Energy 289 (2024) 129989

Contents lists available at ScienceDirect

Energy

journal homepage: www.elsevier.com/locate/energy

Performance enhancement of solar PV system introducing semi-continuous tracking algorithm based solar tracker

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ARTICLE INFO

Handling Editor: Henrik Lund

Keywords:
Single axis solar tracker
Semi-continuous solar tracker system
Linear actuator
Micro-controller
Photovoltaic panel

ABSTRACT

One common method of harnessing solar energy is via a Photovoltaic (PV) system. When sunlight strikes a PV panel surface at around ninety-degree angle, the system produces the most energy. The electricity generated by a PV system may be increased by using a solar tracker (ST). However, the ST has its own energy requirements and additional expenses. A semi-continuous single-axis ST is developed for this purpose. The "Semi-continuous tracking algorithm " is used to monitor the sun rather than constant tracking in the developed ST. While comparing the performance of a fixed PV system, a continuous single-axis solar tracker-based PV system, and a semi-continuous single-axis solar tracker-based PV system, the developed semi-continuous system is only slightly less efficient than the continuous system (by 1.12 %). Nevertheless compared to a PV system with continuous tracking, the semi-continuous tracking system reduces self-energy consumption by 34%.

1. Introduction

The present global demand for energy is quite high and continuously increasing. Primary sources of energy encompass fossil fuels, including coal, oil, and natural gas. The extraction and utilization of such sources of energy result in the release of greenhouse gases, therefore contributing significantly to the phenomenon of global warming, which is now a prominent worldwide issue [1]. Solar energy is an instance of sustainable and renewable energy that has the potential to serve as a viable alternative to traditional primary energy sources [2]. There has been a growing global focus among academics on the advancement of renewable energy. Renewable energy sources have been widely recognized as being more environmentally friendly and sustainable in comparison to fossil fuels, as supported by several studies [3–6]. Renewable energy encompasses several kinds, including solar and wind energy. The global interest in transitioning from fossil fuel to renewable energy sources has seen a significant surge, leading to a notable growth in the use of solar energy by many nations. As described in the statistical review of world energy, there was a significant exponential growth in the global use of solar energy between the years 2009 and 2020. The data compilation in question relied on official data obtained from many government departments and statistics bureaus. This review states that there has been a significant exponential rise in the overall capacity and utilized energy. Additionally, the overall growth in solar energy capacity and utilization amounts to 29.6 % [7].

Photovoltaic devices are capable of transforming solar energy into electrical energy without generating any internal or external heat, mechanical motion, or audible noise and carbon emission as by-products in the course of the conversion procedure. Despite the significant upfront cost, PV technology has garnered considerable interest owing to its efficient energy conversion, dependability, and the limitless availability of solar energy. PV technology was originally designed with a special focus on generating electricity in space and extraterrestrial contexts, mostly owing to its poor conversion efficiency and high device cost [8]. Currently, the economic viability of solar technology is comparable to, or even superior to, that of fossil fuels [9,10]. The use of PV systems has been identified as the most effective method for harnessing solar energy to create electricity [11,12]. However, solar PV systems have many limitations. Thus far, its efficacy has seen a significant decrease because the majority of them are immobile, so restricting the duration of energy

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https://doi.org/10.1016/j.energy.2023.129989
Received 17 September 2023; Received in revised form 3 December 2023; Accepted 10 December 2023
Available online 14 December 2023

reception to a few hours daily [13]. In order to address these limitations, the implementation of a solar tracker was initiated.

1.1. Solar tracker

The solar tracker system is an automated control mechanism that allows for the monitoring of the sun's trajectory. There are solar panels, programmable logic controllers, signal processors, sensors, modules for controlling electromagnetic and mechanical motion, and power supplies all integrated into the system. When the sunlight hits the PV panel, a sensor senses it and transfer the data to the control unit. The data is compared by the microcontroller, which then sends a signal to the actuator to rotate the pannels. The panels are turned perpendicular to the sun. A solar panel tracking system keeps it facing the sun for maximum efficiency. When the panels are tilted perpendicular to the sun, they absorb more of its energy. Reduced light reflection allows the solar panels to absorb more sunlight. Reduced incidence angles have a direct impact on the output power of solar PV panels. Thus efficiency of solar panels can be improved by increasing their output [14–16].

A solar panel's ability to generate electricity is proportional to the brightness of the sunlight striking it. By maximizing exposure to regular, straight sunlight, a solar tracker device may increase the output of solar panels [17–19]. During the course of the day, solar trackers (ST) position PV panel surfaces so that they face the sun. This is achieved by continuously monitoring the relative motion of the sun. Previous research has demonstrated that local weather variables might have an impact on solar energy harvesting [8]. Single- and double-axis ST are the two most common types [20]. East-to-west movement is the focus of single-axis solar trackers. The trackers may spin as a unit, in a panel row, or a specific region. Dual-axis trackers, which rotate along both the X and Y axes, allow solar panels to precisely follow the sun's path across the sky.

1.2. Solar tracker: Single axis and dual axis

Single-axis trackers only rotate on one axis. Almost 30 % more power might be produced with this tracking technique compared to the fixed system. These low-cost and simple tracking methods boost solar panel efficiency. In the summer and spring, when the Sun is at a higher angle, these solar trackers may help increase the efficiency of solar panels. The efficiency of single-axis trackers decreases as one travels north. The larger variation in solar angle may be attributable to seasonal differences between summer and winter. Whenever the Sun is at an angle to the horizon, efficiency declines. Higher latitudes are more conducive to the use of vertical axis trackers. Therefore, solar panels or arrays may follow the Sun's arc over the year.

