



High-Efficiency Auto-Tracking Solar Combined Heat and Power Generation System

KEYWORDS

Combined Heat and Power (CHP) Concentrated Solar Power (CSP);single board controller(SBC) Concentrated photovoltaic (CPV);concentric solar thermal(CST)

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ABSTRACT Importance of Solar power generation means to solve environmental pollution and energy shortage. There is need of time to improve the efficiency of power and heat generation with help of high-efficiency solar concentric power and heat generation system at present, we start first improving the precision tracking of solar tracker for heat and power generation system then improving overall light focusing efficiency, for that a new solar two dimensional auto-tracking control method and concentrating parabolic mirror suitable for both power and heat generation which utilizes real-time control strategies. This Proposed system having many application, This developed solar tracking system follows sun for catching maximum sun ray having main objective is 1. Tracker must trap maximum sun rays 2. Tracker should have Real-time control strategies

I. INTRODUCTION:-

Renewable energy is a good concept in the 21st Century .The drastic change in climate, increasing energy needs day by day in emerging economies (India), a secure energy supply and exhaustion of the classical energy resources these are the principal’s features that must be taken into account when attempting to present the future of the world in Hopeful vision.

There are some main topics in which include solar thermal energy, photovoltaic, wind energy, geothermal energy, bio-energy, wave Energy, solar-assisted cooling systems and hydrogen technologies. Renewable energy involves efficient storage, efficient energy collection, efficient energy conversion and transport. To achieve maximum or an efficient solar energy we required three important requirements: Receiver concentrators, and solar tracking systems. The solar energy can be divided into thermal solar technology and photovoltaic technology. If a device combines both thermal and photovoltaic collectors it is possible to increase the efficiency of the collectors. Simultaneous goals of the solar energy systems design are the robustness of the equipments and the cost of produced energy

II. CHP System:-

In Concentrated Solar Power (CSP) systems, tracking the sun is essential. These systems can be of Photovoltaic (CPV) type as well as of Solar Thermal (CST) type. In the geometric domain, they are two-axis tracked. The tracking precision requirement in a solar tracked system is mostly dependent upon the concentration ratio of the system.

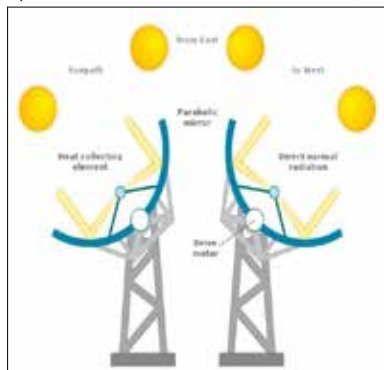


Fig.-1

CPV systems have a wide range of benefits over conventional PV generation. By utilizing high-efficiency multiple-junction PV cells, CPV systems can obtain efficiencies up to 40%. The concentration ratios of CPV cells range up to three orders of magnitude. These devices concentrate the radiations which is energy came’s from the sun using a variety of optical configurations. Their focal points comprise of heating elements, through which a fluid of high thermal capacity and high boiling point circulates. The fluid is channeled into a boiler this causes generation of steam, which is used in a conventional thermal to mechanical energy conversion, such as the Rankin cycle. Some of these systems operate on a much more direct manner, by utilizing the Sterling cycle, where the hot reservoir of the engine is located at the focal point of the concentrator.

III. Solar Tracking Methods

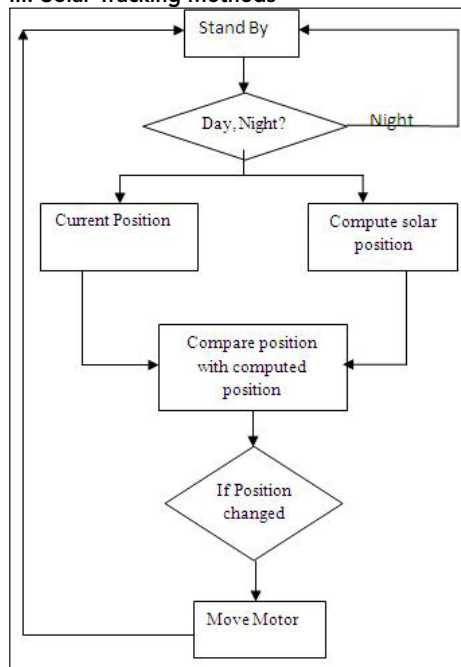


Fig-2. Tracking method

This solar tracking method use solar position Algorithm to “see” the sun and position (i.e. Azimuth and Zenith) and ac-

According to this it changes very dynamic fashion to the optimal position. For more efficiency this solar tracking method work in the "high DNA of sun"(brightest sky) approach. Thus, unwanted movement in the "search of the sun" of the due to GPS fault that result expected, leading to increased power consumption, mechanical wear and decreased overall feasibility. The precision range of tracked systems is between 0.01 degrees. Since concentric PV and heat devices exhibit only a very small deviation in efficiency with tracking accuracy. Relatively low technical complexity, they are applied mainly for industrial PV and concentric solar heat tracking.

