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# Literature Survey on Solar Power Prediction System

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**ABSTRACT:** Solar power, without a doubt, is the cleanest energy in the world and is being used as a renewable energy since years ago. Residential that uses solar power as their alternative power supply will bring benefits to them. The main objective of this project is to develop an automatic solar tracking system which will keep the solar panels aligned with the Sun in order to maximize in harvesting solar power. The system tracks the maximum intensity of light. When the intensity of light is decreasing, this system automatically changes its direction to get maximum intensity of light. This application calculates and generates the sun's position according to their geographic location (GPS coordinates).Finally, the project is able to track and follow the Sun intensity in order to get maximum power. The main modules include location fetcher, climate fetcher and prediction logic

**KEYWORDS:** solar tracking, PV, Machine Learning, GPS.

## I. INTRODUCTION

As part of an environmental approach, the world is moving towards the discovery of new clean (green) energy resources that are both renewable and have less negative impact on the environment. The solar energy is one among this green resource. Several techniques and systems had been developed to collect this energy on a higher scale by maximizing the concentration of the solar irradiance. One well-known type of solar tracker is the heliostat, a movable mirror that reflects the moving sun to a fixed location, but many other approaches are used as well.

In last ten years, many of residential around the world used electric solar system as a sub power at their houses. This is because solar energy is an unlimited energy resource, set to become increasingly important in the longer term, for providing electricity and heat energy to the user. Solar energy also has the potential to be the major energy supply in the future. Solar tracker is an automated solar panel that actually follows the Sun to increase the power [1]. The sun's position in the sky varies both with equipment over any fixed position. Active trackers use motors and gear trains to direct the tracker as commanded by a controller responding to the solar direction. The solar tracker can be used for several application such as solar cells, solar day-lighting system and solar thermal arrays . The solar tracker is very useful for device that needs more sunlight for higher efficiency such as solar cell. Many of the solar panels had been positioned on a fixed surface such as a roof. As sun is a moving object, this approach is not the best method. One of the solutions is to actively track the sun using a sun tracking device to move the solar panel to follow the Sun. With the Sun always facing the panel, the maximum energy can be absorbed, as the panel is operating at their greatest efficiency [4]. The large scale solar tracker that normally used is not suitable for the residential use.

The power generated from PV systems is highly variable as it depends on the solar irradiance and other meteorological conditions. The uncertainty in solar power generation may lead to unnecessary increase in the spinning reserve and operational costs. This motivates the need for accurate forecasting of the generated solar power at different time intervals to ensure the stability of the grid by balancing the demand and supply, while keeping the costs low. Different approaches for forecasting the power generated from PV systems have been proposed. They are based on statistical methods such as liner regression and autoregressive moving average , and machine learning methods such as Neural Networks (NNs) [2,8], nearest neighbor [5] and Support Vector Regression (SVR) . Most of the previous work focused on developing general prediction method for all types of weather conditions.

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## II. RELATED WORK

The purpose of this document is to present a classification method for solar power prediction systems We wish to be able to use this method as a research and innovation tool, useful for selecting the optimal system during the stage of technological development of the new systems and during the stage of development of the opportunity and feasibility studies, and of the business plans on the development of new production capacities of solar energy.

A Design of Single Axis Sun Tracking System[1], main objective for this project is to develop the sun tracking solar system model which is a device that follow the movement of the Sun regardless of motor speed. Beside that, it is to improve the overall electricity generation using single axis sun tracking system and also to provide the design for residential use. LDR or light dependent resistor has been chosen as the sensor because LDR is commonly used in sun tracking system. This is because LDR is sensitive to the light.

The resistance of LDR will decreases with increasing incident light intensity [9]. For the controller, PIC18F877A had been chosen. This PIC programming will give the pulse to the driver to move the motor. For the driver, bidirectional DC motor control using relay has been used. The motor controller had been chosen because it can control the motor to rotate clockwise and counter-clockwise easily. DC geared motor also been chosen because it has a hold torque up to 24 kg.cm and low rpm. Last but no least, LM7805 issued to convert the input voltage from the source to 5 V output because integrated circuit only need 5 V to operate.

