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SINGLE AXIS SOLAR TRACKING SYSTEM

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Abstract: **In this study, the layout and implementation of a PV converter panel solar tracking system are discussed. Generally, the amount of solar radiation and the ambient temperature will affect the electricity production of photovoltaic panels. As they will create their most electricity when the amount of solar radiation they receive is at its highest, PVs should be controlled to keep them always perpendicular to the sun.**
The proposed single-axis solar tracking system offers an ideal solar energy conversion process by correctly aligning the photovoltaic panels with the actual location of the sun. The experiment's mechanism depends on a DC motor that intelligently moves the prototype in response to input from an LDR sensor using a fuzzy logic controller. An experimental study was carried out to study the performance of the solar tracking system. There is a 47% increase in strength between the design system and the fixed system.

Keywords: **solar tracking system, fuzzy logic controller, photovoltaic panel.**

I. INTRODUCTION

The recent global crisis caused by dwindling supplies of fossil fuels, skyrocketing energy consumption and runaway environmental pollution has forced researchers to develop cutting-edge methods to generate electricity at from clean and renewable energy sources, including solar, geothermal, wind and utility power.
Solar energy has a tremendous potential for conversion into electricity, which can satisfy a significant portion of the world's electrical consumption. Indonesia is a country with a lot of solar energy resources because of its location on the equator, and its average daily sun radiation intensity is level 4.
National 8 kWh/m2. Given that solar energy is abundant but still hasn't reached its full potential, solar energy systems are a possibility to be taken into account as an alternative energy source to satisfy future increases in energy demand. exploited. In order to provide products that meet standards of cleanliness, quietness and reliability, with extremely low maintenance costs and minimal environmental impact, everyone will work hard to find new breakthroughs in this area of technological development, making it most exciting and one of the most challenging. the fields. Solar energy is completely renewable, free and does not emit greenhouse gases or other pollutants.
The solar panel uses photovoltaic or PV technology to convert sunlight into electricity.
Although photovoltaic panels are not particularly new, industrial and academic research continues to focus on ways to improve their performance. Solar tracking systems [1,5], solar cell design and geometry optimization [2] and new material technologies are some of the solutions that can be used to improve the performance of PV solar panels . The growth of the photovoltaic panel market has increased significantly over the past few years by
units, and this trend is expected to continue. Many theoretical and experimental studies have been carried out by researchers to improve photovoltaic power plants using uniaxial or biaxial PV solar tracking [1,3,4,7,8]. Additionally, Kacira et al.
[6] studied the impact of dual-axis solar tracking systems on electricity production compared to static photovoltaic panels in Sanliurfa, Turkey, and found a 34.6% increase in electricity production daily life and a 29.3% increase in solar radiation. Abu Khader et al conducted a
experimental investigation of the effects of a two-axis sun tracking system in a Jordanian environment. On some days, a 30-45% increase in output power has been observed compared to stationary PV systems.
This study created a prototype single axis solar tracking system using a fuzzy logic controller to find the best PV array placement for the sun.

II. METHOD

On certain days, in accordance with set photovoltaic systems. In order to determine where the PV arrays should be placed in relation to the sun, this study built a prototype single axis solar tracking system utilising a fuzzy logic controller. The set point refers to the amount of sunshine that the east side of the solar panel receives.

