ARDUINO BASED LOW COST ACTIVE DUAL AXIS SOLAR TRACKER

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Abstract— Sun is a source of energy. Solar energy can be used abundantly using solar panel. Conversion efficiency depend on the intensity of sun light,the intensity depends on season and position of the sun. If the sun rays reach in perpendicular direction, efficiency increases. So we have to tilt the panel according to the sun's position. For that purpose solar trackers came into play. This paper presents the dual axis solar tracking system using arduino uno where the servomotors reorient the panel to get optimum power and the LDR circuit detects the suns position. The exact position of the sun is determined according to the Indian calender system. The automatic reorientation of the panel is done by the servomotor. The result is observed and the panel is monitored using android application.

1 INTRODUCTION

Solar energy is the radient light and heat from the sun that is harnessed using different technologies. Solar panel works by capturing sun's energy which is then converted into electricity for homes or bussiness purpose with the help of solar powered photovoltaic panels. Sun is the most reliable form of energy. The eletrons in the silicon cells when excited using photons of light from the sun, electricity is obtained. When these solar panels are perpendicular to the sun's position, maximum efficiency is obtained. The panels are reoriented to proper position with the help of trackers. The tracker ensures that panel is directed towards sun. Maximum energy is captured when trackless orientation keeps changing throughout the day to follow the sun's path.

Ground mounted solar farms are used in solar tracker which has capacity more than 1MW. Horizontal single axis trackers are used for distribution of large generation projects and for utility scaled projects. By deploying ground mounted solar farm, product cost and installation complexity can be reduced and energy can be improved. A well dedicated maintainace team is required in doing solar projects. For commercial and utility purposes, these are easily repaired and monitored with the help of solar trackers.

Passive tracker contains low boiling point compressed gas fluid which is capable of driving one side or other side of tracker ,so that the tracker moves in response to an imbalance. However this is non precision orientation and it is not suited for other photovoltaic collectors but it works good with common photovoltaic panel types.

Active trackers are used to direct trackers when the command is given by the controller and it simultaneously responds to the solar direction . Active tracker mainly contains motors and gears which helps in doing the above mentioned functionality. Single axis trackers have one degree of freedom towards the rotation axis.HSAT,VSAT,TSAT,PSAT are some of the implementation of single axis trackers.

Dual axis trackers have two degree of freedom to rotation axis and thus axis are usually normal to one another. Here primary axis will be fixed with respect to ground and referred axis will be fixed with respect to primary axis which is also known as secodary axis. Some imlementation of dual axis solar tracker are: a] TTDAT- Tip-Tilt Dual Axis Tracker
b]AADAT-Azimuth–Altitude Dual Axis Tracker

The propsed paper is based on arduino with active dual axis tracker which is of minimum cost. Reduction in cost is due to the usage of servomotor and arduino uno. Active tracker is a combination of open and closed loop tracker. The position of sun is obtained with reference to the Indian calendar and LDR circuit.

2 LITERATURE REVIEW

1]. Dr.Tarlochan Kaur proposed optimisation of solar PV system and analysis of tilt angle.
Solar tracker is a device that ensures maximum intensity of sun's ray is hitting the surface of the solar panel.This action is done throughout from sunrise to sunset. It ensures that maximum power is obtained.More energy can be captured by adjusting the tilt angle of the panel according to the season.

For eg: sun is higher in summer and lower in winter.
Panel's tilt angle is adjusted according to the sun's position.Solar tracker plays an important role in doing the above mentioned function. The device is implemented by 12V,100W battery. Tracker is constructed mainly based on two segments:
a]electrical part and
b]mechanical part

PV sensor,comparator circuit and battery are used as the electrical part. DC motors are used as mechanical parts. DC motors are tested for resistivity and induction to ensure good performance.

