OPEN ACCESS
Global Journal of Research in Engineering & Computer Sciences
Volume 01| Issue 01 | Sep-Oct | 2021
Journal homepage: https://gjrpublication.com/journals/
Review Article

A review on the Impact of Solar Power Energy

*Muhammad Ahmad Baballe

Department of Computer Engineering Technology, Kano State Polytechnic, School of Technology

DOI: 10.5281/zenodo.5701335 **Submission Date:** 09 Oct. 2021 | **Published Date:** 30 Oct. 2021

***Corresponding author:** Muhammad Ahmad Baballe

Abstract

Solar energy is a clean source of energy that has a much lower environmental effect than conventional forms of energy. Solar energy has been an increase in a wider range of applications. Numerous research has been made on the use of photovoltaic (PV) cells in accumulating the solar radiations from the sky and converting it to electrical energy especially if the solar trackers are used. A solar tracker is a machine that is designed as a mounting for photovoltaic (PV) panels so that they track the sun in such a way that the panels are perpendicular at all times to its rays, thereby increasing energy efficiency. Nevertheless, most of these do not take into account the change of the sun angle of incidence by installing these panels in the immovable location, which is highly influenced by the solar energy that is collected by these panels. With the imminent insufficiency of non-renewable resources, the world is now considering using different sources of energy available nowadays. From all these available resources in the world available, solar energy is the most copious and is quite tranquil to convert it to electrical energy. The principal objective of this study is to analyze the various solar tracking devices, reasons why solar power energy is required and the components use in the solar tracker system.

Keywords: Sun, microcontroller, photovoltaic (PV) panels, light rays, light sensor, and motor

Introduction

In nowadays epoch, the main problem the world is facing especially in African countries is energy catastrophes and we all know that fossil fuels are available in very inadequate quantity [1]. Likewise there overdo in the previous years has abridged them more. Therefore, now if we want to meet our energy demands in this world, the only option we are left with is to exploit the renewable resources of energy that are accessible in copiousness. In this world nowadays, there are numerous sources of renewable energy such as the sun, wind, and geothermal but the most cost-effective among these renewable energy is solar energy. This solar energy cannot only meet our current energy hassles but can also provide us with cheap and clean energy. The solar panels once installed can give us energy for numerous years without having any or much maintenance cost [2]. Solar photovoltaic (PV) panels (figure one below shows the image of the photovoltaic solar panel) are panels, which are used in coupling solar energy, but since the earth is revolving around the sun, due to which the solar energy in existing, the solar panels are available only for a limited time throughout the day. To overcome such a tricky, a solar tracker is used [3]. Most of the research done on the solar tracker system makes use of a photo sensor, which is normally used, in conjunction with a stepper motor that will help in controlling the movement of the solar panel. For this tenacity, a Phototransistor is mounted on the solar panel frame in which the panels are fixed. The stepper motor used in the research will be programmed using a Microcontroller; the microcontroller is the brain of the whole research because all instructions are given from there. Due to the rotation of the stepper motor, the solar panel mount on it moves in a direction to search for the maximum light intensity. When the light-dependent resistor (LDR) use in the research receives maximum light, the stepper motor will stop in the position of the sun; this is done with the help of the microcontroller as the brain of the research. Henceforth, with changing light intensity, the position of the solar panels also changes. The solar tracker is a device onto which the solar panels are fixed which tracks the movement of the sun across the sky ensuring that the maximum amount of sunlight strikes the panels throughout the day. In terms of cost per watt of the completed solar tracker system, it is generally cheaper (for all but the smallest solar installations) to use a solar tracker and fewer solar panels where space and planning laws permit. A good solar tracker system can usually lead to an increase in electricity generation. Despite its comparatively hoary age, the microcontroller 8051 is one of the most popular microcontrollers that is used currently [4].