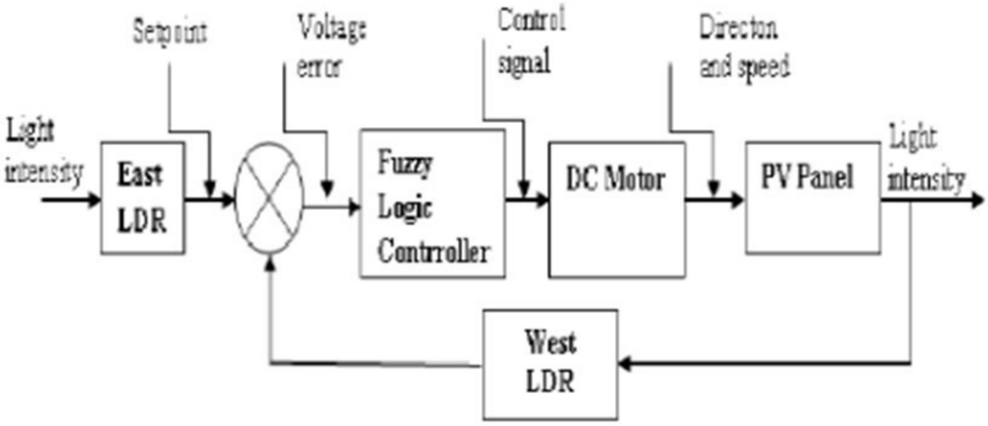

Fig.1-Block Diagram of Solar Tracking System

As a result, the PV array is always pointed west at startup (07:00) (on the previous day, it was facing that direction). The difference in the quantity of sunshine the solar panel receives from the east and the west determines the position of the panel, which is a controlled variable. To ensure that the input to the fuzzy logic controller is error-free, the output voltages of the two LDR sensors must coincide. The DC motor will be told to move or stop by a PWM signal produced by a fuzzy logic controller. The solar panels will therefore always be perpendicular to the sun.

Design and realization

The realization of the components and their integration in a unique and coherent system are two steps in the process of realization of a single-axis solar tracking system. The implementation and testing of the components takes place in the initial phase. These include mechanical and electrical components (LDR sensors, control modules, DC motors and photovoltaic panels).

Mechanical frame

Calculating the moment of inertia of a solar panel is the first step in designing an installation because it helps to decide where to place the shaft or axis of rotation. In this case, the centre of the horizontal side (l) or the centre of the vertical side (w) of the solar panel are the two options.

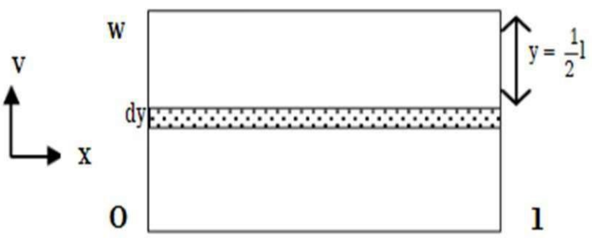

Fig.2-Spindle for solar panels.

Theoretically, an object will move more easily if its moment of inertia is small.

Calculations indicate that the solar panel's vertical side, which has a lesser moment of inertia than the other sides, should have the axis of rotation there.

The second step is to determine the torque needed to move the solar panel in order to determine the proper information about DC motors. The specifications of the apparatus information about DC motors. The specifications of the apparatus indicate that a minimum torque of 21.75 N.cm is needed to drive the PV array. The viewpoint will then be created using software as the following phase.