IV. System Flow Diagram

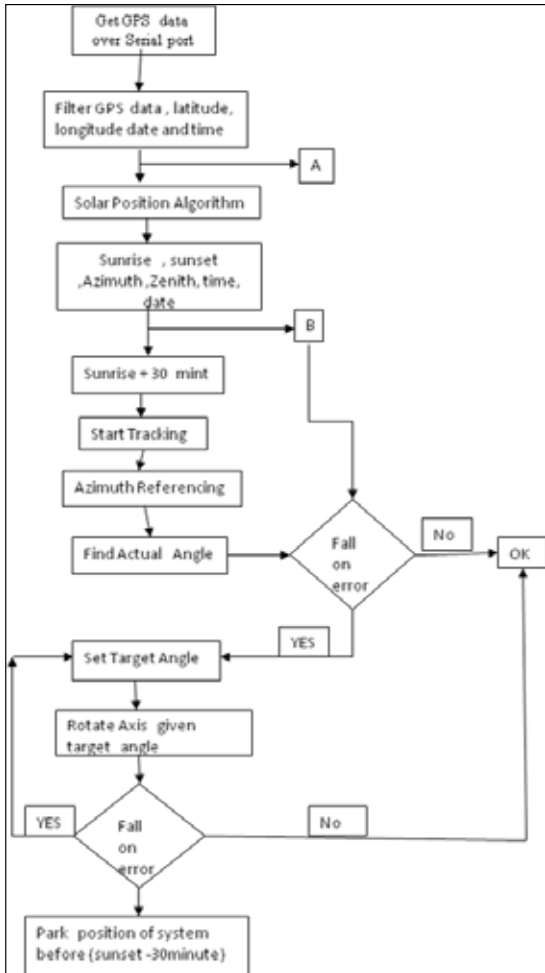


Fig. 3 Flow chart of system

Fig.-3 show that system flow diagram in which first step capture the frame from GPS it gives UTC time , Latitude , Longitude , N/S and E/w indicator ,used satellite , Horizontal Dilution of Precision , MSL Altitude. I sea all this data and studied each of them meaning. I used GPS LM478 module it different types of frames the protocol or standard for this is NMEA i.e. National Marine Electronic Association. The output of this module in the form of ASCII values. Following is some GPS data frame as I observed on my laptop in lab with the help of SiRF software. Result of this shows following.

```

COP48:115200baud - Tera Term V1
File Edit Setup Control Window Keyboard Help
Frame:$GPGGA
UTCTime:102722.915
Latitude:1838.4104
Longitude:07348.2392
Mslaltitude:3.1
Frame:$GPGGA
UTCTime:102723.914
Latitude:1838.4144
Longitude:07348.2377
Mslaltitude:3.1
Frame:$GPGGA
UTCTime:102724.914
Latitude:1838.4135
Longitude:07348.2369
Mslaltitude:3.1
Frame:$GPGGA
UTCTime:102725.914
Latitude:1838.4130
Longitude:07348.2363
Mslaltitude:3.1
Frame:$GPGGA
UTCTime:102726.914
Latitude:1838.4127
Longitude:07348.2358
    
```

Fig. 4 NMEA Frames Received from GPS

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COP48:115200baud - Tera Term V1
File Edit Setup Control Window Keyboard Help
Mslaltitude:3.7
Julian Day: 2456294.658692
L: 1.019124e+02 degrees
B: 9.753026e+05 degrees
R: 0.983290 AU
H: 309.939232 degrees
Delta Psi: 4.063081e-03 degrees
Delta Epsilon: -1.641048e-03 degrees
Epsilon: 23.435959 degrees
Zenith: 64.129494 degrees
Azimuth: 128.298746 degrees
Incidence: 44.456710 degrees
Sunrise: 06:55:38 Local Time
Sunset: 17:58:04 Local Time
Frame:$GPGGA
Mslaltitude:3.7
Julian Day: 2456294.658704
L: 1.019124e+02 degrees
B: 9.753011e-05 degrees
R: 0.983290 AU
H: 309.943397 degrees
Delta Psi: 4.063081e-03 degrees
Delta Epsilon: -1.641048e-03 degrees
Epsilon: 23.435959 degrees
Zenith: 64.126398 degrees
Azimuth: 128.301261 degrees
Incidence: 44.452911 degrees
Sunrise: 06:55:38 Local Time
Sunset: 17:58:04 Local Time
    
