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DESIGN OF APPARENT LOCAL CLOCK FOR TIME SYNCHRONIZATION IN THE FIELD OF SOLAR OBSERVATION AND MPPT

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ABSTRACT:

Local time is the time which is recognized at the particular place whereas the standard time is followed across the country in a uniform manner. The local time of the place can be calculated by simple arithmetic and trigonometric calculation. Local time forms a uniform time scale at a specific longitude. Local time performs a key role in the field of solar observation and Maximum Power Point Tracking [MPPT].

The local time clock is the clock used to fetch the local time according to the Geo-coordinates. That clock will address the synchronization problem for the observation at different places simultaneously. The incorporation of a local time clock with a solar panel leads the way to gaining the maximum power from solar energy. In comparison with other sun trackers, this has low cost, simplified hardware structure, and an exact controlling algorithm are advantages of this system. The power loss is due to a mis-alignment between the solar panel and the beam of light. This will not be a concern in the LTC-incorporated solar panel. The controlling algorithm is based on a very basic idea of geostationary coordinates. With the help of some arithmetic and trigonometric functions, the exact position of the sun can be detected. The incorporation of Local time clocks with the solar power plant improves the efficiency and flexibility of the tracking system.

KEYWORDS:

IST, LTC, SUNDIAL, GEO-COORDINATES, TIME SYNCHRONIZATION, MPPT.

INTRODUCTION

India is the second-largest country that does not have multiple time-zones. India stretches from 97 degrees25-minute East in Arunachal to 68 degrees 7-minute East in Gujarat almost 30 degrees of longitude. It has only one Indian Standard Time. So there is a huge time difference from place to place, this creates a time synchronization problem in departments like solar observatory, meteorology, space observation, etc., and this also affects in the measurements of solar parameters like radiation and luminosity at different places simultaneously. Hence this project proposes a local time clock which is recognized at different places that will be useful to address the time error. The incorporation of local time clock with solar panel can give added benefits as measurements of solar energy are typically expressed as total radiation on a horizontal surface which can give maximum power from the solar energy.

A) OBJECTIVES

As it is difficult in calculating the time difference in the observation of solar parameters, we are developing a local time clock.

- To address the time synchronization error in solar observatory.
- To incorporate the Local time clock (LTC) with solar panel to obtain the Maximum Power Point Tracking (MPPT).

B) MOTIVATION

When we closely observe the time, we could see the difference in time in various places. This creates a time synchronization error in various places. So we researched about the departments where this time synchronization error was a major issue and saw that the solar parameters are the ones which are mostly affected. The observation of space and meteorology departments were also being affected by this time synchronization error so this

motivated us to create a local time clock which could overcome this error and which could also be useful in obtaining the maximum power from sun energy that is useful in many sectors. So we decided to incorporate the local time clock with the solar panel which would tilt the panel according to the proposed local time clock, this could be much efficient and flexible in obtaining the maximum power from the sun. This system will also be cost effective. Most of the systems which have advanced technology are costly and complicated to handle which can be a great disadvantage. Our motivation was to create a system which is easy, efficient and flexible to handle.

MATERIALS AND METHODS

A) HARDWARE REQUIRED

1) Micro-controller (ATMEGA328P)
2) GPS Sensor (NEO-6M)
3) RTC Module (DS1307)
4) Keypad (4 x 4 MATRIX)
5) Micro-controller (ESP8266)
6) OLED display (128 x 64)

