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Microcontroller Based Solar tracking System for enhancing efficiency of a Photovoltaic system

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Abstract
In today's scenario of increasing energy needs, there is a huge dependence on renewable energy sources along with the conventional sources. One of the most important renewable energy resources is the sun. However, the problem with solar power is that it is directly dependent on light intensity. To produce the maximum amount of energy, a solar panel must be perpendicular to the light source. Because the sun moves both throughout the day as well as throughout a year, a solar panel must be able to follow the sun's movement to produce the maximum possible power. There are a large number of methods available for solar tracking and hence maximizing the output .This paper proposes an Arduino Uno microcontroller board based solar tracking system. As compared to the conventional solar panels, the one mounted with microcontroller based tracking system will give enhanced output.
Key Words: Microcontroller, Tracking, Light Dependent Resistors.

I. Introduction

With the impending scarcity of non-renewable resources, people are considering to use alternate sources of energy. From all other available resources sun energy is the most abundant and it's comparatively easy to convert it to electrical energy. Use of solar panel to convert sun's energy to electrical is very popular, but due to transition of the Sun from east to west the fixed solar panel may not be able to generate optimum energy. A solar panel in unification with a tracking system can provide best results.

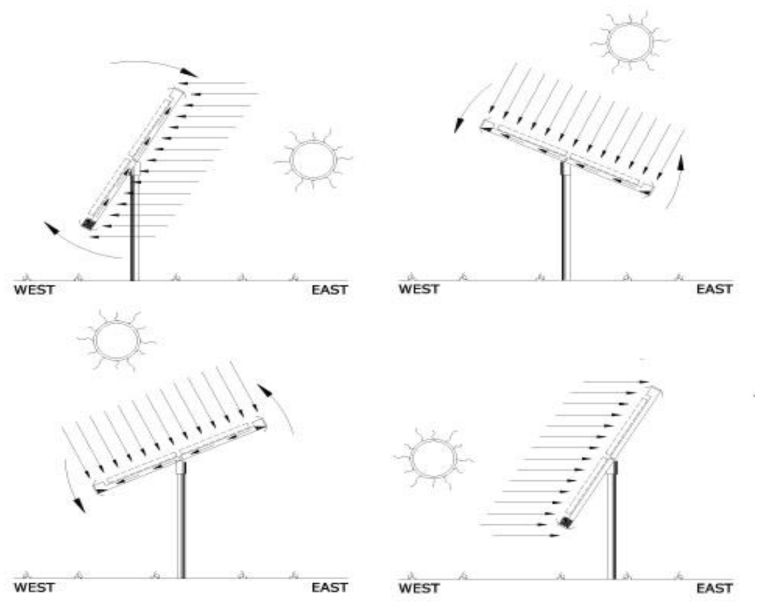
This tracking movement is achieved by coupling a stepper motor to the solar panel such that the panel maintains its face always perpendicular to the Sun to generate maximum energy. This is achieved by using a programmed microcontroller to deliver stepped pulses in periodical time intervals for the stepper motor to rotate the mounted panel as desired.

Further the project can be enhanced by using RTC (Real Time Clock) to follow the Sun. This helps in maintaining the required position of the panel even if the power is interrupted for some time.