Depending on the position of the Sun during the day, the axis of rotation may shift vertically upward or downward. Dual-axis tracking improves the precision of solar panel alignment. Absorption of energy is increased by 40 %. However, solar trackers are more difficult to install and costly to purchase. Solar trackers with dual-axis motion can continually point towards the direction of the Sun. Mirrors with dual-axis tracking are used to aim solar radiation at a fixed receiver. Tracking the sun's horizontal and periodic movements, solar trackers optimize solar energy collection. The use of dual-axis trackers might solve these problems [21,22]. The cost of installing solar panels will go up if a monitoring system is also included [23].

Recent decades of theoretical study on single- or dual-axis solar tracker PV systems have increased the efficiency of PV power generation [24–26]. Theoretical studies reveal that the single-axis solar tracker PV system outperforms the south-facing fixed-mounted PV system by 30 % in locations with abundant sunlight. The increase in output is less than 20 % in low-sun regions [24]. In a controlled experiment conducted in May in Aguascalientes, central Mexico, researchers compared the average increase in production energy. Compared to a stationary sun, the trial revealed a 29.9 % improvement [27]. A July day in Sanliurfa, Turkey, saw a 34.6 % rise in electricity generation and a 29.3 % increase in solar radiation, according to research by Kacira et al. (2004) [28]. Electricity production from PV systems in Jordan was studied by Abu-Khader and colleagues. On certain days, the PV system's output was 30–45 % higher than that of the stationary PV system [29]. Photovoltaic panels benefit from a single-axis solar tracker (ST) [30]. Single-axis STs have a performance boost of 12–20 % compared to fixed solar panels. According to previous research [31], double-axis solar trackers (ST) collect only 3–5% more energy than single-axis ST but with 3 times higher cost. Using astronomical data, a solar tracker may elevate its production by 13.9 % compared to a stationary system [32].

1.3. Continuous tracking

The aforementioned studies and their findings, as outlined in the provided source [33], have been thoroughly examined. The primary emphasis is either on the theoretical projection or the documented empirical observations pertaining to the ongoing monitoring of the sun's spatial coordinates. The concept of "Continuous Tracking" refers to the functionality of a solar tracker system that continuously seeks optimal positioning to maximize sun ray reception. Solar trackers use various drives, software systems, and principles of physics to accurately monitor and adjust the position of the sun. Active trackers use drivers, which are motorized components connected to sensors that respond to sunlight or monitor their whereabouts using GPS coordinates. Certain tracker types use distinct, smaller PV panels that are specially designed to provide electricity to the drive mechanism. Passive trackers are capable of rotation by the use of pressurized gas and liquid, which circulate through channels in the driver as a result of exposure to sunlight. Over the last several years, firms specializing in tracking systems have included operational enhancements to their systems. These changes include the development of monitoring software for proactive maintenance and the optimization of angles to maximize energy production [34,35]. The advancement of tracking technology is facilitating the optimization of solar project installations, enabling installers to optimize electricity production. The economic viability of solar trackers is determined by the extent to which the increase in energy output, compared to fixed-tilt systems, justifies the initial investment required for their implementation. Over the course of the last ten years, there has been a significant reduction in the cost of solar trackers due to value engineering and the increasing demand for these systems. This is primarily attributed to the fact that solar trackers provide a production increase of 35–40 % compared to fixed-tilt systems of equivalent array size [36–39].

1.4. The current and prospective utilization of Solar energy

In 2022, 270 TWh of electricity was produced by solar PV, a 26 % increase over 2021. In 2016, solar PV ranked behind only hydropower and wind as the third biggest renewable energy generator. To increase solar PV output from the current level of 1300 TWh to 8300 TWh in 2030 as envisaged by the Net Zero Scenario, an average annual growth rate of 26 % in production must be achieved between 2023 and 2030. This growth rate is comparable to that of 2022, but maintaining it as the PV industry expands will need determination [40].

SEIA data in Fig. 1, shows a substantial increase in residential solar installations over the last several years. In the third quarter of 2022, residential solar systems in the United States contributed more than 1,500 MW of capacity. SEIA estimates that residential solar energy will increase by 6,000 to 7,000 MW between 2023 and 2027. By 2030, solar panels will be installed in over 20 % of American homes [41].

Numerous businesses and private residences utilize solar tracker systems to maximize the output of their solar panels. The worldwide market for solar trackers is expected to expand by 6.1 %, from $8.9 billion in 2022 to $16.0 billion in 2031. Array Technologies, Inc., Convert Italia, Nextracker Inc., SunPower Corporation, Trina Solar, DEGERENERGIE GMBH & CO. KG, GameChange Solar, STI Norland,

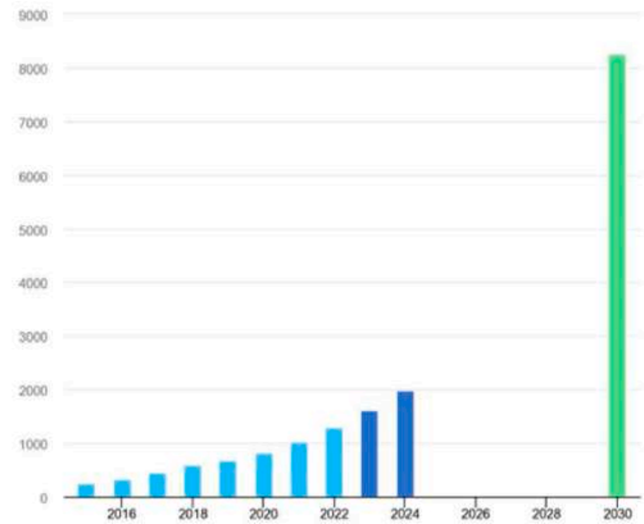

Fig. 1. Solar PV power generation (TWH) in the Net Zero Scenario, 2015–2030 [40].