Fig. 1: photovoltaic solar panel

RELATED WORKS

The single-axis trackers

The single-axis trackers usually place around the equator where there is no sizeable change in the divergent position of the sun. Mayank [5] offered an automatic solar tracking system. Mayank designed a solar panel tracking system based on a microcontroller and observed that the single-axis tracker system increases proficiency by about 29.99% if you are going to compare it to the fixed module. Runsheng Tanf, Guiha Li, and Hao Zhong [6] scrutinized the horizontal single-axis solar panels tracked. They got the result as east-west axis tracking was deprived to improve the energy while tracking the sun about south-north was the best. The proficiency increased for the east-west axis was less than 7.9% while for the south-north axis increased by 9.98 to 23.56%. Rizk. J and Chaiko [7] established a tracking system using solar panels proficiently. Rizk and Chaika. Y designed a simple single-axis tracking system using a light sensor and stepper motor. This Rizk and Chaiko detected that this system gives the proficiency of power collection by keeping the perpendicular of the solar panel to the sunrays. Rizk and Chaiko also found that this power gain was increased by 29.89%. Ali Mustafa, Imam Abadi, and Adi Soeprijanto [8] designed a fuzzy logic-based single-axis solar tracker system. Ali Mustafa, Imam Abadi, and Adi Soeprijanto implement a fuzzy logic controller on the ATMEGA 8353 microcontroller to improve the powerful energy of the photovoltaic (PV) panel. They found that the photovoltaic (PV) panel has maximized and it exceeded up to about 46.87% compared to the stationary system. Varun A.K, Ashwin R, et al. [9] offered a sensor-based single-axis solar tracker to attain the highest degree of energy through the solar panel. This keeps tracking continuously for the maximum strength of light. This system extemporaneously changes its direction when the sun moves from its position to get the maximum light energy. Therefore, the investigational outcome shows the productiveness and robustness of the proposed method. Abou-Hashema, Gamal M Dosouky et al. [10] offered an improved orientation design for energy-productivity in photovoltaic (PV) panels. For maximum incident radiation, the panels are inclined with a monthly-based angle. They scrutinize the suggested strategy in two cities that is Egypt (AI-Kharijah) and Japan (Fukuoka). The outcomes revealed that the proposed design accomplished the progress of energy building in both cities. In the year 2013, Mohan Reddy, Anusha, K., and Chandra. S [11] designed a solar tracking system based on a real-time clock. Reddy, Anusha, and Chandra compared a static photovoltaic (PV) panel and single-axis tracker based on a real-time clock using the ARM processor. Their research revealed that the tracking system builds up the proficiency of about 39.87 percent(%) and the energy that is normally achieved from the sun is boosted from morning 9:00 am to afternoon 6:00 pm. Constantin Daniel once, Liviu Kreindler, and Tiberiu Tudorache [12] offered a tracking system fanatical to the photovoltaic (PV) conversion panels. The proposed design verifies the accomplishment of converting solar energy into electricity by genuinely bring into line the solar panel according to the actual position of the sun. The result concluded as output energy is maximized by the photovoltaic (PV) panel through desirably locating implemented only for a sufficient amount of light intensity. Below are the images of the single tracker solar system.