B) BLOCK DIAGRAM

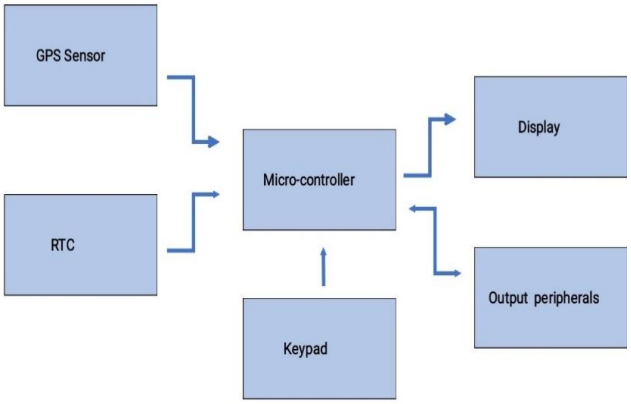

FIGURE 1: BLOCK DIAGRAM

C) PRINCIPLE

India follows the single time zone (i.e., IST). Usually, IST is calculated by the GMT + 5.30. In the world, GMT will be used as a reference time for calculating the time at different locations. Earth takes 24 hours to complete the one revolution (360°). Earth will surpass the 15° for every hour.

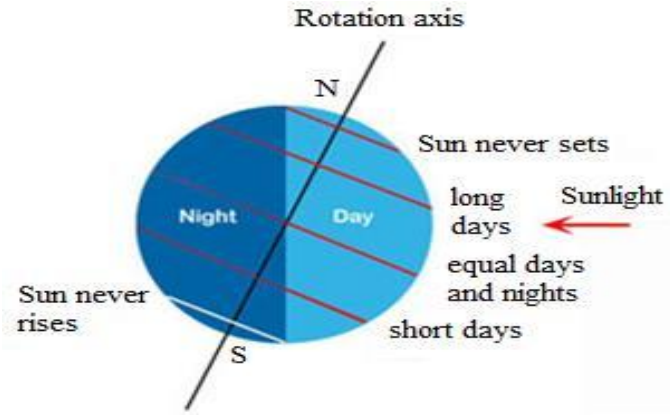

FIGURE 2: EARTH ROTATIONAL AXIS

X= 360 /24 = 15 °

X= 60 / 15 = 4 minutes

Earth takes 4 minutes to complete the 1 ° of revolution. The Geo co-ordinates of the Greenwich (GMT) is 51.49 ° N, 0.0098°E. The Geo co-ordinates of the Allahabad (IST) is 25.13 ° N, 82.5644 ° E. Time zones are specified across the longitude. So, ourpoint of concern is completely towards the co-ordinates of Longitude. Difference in the longitude co-ordinates of two locations is

| 82.5644 - 0.0098| = 82.55°

X = 82.55 x 4 = 330 minutes (5.30 hours)

Similarly, the idea of calculating the local time as follows

Local time of Chennai -------> Geo Co-ordinates (13.08 ° N, 80.27 ° E). Difference in time of local co-ordinates with the reference of IST ----> |82.5 - 80.27|x 4 = 2.23 x 4 = 8.92 minutes. If it is 12:00 PM of IST, then the local time of Chennai is 11:51 AM.

C) WORKING

The project works by obtaining the local time for a particular place. The GPS sensor senses the location and gives the longitude of the place. The calculation is done by calculating the time at different places as of mentioned in the principle above. The difference in time of local co-ordinates with the reference of IST using the micro-controller ESP8266 and the location is displayed in the OLED display.

