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Study and Design of Sun Tracking System

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Abstract- The focus of the paper is on the optimization of the electric energy production by photovoltaic cells through the development of an intelligent sun-tracking system. The developed tracking system is innovated in respect to the usual sun tracking systems available in the market. In fact, the developed solution has many advantages in relation to similar existing devices, as this system is autonomous regarding the information needed to process the optimal orientation and is intelligent in a way that it performs on-linemonitoring of the photovoltaic energy production. An experimental prototype was built and field results have proven the good performance of the developed tracking system.

I. INTRODUCTION

Vitality is the prime factor for the improvement of a country. A tremendous measure of vitality is removed, appropriated, changed over and devoured in the worldwide society every day. 85% of vitality generation is reliant on non-renewable energy sources. The assets of the petroleum derivatives are restricted and their utilization brings about an unnatural weather change because of outflow of ozone depleting substances. To give a feasible force creation and safe world to the group of people yet to come, there is a developing interest for vitality from sustainable sources like sun oriented, wind, geothermal and sea tsunami.

Sun powered boards straightforwardly convert sun based radiation into electrical vitality. The sun-based board is chiefly produced using semiconductor materials. Si utilized as the significant part of sun powered boards. Expanding the cell productivity, amplifying the force yield and utilizing a following framework with sunlight based board are three different ways to build the general proficiency of the sun oriented board.

Improvement of sun powered cell productivity is a progressing research work and individuals all through the world are effectively doing examination on this. Augmenting the yield power from sun based board and incorporating sun oriented following framework are the two different ways where electronic structure philosophy can bring achievement. Greatest force point following (MPPT) is the procedure to expand the yield power from sun based board by keeping the sunlight based board's activity on the knee purpose of P-V qualities. MPPT innovation just offers the most extreme force that can be gotten from a stationary cluster of sun oriented boards at a specific time; it can't, nonetheless, increment the force age when the sun isn't lined up with the framework. Sunlight based following is an automated framework to follow the sun's position that expands the force yield of sun powered board 30% to 60% than the stationary framework. This is undeniably more financially savvy arrangement than buying extra sunlight-based boards.

Current arrangements fuse a GPS framework to compute the situation of the sunlight-based board on the Earth surface. The directions to be trailed by the photovoltaic board, on a customary time-base, are then pre-customized, on an open circle approach. There are huge endeavors on the streamlining of sun following frameworks as it is archived by a few enrolled worldwide licenses. These arrangements depend either on the above depicted rule either on the measurement of the got sunlight-based vitality, either on the expansion of the sun powered occurrence radiation using light focus focal point.

This venture helps for power age by setting the hardware to get most extreme daylight naturally. This venture will utilize a six sensor a six way to detect the bearing of greatest force of light. Every sensor will confront 30°. Thus, the all out point that this framework can detect is 180°. This framework will identify the most extreme power of light. When there is decline in force of light, this framework will naturally alter it course utilizing an engine to get most extreme power of light.

Sun based trackers are gadgets used to arrange photovoltaic boards, reflectors, focal points or other optical gadgets toward the sun. Since the sun's situation in the sky changes with the seasons and the hour of day, trackers are utilized to adjust the assortment framework to amplify vitality creation.

1.1 Literature Survey

Design and Development of a Sun Tracking mechanism using the Direct SMA actuation (Jeya Ganesh N, Maniprakash.S, Chandrasekaran L., Srinivasan S.M.).

Load Variation effect on Maximum Power Point Tracker (MPPT) for Solar Photovoltaic (PV) Energy Conversion System. (2017). International Journal of Modern Trends in Engineering & Research.

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Sun oriented following framework venture had been generally utilized by the other goliath organization like BP Solar, Yingli Green Energy, Kyocera, Q-Cells, Sanyo, Sharp Solar, Solar World, Sun Power, and Suntech. Presently, numerous individuals utilize sun based vitality or photovoltaic vitality as an elective force since it's free and sustainable. As should be obvious now, the installment charge for a power had risen quickly on the grounds that the expansion in gas cost. Numerous scientists have attempted to locate the elective vitality to supplant the gas.

Finster, in 1962, was the first to develop a simply mechanical gadget that followed the sun. Afterward, Saavedra understood a similar goal by utilizing a programmed electronic control to situate an Eppley pyro heliometer. From that point forward, critical measure of work has been completed on the structure of sun following frameworks utilizing electromechanical actuators. Abdallah and Nijmeh (2004) built up the two-hub sun following framework with an open circle Programmable Logic Controller (PLC).

