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Mechanical Solar Tracking System using proposed least square Methods

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ABSTRACT

Discovering energy sources to fulfill the world's developing interest is one of society's preeminent difficulties for the following 50 years. Despite the fact that utilizing sun-tracker isn't fundamental, its utilization can support the gathered energy 10–100% in various timeframes and geological conditions. Be that as it may, it isn't prescribed to utilize following framework for little solar panels due to high energy misfortunes in the driving frameworks. It is discovered that the power utilization by GPS beacon is 2– 3% of the expanded energy. In this Thesis ALS (Alternative least square) of sun-following frameworks are surveyed and their cons and masters are talked about. Utilization of solar energy either PV panels or concentrated solar power (CSP) to produce electrical energy is ending up more well known. The majority of the solar panels that had been utilized have a static course. This work is about an examination that built up a "Solar Tracking System" utilizing different strategies, for example, Traditional, ALS (Alternative least square) and Solar Orientation in light of Location and Time.

Keywords: Solar energy, Photovoltaic panel, solar tracker, Alternative least square etc.

I. INTRODUCTION

1.1. Background

The majority of the piece of India gets 4-7 kilo-Watt long stretches of solar radiation per square meter every day with 250-300 bright days in multi year. The most noteworthy radiation energy is gotten in western Rajasthan while the North Eastern area of the nation got the least yearly radiation. Yearly solar radiation at the world's surface is more than 10000 times add up to essential worldwide energy utilization. Add up to worldwide essential energy utilization is not as much as the solar radiation episode at the world's surface in 60 minutes. As indicated by showcase economy, the expanding overall interest for energy, powers a constant ascent on the cost of fossil combustibles.

A few variables must be considered while deciding the utilization of trackers. A portion of these include: the solar technology being utilized, the measure of direct solar illumination, feed-in levies in the area where the framework is sent, and the cost to introduce and keep up the trackers.

Solar energy: It is a brilliant light and warmth from the Sun saddled utilizing a scope of regularly developing advancements, for example, solar warming, photograph voltaic, solar warm energy, solar engineering and fake photosynthesis. It is a critical wellspring of sustainable power source and its innovations are comprehensively portrayed as either inactive solar or dynamic solar relying upon the way they catch and circulate solar energy or change over it into solar power .It has been assessed that the utilization of a following framework, over a settled framework, can build the power yield by 40%-70%. Plan prerequisites are:

i) amid the time that the sun is up, the framework must take after the sun's situation in the sky.

ii) It ought to be absolutely programmed and easy to work [9].

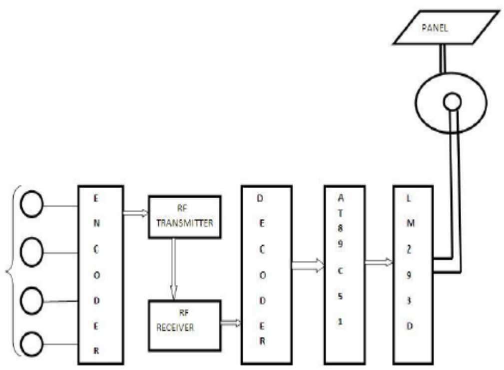

Figure 1.1: The block diagram of the system

1.1.1. SINGLE AXIS

Solar trackers can either have an even or a vertical hub. The even kind is utilized as a part of tropical districts where the sun gets high at twelve, yet the days are short.

1.1.2. DUAL AXIS

Solar trackers have both a level and a vertical pivot and in this way they can track the sun's obvious movement basically anyplace on the planet. CSP applications utilizing double hub following incorporate solar power towers and dish (Stirling motor) frameworks.

Figure 1.2: single axis solar tracker

Figure 1.3: dual axis solar tracker

1.2. Types of tracker

There are different kinds of solar tracker; some of them are as said below:

• Horizontal axle solar tracker

• Vertical axle solar tracker

• Passive trackers

• Chronological tracker

1.2.1Horizontal axle solar tracker

In this kind of following framework a long flat tube is bolstered on bearing mounted upon the tube and the tube will pivot on the hub to track the clear movement of the sun as the day progressed. As they don't tilt towards the equator so in this manner they are not that much powerful in amid the winter late morning (except if situated close to the equator), yet these following framework are particularly profitable in amid the spring and summer season when the solar way is high in the sky.

