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Automated Dual Axis Solar Tracking System using LDR Sensors

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***Abstract*-- The aim of this paper is to present a novel design of an automated dual axis solar tracking system using a four quadrant light dependent resistor (L.D.R) and simple electronic circuit to provide a sinewy system performance. The proposed system uses the tracker to actively track the solar radiation and accordingly adjust the panel to maximize the power output. The project focuses on the simulation and implementation of the most efficient algorithm on the dual axis solar tracker which rotates in azimuth and elevation direction. This simulation positions the panel in a hemi spherical rotation absorbing maximum solar irradiation thus increasing the total electricity generation**.

Keywords-- Solar panel, Solar Tracker, LDR Sensor.

I. INTRODUCTION

As the energy demand and the environmental problems increases with population and economic developments, the problem of energy crisis and global warming effects are today a cause of increasing concern. It is the need of the hour to utilize conventional energy resources which are copious that is collected from resources which are naturally replenished on a human timescale such as sunlight, wind, rain, tides and geothermal heat, etc. Solar energy is one of the most promising renewable energy resource which is abundant in nature generally in warm countries.

In general India has relatively long sunny days for more than 10 months and partly cloudy sky for most of the days of the rest two months. Also worldwide many projects have been done using photo voltaic cells (PV) in collecting solar radiation and converting to electrical energy, but most of these projects did not take into account the difference of sun angle of incidence by installing the panels in fixed orientation which very highly influences the solar energy collected by the panel.

Solar cell (Also called photo voltaic cell) is an electrical device that converts energy of light directly into electricity by photovoltaic effect. Solar cells are building blocks of photovoltaic modules, otherwise known as solar panels. Solar panel is a set of photo voltaic modules which is electrically connected and mounted on supporting structure to absorb sun rays as a source of energy for generating electricity or heating.

This design consists a working experimental model which focuses on the use of solar panel which would follow sun's motion viz. Azimuth altitude, automatically adjusting itself every time without human intervention. To serve this purpose, we are using Light Dependent Resistors (L.D.Rs - 4 Nos.) which will trace the sunlight every time and would give signal to main circuit for the motion of the panel. The motion of the panel would be done by means of gears and D.C motor. All the electrical components would be controlled by means of 8051 microcontroller which would be programmed accordingly. Dual axis tracking makes sure that panel is always in the most accurate position for better output. The photo voltaic cell (PV) cell of solar panel will convert this solar energy to electrical energy which we can store in batteries for further use Small prototype model can be installed in schools, home use, offices, etc. as standard power source and this would help reduce the energy cost substantially.

The Main components of our system are:

A. Solar Panel

The solar panel of 20W which is a collective form of photo voltaic modules is the main component of the system which is the reason for the conversion of solar energy into electrical energy.

B. Sensors

The main aim of LDR is to sense the higher density range of sunlight give command to relay circuit which will direct the direction of our solar panel.

Fig.2 DC Motor.

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II. SOLAR TRACKER

The Solar Trackers are used to continuously direct the solar panel towards the sun rays, thus assisting in maximising the expectation towards this system. This system efficiently tracks sun's position in the sky and generate more electricity than their counterparts because of increased direct exposure to the sun light. There are two kinds of solar tracker single axis and dual axis trackers. Solar tracker generates more electricity in roughly the same amount of space needed for fixed tilt systems, making them ideal optimising land usage [11]. Also very necessarily, it emphasizes on not only on increasing the production of energy, but also ameliorates the way power output is delivered.

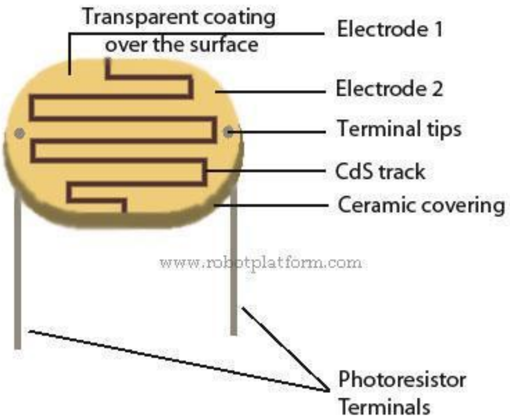

Fig.1 LDR Sensor

C. DC Motor

It gives gradual yet accurate motion to the panel thus we can obtain precise motion of the tracking system. Dc motor consists mainly of a gear reduction unit, a position sensing device and a control unit. It receives a control signal that represents a desired output position of the servo shaft and apply power to its DC motor until its shaft turns to that position [11].