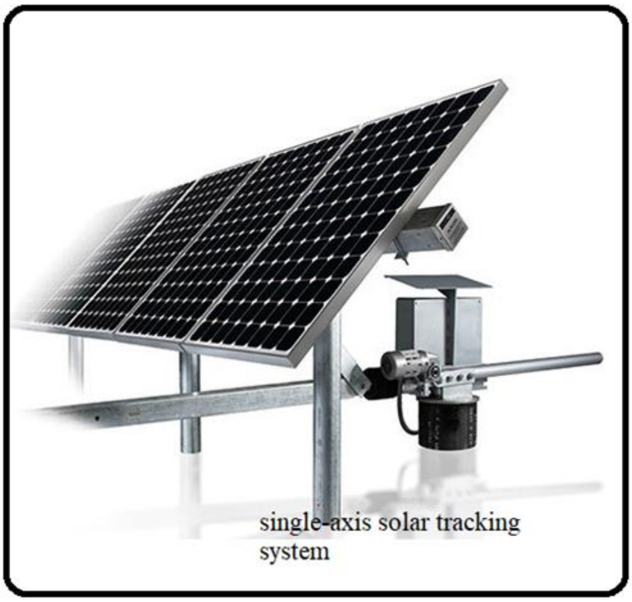

Fig- 2: single-axis solar tracking system

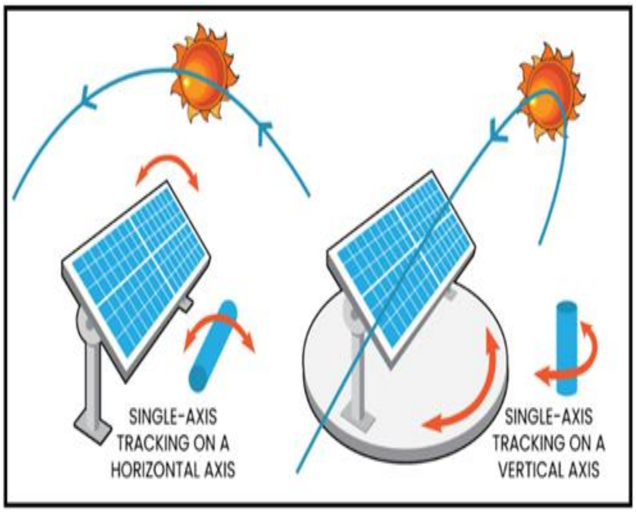

Fig-3: single-axis solar tracking system

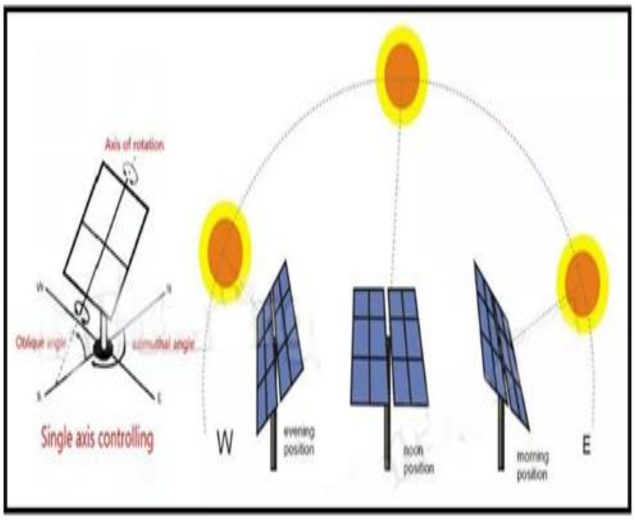

Fig. 4: single-axis solar tracker

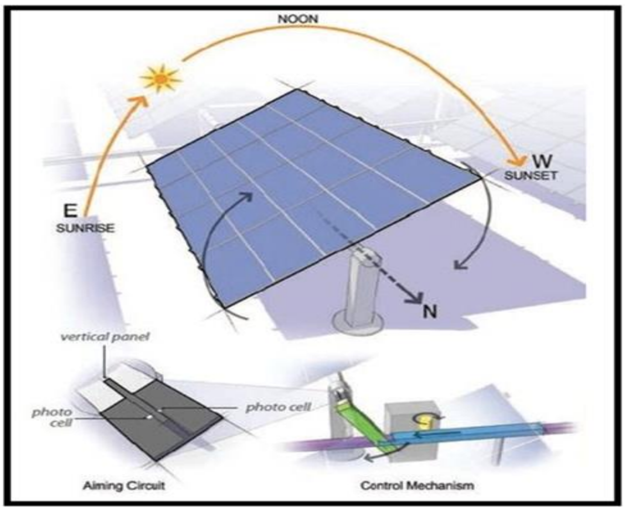

Fig.-5: single-axis solar tracker

The dual-axis trackers are for places where the movement of the sun is a track from east to west all over the day and from east to north or south throughout the seasons. S Jha, Shibani K., Puppala, Harish, [13] suggested a dual-axis tracking system to develop and implement a simple and proficient control scheme with merely a single tracking motor. Jha, Shibani K., Puppala, Harish, core purpose is to improve the power gain by precise tracking of the sun. In the work, they successfully designed, built, and scrutinized a dual-axis sun tracking system and received the best result. S Suryanarayana and V Sundara Siva resolved that saying that this tracking technology is very modest in the design, accurate in tracking, and low-cost. Lakshmi Prasanna H.N and Dhanalakshmi. V [14] offered a smart dual-axis solar tracker. Lakshmi Prasanna H.N and Dhanalakshmi. V used Arduino for the development of their suggested prototype. After their research, they witnessed that maximum voltage was a track of about 24.97% to about 29.68% and the generating power is increased by 29.69% compared to a static system. M. Kacira, M. Simsek, Y. Babur, and S. Demirko [15] overlooked the cause of a dual-axis solar tracking with the development of power energy compared to a fixed photovoltaic (PV) panel in Sanliurfa, Turkey. M. Kacira, M. Simsek, Y. Babur, S. Demirko found that everyday power gain is 29.29% in solar radiation and 34.57% in power generation for a particular day in July. In the year 2017, Tejas Gaidhani and Chaitali Medhane [16] implemented a microcontroller-based dual-axis prototypical working on a solar panel. Through this model, they observed that the solar panel excerpt maximum power if the solar