Sun tracking solar system using microcontrollers

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***Abstract*- Solar energy is fast becoming a very important means of renewable energy resource. With solar tracking, it will become possible to generate more energy since the solar panel can maintain a perpendicular profile to the rays of the sun. Even though the initial cost of setting up the tracking system is considerably high, there are cheaper options that have been proposed over time. This project discuses the design and construction of a prototype for solar tracking system that has a single axis of freedom. Light Dependent Resistors (LDRs) are used for sunlight detection. Silicon solar cells produced an efficiency of 20% for the first time in 1985. Whereas there has been a steady increase in the efficiency of solar panels, the level is still not at its best. Most panels still operate at less than 40%. As a result, most people are forced to either purchase a number of panels to meet their energy demands or purchase single systems with large outputs.**

Index Terms- LDR, Solar Tracking System, Stepper Motor.

INTRODUCTION

Solar energy is clean and available in abundance. Solar technologies use the sun for provision of heat, light and electricity. These are for industrial and domestic applications. With the alarming rate of depletion of depletion of major conventional energy sources like petroleum, coal and natural gas, coupled with environmental caused by the process of harnessing these energy sources, it has become an urgent necessity to invest in renewable energy sources that can power the future sufficiently. The energy potential of the sun is immense. Despite the unlimited resource however, harvesting it presents a challenge because of the limited efficiency of the array cells.

When it comes to the development of any nation, energy is the main driving factor. There is an enormous quantity of energy that gets extracted, distributed, converted and consumed every single day in the global society. Fossil fuels account for around 85 percent of energy that is produced. Fossil fuel resources are limited and using them is known to cause global warming because of emission of greenhouse gases. There is a growing need for energy from such sources as solar, wind, ocean tidal waves and geothermal for the provision of sustainable and power. Solar panels directly convert radiation from the sun into electrical energy. The panels are mainly manufactured from semiconductor materials, notably silicon. Their efficiency is 24.5% on the higher side. Three ways of increasing the efficiency of the solar panels are through increase of cell efficiency, maximizing the power output and the use of a tracking system.

There are various types of trackers that can be used for increase in the amount of energy that can be obtained by solar panels. Dual axis trackers are among the most efficient, though this comes with increased complexity. Dual trackers track sunlight from box axes. They are the best option for places where the position of the sun keeps changing during the year at different seasons. Single axis trackers are a better option for places around the equator where there is no significant change in the apparent position of the sun.

The level to which the efficiency is improved will depend on the efficiency of the tracking system and the weather. Very efficient trackers will offer more efficiency because they are able to track the sun with more precision. There will be bigger increase in efficiency in cases where the weather is sunny and thus favourable for the tracking system

Commercial purpose of solar tracking system:

- In order to increase the solar panel output.
- To achieve Maximum efficiency of the panel.
- Maximize Power per unit area.
- To receive the continuous energy throughout the day.

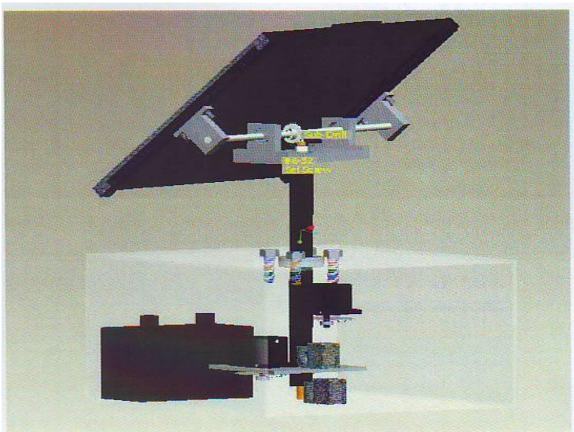


Fig. 1: Solar tracking system

The sun's position in the sky varies both with the seasons (elevation) and time of day as the sun moves across the sky.

Hence there are also two types of solar tracker:

- Single Axis Solar Tracker
- Dual Axis Solar Tracker

Single axis trackers have one degree of freedom that act as the axis of rotation. The axis of rotation of single axis trackers is aligned along the meridian of the true North. With advanced tracking algorithms, it is possible to align them in any cardinal direction. Common implementations of single axis trackers include horizontal single axis trackers (HSAT), horizontal single axis tracker with tilted modules (HTSAT), vertical single axis trackers (VSAT), tilted single axis trackers (TSAT) and polar aligned single axis trackers (PSAT).