```

Fig.-5 show that the required parameter for solar position Algorithm at every seconds

Fig.-5 Required Parameter SPA

V. Solar Position Algorithm (SPA) :-

Solar Position Algorithm is a heart of our tracking and real time control strategy system .This algorithm having following input is required and this input I already extracted from GPS frame as above shown.

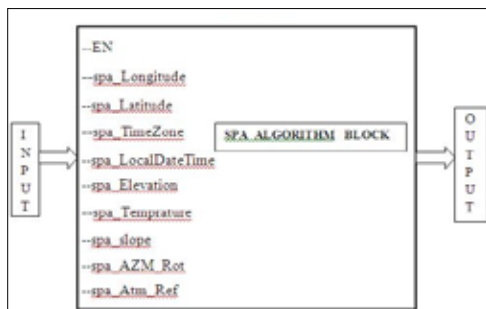


Fig.- 6 SPA Block dig. With I/O

Above fig. show the output generated by SPA program this output is Real time it tells us what is our zenith position and azimuth and it gives accurate position of sun i.e sun zenith ,azimuth ,sunrise, sunset time .This information helps to us how and how much degree should be rotate solar panel or solar dish . The accuracy of system is dependent on GPS i.e. accuracy of GPS.

```

COP48:115200baud - Tera Term V1
File Edit Setup Control Window Keyboard Help
Mslaltitude:3.7
Julian Day: 2456294.658692
L: 1.019124e+02 degrees
B: 9.753026e+05 degrees
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Delta Psi: 4.063081e-03 degrees
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Zenith: 64.126398 degrees
Azimuth: 128.301261 degrees
Incidence: 44.452911 degrees
Sunrise: 06:55:38 Local Time
Sunset: 17:58:04 Local Time
    
```

Fig.-7 Result SPA Program

VI. AZIMUTH AND ZENITH REFERENCING :-

For rotation of axis there should be referencing of axis because motor should know how much rotation require to move axis with required degree from referencing axis. The angular displacement of axis is always with respective to homing or referencing position.

VII. SBC (Single Board Controller)

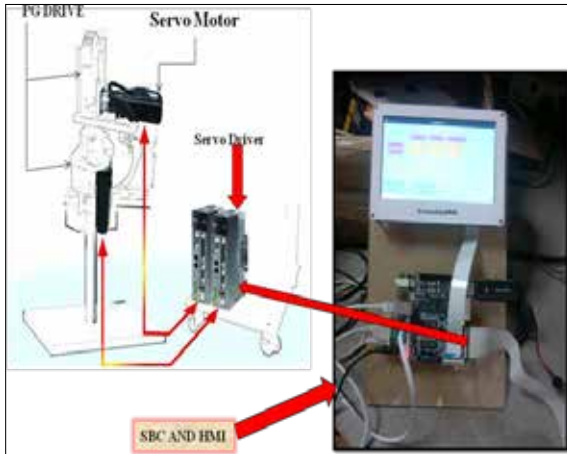


Fig.-8 SBC with HMI and Servo Motor with driver

Fig. 8 shows the single board controller is used for dual axis tracker. I am selected this S.B.C. it full fill my requirement. It having CPU: 400 MHz Samsung S3C2440A ARM920T (max freq. 533 MHz) RAM: 64 MB SDRAM, 32 bit Bus , Flash: up to 1GB NAND Flash and 2 MB NOR Flash, EEPROM: 256 Byte (I2C) , Ext. Memory: SD-Card socket, Serial Ports: 1x DB9 connector (RS232), total: 3x serial port connectors , USB: 1x USB-A Host 1.1, 1x USB-B Device 1.1 ,for communication RJ-45 10/100M (DM9000).It support Qtopia tool for development of touch screen this is used for Human Machine Interface(HMI) 7" LCD. O. S. Supported by this board is 1.Windows CE 5 and 6 2.Linux 3.Android for the development I used Linux



Fig.-9. CHP module

Fig.-9 shows receiver this is used for receive concentric sun ray which reflected from concentrating parabolic mirror having high temperature it is cause for Combined Heat And Power generation. In this at center we are placed concentric photovoltaic cell which cause generation of voltage and to avoid melting of receiver water is circulated around receiver at a certain flow due to this we get hot water.

VII. CONCLUSION

We observed High-Efficiency Auto-Tracking Solar Combined Heat and Power Generation System and conclude that CPV (Concentrated photovoltaic) power is generated by system 6kw. The dynamic characteristics and reliability of whole equipment of the system by inspecting and analyzing data, monitoring data and characteristic. We observed improvement of control parameters of motor system. Experiment results show that the proposed auto-tracking strategy improves the tracking operation precision and reliability of solar power and heat generation system, improves the photoelectric transformation efficiency and thermal receiver capability of CHP module.

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