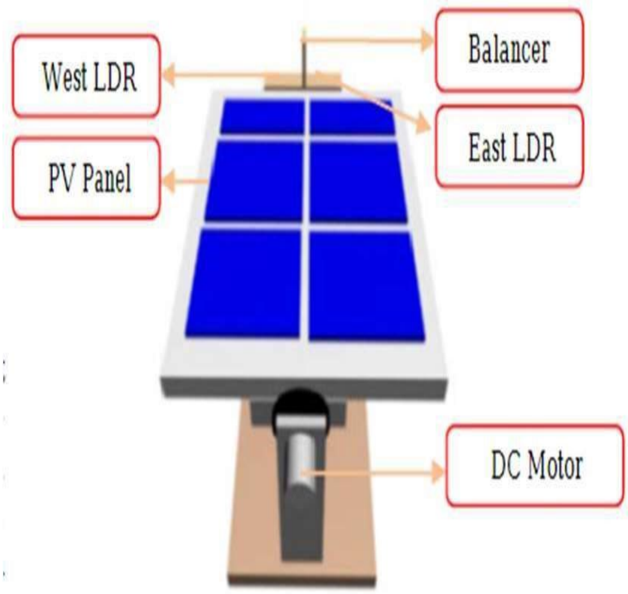

Fig.3-Perspective View of PV Panel

Specification	Quantity
Type	Monocristallin
Max Power	10 Watt
Voltage at P_{max}	17 Volt
Current at P_{max}	0.59 Ampere
Short Circuit Current	0.65 Ampere
Open Circuit Voltage	21.1 Volt
Dimension (LxWxT)	39.6 cm x 28.9 cmx 2.3 cm
Weight	1.5 Kg

L= Length W=Width T= Thickness

Table1. Specifications of PV Panel

Power Frame

LDR Sensor Unit -A resistor called LDR whose resistance value decreases with increasing incident light intensity. Two sensors form an LDR sensor unit. It is used to generate the analog voltage signal transmitted to the control module and detect the light intensity.

They detect east and west of the sun's position on the vertical axis. The container containing the sensor and the LDR is separated by an opaque surface called a balancer.

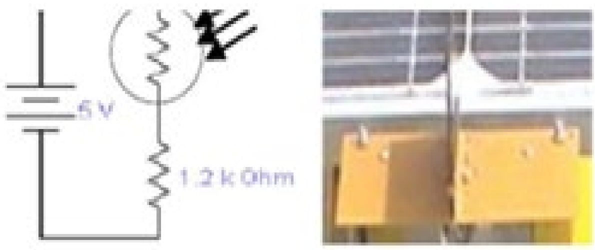

Fig.4-LDR Circuit Driver Module

The system's primary controller is the microcontroller. In this project, the control strategy is a fuzzy logic controller (FLC), which maps input to output space using IF-THEN rules. Typically, a fuzzy logic controller consists of three fundamental components.

Defuzzification, a fuzzy rule foundation for inference (which compiles the output of every IFTHEN rule), and previous implications for the output are some of these.

Fuzzification is the process of transforming an unblurred or crisp input into some degree of membership; in this example, a voltage mistake. Here, the voltage error is determined by comparing the east and west LDR voltage outputs. According to Figure 5,

(minus negative), NS (minus negative), ZE (zero), PS (minimum positive) and PVS (minimal positive) Yes). Instead, the fuzzy outputs are FAST CCW, CCW SLOW, STOP, SLOW CW, and CW.

FAST

Negative When the East LDR voltage is considerably lower than the West LDR, small (NS) Negative It will output extremely low (NVS) if the East LDR voltage is lower than the West LDR. Null (ZE) In the event that the East LDR voltages are positive If the East LDR voltage is significantly greater than the West LDR, small (PS) Very little (PVS)

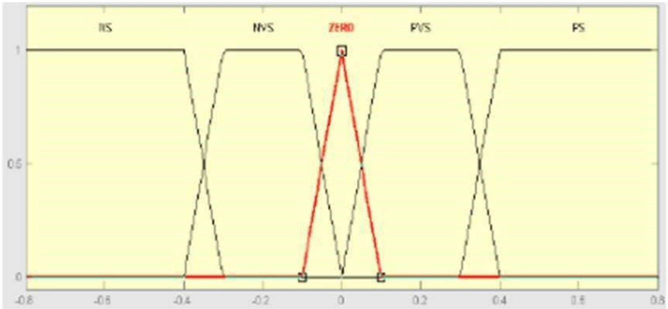

Fig.5-voltage readings

Fuzzy Logic Control Unit if the East LDR voltage is lower than the West LDR The input range of the ZE triangular membership function's membership function is between -0.1 and 0.1 volts. According to the experimental findings, each collector's solar radiation is practically identical at this amount, proving that the photovoltaic panel is perpendicular to the sun.

As a result, when the error is within the range, the motor activity stops (STOP MODE), as shown in Figure 7. The 0.1 to 0.3 volt trapezoidal membership function of the PVS. At this distance, the solar panels are almost parallel to the sun.