Ideematec, PV Hardware, MECASOLAR, Mechatron, OPTIMUM TRACKER, Powerway Renewable Energy Co. Ltd., and Schletter are all mentioned as major players in the global solar tracker market analysis [42]. Detailed competition analysis and profiles of these leading companies can be found in the global solar tracker market report. From 2021, the market is dominated by single-axis trackers as presented in Fig. 2. Single-axis trackers are more often used since they are less expensive and simpler to produce. Electricity capacity must be increased by energy providers and national governments to accommodate ongoing and planned construction. Single-axis solar trackers have the potential to increase output by 20–30 % [42].

1.5. Problem statement

It is clear from the above that people are gradually becoming used to using solar power. Tracking systems and other novel technologies are also enjoying widespread use. The power consumption of a tracking device, which is a crucial factor regardless of the requirements and urgency, is being ignored. The automated nature of the system necessitates the constant operation of a number of electrical and mechanical components, all of which use current. The tracking motors are responsible for 0.05 % of the whole day's power usage on a sunny day, whereas the controller is accountable for 5.84 % of the total. 5.89 % of the electricity produced is used by the system [12]. When all the benefits and efficiencies are considered, it's clear that this is a very basic kind of power. However, as was discussed in the segment before this one, the projections for the year 2030, this little consumption will grow much higher due to the vast scale. We may accept it if there is no other choice, but if science has taught us anything, it's that there always is. What if, though, we can also reduce our own consumption?

Fig. 2. Solar tracker market domination_by type [42].

1.6. Single axis Semi Continuous tracking: Whys and Wherefores

Based on the aforementioned, lightweight photovoltaic panels with a single solar array benefit more from single-axis rotating trackers [9,28,31,43]. The best yearly direction of disposition to the Sun is set for trackers with a single axis of alternation contingent on the latitude of the location and the influence of climate [24,43–45]. In Ref. [46], a vertically oriented single-axis tracker was analyzed. The authors concluded that this kind of tracker is the best option in more regions of China. The authors of the article also built a very efficient single-axis tracker that spins horizontally [46–48].

In a solar tracker system that operates constantly, the sun position sensor unit is responsible for detecting the precise location of the sun at each moment, enabling the solar panel to be continually adjusted to face the direct sun rays. However, upon closer examination of the planet's rotational process, it is documented that the Earth takes around 4 min to complete a one-degree revolution around its axis [9]. If the tracking motor is off for around 4 min, it is unlikely to have a substantial influence on the power produced by the panel. In this paper, a novel semi-continuous algorithm has been successfully applied in a single-axis solar tracker system, marking the first instance of its use worldwide. By providing both theoretical explanations and practical evidence, we have effectively reduced self power consumption in the system.

2. Device and methods

2.1. Electromechanical system

A sun position detecting module, control system based on a microcontroller, driver unit, linear actuator, and a frame for supporting solar panels combine up the electromechanical unit of the ST. Fig. 3 is a block schematic of the auto ST.

Light-Dependent Resistors (LDR): The sun position sensing module consists of two light-dependent resistors (LDR) having identical characteristics. In response to the deviations in light intensity, the resistance of two LDRs changes. In this configuration, a voltage divider has been built by connecting a resistor, the LDR, and the power line in series. In the situation shown in Fig. 4(a), an opaque barrier stands between two light detectors. Fig. 5 illustrates the schematic design from Proteus simulation software of the single axis ST. Before starting the experiment, the algorithm and the circuit diagram were tested by the simulation. Every component used here in Fig. 5, is described distinctly in this section. Whenever the solar array is not oriented perpendicular to the sun, a shadow falls on one of the sensors. Because of an obstruction, a

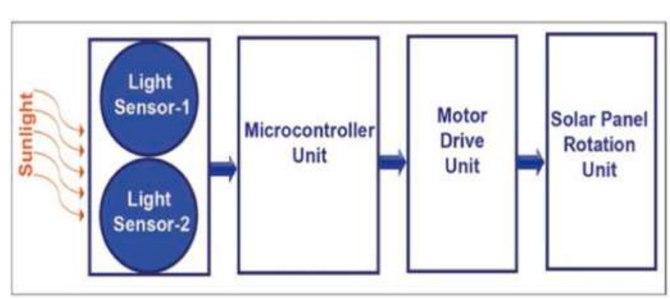

Fig. 3. Working block diagram of the solar tracker system.

(a) (b)

Fig. 4. (a) LDR sensor arrangement (b) Linear Actuator.

shadow is cast on the EAST LDR when the sun moves across the sky from east to west. Therefore, this tint raises the resistance of the aforementioned EAST LDR. At the same time, the lack of a barrier-caused shadow on the WEST LDR maintains a greater incident light intensity compared to the EAST LDR. So, the EAST LDR's resistance is reduced to a lesser extent in the west than in the east. Due to differences in resistance, LDRs produce voltage drops of variable magnitudes. The microcontroller receives information about the voltage drop across two light-sensitive resistors (LDRs) using dual Analog-to-Digital Converter (ADC) inputs.