1.2.2 Vertical axle solar tracker

In this sort of following framework the panels are mounted on a vertical hub at a settled, customizable or following height point. Such trackers with settled or (conveniently) movable points are reasonable for high elevations. This is on account of at high scopes the clear solar way isn't particularly high yet which prompt long days in summer, with the sun going through a long circular segment.

1.2.3 Altitude azimuth solar tracker

Here the mounting is done in such a route along these lines, to the point that it bolsters the whole weight of the solar tracker and enables it to move in the two bearings and find a particular target.

1.2.4 Two-axis mount solar tracker

In two hub mount, one hub is a vertical turn shaft or even ring mount that enables the gadget to be swung to a compass point. The second hub is a level height turn mounted upon the azimuth stage. Utilizing this mix of the two hub any area in the upward side of the equator can be pointed. Such framework needs PC control or following sensor to control engine drives that arrange the panels toward the sun.

1.3.5 Multi-mirror reflective unit

This gadget utilizes different mirrors in a flat plane to reflect daylight upward to a high temperature photovoltaic or other framework requiring concentrated solar power. Just two drive frameworks are required for every gadget. As a result of the setup of the gadget it is particularly suited for use on level rooftops and at low elevations.

1.3.6 Active tracker

It utilizes engines and rigging trains to coordinate the tracker toward the sun. a controller is utilized to control the engines and the apparatus prepares so it moves likewise and the board faces the sun the correct way required. The dynamic two pivot tracker utilizes a heliostat – versatile mirror that mirrors the daylight towards the safeguard of a focal power station, or a light sensor to track the sun.

1.5. TRACKER COMPONENTS

The primary components of a following framework are as per the following:

1. **Sun tracking algorithm:** This calculation computes the solar azimuth and apex points of the sun. These edges are then used to position the solar board or reflector to point toward the sun. A few calculations are absolutely scientific in view of galactic references while others use constant light-force readings.

2.**Control unit**: The control unit executes the sun following calculation and directions the development of the situating framework.

3.**Positioning system**: The situating framework moves the board or reflector to confront the sun at the ideal points. Some situating frameworks are electrical and some are water powered. Electrical frameworks use encoders and variable recurrence drives or straight actuators to screen the present position of the board and move to wanted positions.

4.**Drive mechanism/transmission**: The drive systems incorporate direct actuators, straight drives, water powered barrels, and swivel drives, worm gears, planetary apparatuses, and strung shafts.

1.6. TRACKER CONTROL ALGORITHMS

Shut circle frameworks track the sun by depending on an arrangement of focal points or sensors with a constrained field of view, coordinated at the sun, and are completely lit up by daylight consistently. As the sun moves, it starts to shade at least one sensors, which the framework distinguishes and enacts engines or actuators to move the gadget once more into a position where all sensors are indeed similarly enlightened.

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II. RELATED WORK

Tudorache, Oancea, and Kreindler (2012) contrasted the solar following PV board and a settled PV board as far as electric energy yield and productivity. The proposed gadget naturally looks through the ideal PV board position as for the sun by methods for a DC engine controlled by a smart drive unit that gets input signals from devoted light force sensors. The solar following PV board delivered more energy than settled one with around 57.55%. Bione, Vilela, and Fraidenraich (2004) looked at the pumping frameworks driven by settled, following and following with fixation PVs. The outcomes demonstrated that for a given irradiance, the pumped water stream rate was altogether not quite the same as each other.

Liu et al. (2013) talked about the impact factors examination of the best introduction with respect to the sun for double hub sun following. In this exploration work distinctive sorts of following frameworks were surveyed, for example, settled board, single pivot following in east-west, single hub following in north-south, and double hub following utilizing both tip-tilt and elevation azimuth following.

Arbab, Jazi, and Rezagholizadeh (2009) actualized a PC following arrangement of solar dish with two-pivot degree flexibilities in light of picture preparing of bar shadow. The plan depended on PC picture handling of a bar shadow to get the advanced picture of solar dish relocations. The framework was autonomous to geological area of the solar dish and periodical changes like day by day or month to month controls. Tune et al. (2013) actualized a high exactness double pivot following framework in light of a mixture procedure intended for concentrated daylight transmission by means of filaments.