The motor will gradually revolve clockwise to place the PV panel back in its initial position (CW SLOW).

The PS has a trapezoidal membership function, according to studies, and an error input bigger than 0.4 volts. The PV panels in this instance are not oriented directly toward the sun. When the solar panels are oriented westward and the sun rises in the east in the morning, this occurs.

As a result, the motor will swiftly revolve in a clockwise direction to determine the sun's real location (CW FAST). The NVS membership function has a trapezoidal shape and a -0.1 to 0.3 volt error range. Presently, the solar panels are practically parallel to the sun.

This indicates that in order to maintain the solar panel towards the sun, the motor must gently rotate counter clockwise. In comparison, the input error of the NS trapezoidal membership function is less than -0.4 volts. It is equivalent to PS, but differs in that the motor rotates in a counter clockwise manner (CCW FAST).

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Input (LDR Voltage error)	Output (Direction & speed of DC Motor)	Definition
Negatif Small (NS)	CCW FAST	**CCW:** Counter clock wise
Negative Very Small (NVS)	CCW SLOW	
Zero (ZE)	STOP	
Positive Very Small (PVS)	CW SLOW	**CW:** Clockwise
Positive Small (PS)	CW FAST	

Table.2-shows the fuzzy rule base used in this scheme.

The method used in the fuzzy system entailment phase, where the next step, known as the aggregation step, is to combine the outputs of all the IF-THEN rules into a single set of fuzzy outputs (FAST CCW, CCW SLOW, STOP, SLOW CW, CW FAST) at each of the IF-THEN rules' outputs, is called the fuzzy system approach. The implication phase of an IF-THEN rule determines the rule's output (i.e. the output fuzzy sets are given weights).
Defuzzification is the final stage of the fuzzy system, and in this study, it is done using the centroid approach. Each fuzzy set (aggregated output) is transformed through this method into a net value (motor speed), which is then reflected by the appropriate PWM (Pulse Width Modulation) signal.

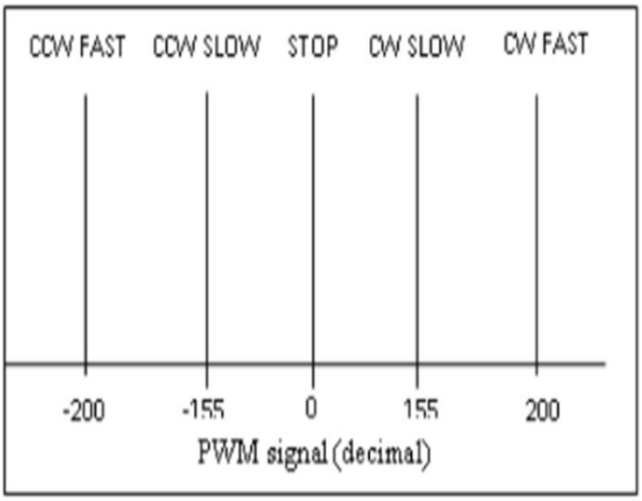

Fig.6-Fuzzy Output Set (DC Motor Speed)