Roth et al (2004) planned and built a framework for sun-following which works naturally, guided by a shut circle servo framework. A four-quadrant photograph locator is utilized for detecting the situation of the sun and two little DC engines are utilized for moving the instrument stage keeping the sun's picture at the focal point of the four quadrant photograph finders. As of late, Alata et al have built up a multipurpose sun following framework utilizing fluffy rationale control. Rizk and Chaiko have as of late presented a basic close planetary system tracker utilizing a stepper engine and a light sensor.

In the shut circle framework, the sensor detects the situation of the sun and sends a sign to the controlling unit, while in an open-circle framework control calculations are preloaded in the controlling unit, which decides the measure of activation required and sends a fitting sign to the engine which tilts the sun powered gadget towards the sun.

The Shape Memory Alloy (SMA) based actuators can react to a warm boost so as to prompt a development by applying a critical power on a portable component. It is being utilized in an assortment of uses, for example, military, restorative, wellbeing, and automated applications. Nitinol (a SMA material) couplers are being used in F-14 military aircraft since the late 1960s. In this way, it seems conceivable to plan a SMA based gadget that can be invigorated by sun powered warming to accomplish the proper tilting of the sun based receptor. A patent for a following system utilizing shape memory amalgams (SMAs) as warmth responsive components had been taken at first by Hashizume.

The framework plot in the report requires various illustrative trough reflectors or compound explanatory concentrators and SMA springs and pulleys relying upon the quantity of places of the development looked for. The goal is to manufacture a system where the SMA component plays out the double elements of detecting and impelling so as to situate the sun powered receptor tilted suitably to confront the sun straightforwardly consistently during the day.

II. NECCESSITY

It is critical to improve the creation proficiency of power from the Sun as this enthusiastic source is the most dominant in our planet, and it is normal that the Sun will turn into the principle power generation source constantly 2100, as indicated by the examination displayed by the German Advisory Council on Global Change.

The productivity of the photovoltaic (PV) framework relies upon the atmosphere states of sun powered radiation, surrounding temperature and wind speed, coordinating of the framework with the heap and suitable position of the sun based boards. A lion's share of sun based boards being used today are stationary and along these lines don't reliably yield the most extreme measure of intensity that they can really create. A sun powered tracker will follow the sun for the duration of the day and change the edge of the sun oriented board to make the sun typical to the sun oriented boards consistently. The sun following sun based force framework is a mechatronic framework that incorporates electrical and mechanical frameworks, and PC equipment and programming.

2.1 Design of Solar Tracking System

This section clarifies insight concerning the procedure of the entire framework and stream of step that is utilized in Solar Tracking System.

2.2 Working

The programmed sun following component depicted in this workshop is planned and developed to empower the sun powered receptor to follow the sun for 1200 hour edge (generally from 8am to 4pm) and the turning hub of the sun oriented receptor and focal point are held opposite to the tropical plane. The sun oriented receptor and the concentrating focal point course of action are mounted on a similar shaft with the end goal that a steady rakish distinction exists between the typical of the sunlight based receptor and the focal point game plan. This rakish distinction is to give sufficient opportunity to SMA actuator to get impelled by the sun and for it to cool in still air.

Toward the beginning of the day, the sun based receptor is in a position to such an extent that the sun based receptor ordinary is around typical to the sun at 8am. At the point when the sun moves from the sunlight based receptor and approaches the most extreme estimation of the rakish deviation, the beams start to get engaged towards the SMA spring by the focal points. The engaged beams start warming the SMA spring making it contract. This activity pulls the link associated with the SMA spring, making the link pivot the pulley A. This pivot gets under way a progression of rotational developments by pulleys, B, C and D and the inclined riggings, coming full circle in the development of the sun based receptor, which gets tilted forward with the end goal that it faces the sun.

As showed before, the stroke of the SMA is constrained by the decreased plug to limit the tilt in such manner that the sun oriented receptor gets effectively adjusted towards the sun's beams. This tilt would at the same time cause the focal point stage likewise to move away, since both the focal point stage and the sun oriented receptor are mounted on a similar shaft, with the end goal that the sun beams are no increasingly centered around the SMA spring. Without any warming, the SMA spring would begin to cool and lengthen because of the force applied by the weight joined to the wheel C. The wheel D will likewise attempt to turn back, yet would be kept from doing as such by the wrench pawl system that would capture such development, enabling just wheel C to pivot, forestalling the switch revolution of the sun oriented receptor. As respects the SMA actuator it would have been reestablished to its underlying status and would be indeed prepared to execute the activation cycle when the sun again arrives at the limit of the precise deviation referenced before.

By the day's end, after 1200 rotation of the sun, the switch grasp plan reestablishes the sun based receptor back to the underlying position for example to the situation of the sun powered receptor at the hour of the primary incitation of the day.