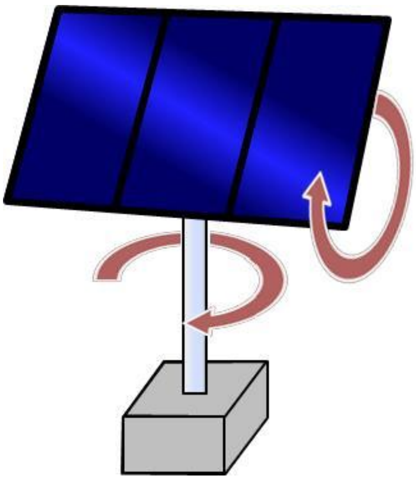

Fig.3 Dual Axis Motion

Sunlight has two components, the direct beam that causes about 90% of the solar energy, and the diffused sunlight that carries the remainder. The diffused portion is the sky on a clear day which increases proportionately on a cloudy day. As the majority of the energy is in the direct beam, maximum collection requires the sun to be visible to the panels as long as possible. A typical solar panel converts only 30 to 40 percent of this incident solar radiation into electrical energy [1], [5].

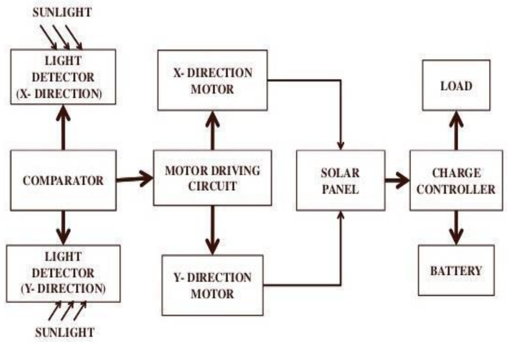

Fig.4 Functional Block Diagram

III. METHODOLOGY

The complete operation of the dual axis tracking system wholly depends on the light dependent resistor (L.D.R) which is used as a sensor whose resistance decreases with increasing light intensity. The fully geared stepper motors are implemented for the rotation of the solar panel in two different axes. This dual axis design consists of four LDRs which are placed on the solar panel for detecting the light intensity. The main objective of this system is to make the panel always face the sun in order to maximize the energy absorbed thus giving greater efficiency. The daily motion causes the sun to appear in east to west direction over the earth whereas the annual motion causes the sun to tilt on at an angle 23.5 degrees while moving along east-west direction ,so maximum efficiency of solar panel cannot be obtained using single axis tracker.

In the conventional design of dual axis solar tracking system, motion is conveyed to the panel with the help of two linear actuators. But the use of linear actuator results in various problems:

- Motion range is limited
- Noisy operation.
- Very slow operation.

Thus, in this design we opted for the use of gear arrangement for the motion of panel along both the axes. The use of gear instead of linear actuator we get:

- Increase in step motion accuracy.
- Smooth operation.
- Increase in the motion range.

The panel consists of two pairs of LDRs which are used to track the sun's exact position is along the inclined axis and along the azimuth axis. LDR is a resistor whose resistance decreases with increasing incident light. When any of the LDR receives maximum intensity radiation its resistance decreases. This information is sent to the light comparison unit which further transfers this information to the microcontroller.

The microcontroller is the main control unit of the whole system, which determines the direction of movement of the motors in both azimuth and vertical axis. The implementation of the LDR is based on shadow effect. If the solar panel is not perpendicular to the sun's rays the shadow will cover only one or two LDRs, this causes different light intensity to be received by the sensing device.

The output signal from the microcontroller is supplied to the DC motor which gives step motion to the panel accordingly to the incident radiation.

V. PERFORMANCE ANALYSIS AND RESULTS:

The performance carried on our working model showed improvement in the output performance against the static panel and single axis solar panel.The following two graphs show the values of the output obtained on our model. The first graph as shown in Fig.4 gives performance throughout the day and the second graph as sown in Fig.5 gives the comparison of output between the various tracking systemas mentioned above.

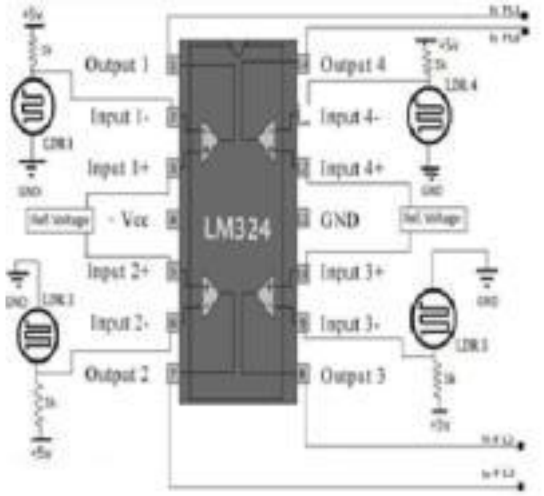

Fig.5 Comparator Circuit Diagram [6]