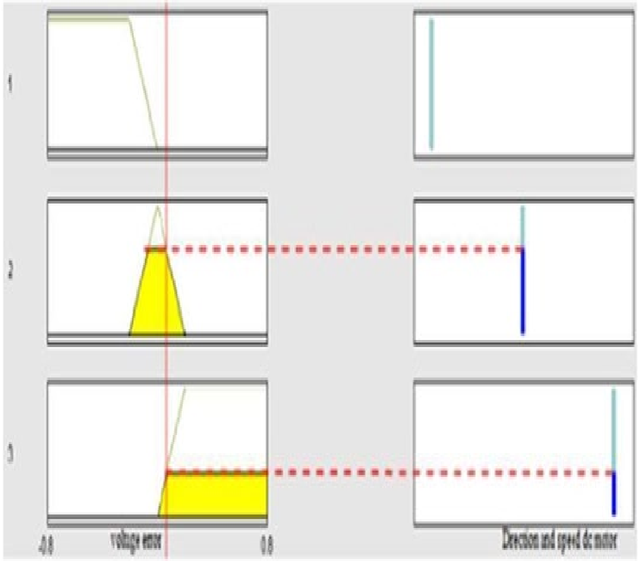

Fig.7-Meaning Fuzzy Logic Drive Phase

The ATMEGA 8535 microcontroller is used to implement the fuzzy logic approach discussed above. Figure 8 depicts the flowchart for programming a microcontroller, with ports A, B,..., C, and D standing in for the various outputs of a DC motor, LCD display, limit switch, and light intensity sensor.

Motor, DC
DC motors have several advantages including small size, light weight, quiet operation, high torque, and simplicity of design. Using a gearbox as a reducer, the system actuator is a DC motor with a maximum angular speed of 5 rpm and a supply voltage of 12 V, which may move or spin smoothly.
The device's output is matched to the direction and speed of the DC motor. In this scenario, the direction of the DC motor may be controlled by a motor driver circuit, namely the IC L298N. Additionally, the angular speed of DC motors is managed using the PWM technique (pulse width modulation).
As mentioned before, when the difference in strength received from the two LDRs is small (0.1 volts), the DC motor will be in stop mode.
Based on experimental results, this number is designed to avoid oscillations.

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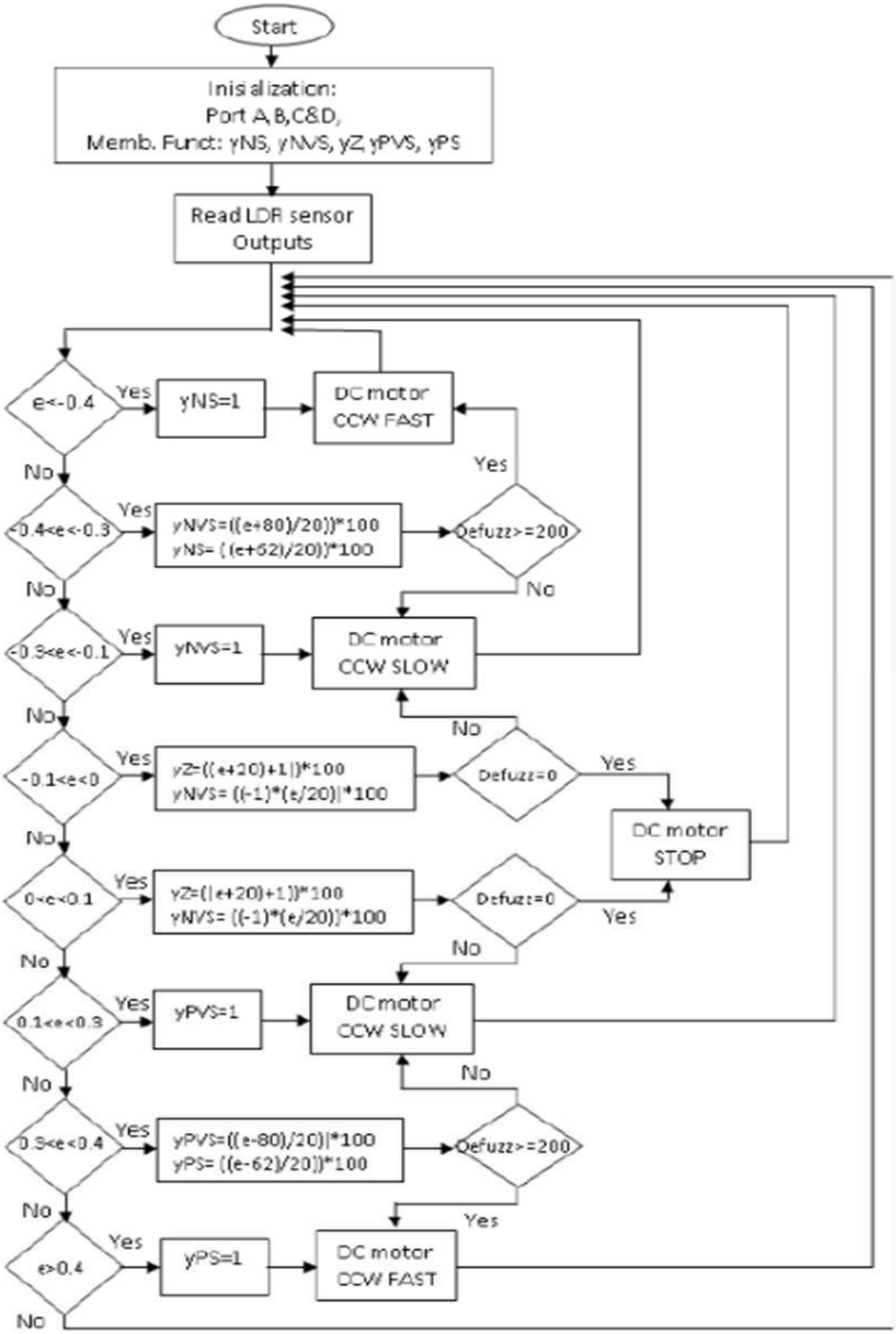