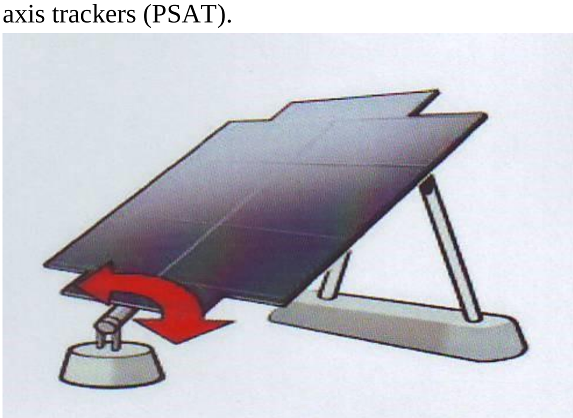


Fig. 2: Single axis solar tracker

Dual axis trackers have two degrees of freedom that act as axes of rotation. These axes are typically normal to each other. The primary axis is the one that is fixed with respect to the ground. The secondary axis is the one referenced to the primary axis. There are various common implementations of dual trackers. Their classification is based on orientation of their primary axes with respect to the ground.

Fig. 3: Dual axis solar tracker

Solar tracker drives, can be divided into three main types depending on the type of drive and sensing or positioning system that they incorporate.

- Passive Trackers: Use the sun's radiation to heat gases that move the tracker across the sky.
- Active Trackers: Use electric or hydraulic drives and some type of gearing or actuator to move the tracker.

Passive trackers: Passive trackers use a low boiling point compressed gas fluid driven to one side or the other to cause the tracker to move in response to an imbalance. Because it is a non-precision orientation it is not suitable for some types of concentrating photovoltaic collectors but works just fine for common PV panel types. These have viscous dampers that prevent excessive motion in response to gusts of wind

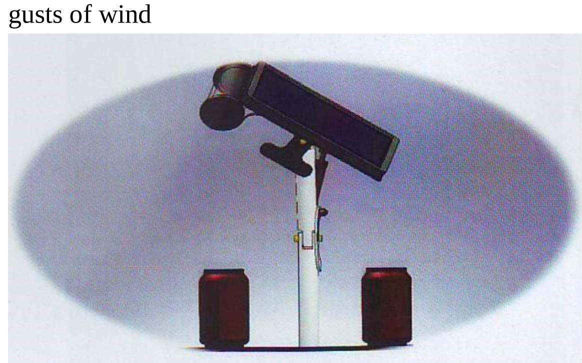
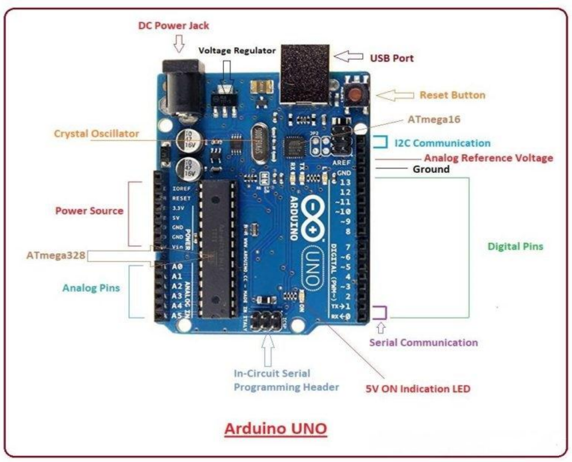


Fig. 4: Passive tracker

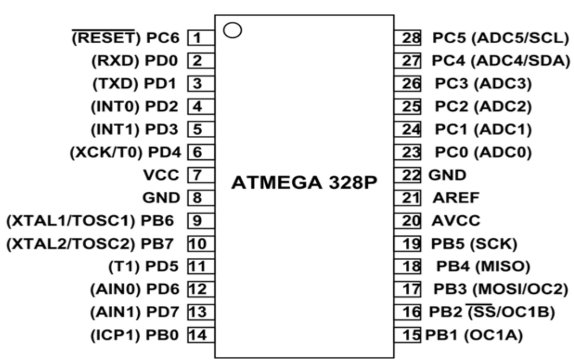
Active Trackers: Active trackers make use of motors and gear trains for direction of the tracker as commanded by the controller responding to the solar direction. The position of the sun is monitored throughout the day. When the tracker is subjected to darkness, it either sleeps or stops depending on the design. This is done using sensors that are sensitive to light such as LDRs. Their voltage output is put into a microcontroller that then drives actuators to adjust the position of the solar panel

Fig. 5: Active tracker

Arduino UNO



ATMega328 Pin Configuration



ATMEGA328P is a 28 pin chip as shown in pin diagram above. Many pins of the chip here have more than one function. We will describe functions of each pin in below table.