Linear Actuator: The solar panels can rotate with the help of a linear actuator. By definition, a linear actuator creates linear motion as opposed to the circular motion of a conventional electric motor. It provides high torque, better precision and smooth movement of the system. The linear actuator has a robust self-lock feature which helps the system to remain stable when there is no power on the input of the linear actuator without extra locking facilities. The used linear actuator has a 250 mm stroke length, 1000 N push load,12 mm/s speed and 12V voltage rating. Fig. 4(b) shows the linear actuator image.

Microcontroller: The ATmega328P microcontroller has been used as the central processing unit in this our design. The ATmega328P, an 8-bit AVR microcontroller, has a revolutionary RISC architecture that enables the execution of 131 instructions inside a single clock cycle. This design contributes to the microcontroller's exceptional performance and low power consumption. The microcontroller has been coded with Flowcode version 9.0 software [49]. Embedded devices that utilize PIC, AVR (including Arduino), and ARM technologies can be programmed using the commercially accessible Flowcode development environment [50,51].

Motor Driver: An L298 N Motor Driver has been used as the driving module of the actuators. The L298 N can control the speed and direction of two DC motors at once because of its twin H-Bridge motor driver design. DC motors having peak ratings of no more than 2A and voltages of 5–35V are supported by the module. L298 N Motor Driver is more economical and robust than an H-bridge driver circuit using four separate MOSFET or transistors. An L298 N Motor Driver unit can be used for dual axis solar tracker system as well.

Solar Panel and shaft: The supporting structure has been made of metal and has a movable shaft. Two solar panels have been attached on the two sides of the shaft by supporting metal bar. Hareonsolar HR-100W/12 solar panel has been used in the tracking system which has a maximum power rating of 100W, maximum current at standard testing condition (STC) is 5.81A, maximum voltage at STC is 17.2V, short-circuit current at STC is 6.46A, the open-circuit voltage at STC is 21.6V.

2.2. *Semi-continuous tracking algorithm*

The solar panel in a continuous solar tracker system is constantly moved to face the sun's direct rays due to the system's sun position detecting device. Due to structural instability or overshoot features of the motor, this constant tracking causes the solar panel system to oscillate. In addition, wind turbulence might temporarily misalign the

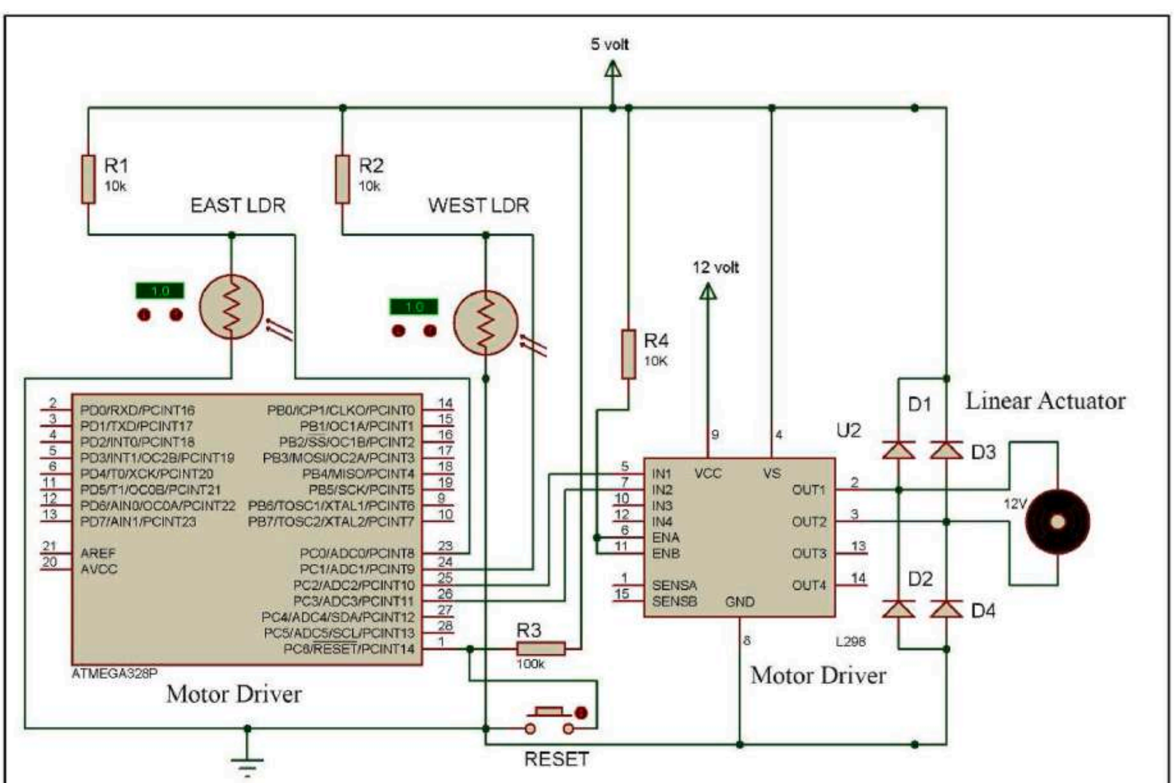

Fig. 5. Schematic diagram of single axis solar tracker **in Proteus simulation**.

panel, leading to a false trigger of the output sensor. This causes the motor to waste energy by spinning in both directions (backwards and forwards). Semi-continuous tracking is offered as a method to address this issue [52]. The earth takes 24 h to complete a rotation on its own axis. During this rotation, the sun apparently moves from east to west at a rate of 15° per hour, or one degree every 4 min with respect to a point on the earth's surface.

