Efficiency Optimization of Solar PV cell with Implementation of Fuzzy logic and Solar Tracking System

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Abstract: As we know that needs of energy increasing day by day so many technologies have been designed for attainment of this demand, from one of them most popular resource of energy is solar energy. The solar technologies already been developed before several years. But in this paper author using a combination of modules that is single axis and dual axis trackers. By applying single axis technique found that single axis tracker with bifacial modules achieve the lowest power in majority locations so for boosting this researcher want to combine single axis and dual axis tracker. For designing this system double sided solar panel used. Which receives sunlight from two side in lieu of one. Therefore author using this structure for combination of single axis and dual axis sun tracking solar energy system using software MATLAB2017a. In this fuzzy logic controller system decide the timing for tracking the sun. This approach reduce losses and give better efficiency in cloudy as well as unstable climate conditions.

Keywords: Environmental effects, fuzzy logic controller, materials, solar tracking

I. INTRODUCTION

Requirement of power is consistently expanding step by step. The existing station are not capable of meeting future demand. Additionally, it builds, nature contamination prompting a dangerous atmospheric deviation. "Consequently, analysts are looking towards inexhaustible and clean vitality assets. Sunlight based vitality is one of such encouraging spotless and sustainable power source asset" [1-3]. Various photovoltaic (PV) cells interconnected each other comprise a PV board and changes over sunlight based vitality to DC power [1-3]. In order to achieve best effectiveness, Solar board should be put opposite to the Sun and interest for a sun powered global positioning system. It has been seen that a portable PV board passed through Sun tracker created more vitality contrasted with a fixed PV/Solar board [4]. "Two plans are typically followed for sunlight based following: single hub conspire [18] from east to west development of the tracker and double pivot plot [9-17] for both the east to west and north to south development of the tracker. Double hub exhibited more productive than the single hub one. Be that as it may, double pivot conspire for the most part utilizes two engines (DC [9,10,14,15] Stepper [12,13]) set in opposite bearing for an age of two degrees of opportunity prompting complex following techniques and interest for legitimate controller [18-20]. In order to achieve a serious extent of following exactness, a few methodologies have been generally researched. For the most part, they can be use open circle and short circle approach were adopted [17]. In the open-circle following, an investigative recipe or control calculation is utilized. Alluding to the writing [19–21], the azimuth and the rise points of the Sun were controlled by sunlight based development models or calculations at the given date, time and topographical data. The control calculations were executed in a microchip [20,21]. In the shut circle following methodology, different dynamic “sensor devices , for example, charge couple devices (CCDs) or light ward resistors (LDRs)” [21] were used to detect the Sun's position. An input mistake signal was then produced by the

control system to ceaselessly get the greatest sun powered radiation on the PV board. The paper proposes an exact model in this issue. Which is ordered as follows: Section II of this paper presents the various kinds of sun powered global positioning system. Results and conversations have been made in segment VI.

II. CLASSIFICATIONS OF SOLAR TRACKERS AND THEIR ADVANTAGES AND DISADVANTAGES

Sunlight based trackers are a sort of gadget with photovoltaic (PV) boards, which precisely tracks the way of the Sun for the duration of the day.

Ordinarily, a sun oriented global positioning system changes the substance of the sunlight based board or intelligent surfaces to follow the development of the Sun. The development of sun based trackers builds the sun oriented vitality yield by up to 40% than standard boards. Sun powered trackers are progressively utilized in both private and business grade sunlight based boards because of improved and increasingly proficient sun powered catching innovation.

Sun oriented global positioning frameworks can be characterized by the method of their movement. There are tomahawks for a moving surface: two even tomahawks and one vertical hub. The surface can be turned a round every pivot (inclined) to get the correct plot for accepting the greatest daylight. [15,18]When development or modification of the surface occurs by turning around one hub, it is called single-hub following. Then again, when the revolution of the surface occurs around two tomahawks all the while, it is called double pivot following. [19]

Purpose of single hub sun powered trackers System[18-19]

Single-axis trackers for the most part move from the east toward the west and follow the Sun's course. Single-axis trackers have just one point that is utilized as the axis of revolution. This kind of tracker can build power creation by over 30%. These trackers give a productive, straightforward, and minimal effort approach to improve the working of sun based establishments. Additionally, these trackers can improve the presentation of the Sun throughout the late spring and spring seasons, when the Sun is in a higher situation in the sky. The convenience of single-axis trackers, be that as it may, drops as they move farther towards the North. It is on the grounds that the change of the sunlight based edge is higher between the late spring and winter seasons. Additionally, the presentation drops during different seasons for the flat situation of the Sun. At higher scopes, vertical axis trackers work better. [18,19]

Along these lines, sun based clusters or boards can follow the situation of the Sun during winter just as summer.

