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# An imperative role of sun trackers in photovoltaic technology: A review

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ABSTRACT

The efficiency of the photovoltaic (PV) system is directly proportional to the solar energy. The maximum efficiency from the PV systems can be achieved if the panel is kept perpendicular to the direction of the radiations of sun. Hence, in order to achieve maximum concentration, radiation and efficiency of the PV cell, tracking of the position of the sun with accuracy is extremely important. The various methods of sun tracking system have been discussed which includes two axes, one axis, polar axis, open loop, closed loop, hybrid model, azimuth and tilt roll mechanism. The comparison of existing solar tracking systems and methods has also been discussed. In this paper, various existing solar tracking systems in terms of the controller used like PLC, microcontroller, FPGA to design the system and their economic assessment have been studied. It is concluded that two axis solar tracking systems has more power gain with respect to fixed systems. The microcontroller based tracking system with same size, capacity and location as of PLC based systems are more economic.

## 1. Introduction

Sun tracking system provides a solution to fixed photovoltaic panels which lost their productivity when sun is not in the range of optimal angle. Solar trackers are designed to follow the location of the sun which results in the 10–25% more output efficiency of the PV panels. It is observed that the tracking systems are more efficient than fixed systems of same capacity. Normally fixed PV systems are fixed at the rooftop of small industries and residence. The advantages of fixed systems are less complexity and low installation and maintenance cost. Solar trackers are complex and expensive and more maintenance is required. The tracking systems are designed for the sunny season but in case of clouds and snow, the viability of fixed systems are more. Nsengiyumva et al. [106] elaborates that the solar trackers are the systems which are designed to track the Sun and keep the PV panels perpendicular to the Solar radiations to maximize the energy collection. Yilmaz et al. [30] revealed that the two axis trackers are more efficient than single axis trackers. The efficiency of the two axis sun tracker is even more than 98.5%. Author suggested minimum tracking error to maximize the energy gain [106]. Although solar trackers are more prone to get damaged in the disaster, yet due to sustainability it is easy to make it functional again. Floating foundation can also be used for solar tracker, it increases its ability to tolerate same pay load as fixed system. The primary focus of solar tracking system is to collect solar energy for maximum time. The objective of the paper is to discuss the different methods to control the operation of sun tracker systems and concludes the comparative study of the existing systems available in the literature.

## 2. Classification of solar trackers

The solar/sun tracking systems are generally categorized into two types, one axis and two axis sun tracker system. The classification of solar trackers depends on different parameters including the control strategy, tracking strategy, drives and degree of freedom as shown in Fig. 1.

### 2.1. Control strategies based sun trackers

(1) **Closed loop sun trackers -** These type of sun trackers are based on the principle of feedback control system which receives the information from the sensors to detect the position of sun. The sensory data is by the controller to relocate the collector [106,107]. The block diagram of closed loop solar tracker is shown in Fig. 2.

(2) **Open loop sun trackers-** A controller is used to achieve the goal which computes the status of operation on the basis of current state. These type of systems are easy to implement and cheap, but with the complexity of algorithm. The block diagram of open loop sun tracker is shown in Fig. 3.

### 2.2. Sun trackers based on drives

(1) **Passive sun trackers-** These are designed to track the sun to orient

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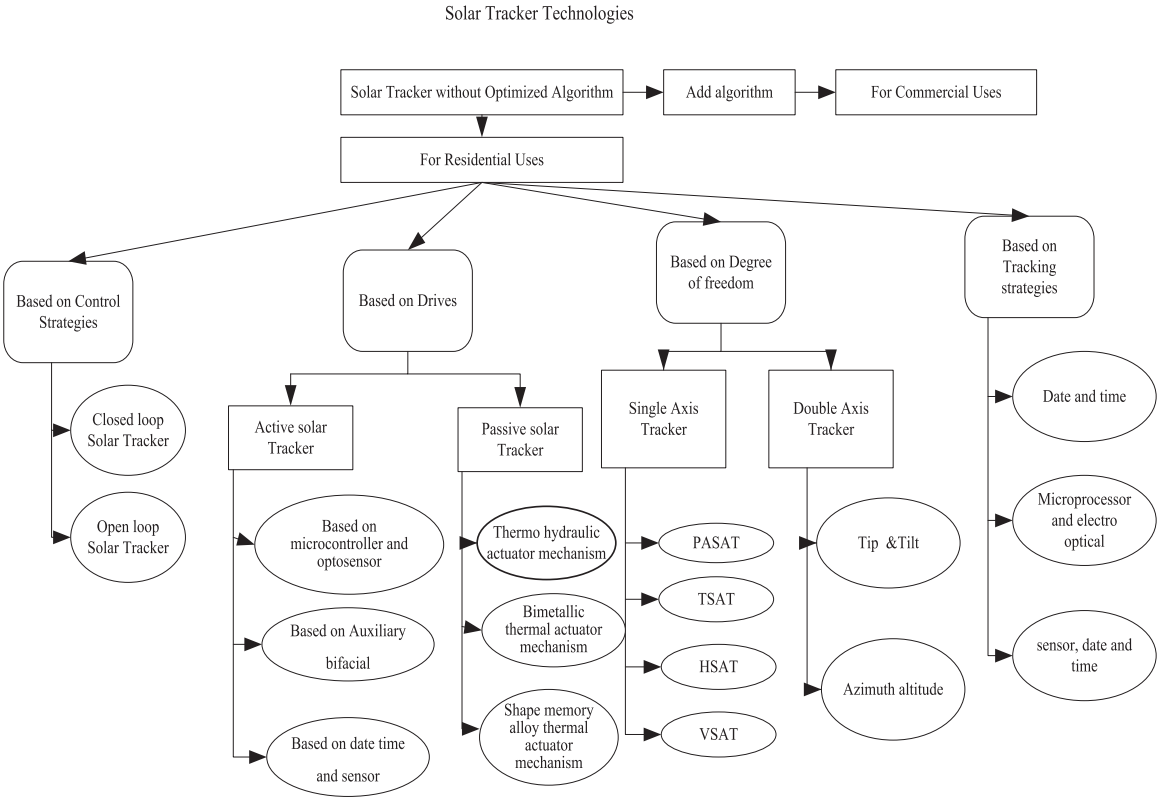