Let us consider, θ is the incident angle between the direction of the sun ray and normal to the panel surface as shown in Fig. 6. When $\boldsymbol{\theta} = 0$ the incident solar radiation on the panel's surface is denoted by I. Now the equation for radiation incident on the panel is

$$I_\theta = I\,cos(\theta)$$

For $\theta = 1$ degree $$I_\theta = I\cos(1)$$ $$I_\theta = 0.99984I$$

The decrease in the amount of radiation due to 1-degree misalignment is $(1 - 0.99984) \times 100\% = 0.016\%$.

As stated before, for the Earth to rotate one degree takes about 4 min [9]. However, a 1-degree deviation from the normal to the solar panel's surface has just a 0.016% effect on the incident radiation reaching the panel's surface. Turning off the tracking motor for 4 min won't have much of an impact on the panel's efficiency. It is possible to double or triple this off time if desired. The motor's driver circuit is turned off and draws practically minimal power during the off period. The time was tracked by leaving just the microcontroller unit on, which has a small power footprint. When the timer expires, the motor driver unit and sun position detecting unit will activate, and the solar panel will be rotated to face the sun.

The Continuous tracking technique is shown in Fig. 7(a), whereas the semi-continuous tracking approach is depicted in Fig. 7(b). The semi-continuous tracking technique adds a delay period that isn't present in the continuous approach, which is the primary distinction between the two. The EAST LDR is cast into shade by the dividing wall as the sun passes across the sky from east to west. Since this is the case, the resistance and voltage drop rise in the EAST LDR while decreasing in the WEST LDR. The microprocessor evaluates the differences in voltage drops between two LDRs. The panel will rotate from east to west if the microcontroller detects a larger voltage drop in the east LDR compared to the west LDR. A microprocessor keeps track of the voltage dips between LDRs as they move and makes comparisons in real time. The spinning is halted if and only if the voltage dips at two different places become equal to one another.

3. Data collection

The short circuit current of a solar panel is directly influenced by the light intensity that is incident directly on the surface of the solar panel [20]. To evaluate the effectiveness of the semi-continuous solar tracker-based PV system compared to the fixed-mounted PV system and the continuous solar tracker-based PV system, measurements has been performed on the short circuit current of the solar panels. Three different PV systems were built on the rooftop of the Institute of Energy Research and Development (IERD). These systems include a permanently mounted PV system, a PV system that utilizes continuous solar tracker, and a PV system that utilizes semi-continuous solar tracker. The configuration of the semi-continuous solar tracker-based PV system is shown in Fig. 8. Each of the three systems is equipped with a pair of solar panels, which are strategically positioned on a metal frame to ensure optimal balance. The short circuit current of a single solar panel was measured for each set-up. The short circuit currents were recorded at 15-min intervals from 9 a.m. to 5 p.m. for a period of 10 days, namely from August 4th, 2022 to August 15, 2022, omitting Fridays and Saturdays. In order to facilitate comparison, the mean value of a dataset spanning 10 consecutive days has been computed and visually shown on a graph.

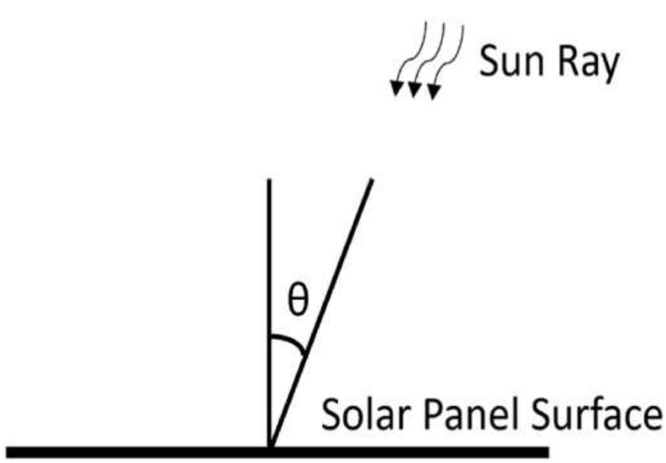

Fig. 6. Solar panel surface and sun ray direction.

4. Results and discussion

Fig. 9 shows the comparison graph of the average data of 10 days for a fixed-mounted PV system, a semi-continuous tracking-based PV system and a continuous tracking-based PV system. The short circuit current for semi-continuous and continuous tracking-based PV systems has always been found greater than the fixed-mounted PV system. At a particular time of the day, the fixed-mounted PV system and tracker-based PV systems, all get approximately same amount of solar radiation. So, the short circuit currents of all three systems are almost the same at that time but before or after, more solar radiation incidents on tracker-based systems and hence tracker-based systems give more short circuit current. The short circuit of the semi-continuous tracking-based PV system and continuous tracking-based PV systems are about to coincide with each other with some deviation. The semi-continuous tracker rotates the solar panels every 4 min which causes at most one degree of misalignment of the surface direction of the solar panel and the direction of solar radiation. So, the short circuit current of the semi-continuous tracking-based PV system is 16.24 % higher than the fixed-mounted PV system whereas it is 17.5 % greater in the case of the continuous tracking-based PV system.