Fig.8-Microcontroller programming flowchart

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Fig.9-Dc motor actuator

3.3Solar Tracking System Assembly

The best slope or inclination for solar panels during the dry season, according to experiments, is 30 degrees (set according to the day, month and latitude). Each element has a linear characteristic with a maximum hysteresis of less than 5%, according to the test findings. They were, thus, nicely behaved.

Fig.10- Single Axis Solar Tracking System

III. RESULTS AND DISCUSSION

Several experiments were performed to compare the power output generated by the fixed system PV arrays and the tracking system Two PV arrays of the same specification and function developed to test system performance.
The configuration for experiments

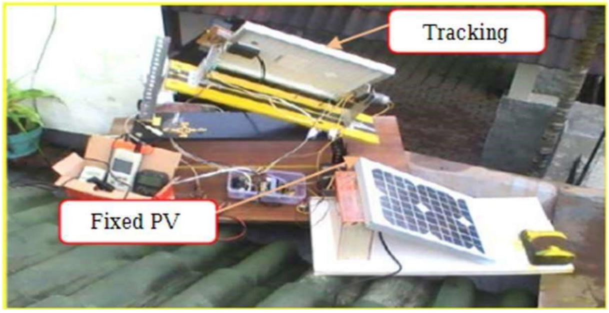

Fig.11-The experiments for fixed and rail PV panels

The average air temperature, wind speed, and light intensity are 110,600 lux, 36.3°C, and 2 m/s when the sky is clear and the light intensity is at its highest. A comparison of the output energy of a track against a track is produced by two separate systems. Photovoltaic panel installation takes one day, from 7 am to 4 pm.
Data is gathered every 30 minutes starting at 0:00. The experiment will be carried out in Indonesia's Surabaya. The solar tracking system improved the power of the fixed PV panels by 192.5 percent at 09:00, which was the biggest increase, according to the trial data. This demonstrates that the PV panel tracker gets improved temperature and irradiance.

