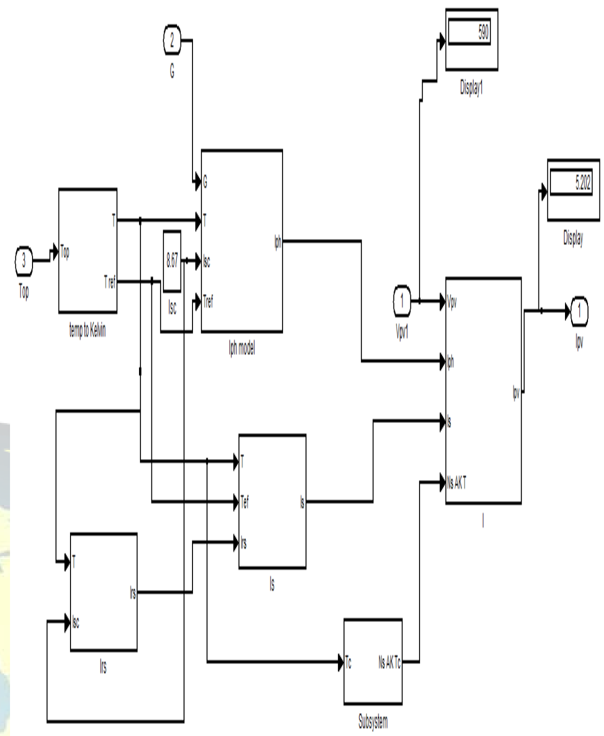

Figure 7: Internal PV model

IV RESULTS & DISCUSSIONS

The installed solar tracker has been tested on different dates to find its efficiency at both fixed, with manual perpendicular angle tracking & automatic tracking mode at various hours of the day.

Fixed position of the tracker is kept at17° as per Hyderabad altitude & longitude.

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Table 2: Results of without tracking at 17˚ on 15.3.2017 with 250W PV panel

Time	Voltage(V)	Current(A)	Power(W)	Efficiency
9AM	20	2.7	54	21.6%
10AM	22.5	3	67.5	27%
11AM	30	4.2	126	50.4%
12PM	31	4.2	130.2	52.08%
1PM	31	4.3	133.3	53.32%
2PM	20	2.3	46	18.4%
3PM	16.5	2.1	34.65	13.86%
4PM	12.5	2	25	10%

From the above table, the conclusion can be drawn that efficiency is increased up to mid afternoon & it has decreased. The efficiency is dependent on the Sunlight intensity and the average efficiency is 30.83%.

Perpendicular angles are taken from the NASA (National Aeronautics and Space Administration) website. Perpendicular angle= (90- Altitude angle)

Table 3: Results of with manual tracking by NASA perpendicular angles on 16.3.2017 with 250W PV panel

Time	Perpendicular angle(deg)	Voltage(V)	Current(A)	Power(W)	Efficiency
9AM	28	30	4.2	126	50.4%
10AM	24.5	30	4.1	123	49.2%
11AM	17.2	30	4.2	126	50.4%
12PM	2.6	30	4.2	126	50.4%
1PM	12.9	30	4.3	129	51.6%
2PM	27.9	30	4.1	123	49.2%
3PM	42.9	30	4	120	48%
4PM	57.9	30	4	120	48%

In manual tracking all the voltages, currents, power & almost efficiency of the tracker is same throughout the day. The average efficiency is 43.35%.

Table 4: Calculated perpendicular angles from Altitude angles

Time	Altitude angle(deg)	Perpendicular angle(deg)
9AM	62	28
10AM	65.5	24.5
11AM	72.8	17.2
12PM	87.4	2.6
1PM	77.1	12.9
2PM	62.1	27.9
3PM	47.1	42.9
4PM	32.1	57.9

Sun based elevation is measured in degrees. The estimation of the sun oriented elevation shifts in view

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of the season of day, the season of year and the scope on Earth. Locations near to the equator have a higher sun oriented height than the areas close to the Earth's shafts.

Table 5: Results of with automatic tracking on 16.3.2017 with 250W PV panel

Time	Voltage(V)	Current(A)	Power(W)	Efficiency
9AM	30	4.2	126	50.4%
10AM	30	4.1	123	49.2%
11AM	30	4.2	126	50.4%
12PM	30	4.2	126	50.4%
1PM	30	4.3	129	51.6%
2PM	30	4.1	123	49.2%
3PM	30	4	120	48%
4PM	30	4	120	48%

It has proven that both perpendicular angles from manual tracking are same as the angles obtained by automatic tracking. From the below table, the conclusion can be drawn that efficiency is increased up to mid afternoon & it has decreased. The efficiency is dependent on the Sunlight intensity. The readings are taken from 9AM to 4PM. In automatic tracking all the voltages, currents, power & almost efficiency of the tracker is same throughout the day. The average efficiency with tracking is 43.35%.