In the data collection period from 4 August to August 15, 2022, the sky was mostly cloudy on 9 August. Fig. 10 depicts the collected data for that day. The average improvement of the short is current was 10.01 % for the continuous tracking-based PV system and 9.37 % for the semi-continuous tracking-based PV system with respect to the fixed-mounted PV system. As the sun was mostly covered by clouds and the amount of direct radiation was low, the percentage of the amount of short circuit current due to the use of an ST is considerably less on a cloudy day.

On a sunny day, the short circuit current elevation was 19.4 % for the continuous tracking-based PV system and 17.60 % for the semi-continuous tracking-based PV system compared to that of the fixed-mounted PV system. The collected data for that day is shown in Fig. 11. It is observed that the ST is more effective on a clear and sunny day than on a cloudy day.

If we consider the average data of 10 days, the difference between the short circuit current for continuous and semicontinuous ST is 6.34-6.27 = 0.07 which means the 10 days average output efficiency of continuous ST is only 1.12 % higher than the semicontinuous ST.

In this experimental setup, the measured power consumption by the tracking unit is 16.13 W when the sun ray is not perpendicular to the panel surface. When the tracking system rotates the solar panel to sun rays at ninety degree angle, the power consumption is reduced. But due to overshoot of the tracking system or small shading by cloud oscillation occurs and the solar panel is rotated backwards and forward continuously. For 1 h, the continuous tracking system consumed 8.44 Wh. Our

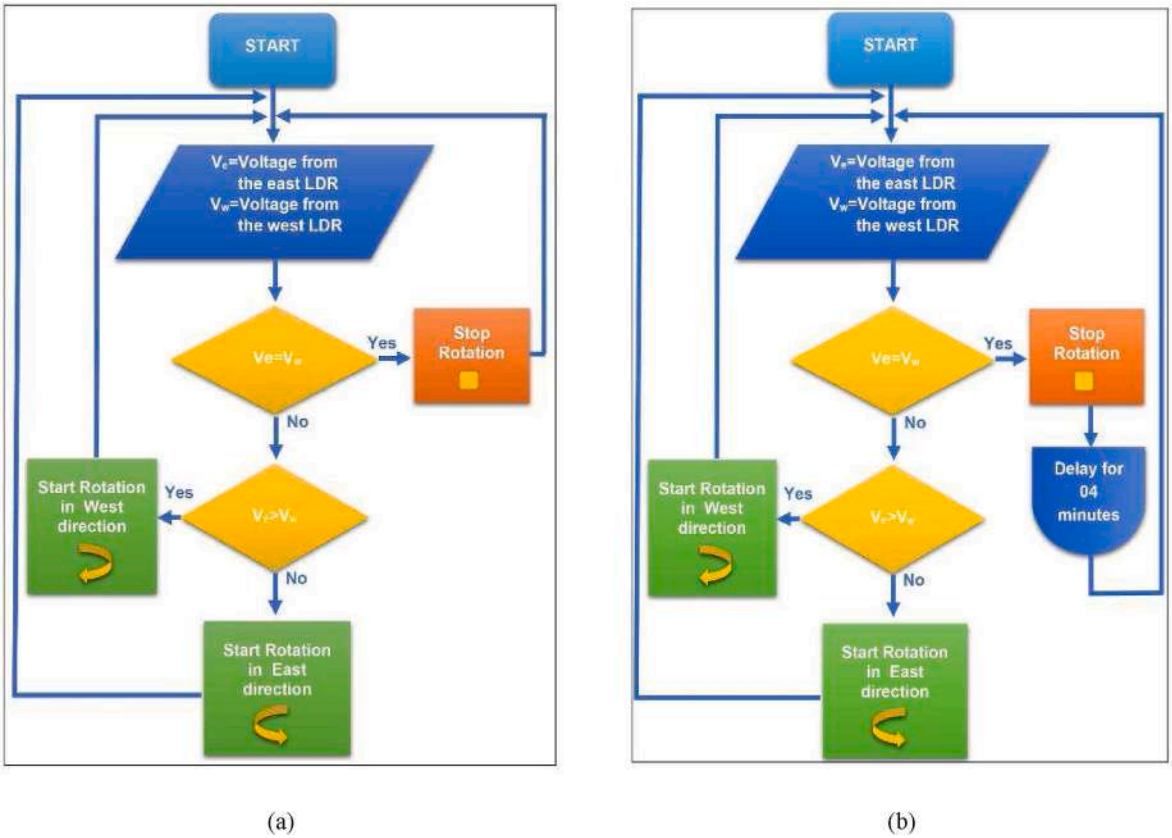

Fig. 7. (a) Continuous tracking algorithm (b) Proposed semi-continuous tracking algorithm.