Pin No.	Pin name	Description
1	PC6 (RESET)	Pin by default is used as RESET pin
2	PD0 (RXD)	RXD (Data Input Pin for USART)
3	PD1 (TXD)	TXD (Data Output Pin for USART)
4	PD2 (INT0)	External Interrupt source 0
5	PD3 (INT1/OC2B)	External Interrupt source1
6	PD4 (XCK/T0)	T0(Timer0 External Counter Input)
7	VCC	Connected to positive voltage
8	GND	Connected to ground
9	PB6 (XTAL1/TOSC1)	External clock input
10	PB7 (XTAL2/TOSC2)	Chip Clock Oscillator pin 2
11	PD5 (T1/OC0B)	Timer1 External Counter Input
12	PD6 (AIN0/OC0A)	Analog Comparator Positive I/P
13	PD7 (AIN1)	Analog Comparator Negative I/P
14	PB0 (ICP1/CLKO)	Timer/Counter1 Input Capture Pin
15	PB1 (OC1A)	Counter1 Output Compare Match A Output
16	PB2 (SS/OC1B)	SPI Slave Select Input
17	PB3 (MOSI/OC2A)	Master Output Slave Input
18	PB4 (MISO)	Master Input Slave Output
19	PB5 (SCK)	SPI Bus Serial Clock
20	AVCC	Power for Internal ADC Converter
21	AREF	Analog Reference Pin for ADC
22	GND	GROUND
23	PC0 (ADC0)	ADC0 (ADC Input Channel 0)
24	PC1 (ADC1)	ADC1 (ADC Input Channel 1)
25	PC2 (ADC2)	ADC2 (ADC Input Channel 2)
26	PC3 (ADC3)	ADC3 (ADC Input Channel 3)
27	PC4 (ADC4/SDA)	ADC4 (ADC Input Channel 4)
28	PC5 (ADC5/SCL)	ADC5 (ADC Input Channel 5)

Stepper motor

A Stepper Motor is a brushless, synchronous motor divides a full rotation into a number of steps. Unlike a brushless DC motor, which rotates continuously when a fixed DC voltage is applied to it, a step motor rotates in discrete step angles. Stepper motors have steps per revolution of 12, 24, 72, 144, 180, and 200, resulting in stepping angles of 30, 15, 5, 2.5, 2, and 1.8 degrees per step.

Stepper motor can spin in precise increments whereas DC motor spins in only one direction. Total control of motor can be done by using stepper motor which can run an exact amount of degrees.

Light depending resistors:

Light depending resistors have more resistance. The resistance of LDR depends upon the intensity of light which is falling on the LDR. The resistance of LDR decreases as intensity of light increases.

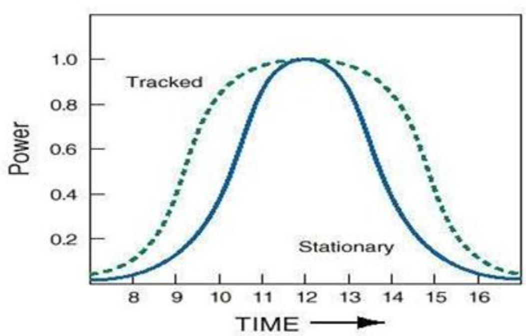
In sun tracking solar panel, we use 2 or 4 LDRs and these LDRs are connected as voltage divider circuit. And the output of LDR is analog output.

Methodology:

In single axis sun tracking solar panel system two LDRs are connected in both sides of the solar panel and the analog output of these two LDRs is given as a analog input to the Arduino (pin-1 to 6),these LDRs are connected as voltage divider circuits for better comparison. Whenever light falls on the LDR1 (absence of light on LDR2) the resistance of LDR decreases which makes the voltage which is given to the Arduino analog pins reduces and active high digital output is coming out by comparing this reduced voltage to the input voltage this active high digital output is given as digital input to the motor driver and the output of the motor driver is given as a input to the stepper motor.So, the stepper motor will rotate according to the sensing signal sensed by two LDRs.

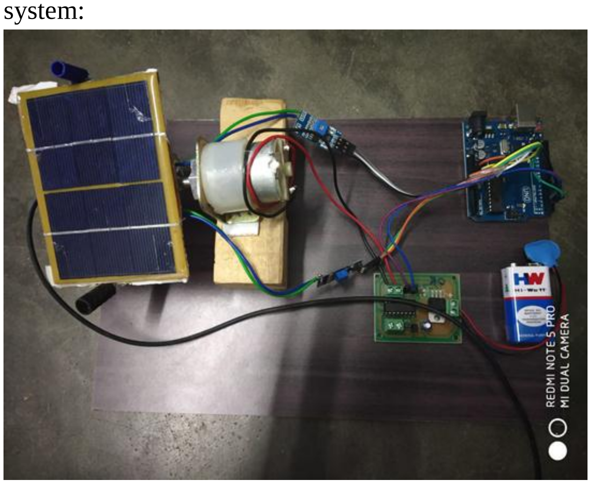
- LDR1>LDR2 the stepper motor rotates in clock-wise direction (In direction of LDR1).
- LDR1<LDR2 the stepper motor rotates in anticlock-wise direction (In direction of LDR2).

Comparison of tracking and fixed solar panels:



The average output power of tracking solar system is greater than the average output power of fixed solar system.

Pictorial representation of a sun tracking solar system:



CONCLUSION

In this paper of solar tracking system I reached up to the movement of solar panel and all the parameters have been achieved. The aim of my paper was movement of motor by signal from light sensing circuit when the intensity of light is maximum, which has been successfully achieved.

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