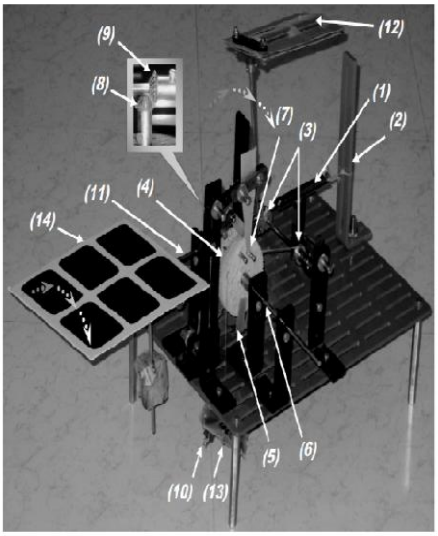

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Fig No 1 Automatic Solar Tracking System

As appeared in the above figure, the numbering represents different parts portrayed underneath:-

1) SMA Spring
2) Fixed Frame X.
3) Pulley A&B.
4) Wheel C, D and E.
5) Pawl and ratchet.
6) The primary shaft.
7) Stopper course of action.
8) Driving slant gear.
9) Driven angle gear.
10) System Dead weight.
11) Solar receptor shaft.
12) Lens
13) Actuator dead weight.
14) Solar receptor.

2.3 Material Selection for Sma Actuator

The most significant component of this sun tracker is the SMA actuator. This actuator is comprised of a Ni-Ti combination that shows the marvel called 'shape memory impact'. Data is plentiful in writing that depicts this marvel in detail and how it could be put to use in the plan of savvy actuators that react to a warm improvement. Of all the various states of actuators that are conceivable, a spring formed actuator appeared to be the most suitable shape for joining in the ASTM instrument, for the most part since it's stroke ability.

The SMA spring actuator could be either a pressure spring or a pressure spring. A pressure spring that would be open-snaked in the low temperature under the heap and would show the memory compression in the high temperature was picked as the SMA spring actuator for fuse in the SSTM. The all-encompassing spring at low temperature would contract and apply a pliable power on warming by the daylight centered onto it by the properly situated tube shaped focal points in the ASTM system.

2.4 Design Specifications of The Model

Values used in the standard design calculations:-

1) Wire diameter (d) - 0.5mm
2) Spring index (C) - 10
3) The maximum shear stress allowable in the austenite state - 100 – 200 MPa.
4) The maximum allowable shear strain - 1.03 %
5) Stress-free austenite transformation temperatures (start to finish temperatures) - 56.4°C to 63.8°C
6) Stress-free marten site transformation temperatures (start to finish temperatures) - 42.9°C to 36.4°C
7) High temperature modulus (Gh) - 20700Mpa
8) Low temperature modulus (Gl) - 2750Mpa
9) Bias force - 0.49 N
10) The required Stroke - 7 mm
11) SSTM driving force - 1.18 N
12) Wire diameter (d) - 0.5mm
13) Average spring diameter (D) - 5mm
14) The number of coils – 52
15) Hot test temperature ≥ 65o C
16) Cold test temperature ≤ 35 o C
17) No of actuation /day - 24
18) The hour angle tilting rang - 60°to 60°
19) The tilting hour angle /actuation - 5°
20) The actuation duration - 20 min

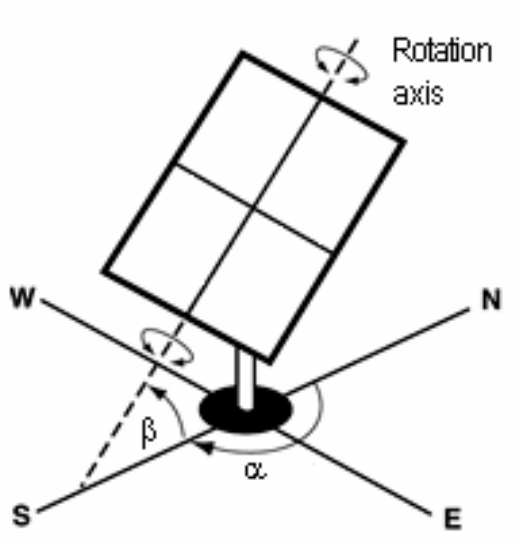

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Figure no. .2 2.5

2.5 Characterization of the Sma Spring1 Actuator

The useful exhibition of the SMA spring actuator is dictated by the heap diversion attributes. Examinations have been led on the created SMA spring to survey its exhibition. In the standard structure methodology depicted in the past segments, one is required to acquire the power redirection qualities in the high and low temperature states of the spring actuator, for ascertaining the stroke at any given load.Two various states of stacking are evaluated for approving the outcomes got from plan counts:-

Case 1: The heap diversion plots for the hot condition (temperature expected to get completely austenite state. In the test it was taken to be above 85°C) and the virus condition (temperature expected to get completely martensitic state – beneath 25°C) are landed at freely. This is accomplished by first taking the temperature of the tranquil spring comparing to the completely martensitic state and afterward applying different loads and estimating the redirection for those heaps so as to land at the heap avoidance in this virus state. Furthermore, also, taking the temperature of the spring comparing to the completely austenitic state (hot express), the diversion was estimated for various burdens at the hot state to land at the heap redirection plot in the hot state. Utilizing the plots in this manner acquired, the stroke is determined as the distinction in the extensions between the cold and the hot state bends for the comparing load.