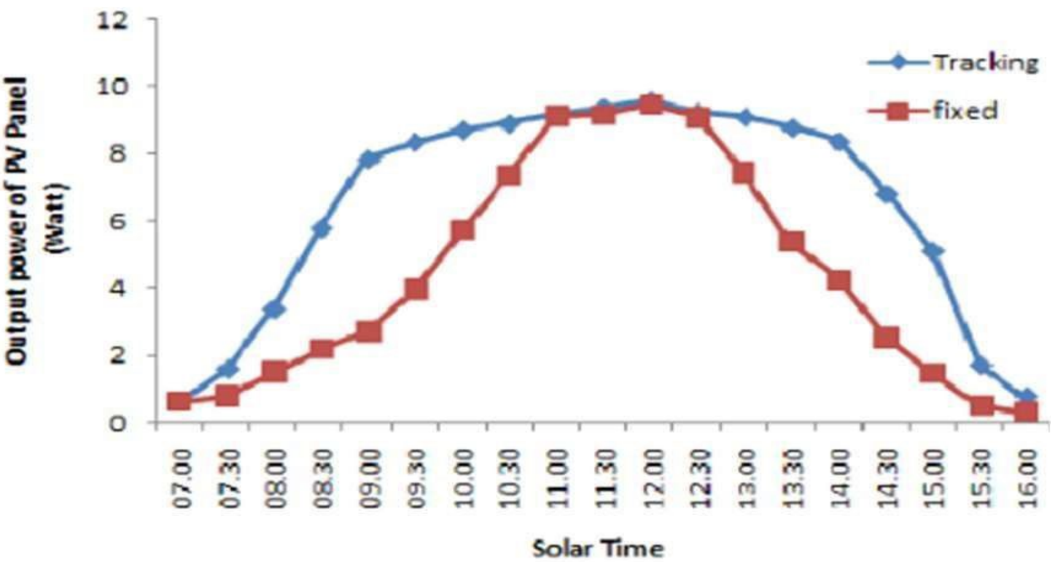

Fig.12-fixed for a day compared to the PV panel output power tracker

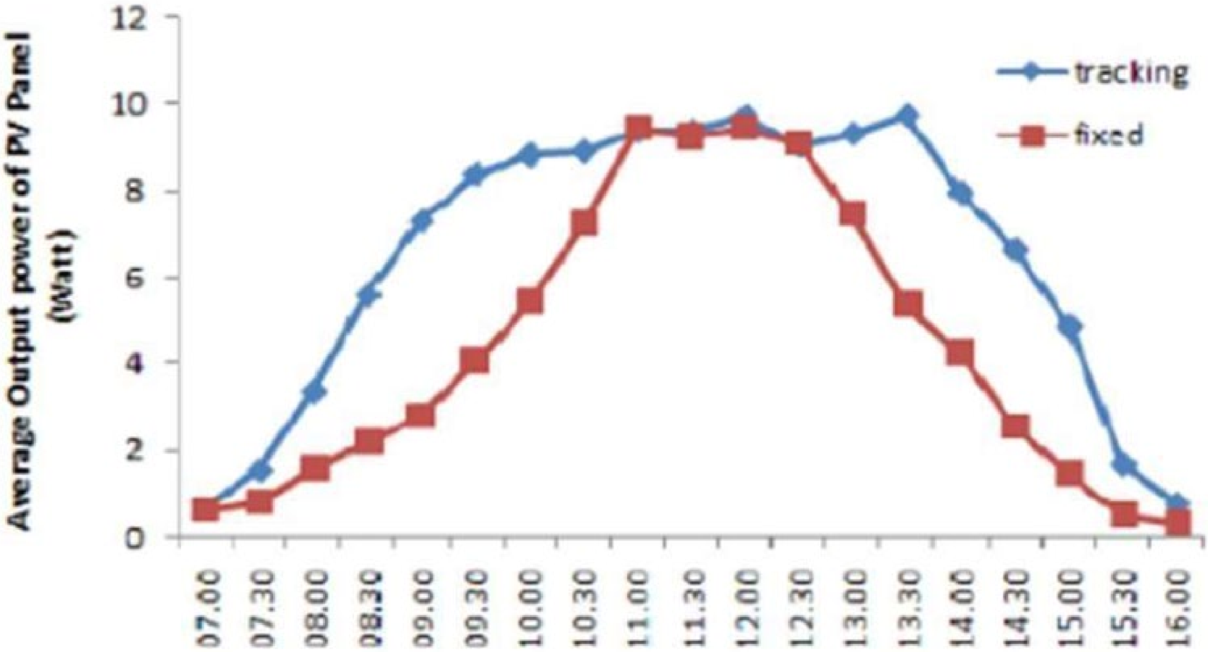

Fig.13-fixed compared to the average output power for a day

PV Panel Tracking for a Month

The experiment was carried out from June 1 to June 30, 2013, and the findings indicated that the temperature, solar intensity, and wind speed were essentially unchanged. The average power of this system has grown by 47.16 percent as compared to the fixed system. This demonstrates that the prototype, especially in Indonesia, a tropical nation with two different seasons, may increase electricity efficiency by more than 47% during the dry season.