Presently, let us talk about various sorts of single hub trackers, for example, flat, vertical, inclined, and polar adjusted.

Flat Single hub sun powered trackers (FSAT)

“Even single-axis sun oriented tracker turns from east to west for the duration of the day on a fixed axis which is corresponding to the ground. This sort of tracker is viewed as the most practical tracker geometry in numerous applications. single hub trackers can follow the Sun's development from the morning to night over the sky. A FSHT structure might be bolstered at numerous focuses along the ax axis and in this way requires less multifaceted nature and less material for development than other following geometries. [15,18,19] The flat following geometry is increasingly favored as it lessens the basic material prerequisites by keeping the modules at a moderately low profile to the establishment. Additionally, no uncommon association is expected to turn the system about its focal point of gravity”.[15]

Flat Tilted single hub sun powered trackers (FTSHT)

This sort of single-axis sun based tracker is like the FSHT. Nonetheless, the gadget is introduced at a specific tilt. Inclined axis global positioning systems are moderately more perplexing than even single-axis trackers and generally require a solid establishment. FTSHTs are inclined upward and southward or the northern side of the equator and axis the boards from east to west for the duration of the day to follow the Sun's development. Since FTSHTs are increasingly unpredictable, they might be costly. Additionally, the possible prerequisite to have a solid establishment includes cost. By and large, FTSHTs isn't adaptable, which implies the mechanical parts are not shared between units. Because of this, the expense per board may not be lower in bigger arrays.[14-16]

Perpendicular single hub sun powered trackers [14-15]

Perpendicular single-axis sun based trackers or PSATs turn from east to west after the Sun for the duration of the day. These systems are regularly introduced in high-elevation or sloping areas. [15-16] The profile of PSATs isn't resemble to the ground, due to which it is simpler for these trackers to keep up a reliable edge of sunlight based occurrence when the Sun is lower in the sky. This is especially valuable in northern scopes, for instance, somewhere in the range of 40° and 55°. Be that as it may, in contrast to planar level exhibits, vertical field designs need to oblige the taller profile of the vertical tracker and spread units out to maintain a strategic distance from self-concealing and vitality misfortunes. Accordingly, Perpendicular single-axis trackers will in general have a moderately lower power thickness.

Perpendicular Tilted Single-Axis Solar Tracker (PTSAT)

This kind of tracker is like an even, inclined single-axis tracker. The main distinction is that the tilt is corresponding to an even position and turns on a vertical axis. These trackers can likewise improve vitality gather contrasted with even trackers. In any case, because of the ideal tilt point, the inclined single-axis trackers are liable to expanded breeze stacking contrasted with flat units. In PTSTATs, auxiliary necessities are higher, and subsequently, more steel and cement are utilized contrasted with a flat exhibit.

Returns of single hub sun powered trackers System[14-16]

Single-axis trackers have a solitary level of adaptability that fills in as a axis of turn, which is commonly adjusted along a North-South way. Significant points of interest of single-axis trackers include:

1. single hub trackers are increasingly dependable.

2. single hub trackers has a more drawn out life expectancy than double axis trackers.

3. single hub trackers are less expensive than double axis trackers since they have a basic system and work with ease.

4. single hub trackers are perfect for organizations with a lower financial plan or by and large overcast territories.

5. single hub trackers are about 32.17% effective contrasted with a fixed sun based tracker mount board.

6. These trackers follow the Sun from East to West, giving steady force yield throughout the day.

7. The trackers produce 15-16% higher yearly force when contrasted with a static station of the equivalent introduced limit.

8. single hub trackers give the most elevated thickness of PV board position per square.

9. The compensation period is lesser for the venture of the sun oriented undertaking, and a critical increment in benefits.

Establishment of a sun based global positioning system may require some extra parts and apparatuses to add to the sun based board system, and they require support now and again too.