II. Types of solar trackers:

- **Passive**
- **Active**

- **Passive Solar Tracking:-**



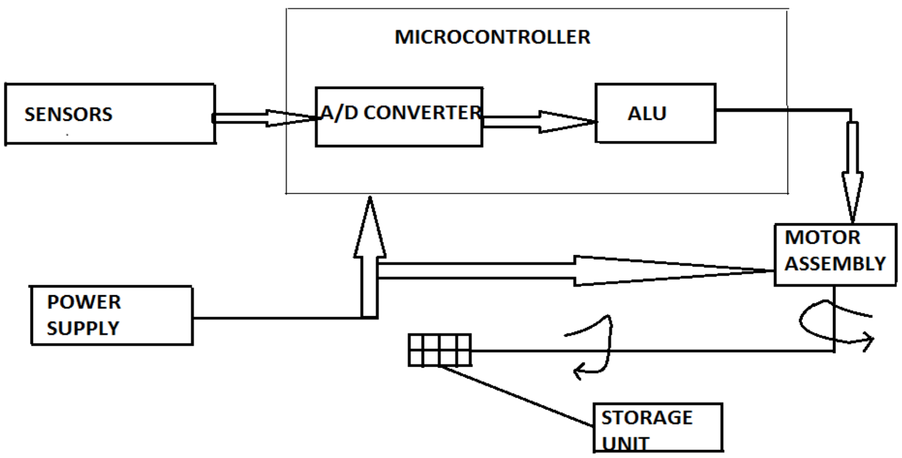
This system uses the idea of thermal expansion of materials as method for tracking. Typically a chlorofluorocarbon (CFC) or a type of shape memory alloy is placed on either side of solar panel. When the panel is perpendicular with the sun, the two sides are at equilibrium. Once the sun moves, one side is heated and causes one side to expand and the other to contract, causing the solar panel to rotate.

- **Active Solar Tracking :**

- Astronomical: The electronic system calculates the current position of the Sun at the location and the tracking motor moves the solar modules perpendicular to the Sun at pre-set times intervals using precise coordinates.
- Sensor Controlled: Instead of aligning the modules using the astronomical position of the Sun, a tracking system fitted with light sensor points the solar panels towards the brightest points in the sky. Under a complete overcast sky for example, the modules will be in a horizontal position.

III. Proposed System for Solar Tracking

- **Block diagram**



Description

1. Sensors:

Light dependent resistors (LDR) are used for sensing the light intensity falling on them. Based on the configuration of these resistors, the software coding and the direction of maximum light intensity, proper control signals are generated for the servomotors.

2. A/D Converter:

This is used to convert the analog voltage signal from the sensors into binary digital levels to be processed by the ALU. It is inherently present in the microcontroller.

3. ALU:

This is used to process the input signal levels from the sensors and provide the resulting control signals to servomotors. This is also present inside the microcontroller.

4. Motor:

Two servomotors have been used. The lower motor rotates the solar panel in the horizontal plane and the upper motor in the azimuthal plane. Based on the control signals generated by the microprocessor, the movement of two motors is controlled and so the inclination of the solar panel.

5. Solar panel

The solar panel is used to harness the solar energy falling on it, and converting it into corresponding voltage to be stored as electrochemical energy.