**Fig. 1.** Solar tracking systems classification.

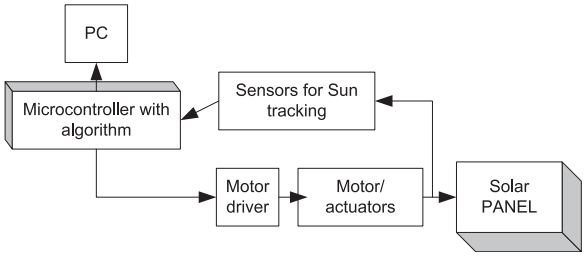


**Fig. 2.** Closed loop configuration of a sun tracker.

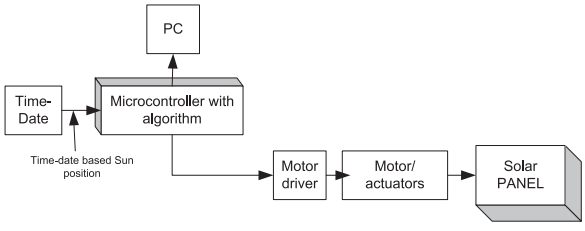


**Fig. 3.** Open loop configuration of a sun tracker.

the PV perpendicular to the radiation without any mechanical drives. Passive trackers are further categorized in thermo hydraulic actuator mechanism, Bimetallic thermal actuator mechanism and Shape memory alloy thermal actuator mechanism. Fig. 4 shows the passive sun tracker.

(2) **Active sun trackers-** Active tradckers use sensors and electrical motors to track the sun continuously. Sensors help the trackers to adjust the alignment of the axis perpendicular to the sun radiation. These are further categorized in three configurations which are based on microcontroller and opto sensors, based on auxilary bificial solar cell and based on date time and sensor. Fig. 5 shows the two axis active solar tracker.

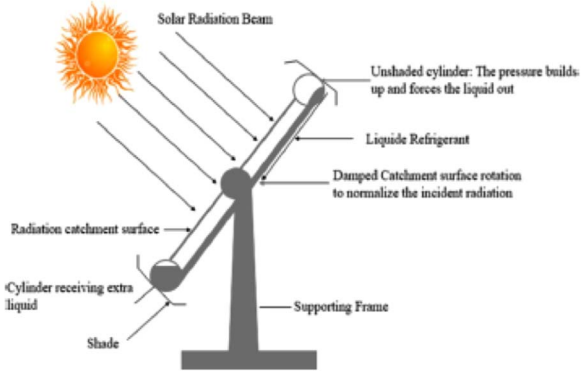


**Fig. 4.** The passive sun tracker [107].

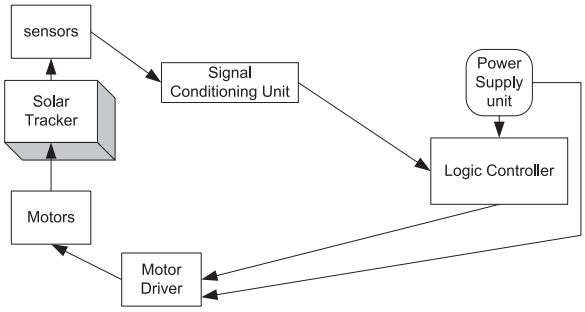


**Fig. 5.** The two axis active sun tracker.

### 2.3. Sun trackers based on degree of freedom

(1) **Single axis trackers**- These systems has only one axis of rotation to