Purpose of Double-hub Sun powered Tracking System

Double-hub Sun powered trackers have two axis degrees, which are known as the "essential axis" and the "optional axis." The rotational axis can move downwards or upwards to change with the points of the Sun for the duration of the day. Double axis following considers the most exact direction of the sunlight based gadget and is said to give 40% more yield through vitality ingestion. Nonetheless, these sun powered trackers are progressively unpredictable and costly. Double axis trackers constantly face the Sun as they can move in two distinct ways. There are two sorts of height based double axis trackers — tip-tilt and azimuth-elevation. Normally, double axis following is utilized to situate a mirror and divert daylight along a fixed axis towards a fixed recipient. As these trackers track the sun's way vertically and on a level plane, they help get most extreme sunlight based vitality. Azimuth-elevation double axis

trackers can explain the two issues. Be that as it may, these trackers can be costly and add about $3,500–$6,500 to the sun based establishment cost. [20,21]

The capacity of Double-hub Sun powered trackers relies upon vertical and even rotates, which are controller-guided like sun based telescopes. These are very expensive, and their utilization is commonly restricted to sun oriented vitality systems of business grade.

The exact following of double hub sun powered trackers is additionally utilized in an engaged sun oriented application, for example, reflects that immediate daylight collectors and convert daylight into heat.[20]

Returns of the Double-hub Sun powered Tracking System[4,5]

- Double-hub Sun powered trackers follow the Sun ceaselessly and give consistent force yield for the duration of the day.
- These sun based trackers give a sensible arrangement in instances of the constrained force limit of the association with the network.
- Double-hub Sun powered trackers need littler space and give a chance to utilize the rest of the region around for other extra purposes, for example, vehicle leaving, planting, and others.
- These trackers create 45-half higher force yield every year, when contrasted with a static station of the equivalent introduced limit;
- Double-hub Sun powered trackers give the ideal answer for regions that may impede sunlight based efficiency. A portion of these zones could be a muddled structure of the ground, entangled alleviation, stone bulges, drop towards the North, and others.
- The compensation time on venture is lower on account of double hub trackers. Likewise, there will be a noteworthy increment in benefits during their life expectancy.

III. FUZZY LOGIC APPROACH

Fuzzy logic controller has wide scope of utilizations in sustainable power source applications. The utilization of Fuzzy logic controllers has been expanded in the course of the most recent decade on account of its effortlessness, manage uncertain sources of info, needn't bother with a precise numerical model and can deal with nonlinearity [10]. FLC can be utilized as a controller to acquire the greatest force that the PV modules equipped for creating under changing climate conditions. The procedure of FLC can be ordered into three phases, fuzzification, rule assessment and defuzzification..The fuzzification step includes taking a fresh info, for example, the adjustment in the voltage perusing, and joining it with put away enrollment capacity to deliver fluffy data sources. To change the fresh contributions to fluffy information sources, enrollment work must be first doled out for each info. When the participation capacities are allocated, fuzzification take an ongoing sources of info and contrasts it and the put away enrollment work data to create fluffy information esteems. The second step of Fuzzy logicpreparing is the standard assessment where the fluffy processor utiliZOs phonetic guidelines to figure out what control activity ought to happen in light of a give set of info esteems. The consequence of rule assessment is a fluffy yield for each sort of subsequent activity [18-19]. The last advance in Fuzzy logichandling in which the normal estimation of a yield variable is determined by secluding a fresh incentive known to mankind of discource of the yield fluffy sets . [5] In this procedure, the entirety of the fluffy yield esteems successfully alter their individual yield enrollment work. One of the most regularly utilized defuzzification procedures is called Center of Gravity (COG) or centroid technique. Fuzzy logiccontroller has been utilized for following the most extreme intensity of PV systems since it has the points of interest with the way things are powerful, moderately easy to plan and doesn't require the information on an accurate model [10-11]. In this paper, another technique based FLC is proposed to accomplish following the most extreme intensity of the PV module under changing the climate conditions.

"The influential around MPP is diminished and the reaction is quicker in contrasted and the customary P&O strategy. The proposed contributions of the FLC are the adjustment in the voltage of the PV module (Δv) and the adjustment in the intensity of the PV module (ΔP)".[19-21]