2]. Okpeki U.K proposed design and construction of bi directional solar tracking system.
The tracker is constructed using two segments electrical and mechanical part. Electrical part consists of PV sensor ,comparator and battery whereas mechanical system consists of dc motors and gears. The device is mainly implemented by integrating it with 900V inverter and 12V,100A battery.DC motors are tested for resistivity and induction. In the first segment voltage difference is detected by comparator circuit. In the second segment it provides control input to driver circuit consisting of logic gates. An operational amplifier with power descipation of 830uW and two LM348W are conected to two sensor voltage dividers. The comparator is not able to handle such fast switching speed and logic gates can not handle such high frequency input signals.

3]. A.Aashir Waleed, B.Dr. KM Hassan proposed designing a dual axis solar tracking system for optimum power.
Solar tracker consist of 4 LDR sensors along with 2 stepper motor and a PIC microcontroller. Stepper motor has the ability to control the position but the controller needs to know the position of stepper motor during power up for this. Limiting factor is performance of stepper motor due to lack of feedback it might have to be restarted and it continues to consume power to lock in and hold the commanded position.

4]. Ankit Ghate and Ruhuja Hiware proposed solar tracking development using arduino along with an efficient boost converter and charge.
The system is based on the use of convetional dc to dc convertor and voltage change in LDR . Here voltage as well as tracking position can be done using the artificial intelligence algorithm. It results in single axis tracking. Sun's path is not aligned accurately.

5]. Asmarashid Ponniran,Ammar Hashim,Arffuddin Joret, "A design of low power single axis solar tracking system regardless of motor speed" International journal of integrated engineering.volume 3 No.2 December 2011.
Sun varies its position with seasons and time of the day as sun moves across the sky. The system has an disadvantage of tracking in one axis. It does not perfectly align the sun's path. To improve solar conversion,dual axis tracker is used.

3 METHODOLOGY

The main component of the proposed methodology is arduino uno microcontroller,LDR circuit,solar panel and servomotor. Arduino Uno Board uses ATmega328 microcontroller, it is an open-source electronics platform for the easy use of hardware and software. A servomotor has a closed loop servo mechanism. Servomotors are generally used as a high-performance alternative to any motor. LDR circuit is used to track the position of sun. It consists of four LDRs that is in the top, right,left and bottom position. LDRs are connected to Arduino analog pin AO to A3 that acts as the input for the system. The LDR converts the analog values into digital with the help of analog to digital converter which is already built in . The value of PWM is used to move the servomotor. The LDR senses maximum sunlight and then solar panel gets tilted towards that position using servomotor according to the programming.

Altitude angle and Azimuth angle as reference helps in tracking sun's position and accordingly the solar panel is moved towards that direction. The declination angle of the sun is the angle between equator and line drawn from the centre of earth to centre of sun. Maximum declination is observed during summer(23.45^0)/winter.Declination angle can be represented by δ and it varies seasonally due to tilt of earth in axis of rotation and also rotation of earth around sun. The angular distance the earth has rotated in a day is known as hour angle. It is equal to 15^0multiplied by number of hours from local solar noon. Earth requires 24 hours to rotate once that is in 360^0. The exact position of the sun can be estimated in every month and at any time during the day.

Altitude angle and azimuth angle divides the position. Astronomical data is taken as reference by dual axis solar photovoltaic panel and has capability to always point solar array towards the sun. It can be installed in various regions with other modifications.