panel is brought into line with the intensity of light-receiving from the sun. It improves the power output and precaution necessary for the system from wind and rain. Midriem Mirdanies, Roni Permana Saputra [17] suggested a dual-axis system with a joint method of an Astronomical algorithm and camera-based feedback processing for localizing and tracking light intensity to increase the proficiency in achieving power energy. They also designed a compound algorithm method to merge approximation data of the sun acquired from astronomical-based and visual-based feedback. After the simulation, it resulted that the azimuth and elevation sum squared errors from the proposed algorithm are 0.3588 and 0.3774 degrees, and the astronomical algorithm is 1.0997 and 1.2877 degrees. N.H. Osman and S.B. Elagib [18] describes the development of a solar tracking system based on solar maps using a microcontroller, which can forecast the real detectable position of the sun by latitude's location for maximizing the proficiency of energy level. The main purpose of this design was to work with minimal operator interaction in isolated areas where network coverage is absent. Chia-Liang Lu and Jing-Min Wang [19] presented a simple execution of a sun tracker with one dual-axis AC motor to predict the sun's position and used a stand-alone photovoltaic (PV) inverter to energize the whole system. They worked in May 2012 in New Taipei City, Taiwan and the day was slightly cloudy. A static panel is placed along the south at a tilt angle of 22.5 degrees with maximal standard solar radiation when the latitude of Taiwan is 23.3 degrees along the north. The experiments stemmed that their system raised the energy level to 25.81% for a slightly cloudy day. M.M. Abu Khader [20] observed an experiment under Jordanian climate on the cause of utilizing two-axis sun-tracking systems. They found that the power result was enhanced by 29.67-44.89% compared to a static system for a particular day. The figures below show the dual-axis solar trackers.