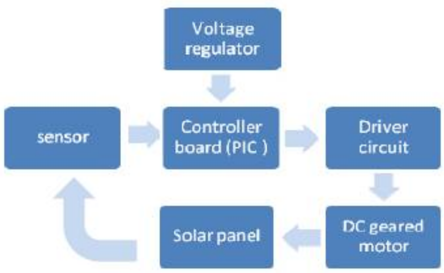


Figure 1: Single Axis sun tracking system

Solar tracking systems for solar concentrator field of heliostats - Innovation, performance and adaptation to small-scale applications[2] The choice of this system is based on several scientific studies and is focused on solar tracking with two-axis. Different mathematical models and simulations have been developed and used to determine: i) the position [1] of the sun relative to a geographic position of an observer, ii) the angular position of the heliostats, and iii) the set of equations modelling the geometry of shadows and the blocking effect between the heliostats. This allows to the geometry optimization of the field in order to obtain the best compromise between productivity heliostats and the land occupied by them, which aim to minimize the cost of energy.

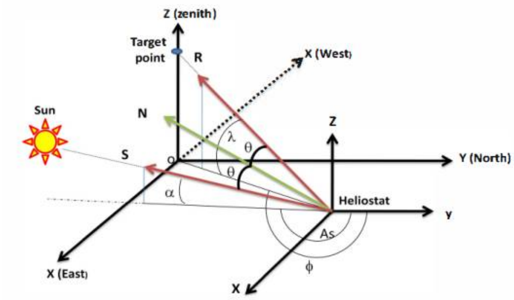


Figure 2: Sun tracking using coordinates

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This mechanical system is the medium carrying the heliostats that follow the sun throughout the day (rotational drive on two axes). The characterization of this system is summarized up in the fact that the design is simple as it is shown in the figure 2 below. In other words, it offers an easy rotational movement, a good stability; and an optimization in terms of weight and size; as it orientates the heliostats with accuracy. This latter characterization of the mechanical system is the most essential element for a better tracking. The rotation on two axes is carried out using two low-power motors.

Power Management Strategy Based on Weather Prediction for Hybrid Stand-alone System [3] is a Stand-alone hybrid generation system that is usually used to supply remote areas or locations interconnected to a weak grid. They combine several generation modules, typically assimilating different renewable energy sources. In this work, a wind-solar system is considered as main energy source. A lithium-ion battery bank is used to overcome the periods of poor production. In fact, the battery operates as secondary source for supplying the power deficit caused by the dynamic power balance [12]. In addition to these sources a *DE* is used as backup source.

To achieve our objective, a management strategy based on three steps to control this multi-source system is considered. The first step consists of the prediction of both renewable potential energy available to the location site and the power consumption of the house over a given prediction time horizon. The prediction of weather conditions is important to ensure uninterrupted power supply of the load. Indeed, it takes into account the future changes of climatic conditions that can affect the good working of the system and also to anticipate critical situations. This prediction also allows reducing the needless solicitations of the backup source which is represented by the *DE* and consequently extends its lifetime. The second step consists in generating the power references for the *PV*, the *WG* and the *BS* sub-systems in order to generate enough energy to satisfy the load demand by taking into account the potential energy available for each source. The power reference generation depends on many parameters such as available energetic potential, maximum power variation supported by the conversion system, charge and discharge battery current, etc. The third step is to design a controller for each subsystem allowing to track the power references. Note that this part is not discussed in this paper, but the readers can refer to our previous works for details [1].
In order to give an overview of the control tools presented in this paper, figure shows a general view of the considered strategy.