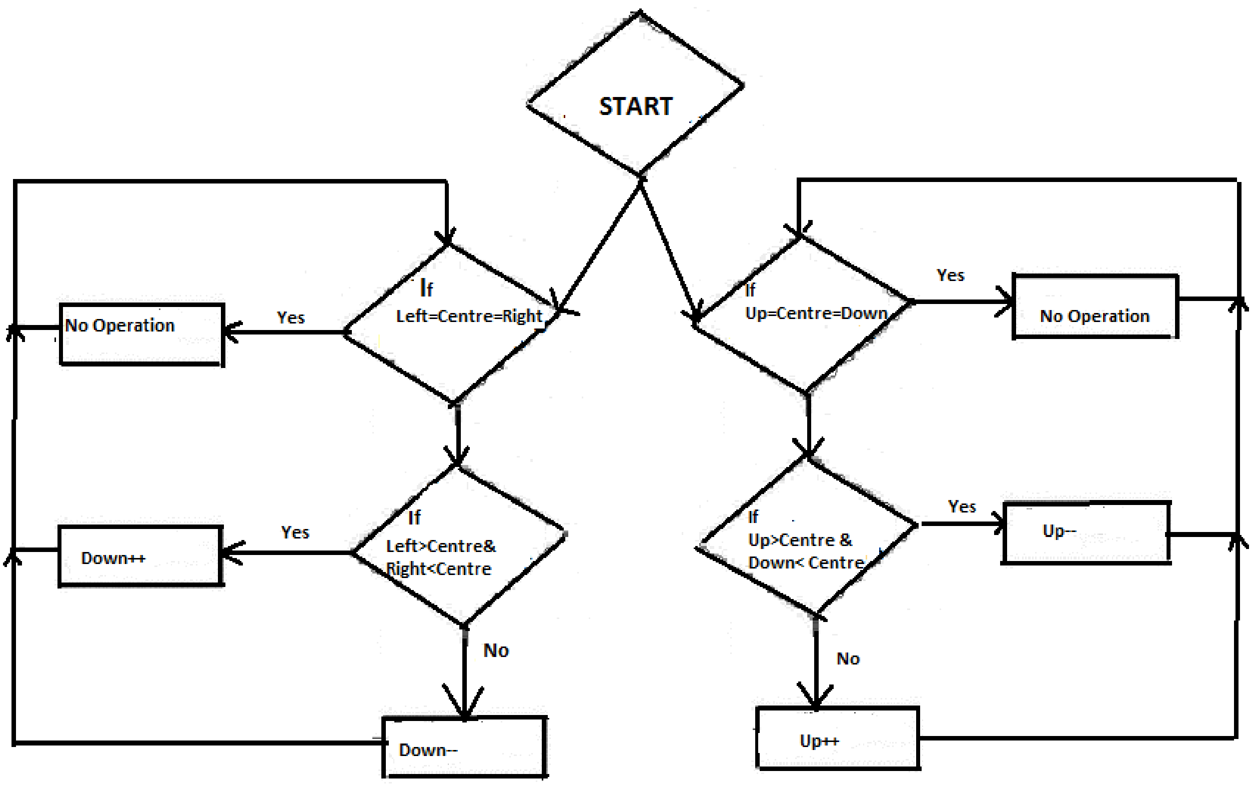
6. Battery

The battery is used to store the electrochemical energy generated by the solar panel.

7. Power Supply:

A constant D.C. power supply is needed to provide proper biasing to the LDRs and also to give power supply to the servomotors.

- **Flowchart depicting the operation of solar tracker**



Description of the Flow Chart

- If the light intensity in the Left, Centre and Right LDR's are the same , then no operation takes place else:

    - If the intensity of left LDR is greater than the Centre LDR and that of Right LDR Less than that of Centre LDR, then the lower servomotor moves one unit left.

    - In the opposite case, the lower servomotor moves one unit right.

- If the light intensity in the left, Centre and Right LDR 's are the same, then no operation takes place
    - If the intensity of top LDR is greater than the Centre LDR and that of Bottom LDR less than that of Centre LDR, then the upper servomotor moves one unit up.

    - In the opposite case, the upper servomotor moves one unit down.

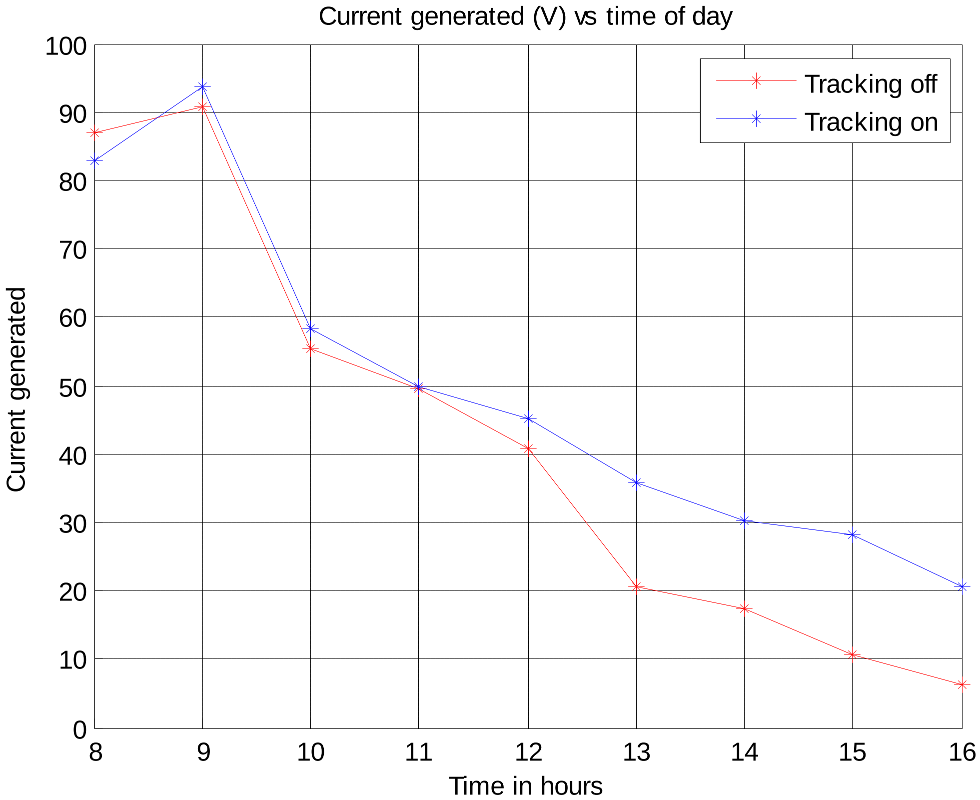
    - **READINGS OBTAINED WITH/WITHOUT TRACKING**