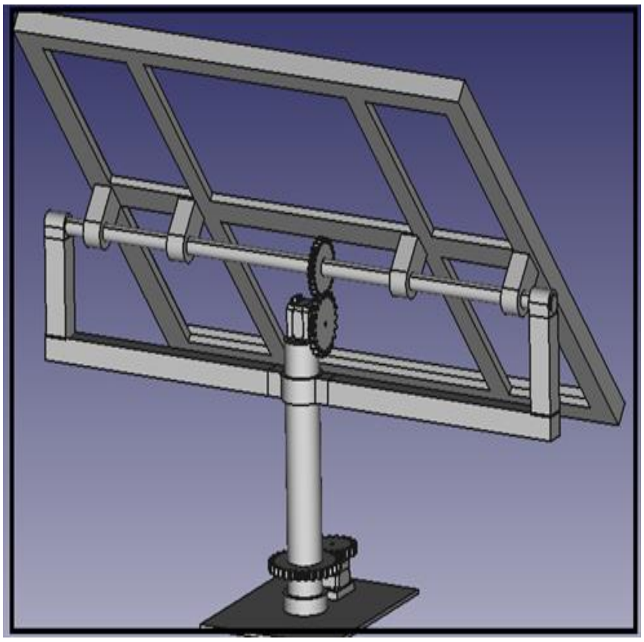

Fig. 6: dual-axis solar tracker

Fig. 7: dual-axis solar tracker

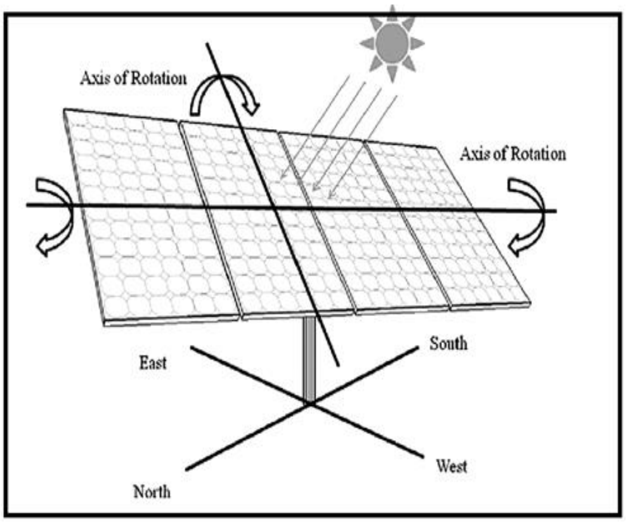

Fig. 8: dual-axis solar tracker

THE IMPACT OF THE SOLAR POWER ENERGY

1. The most generally famous information about solar energy is that it signifies a hygienic, green source of energy. This solar power is a pronounced way of reducing your carbon footprint. They are nothing about solar power that contaminates the Mother Nature of our environments nowadays. Solar power does not discharge any form of greenhouse gasses, and except for needing a source of clean water to function, it uses no other resources to function. Henceforward, solar energy is safe and environmentally friendly to use.

2. The reduction in the cost of these solar panels serves as a pronounced instance of why there is going to be an increase in the use of solar energy in the world. Traditional electricity relies greatly on fossil fuels such as natural gas and coal. Not merely, they are bad for our environment, but they are also inadequate resources. The sun will never raise its rates and it gives you energy security throughout the day especially it is mounted on the solar tracker in other to be tracking the position of the sun's movements. Once you have solar panels up on your solar tracker you have precisely reached an energy-independent status. The solar battery used in the system stores energy for rainy days and nighttime.

3. The electricity we make use of needs to be transported from our big power plants to us the consumers through widespread grids. The long-distance transmissions of power cause losses. The solar panels are mounted on your tracker to get energy from the sun. Solar tracker power is very helpful in increasing electricity productivity, considering the shortest distance of transmission to our homes or places the power needs to be transported. Since your energy is domestic and as a result of that, you are in control of your energy usage, and no bills are required from any form of authority.

4. Solar power increases trellis Security; when many of us decided to switch to solar power, they are likely to experience brownouts or blackouts. If every household will decide to install the solar tracker system, they are high chances of not experiencing a blackout if they are an electricity failure. The installation of this solar tracker provides us with a larger electricity grid security, especially in terms of natural or human-caused tragedies.