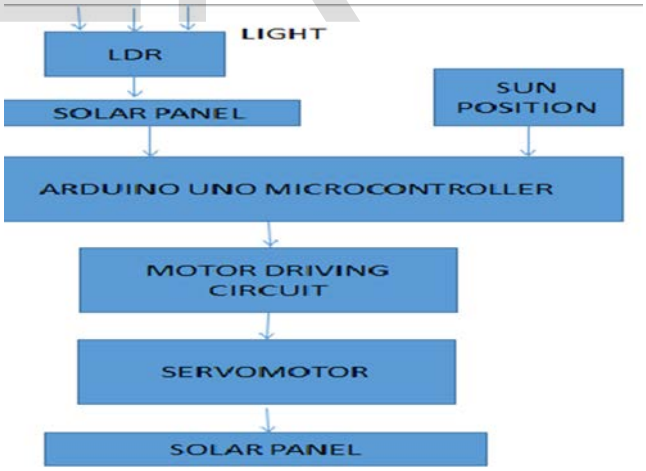

Fig 1.Block diagram of the proposed methodology

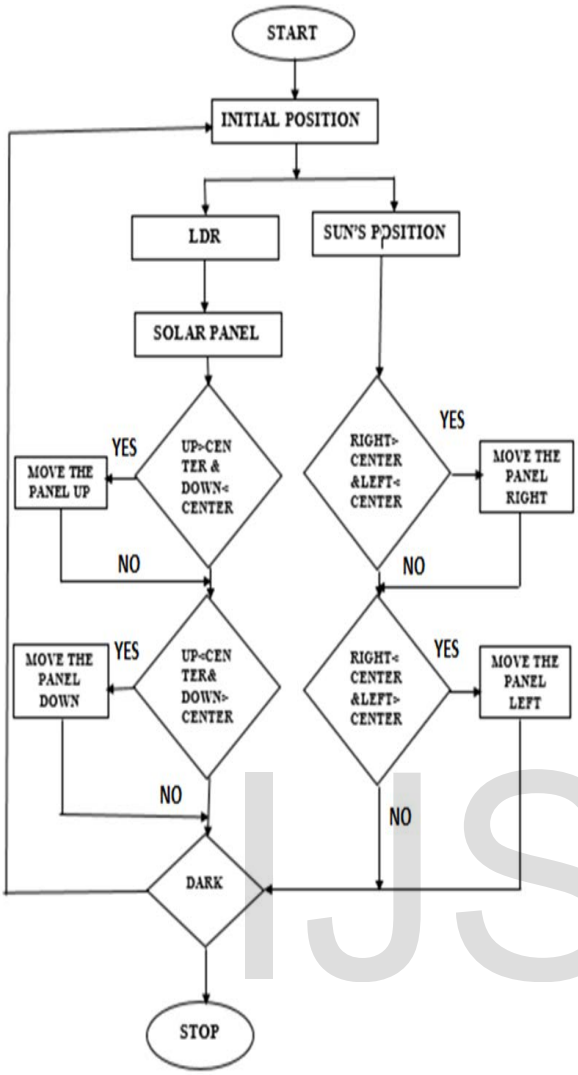

Fig 2: flowchart for the proposed system

Fig2 depicts the flow chart for the proposed system for the software part. Initial position of the sun should be set. LDR is used to detect the light. We need only the sun light, so we have to set the threshold level. If the light intensity is greater than the threshold value then only the proceedings will occur. After that, the sun's position is compared with the centre to the right,left,up and down position. The servomotor rotates the panel to the required position, so that maximum intensity of the light can be captured by the panel.

4 Result

The tracking system is made and output of the same for the static as well as the tracker solar panel was validated by measuring values of voltage,current and power using android app. The light rays from the light source were made to fall first on dual axis solar tracker and then on the immobile solar panel. The voltage, current and power across the solar panels of the system was measured using android application and can also displayed in the LCD display.

5 Conclusion

To provide cost effective solar distributed system, this paper presents a low cost active dual axis solar tracking system using arduino. It ensures design feasibility. It is further tested and monitored via android application. The result shows the mean power gain compared to an immobile solar panel. The advantage of the proposed system is a] cost effective, simple and operates automatically. b] driving motor used here is servomotor, which consumes less power. c] the controlling unit used here is arduino uno which is simple to use. d] accuracy is more since we are using Indian calendar system. This can used for the solar power generation in the remote places. It can be used in stand alone applications and street light systems. This can be further enhanced by the future research

6 References

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