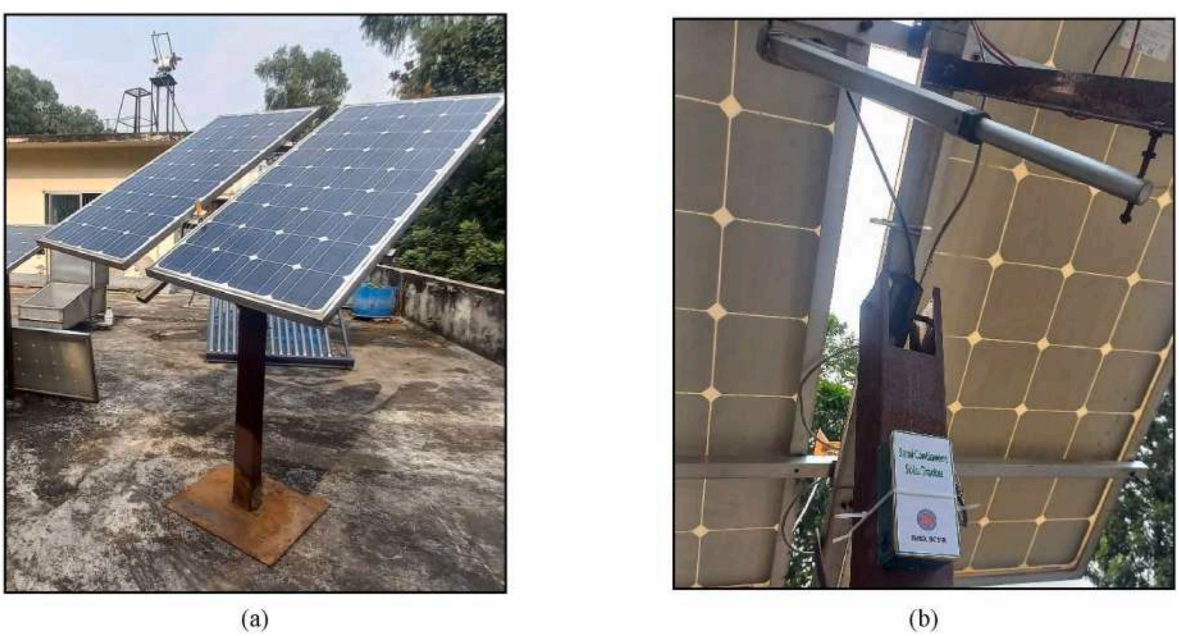

Fig. 8. Single axis Semi Continuous solar tracking system implementation (a) front view (b) rear view.

novel algorithm of semicontinuous ST is only turned on for 5 s after every 4 min which means it is turning on and off 15 and 14 times in an hour respectively. Therefore energy is being saved by semicontinuous ST and in 1 h the value we got was 5.1 Wh.

Considering the graph shown in Fig. 12, in 1 h, the semicontinuous ST model is saving about 34 % of self consumption.

5. Conclusion

This study assesses the performance of a novel algorithmic approach for a solar tracker, which turns it into a semi-continuous tracking one. Research has shown that the use of a semi-continuous solar tracker system in PV technology allows for a greater collection of solar radiation, resulting in a higher conversion of this energy into electricity, as

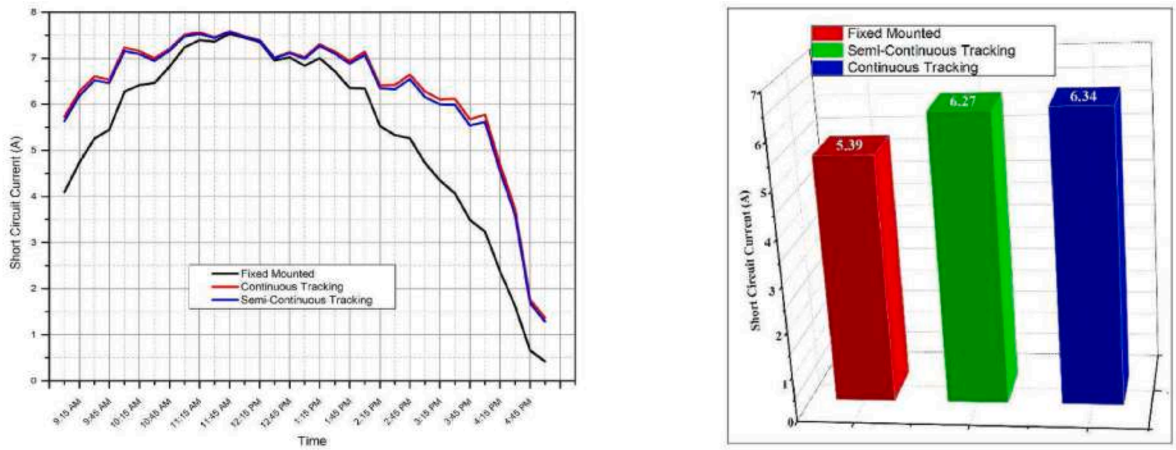

Fig. 9. Comparison of short-circuit current of fixed mounted south facing PV system, semi-continuous solar tracker based PV system and continuous solar tracker based PV system for an average of 10 days data.