Ray et al. (2012) exhibited two different ways of pivoting flexibility solar tracker by utilizing microcontroller. The work incorporated the outline of a two different ways turning opportunity solar tracker in view of microcontroller.

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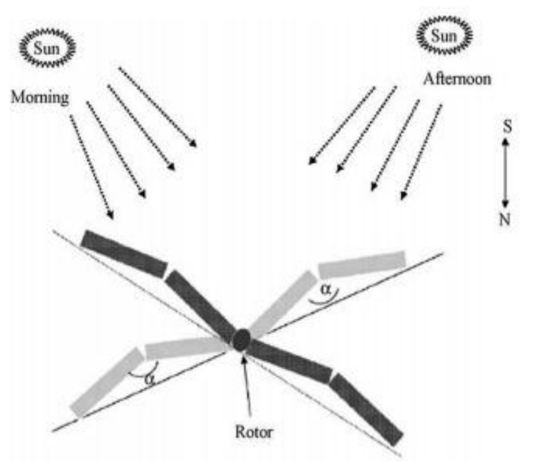

2.5:Position of PV modules in the forenoon and afternoon

Wang and Lu (2013) proposed the outline and usage of a sun tracker with a double pivot single engine for an optical sensor-based photovoltaic framework. This work proposed a novel plan of a double hub solar following PV framework which uses the criticism control hypothesis alongside a four-quadrant light ward resistor sensor and straightforward electronic circuits to give powerful framework execution. The proposed framework utilized an extraordinary double hub AC engine and a remain solitary PV inverter to achieve solar following.

III. SYSTEM MODEL

3.1 ALS (Alternating Least Squares)

Alternating Least Squares (ALS) algorithm is used to train the data. It will use various combinations of the following parameters to get the best compromise between variance and bias:

- Rank: The number of unknown factors that led a user to give a rating. These could include factors such as age, gender, or location. The higher the rank, the better the recommendation will be, to some extent. Starting at 5 and increasing by 5 until the recommendation improvement rate slows down, memory and CPU permitting, is a good approach.
- Lambda: A regularization parameter to prevent over fitting, represented by high variance, and low bias. Variance represents how much the predictions fluctuate at a given point, over multiple runs, compared to the theoretically correct value for that point. Bias represents how far away the generated predictions are from the true value trying to predict. Over fitting happens when the model works well on training data using known noise but doesn't perform well on the actual testing data. The higher the lambda, the lower the over fitting but the greater the bias. Values of 0.01, 1 and 10 are good values to test.

The following diagram shows the relationship between variance and bias. The bullseye represents the value that the algorithm is trying to predict.

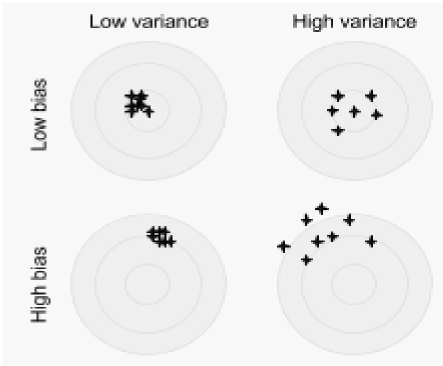

Figure 3.1: Variance versus Bias (best is on the top left)

3.2 Alternating least-squares estimator

A. General low-rank matrix reconstruction

We begin by considering the case of reconstructing X∈Xr. Using a weighted least-squares criterion, the estimator is

$$\hat{\mathbf{X}} = \arg\min_{\mathbf{X}\in\mathcal{X}_r} \|\mathbf{y} - \mathcal{A}(\mathbf{X})\|^2_{\mathbf{C}^{-1}}. \quad (3.1)$$

For brevity we assume spatially uncorrelated noise, $C = \sigma^2 I_m$, without loss of generality. Then minimizing the ℓ2-norm is equivalent to (3.1). For general C the observation model is pre-whitened by forming $y^{-} = C^{-1/2} y$ and $A^{-} = C^{-1/2} A$.