AQI Add-ons

Fig.14-The Air Quality Monitor uses the Air Quality Index to provide daily air quality updates (AQI).

You will learn about the state of the environment's cleanliness, the degree of air pollution, and any possible health dangers. The AQI concentrates on possible health consequences that may appear hours or days after inhaling polluted air.

Humidity Sensor

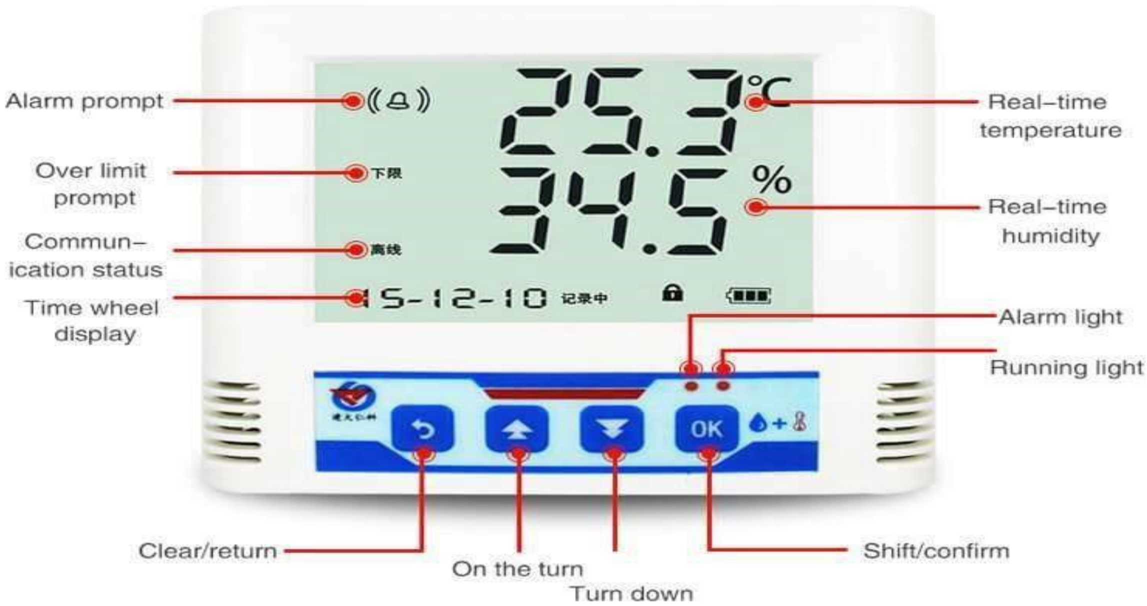

Fig.15-Humidity Sensor Monitor

Moisture Sensor The humidity sensor observes, measures, and reports the relative humidity (RH) of the air and also calculates the quantity of water vapour present in a gas mixture (air) or pure gas.
is used to shield solar panels from sudden temperature fluctuations and precipitation, keeping the panels from being harmed.

IV. CONCLUSION

The experimental findings have shown that the suggested fuzzy logic controller for a solar tracking system performs as predicted. A fuzzy logic controller (one input - one output) was constructed using an ATMEGA 8353 microcontroller to optimise the power gain of the PV panel. The photovoltaic panels' output power reaches a maximum, sometimes surpassing 47% of the fixed panels. Overall, the solar tracking system based on fuzzy logic controllers is an effective source of renewable energy.

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