5. Solar power can create jobs and even increase the economic growth of a country;
The national economy of any country can be increased by solar power installations. The more people or companies need solar power, the more human labor will be required in the installation of the panels, and this will reduce the joblessness of the country and give job opportunities. This will help create extra jobs for skilled workers and subsequently keeps the economy growing.

THE COMPONENTS USED IN THE SOLAR TRACKING SYSTEM

Below are the main components used in the solar tracking system

1. **Light Sensor**

These are passive devices that transform this “light energy” whether visible or in the infrared parts of the spectrum into an electrical signal output. The light sensors are more commonly known as “Photoelectric Devices” or “Photo Sensors” because they convert light energy (photons) into electricity (electrons). The light sensor is used to sense the manifestation of light coming from the sun. Below is the image of the light sensor.

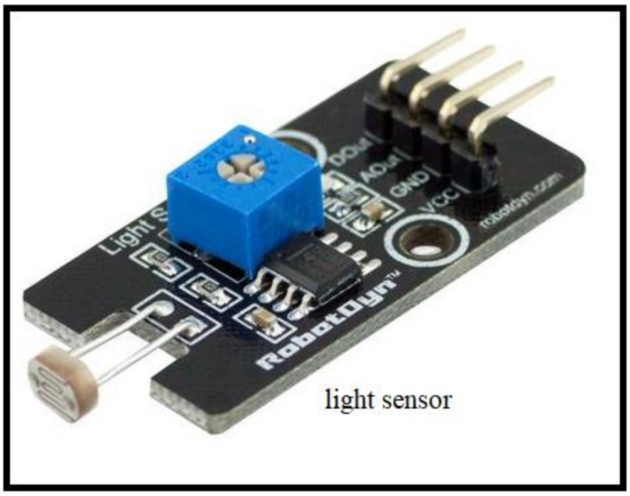

Fig. 9: light sensor

2. **Not Gate:**

A NOT gate is a logic gate that inverts the digital input signal. For this purpose, a NOT gate is sometimes is referred to as an inverter. A NOT gate always has high logical one output when its input is low logical zero. Equally, a logical NOT gate always has low logical zero output when the input is a high

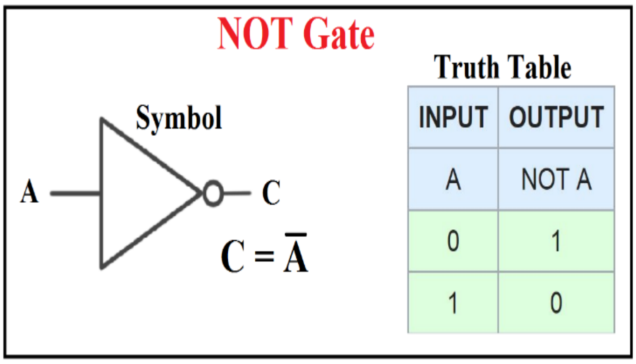

Fig.10: Not gate

logical one. The logical symbol for a NOT gate is shown below. The not gate will invert the incoming signal and will feed this signal to the controller.

3. Microcontroller

A microcontroller is an extremely combined device, which includes one chip, all, or most of the parts needed to perform an application control function. The PIC (peripheral interface controller) is an integrated circuit (IC) that was established to control peripheral devices, improving load from the central processing unit (CPU). It also has a low memory capacity; it is also used in performing calculations and is controlled by software just like the central processing unit (CPU). It is used in the designs where a local resolution needs to be taken. It helps in the programming of the whole circuit. Below is the image of the microcontroller.