The below graphs are voltage and current of Simulink models. The output voltage is 27V and output current is 6.5A.

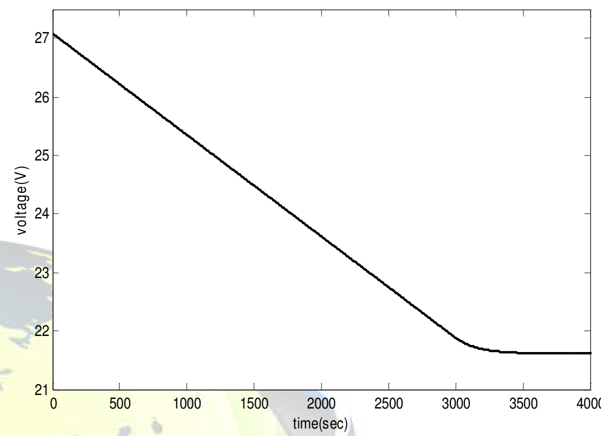

Figure 6: Output voltage of PV module

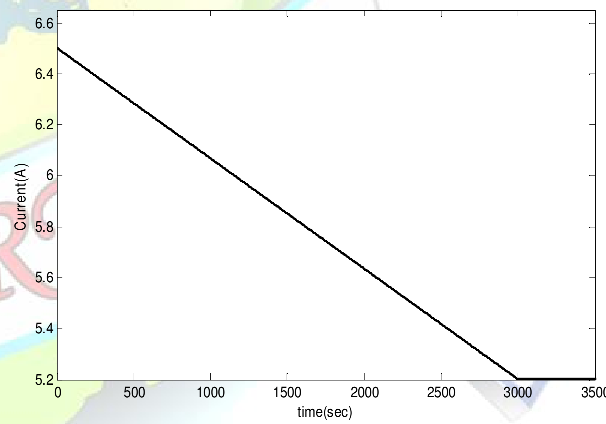

Figure 7: Output current of PV module

CONCLUSION

Analysis of fixed position PV panel(250W) is done with different insolations at various times in a day. Sensor based Single axis Solar tracker with DC motor(linear actuator) including speed controller by micro controller is done.The performance analysis comparison with MMPT, with & without mechanical tracking is done.The

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efficiency has been increased to nearly 13% with automatic tracking compared to fixed tarcking. Simulation of Solar power plant in MATLAB software with MPPT(Incremental Conductance) is done.

FUTURE SCOPE

The solar tracker can be further scaled to mega watts for large scale use of power in industries. Three phase Induction motor can used for large ratings of tracker. There is lot of scope for solar tracker for a clean & green society.

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REFERENCES

[1] A Hardware-in-the-Loop control strategy of a permanent magnet synchronous motor used in positioning a solar tracker, "Nicolae Marian-Ştefan",2017 International Conference on Optimization of Electrical and Electronic Equipment (OPTIM) & 2017 Intl Aegean Conference on Electrical Machines and Power Electronics (ACEMP)

[2] Dynamic Modeling and Performance Analysis of a Grid-Connected Current-Source Inverter-Based Photovoltaic System, Prajna Paramita Dash, *Student Member, IEEE*, and Mehrdad Kazerani, *Senior Member, IEEE*

[3] Modeling and Simulation of Incremental Conductance MPPT Algorithm for Photovoltaic Applications, Saravana Selvan. D, Faculty of Engineering and Computer Technology, Aimst University, Bedong- 08100, kedah, Malaysia, s_selvan@aimst.edu.my.

[4] Single axis solar tracker actuator location analysis "Vukica M. Jovanovic", Published in: SoutheastCon,2016, 10.1109/SECON.2016.7506670 , IEEE, Norfolk, VA, USA

[5] Arduino based low cost active dual axis solar tracker, "Tarlochan Kaur", **Power** Electronics, Intelligent Control and Energy Systems (ICPEICES), IEEE International Conference, 16 February 2017, 10.1109/ICPEICES.2016.7853398, IEEE

[6] Design and Construction of an Automatic Solar Tracking System ---- Md. Tanvir Arafat Khan, S.M. Shahrear Tanzil, Rifat Rahman, S M Shafiul Alam, *Member, IEEE*

[7] Design of a Solar Tracker System for PV Power Plants ----- Tiberiu Tudorache, Liviu Kreindler

[8] Automatic Sun Tracking System ------ *Muhammad Faheem Khan, Rana Liaqat Ali*

[9] Adaptive Sliding Mode Control for Solar Tracker Orientation----- Sajjad Keshtkar

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