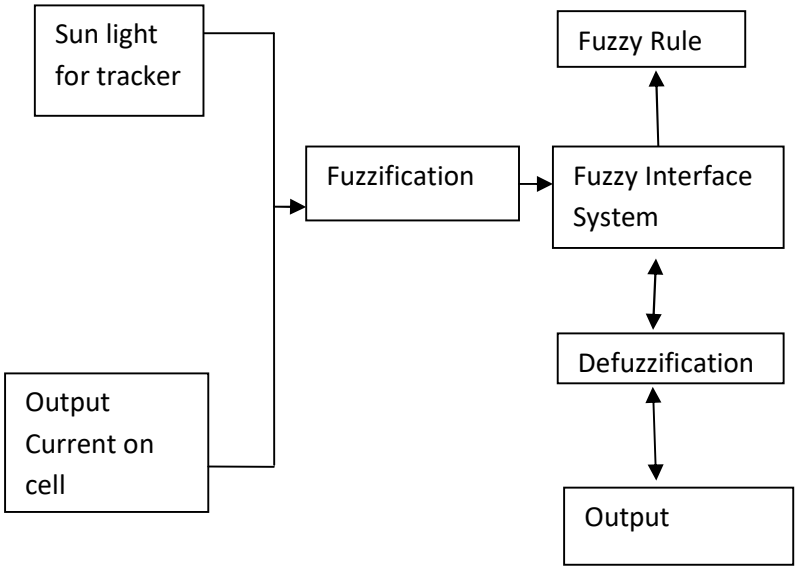


Fig 1 flowchart for solar tracking with fuzzy approach

IV. SIMULATION PARAMETERS[19]

Table -1 simulation parameters

I_{sc}(A)	7.34A
V_{OC}(V)	0.6V
R_S	0.221ohm
R_{SH}	415ohm
N_S	36
Temp	25+273 C
Quality factor(N)	1.2
Irradiance	100, 500, 1000 w/m^2

"A simple model of Solar tracking with PV array including fundamental component of voltage and current source, with fuzzy logic controller is modeled in simulink tool . this simulation is based on basic equation of solar tracking at different parameters. For understating this here we are using simple and step wise technique of fuzzy logic controller system. Firstly add the input and output variable after that set limit and make the rule, finally we get fuzzy rule view and surface."[19]

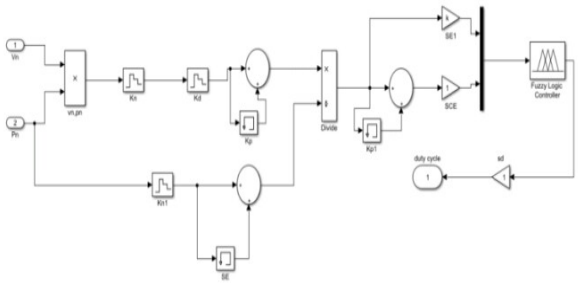
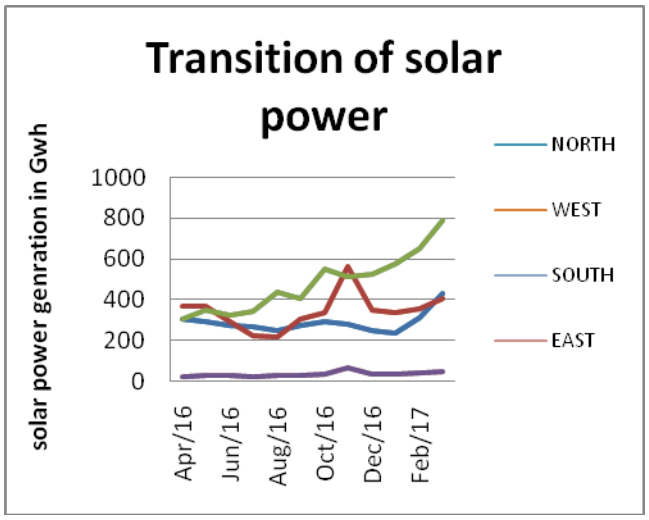


Fig-2 model in simulink

V. SOLAR POWER GENRATION

"Solar power in India is fast developing industry. As on sep 2017 the country solar grid had a cumulative capacity of 16.20GW. In the given chart solar power generation of India, Canada, USA is as follows"[19]

"India quadrupled its solar-generation capacity from 2,650 MW on 26 May 2014 to 12,289 MW on 31 March 2017. The country added 3.01 GW of solar capacity in 2015-2016 and 5.525 GW in 2016-2017, the highest of any year, with the average current price of solar electricity dropping to 18% below the average price of its coal-fired counter part".[19]



"Graph shown in above fig represents the solar power generation in India in various region from april-2016 to march-2017. In this graph absorbed that power generation is decreasing till January 2017 but from feb 2017 its increasing. This represents the transition rate of solar power"[19].

VI. RESULTS AND DISCUSSION

This is overall setup of the system for data collection which includes PV module, fuzzy based MPPT and load. In given table resultant data procure the advanced system for various conditions of whether and the movement of sun at different positions. For calculating this fuzzy logic model is used and fuzzy rules are described here in which 7*7 matrix are described with 49 rules where (NL) negative large,(NM) negative medium , (NS) negative small, (ZO) Zero, PL,PM,PS are respectively positive Large, positive medium , positive small.