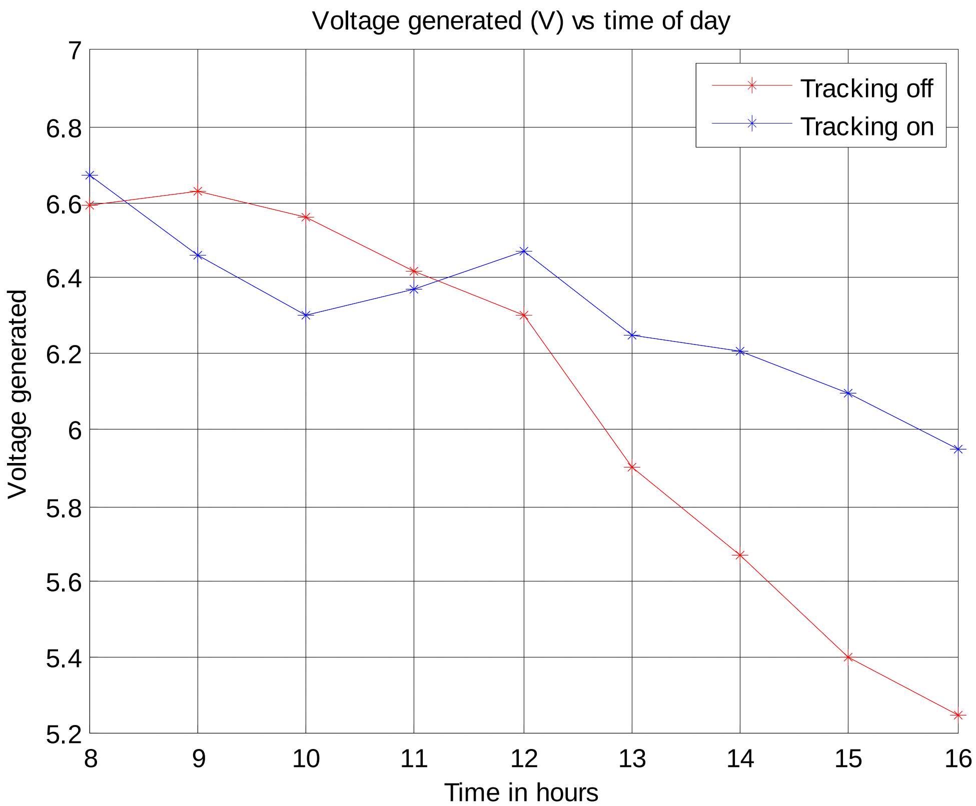
TRACKING OFF

S.No.	Time of Day	Voltage generated in volts	Current generated in mA
1	08:00	6.59	86.9
2	09:00	6.63	90.8
3	10:00	6.56	55.5
4	11:00	6.42	49.6
5	12:00	6.30	40.7
6	13:00	5.90	20.7
7	14:00	5.67	17.4
8	15:00	5.40	10.6
9	16:00	5.25	6.4