Since $X \in X_r$, we express X = LR where $L \in C^{n\times r}$ and $R \in C^{r\times p}$. Then the square of the measurement residual can be written as

$$\begin{aligned} J(\mathbf{L},\mathbf{R}) &\triangleq \|\mathbf{y} - \mathcal{A}(\mathbf{LR})\|_2^2 \\ &= \|\mathbf{y} - \mathbf{A}(\mathbf{I}_p \otimes \mathbf{L})\mathrm{vec}(\mathbf{R})\|_2^2 \\ &= \|\mathbf{y} - \mathbf{A}(\mathbf{R}^\top \otimes \mathbf{I}_n)\mathrm{vec}(\mathbf{L})\|_2^2. \end{aligned} \quad (3.2)$$

The cost J(L, R) is minimized in an alternating fashion by the following steps:

• minimizing R with a fixed L,

• minimizing L with a fixed R.

In the new algorithm, the alternating minimization is performed through iterations. Starting with an initial L, the iterations continue as long as the decreasing trend of J(L, R) is observed. Given L, the minimizer of R is computed by vec(Rˆ) = [A(Ip⊗L)]†y and similarly, given R, the minimizer of L is computed by vec(Lˆ) = [A(RT⊗ In)]†y.

B. Structured low-rank matrix reconstruction

Next, we consider a structured low-rank matrix X ∈Xr, and develop an ALS for a known matrix structure in Algorithm 1. In the algorithm, for each iteration, we approach the LS problem by first relaxing the structural constraint, and compute R with a fixed L. Then, to impose the structural constraint on R, the low-rank matrix estimate is projected onto the set of structured matrices by X , P(LR), similar to 'lift and project' [15]. R is subsequently modified as the least-squares solution of X ,

$$\min_{\mathbf{R}} \|\mathbf{LR} - \bar{\mathbf{X}}\|_F^2. \quad (3.3)$$

L is updated in the same fashion.

After estimating the gradient vector we get a relation by which we can update the tap weight vector recursively as:

$$w(n+1) = w(n) + \mu u(n)[d*(n) - u^h(n)w(n)]. \quad (3.6)$$

Where μ is the step – size parameter

$\mu^h(n)$ = Hermit of a matrix u

$d*(n)$ = Complex Conjugate

We may write the result in the form of three basic relations as follows:

1. Filter output:

$$y(n) = w^h(w)u(n). \quad (3.7)$$

2. Estimation error or error signal:

$$e(n) = d(n) - y(n). \quad (3.8)$$

3. Tap weight adaptation:

$$w(n+1) = w(n) + \mu u(n)e*(n). \quad (3.9)$$

Equations (3.8) and (3.9) define the estimation error $e(n)$, the computation of which is based on the current estimate of the tap weight vector $w(n)$. Note that the second term, $u(n)e*(n)$ on the right hand side of equation (3.9) represents the adjustments that are applied to the current estimate of the tap weight vector $w(n)$.

IV. RESULT & IMPLEMENTATION

4.1 SOFTWARE IMPLEMENTATION OR SIMULATION (TOOL)

Basically MATLAB is cast-off as an experimental and simulation software for the configuration of system established up & for location up the data transmission among various nodes existing in the set-up. MATLAB is an essential software design & commands are used as a replication device.

4.2SIMULATION RESULT

People in underprivileged countries could benefit from the use of a solar tracking generation system. At maximum, the solar tracker was perpendicular to the light source by 1.5 degrees.
Solar power generation had been used as a renewable energy since years ago.When the intensity of light is decreasing, this system automatically changes its direction to get maximum intensity of light. Track Etch rate detector is used to trace the coordinate of the Sun. While to rotate the appropriate position of the panel. The system is controlled by two relays as a driver and a microcontroller as a main processor. This project is covered for a single axis and is designed for residential usage. Finally, the Thesis is able to track and follow the Sun intensity in order to get maximum power at the output regardless motor speed.