Table -2 fuzzy rules for solar tracking

V/P	NL	NM	NS	ZO	PS	PM	PL
NL	ZO	ZO	ZO	NL	NL	NL	NL
NM	ZO	ZO	ZO	NM	NM	NM	NM
NL	NS	ZO	ZO	NS	NS	NS	NS
ZO	NM	NS	ZO	ZO	ZO	PS	PM
PS	PM	PS	PS	PS	ZO	ZO	ZO
PM	PM	PM	PM	ZO	ZO	ZO	ZO
PL	PL	PL	PL	ZO	ZO	ZO	ZO

Fig-3 fuzzy rule view

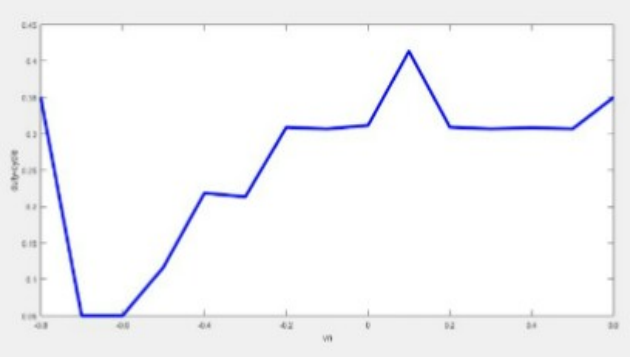


Fig-4 voltage at different point

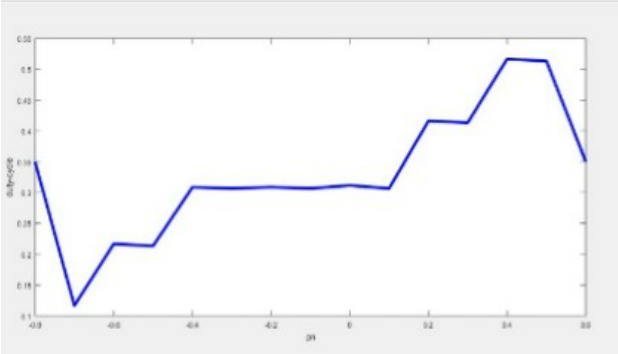


Fig-5 power at different positions

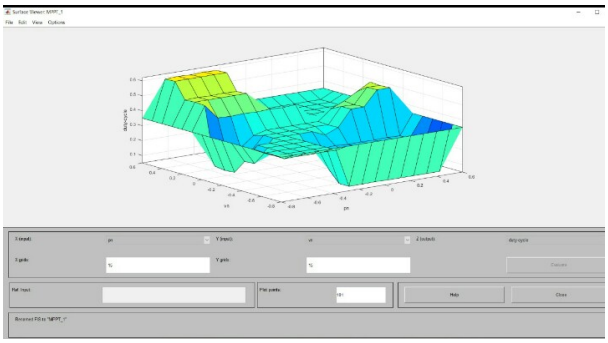


Fig-6 fuzzy surface with different rules

Above figures represents the fuzzy technique in maximum power point tracking system which includes the rule view, voltage, current at different levels and generate the output surface. It can be designed at different levels of tracking point of solar energy with help of fuzzy logic controller system.

VII. CONCLUSION

A multipurpose and precise strategy of PV module with Fuzzy logic based MPPT system has been structured in this manuscript. The primary work in this manuscript were to diminish difficulties of PV displaying and to execute the fuzzy strategy in a effortless manner to manage the following legitimately. The graphical portrayal as for different ecological conditions shows the following capacity and dynamic reaction of structure with Precise control of obligation phase. So it tends to be over that usage of this system will expand the PV system proficiency with a surprising exhaustion in system cost. That representation can be utilized as basic stage for a network associated PV plant, sun oriented siphoning system and keen matrix PV interconnection system.

VII. FUTURE SCOPE

Solar trackers, be it single-hub or dual-hub, can help produces the best quality of sun power. So this is very major part to decide which type of tracker is satisfactory. For taking in consideration various factors, including different weather conditions. If you want to assemble the solar panel then many things you have to keep in mind such that budget, limitations of your client, weather and longevity of structure. you require to observe the input factors for preparing the true judgment. The advertise is foresee to augment at a CAGR of 14.1% by 2025 because of the developing interest for sun oriented cells or photovoltaic cells. This development fee is relied upon to proceed in the upcoming time.

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