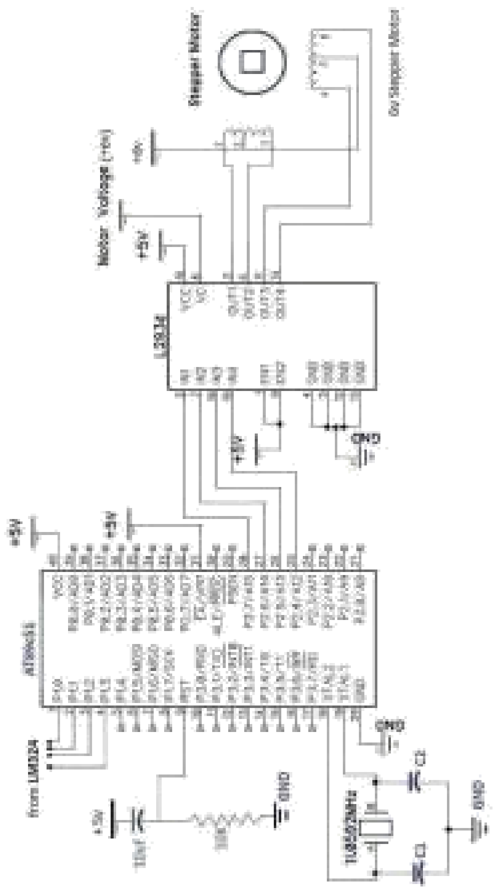

Fig.6 Total Circuit Diagram [6]

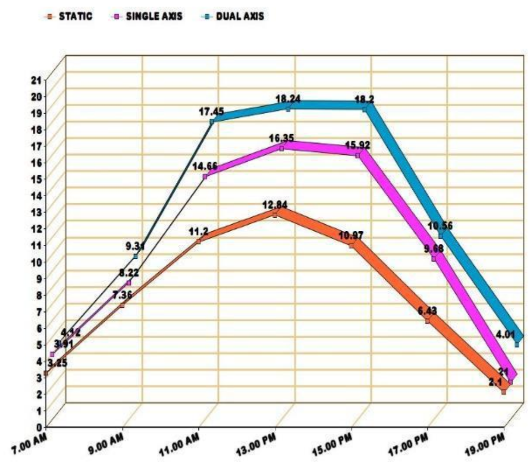

Fig.7 Day based output obtained

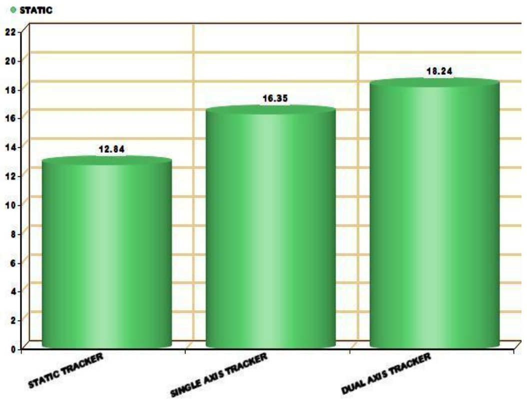

Fig.8 Comparison with static and single axis

IV. COMPONENTS

The main operating components of this system are:

- 20 W Photovoltaic Solar Panel
- Microcontroller 8051
- Comparator LM324
- Sprocket Gears-4
- LDRs – 4
- Motor driver IC L2930
- Stepper motor-2

Other auxiliary components are:

- Resistors (10k ,1k)
- Capacitors (10F,33f)
- Crystal oscillator(11.0592 MHz)
- 12 V power supply

Except these components the connecting wires, circuit board and a universal programmer to turn the clip to load program are used.

From the above two diagrams, it is clear that this dual axis tracking system shows increase in the output by 11.56% w.r.t single axis tracking system and considerable increase of 42.056% w.r.t static solar panel. Thus this proves that the dual axis solar tracking system is much better and efficient in comparison with its counterparts.

VI. FUTURE SCOPE

Similar to this model, various changes can be made and can be implemented in schools, offices, etc as a secondary source of energy. Street Lightning system can also be replaced by this tracking system which would store enough energy throughout the day and be used at night. Efforts should be taken to implement this on a large scale for future purpose so as to meet increasing energy requirements.

VII. CONCLUSION

This paper presents an interesting and simple attempt to implement Dual Axis Solar Tracker by using LDR and Microcontroller. The use of gears instead of linear actuator helps in increasing the efficiency of the overall tracker. The design assists to extract maximum power from the solar radiation by tracking using a dual axis tracker.. This is possible if the solar panel is always in proper alignment with incident rays of sun. The proposed methodology presents the following features:

- A simple and economic implementation.
- An ability to simultaneously adjust panel along both the axes.
- Ability to adjust the tracking accuracy. Provides efficient tracking even under diffuse weather conditions.

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