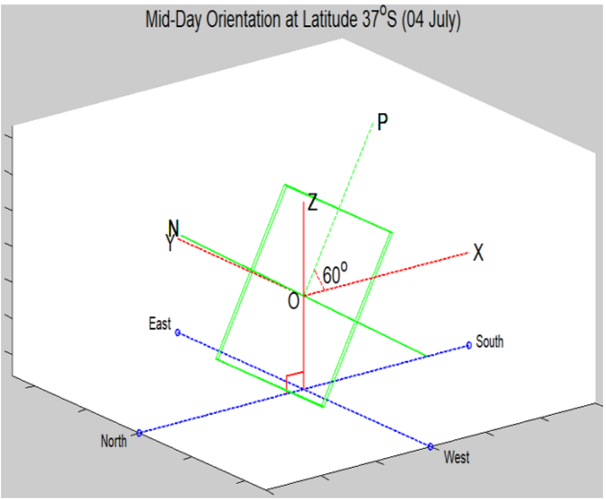

Figure 4.1: Mid-Day orientation at Latitude 37° S (4 July)

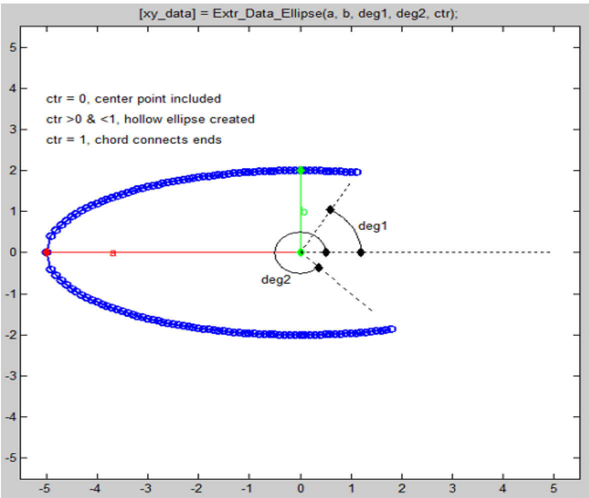

Figure 4.2: [xy_data]=Extr_Data_Ellipse (a, b, deg1, deg2, ctr);

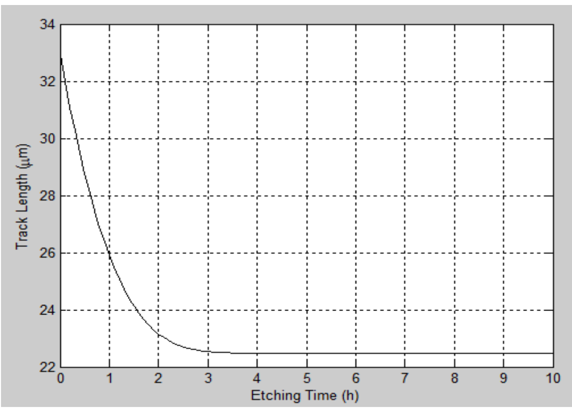

Figure 4.3: Track Length over Etching Time (h)

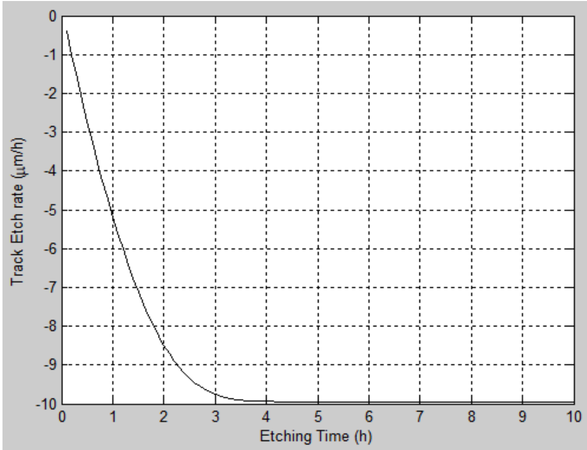

Figure 4.4: Track Etch rate over Etching Time (h)

V. CONCLUSION

In this research, solar tracking system reached up to the movement of Track Etch rate. Due to higher cost we couldn't afford a solar cell. When there is decrease in intensity of light, this system automatically changes its direction to get maximum intensity of light. Single Axis Sun Tracking Solar System model is developed by considering given specification. The system is able to track and follow the Sun intensity in order to get maximum power at the output regardless motor speed. Besides, low speed has been used for neglecting sun speed parameter and therefore the system only focuses in tracking of Sun intensity. The system can be applied in the residential area for alternative electricity generation especially for non-critical and low power appliances.

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