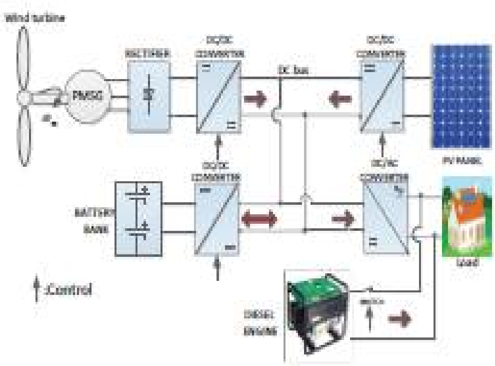


Figure 3: Hybrid stand alone system

Design of a Solar Power Management System for an Experimental UAV[4] is designed to obtain electric energy from the solar system and to make the required power available for the on-board computers and other electronic circuitries for an experimental UAV. The electric power generated from the solar cells depends on the temperature and the solar radiation conditions and the load electric characteristics. MPPT is often used in photovoltaic systems to maximize the solar panel output power, irrespective of the temperature and irradiation conditions and of the load electrical characteristics[21]. The battery management system monitors and controls the storage and delivery of the energy drawn from the solar panels. The system block diagram of the battery management system is shown in Figure. The system consists of three major subsystems, namely the lithium battery modules, an auto-ranging power converter, and a charge controller. The input power of the battery management system comes from the output of the MPPT system.

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The output of the battery management system supplies the required power to the power conversion system (the last stage of the power management system) to provide all the required power for the on-board computers and other electronic circuitries

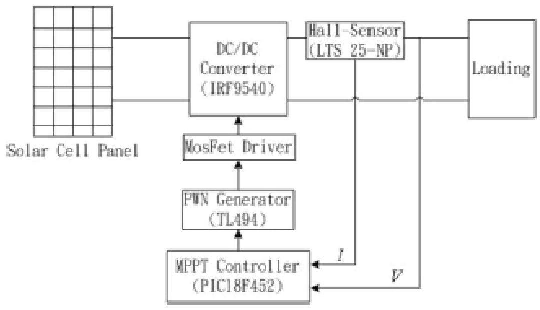


Figure 4: MPPT system

Multicriterial Analysis on Selecting Solar Radiation Concentration Ration for Photovoltaic Panels Using Electre-Boldur Method[5],In this paper, the technical criteria shall be chosen based on the ELECTRE-Boldur Method. ELECTRE acronym stands for the initials of the method's name: ELimination Et Choix Traduisent la REalite Elimination and Choice Expressing Reality[7]. The ELECTRE-Boldur Method was proposed by teacher Gheorge Boldur-Lescu. In order to simplify and make the method operational in the meaning of the theory of utility, the author proposed the use of certain normalized concordance and discordance coefficients. These coefficients are calculated based on utilities "Uij" estimated for the consequences "aij" from the decision making matrix ''A'', according to the procedure Neumann-Morgenstern [8].

In our opinion, applying the ELECTRE-Boldur method involves ten steps, as presented below:

*Step 1*: Establishing the decision-making variants. In this stage, the set of alternatives that can be applied shall be identified, while the data shall be written in the alternatives matrix A = [Ai]. Where i = 1...n, represents the number of alternatives.

*Step 2*: Establishing the decision-making criteria. Here we shall identify the criteria (objectives) that shall be used for the selection of the alternatives, while the data shall be written in the decision criteria matrix C = [Cj]. Where j = 1...m, represents the number of criteria.

*Step 3*: Filling in the performance matrix, where the performance of the alternatives shall be identified for each criterion, and the data shall be written in the performance matrix P = [Pij].

*Step 4*: Calculating the utilities and filling in the utility matrix. The calculation of utilities shall be made based on the performance of alternatives while using the method created by von Neumann and O. Morgenstern in 1947 [9]. One shall estimate the utility for each criterion alone or for the entire decision table, thus obtaining the multicriterion utility matrix U = [Uij] [8].