Case 2: The spring is first taken to the hot state (completely austenitic state). Burden is applied at this state and the diversion estimated. At that point, the temperature is brought down to carry it to the fullymartensitic state with the heap on and the avoidance is estimated at the low temperature state.This strategy is rehashed for each heap for which redirection is estimated. The stroke is just the adjustment in diversion estimated for each heap along these lines applied.

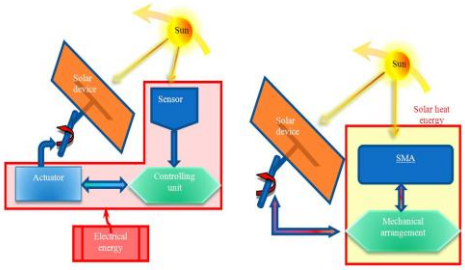

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Figure 4.3 Standard Design and Proposed Designs

2.6 Heat Treatment Processes Carried Out

Warmth treatment and shape setting of the SMA spring are joined in single procedure and it convinces the stage change temperatures and state of the SMA spring. The activation temperature is one of the significant parameters in SMA spring actuator and it relies upon the stage change temperatures of the SMA.

A nearby looped spring with 5mm mean distance across of 52 curls, utilizing 0.5 mm breadth Ni-Ti wire, was twisted around the shape setting dance that was explicitly made for creating the SMA spring that should have been fitted into the sun following component. This was given a warmth treatment and shape setting process at 700°C on 30 minutes. The decision of 52 curls was made, envisioning the probability of changes in stroke prerequisites that could become exposed during the field trails.It is realized that one could generally discover methods for confining the stroke to wanted levels by fitting decision of dynamic number of loops in the sun GPS beacon.

After shape setting the stage change (activation) temperatures of the spring has been discovered structure the DSC result. The marten site to austenite stage change temperature (As&Af) is (56.4°C to 63.8°C) top 59.6°C and the austenite to marten site stage change temperature (Ms& Mf) is (42.9°C to 36.4°C) peak 40.3°C. From this we guaranteed required activation temperatures have been accomplished.

III. ADVANTAGES AND DISADVANTAGES OF PROPOSED SYSTEM

A portion of the helpful focuses and impediments of the proposed programmed sun based following framework are recorded beneath

3.1 Advantages

1) It is conceivable to structure and build up a sun following instrument utilizing SMA that straightforwardly utilizes daylight without the requirement for any extra outer force source.
2) The ASTM can be planned as a reduced framework since the present structure utilizes SMA both as a detecting and an impelling component with direct warming from daylight.

3) Conservative choices on the structure have been made in this activity giving hard stops both during the warming and the cooling phases of the actuator.
4) An optimum cost/performance ratio is achieved by the simplicity of the adopted mechanical solution..
5) Minimum vitality utilization happens because of the way that the board development is done distinctly in supported cases, dispensing with superfluous utilization of vitality, and because of the cutting of the force circuits supply between the development times of the PV board.
6) Maximization of yield vitality created by the PV board through an ideal situating executed uniquely for adequate estimations of light sign force.
7) The disposal of superfluous developments at too little forces of the light signals or at too little contrasts between the signs got.

3.2 Disadvantages

1) The transitory holes on account of passing mists are yet to be tended to in the current shut circle control framework.
2) A increasingly broad way to deal with structuring a SSTM is expected to consider the varieties in plan parameters, for example, load on the SMA actuator, time interim for tilt activating, and so forth.
3) Further examinations must be directed to address the affectability of the gadget to encompassing temperature in understanding the genuine dependable working model

IV. CONLUSION

We successfully designed the automatic solar tracking system and also studied about the various characteristics of the system. In this seminar we came to know about the properties of SMAs and also about the time period of actuation. The designed system has better efficiency as compared to the older standard system and can effectively achieve more power production due to the presence of dual axis movement in the system.
The tracking system adds extra life to this standard system and enables us to gain maximum profit in the electricity bills because of reduction in the usage of the electric supply.

V. REFERENCES

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