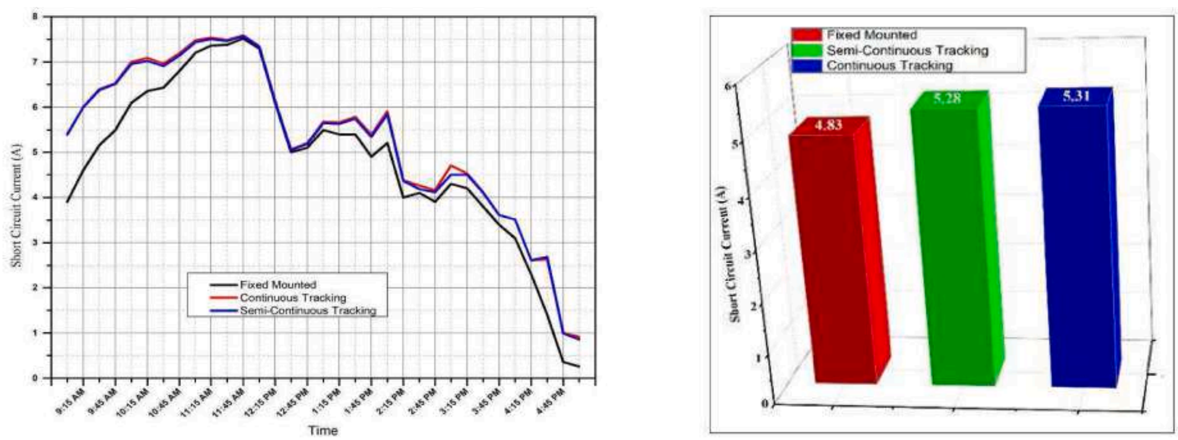

Fig. 10. Comparison of short-circuit current of fixed mounted south facing PV system, semi-continuous solar tracker based PV system and continuous solar tracker based PV system for a cloudy day in August.

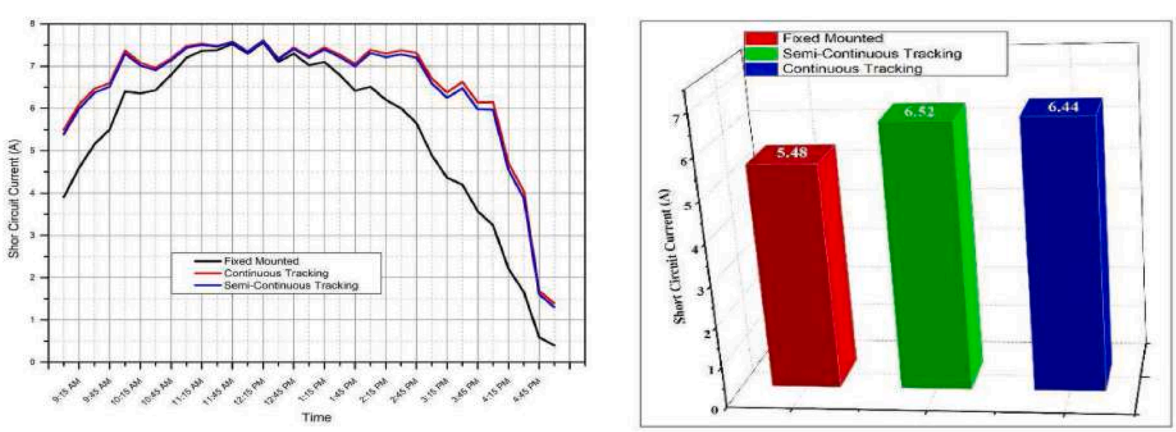

Fig. 11. Comparison of short-circuit current of fixed mounted south facing PV system, semi-continuous solar tracker based PV system and continuous solar tracker based PV system for a sunny day in August.

compared to a fixed mounted PV system. While the semi-continuous tracking-based PV system exhibits a little decrease of 1.12 % in power output, it demonstrates satisfactory overall performance when taking into account its own energy consumption. The use of a linear actuator in lieu of a rotating motor resulted in enhanced stability of the system. The energy usage of a semi-continuous solar tracker system is notably lower, about 34 %, compared to a continuous tracking system due to the inactivity of the sun position detecting module and driving module during the delay period. A delay duration of 4 min was used in this study, with the potential for easy adjustment by modifying the software implemented on the microcontroller. In the future, we want to explore the optimization of this method by experimenting with a diverse range

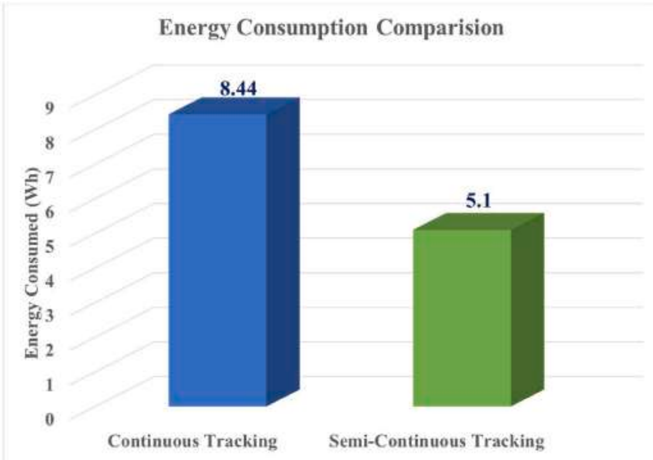

Fig. 12. Energy consumption comparison between continuous and semi-continuous tracking.

of delay times.

CRediT authorship contribution statement

Md Sadequl Azam: Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Atish Bhattacharjee:** Data curation, Writing – original draft, Writing – review & editing. **Mahedi Hassan:** Data curation, Validation, Visualization. **Mashudur Rahaman:** Conceptualization, Formal analysis. **Shahin Aziz:** Formal analysis, Resources. **Md Aftab Ali Shaikh:** Resources, Supervision, Validation. **Md Saidul Islam:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Supervision, Visualization, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgement

The authors would like to express gratitude to the BCSIR authorities in Bangladesh for providing both financial and logistical aid. The Bangladesh Council of Scientific and Industrial Research funded this study via a research grant.

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