TRACKING ON

S.No.	Time of Day	Voltage generated in volts	Current generated in mA
1	08:00	6.67	82.9
2	09:00	6.46	93.8
3	10:00	6.30	58.4
4	11:00	6.37	50.0
5	12:00	6.47	45.2
6	13:00	6.25	35.8
7	14:00	6.21	30.3
8	15:00	6.10	28.2
9	16:00	5.95	20.6


Current generated (V) vs time of day
Tracking off
Tracking on
Current generated
Time in hours
0
10
20
30
40
50
60
70
80
90
100
8
9
10
11
12
13
14
15
16


Voltage generated (V) vs time of day
Tracking off
Tracking on
Voltage generated
Time in hours
5.2
5.4
5.6
5.8
6
6.2
6.4
6.6
6.8
7
8
9
10
11
12
13
14
15
16

IV. Conclusions:

From the tables above, it can be concluded that till the time 12 noon, when the sun reaches exactly overhead, the energy levels are not significantly different in tracking off and on conditions but after 12 noon, significant difference in levels can be observed in the attained values. This is the time when the solar tracker plays an important role in extracting more energy than it would have without tracking. With the values obtained, an average percentage increase of approximately 18% in the power output can be seen. These values are obtained from a low grade solar cell and minor errors in the control systems, with the use of a high grade solar cell and sophisticated circuitry, these values can be improved and higher increase in the power output can be seen.

References:

[1.] A.B.Afarulrazi, W.M.Utomo, K.L.Liew and M. Zarafi "Solar Tracker Robot using Microcontroller" published in 2011 International Conference on Business, Engineering and Industrial Applications.

[2.] Md.Tanvir Arafat Khan, S.M.Shahrear Tanzil, Rifat Rahman, SM Shafiul Alam "Design and Construction of an Automatic Solar Tracking System" published in 6th International Conference on Electrical and Computer Engineering ICECE 2010, 18-20 December 2010, Dhaka, Bangladesh.

[3.] Nader Barsoum "Implementation of a Prototype for a traditional Solar tracking system" published in the 2009 third UKSim European Symposium on Computer Modelling and Simulation.

[4.] Lwin Lwin Oo and Nang Kaythi Hlaing "Microcontroller Based Two Axis Solar Tracking System" published in Second International Conference on Computer Research and Development.

[5.] Shen, C.L.; Tsai, C.T. Double-linear approximation algorithm to achieve maximum-power-point tracking for photovoltaic arrays. *Energies* **2012**, *5*, 1982–1997.

[6.] Liu, K.H. Dynamic characteristics and graphic monitoring design of photovoltaic energy conversion system. *WSEAS Trans. Syst.* **2010**, *10*, 239–248.

[7.] Nayak, S.R.; Pradhan, C.R. Solar tracking application. *IOSR J. Eng.* **2012**, *2*, 1278–1281.

[8.] Rubio, F.R.; Ortega, M.G.; Gordillo, F.; Lopez-Martinez, M. "Application of new control strategy for sun tracking. *Energ." Conv. Manage.* **2007**, *48*, 2174–2184.

[9.] Blanco-Muriel, M.; Alarcon-Padilla, D.C.; Lopez-Moratalla, T.; Lara-Coira, M. Computing the solar vector. *Solar Energy* **2001**, *70*, 431–441.

[10.] Chong, K.K.; Siaw, F.L.; Wong, C.W.; Wong, G.S. Design and construction of non-imaging planar concentrator for concentrator photovoltaic system. *Renewable Energy* **2009**, *34*, 1364–1370.

[11.] Grena, R. An algorithm for the computation of the solar position. *Solar Energy* **2008**, *82*, 462–470.

[12.] Saravanan, C.; Panneerselvam, M.A.; Christopher, I.W. A novel low cost automatic solar tracking system. *Int. J. Comput. Appl.* **2011**, *31*, 62–67.

[13.] Arbab, H.; Jazi, B.; Rezagholizadeh, M. A computer tracking system of solar dish with two-axis degree freedoms based on picture processing of bar shadow. *Renewable Energy* **2009**, *34*, 1114–1118.