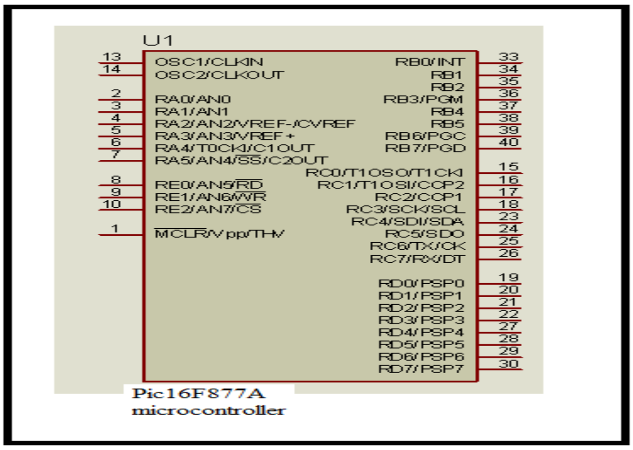

Fig-11: Microcontroller

4. **Motor Driver**

The motor drivers act as an interface between the motor use and the control circuit. The Motor normally requires a high amount of current whereas the controller circuit works on low current signals. Therefore, the function of motor drivers is to take a low-current control signal and then turn it into a higher-current signal that can drive a motor. The signal so received is of very small amplitude and is not able to drive the motor. Thus current amplifier as the motor driver is used to increase the amplitude of the incoming signal. Below is the image of the motor driver circuit

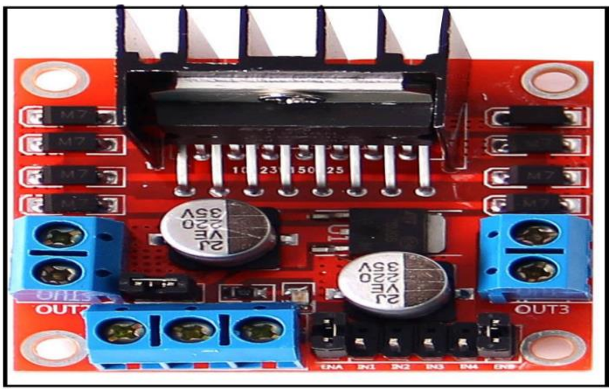

Fig. 12: A motor driver circuit

5. Stepper Motor:

A stepper motor is an electromechanical device that converts electrical power into mechanical power energy. Alternatively, the Stepper motor is an electromechanical device, which converts electrical pulses into discrete mechanical movements. The figure below shows the image of the stepper motor.

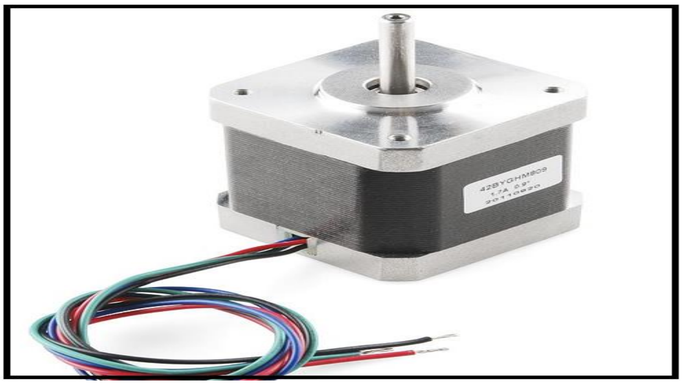

Fig.13: stepper motor

Conclusion

This study presents an outline of the enhancements in the research of the solar power energy and tracking systems in the world nowadays, it highlights the enactment of scrutiny of both the single and dual-axis solar tracking systems fortified with diverse techniques, and designs, which have been developing in the recent years. We have also seen the reason why solar energy power is required and significant over another form of energy generation. Also, some of the major components needed in the solar tracker system are discussed.

References

[1] M., B., Ahmad, A., S., Muhammad, H., A., Hussain, A., H., Muhammad, A., M., Sani, "Review on Impact of Installing the Solar Tracking System Its Challenges and Types", Artificial & Computational Intelligence, https://acors.org/ijacoi/VOL1_ISSUE5_08.pdf, December 2020.

[2] M., Udit, T., Neeraj, "Review on a sun-tracking model in solar Photovoltaics (PV) system and their classification" Alochana Chakra Journal, volume 4, issue 5, Pp 5330-5338, April 2020.