Depending on the nature of the criteria, the utilities will be calculated according to the following formulas

Maximizing criteria:

$$uij = \frac{aij - a\min j}{a\max j - a\min j}$$

Minimizing criteria:

$$uij = \frac{a\max j - aij}{a\max j - a\min j}$$

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State of the Art on Small-Scale Concentrated Solar PowerPlants[6],In SS Solar Plants for off-grid applications are seen as promising technologies to be applied in remote areas. Some countries, like Australia, decided of investing, above all, on solar hybrid mini-grids based on PVs [76]. However, CSPPs remain an interesting alternative to PV based small plants even if the technologies cannot participate in the market at competitive conditions yet. Among them, some SS-CSPP are based on technologies at medium-temperature, like PTC-ORC plants. They can be designed also in low-technology, robust and cheap arrangements like the demonstrator installed in Lesotho. Obviously, performance of such plants are quite low. On the contrary, SS-CSPPs based on technologies at high temperature, like PDC-Stirling engines, reach high-performance (up to 30% efficiency) and reduce the overall plant footprint. However, system reliability and maintainability have to be improved to make them more attractive for installation in rural areas.

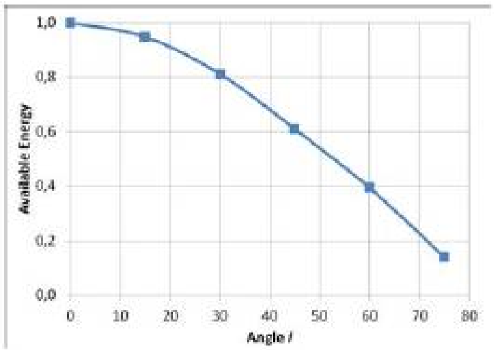


Figure 5: Available energy Vs angle i respect maximal available

Optical Performance of Horizontal Single-Axis Tracked Solar Panels[7] In a specific site, the annual collectible radiation on a full 2-axis tracked panel is largest as compared to fixed or single-axis tracked panels, and is a constant statistically over many years, but the annual solar gain on a traditional fixed south-facing panel, S0, is a function of its tilt-angle, and an optimal tiltangle, *opt* , 0 β , could be obtained by repeatedly calculating S0 for different tilt-angles until a maximum annual collectible radiation, S0,max, is found. For HA-tracked solar panels, the annual solar gain, Sha, is a function of the orientation angle, φ , of the sun-tracking axis. Results obtained in this work indicated that the annual collectible radiation on HA-tracked solar panels was related to the orientation of the tracking axis, the EW-axis sun-tracking was worst to boost the energy collection of tracked panels and the SN-axis sun-tracking was best.

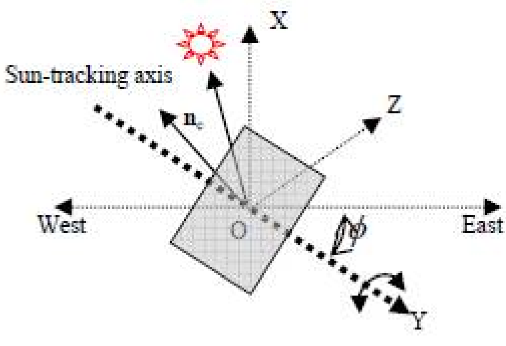


Figure 6: Single axis tracking

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## III. CONCLUSION

In this paper we made a comprehensive review about various solar power prediction systems, as well as its organizational structure. This paper also covered how a Solar tracking system works with methods like weather prediction, Axis tracking, using Heliostats etc. And tells how the system is able to track and follow the Sun intensity in order to get maximum power. These system only focuses in tracking of Sun intensity. These systems can be applied in the residential area for alternative electricity generation especially for non-critical and low power appliances. In this contest, small concentration systems present many performance issues and there are limitations in manufacturing quality. As we already mentioned above, this paper tries to fill a gap in the field of selection between different solar power prediction systems from the point of view of its tracking ability.

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