[3] S., S., Chetan, "Solar Photovoltaics- Fundamentals, Technologies, and Applications". Department of Energy Science and Engineering, IIT, Bombay, 2015.

[4] K., Amandeep, C., Goma, S., Narinder, S., Asif, H., K., C., Kumar, "Designing of a solar tracking system using AT89C51 microcontroller" international journal of scientific research in computer science, engineering and information technology, volume 2, issue 5, pp 709-712, 2017.

[5] K., L., Mayank, "Automatic Solar Tracking System". Journal of Core Engineering & Management, Volume 1, 2014.

[6] L., Guiha, T., Runsheng, Z., Hao, "Optical Performance of Horizontal Single-Axis Tracked Solar Panels", Solar Energy Research Institute Yunnan Normal University, China, 2011.

[7] J., Rizk, Y., Chaiko, "Solar Tracking System: More Efficient Use of Solar Panels", World Academy of Science, Engineering and Technology, 2008.

[8] A., Imam, S., Adi, M., Ali, "Design of Single Axis Tracking System at Photovoltaic Panel Using Fuzzy Logic Controller", Department of Engineering Physics and Electrical Engineering, Institute of Technology, Surabaya, 2015.

[9] Ashwin, R., Joshua, I., K., Lalith, S., C., Ravi, P., P.S, Varun, A., K., "Design and Fabrication of Single Axis Solar Tracking System" Journal of Mechanical and Production Engineering, 2014.

[10] M., D., Gama, E., M., Abou-Hashema., S., Masahito, "Maximizing Energy Efficiency in Single Axis Solar Tracker Photovoltaic Panels". 8th International Conference on Power Electronic-ECCE Asia, 2011.

[11] K., Anusha, S., Chandra, R., Mohan, "Design and Development of Real-Time Clock Based Efficient Solar Tracking System", 2013.

[12] T., Tudorache, O., D., Constantin, K., Liviu. "Performance Evaluation of a Solar Tracking PV Panel". Bucharest Scientific Bulletin, Series C: Electrical Engineering, 2012.

[13] K., S., Jha, H., Puppala, "Prospects of renewable energy sources in India: Prioritization of alternative sources in terms of energy index", Energy http://dx.doi.org/10.1016/j.energy.2017.03.110. Kalogirou, Soteris A., 2017.

[14] V., V., Dhanalakshmi, V, H., N., P., Lakshmi, V., Priyanka, J., K., Rani. "Dual Axis Solar Tracker Using Arduino Uno". Department of EEE, Dr.T.T.I.T, KGF, 2016.

[15] M., Kacira, M., Simsek, Y., Babur, S., Demirkol, "Determining Optimum Tilt Angles and Orientations of Photovoltaic Panels". Renewable Energy, Volume-29, 2004

[16] M., Chaitali, G., Tejas, P., Vivek, D., Piyush," Dual Axis Solar Tracker Using AVR". Department of Electrical Engineering, Sandip Institute of Engineering & Management, 2017.

[17] M., Midriem, S., P., Roni, "Dual-axis Solar Tracking System". Research Centre for Electrical Power and Mechatronics, Indonesian Institute of Sciences (LIPI), Indonesia, 2016.

[18] Elagib, S., B., Oman, N., H., "Design and Implementation of Dual Axis Solar Tracker Based on Solar Maps". Department of Electrical and Electronics, Faculty of Engg. Univ. of Khartoum, 2013.

[19] M., J., Wang, L., L., Chia, "Design and Implementation of a Sun Tracker with a Dual-Axis Single Motor for an Optical Sensor Based Photovoltaic System", 2013.

[20] M., M., Khader, O., O., Abu, A., S., Badran, "Evaluating Multi-axes Sun-tracking System at Different Modes of Operation in Jordan". Renewable and Sustainable Energy Reviews, Volume-12, 2008.