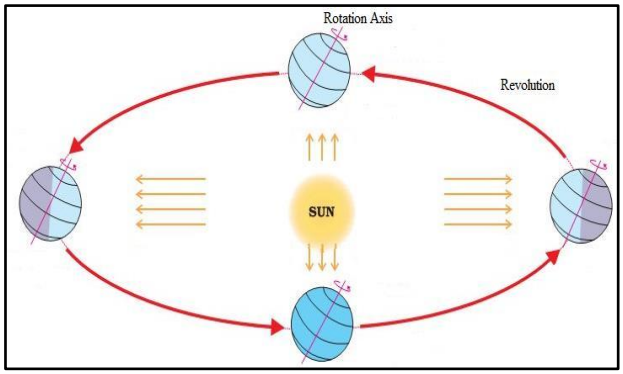

FIGURE 3: ORIENTATION PATH OF AN EARTH

The incorporation of solar panel with the local time works by moving the solar panel according to the local time at the particular place. With the help of some arithmetic and trigonometric functions, the exact position of the sun can be detected and this calculation is based on basic idea of geostationary coordinates. For every 15 minutes, the solar panel moves from 0 to 180 degree to obtain maximum power from the sun. The solar panel also turns its angle to 90 degrees in the month of April as the sun is in the equator. In the month of June, the panel turns 113.5 degrees as the sun is on the tropic of cancer and in the month of December it is on the tropic of Capricorn so the panel turns by 66.5 degrees. So the incorporation of local time with solar panel leads the way to gain maximum power from the solar energy.

EXISTING SYSTEM VS PROPOSEDSYSTEM

A) EXISTING SYSTEM

In the existing system, solar power is generated with the standard fixed collector. The motive is to install collected places which are subjected to receive the maximum amount of sunlight and collect solar energy over a long period of time hence the demand for tracking devices can be overcome. The knowledge of the movement of the sun throughout a season and different hours of the year is essential to enable maximum captivation of solar energy.

This type of fixed collector usually installed along the North - South direction of orientation.

FIGURE 4: EXISTING SYSTEM

B) PROPOSED SYSTEM

In our proposed system, we are introducing the local time clock to incorporate with the solar power plant to achieve the Maximum power transfer and Maximum Power Point Tracking [MPPT].

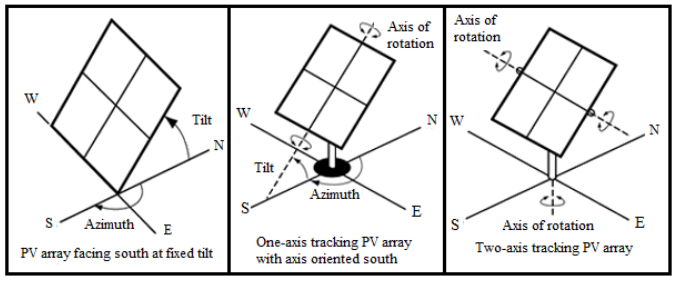

FIGURE 5: PROPOSED SYSTEM

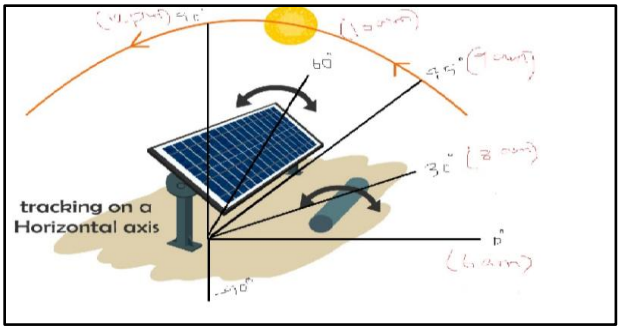

FIGURE 6: SINGLE AXIS TRACKING SYSTEM

RESULTS

In the default mode, system is fetching the Local time corresponding to the Geo-Coordinates.

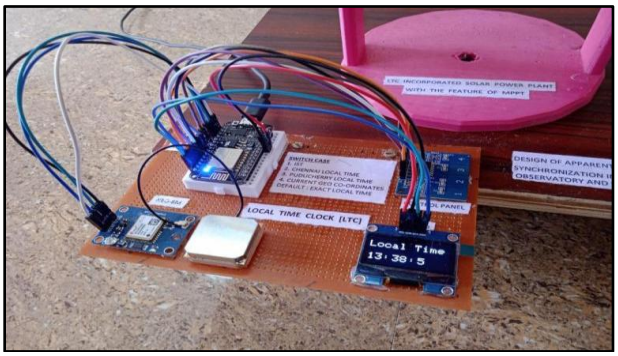

FIGURE 7: LOCAL TIME

When 1 is pressed in the switch case control panel, it shows the Indian Standard Time (IST).

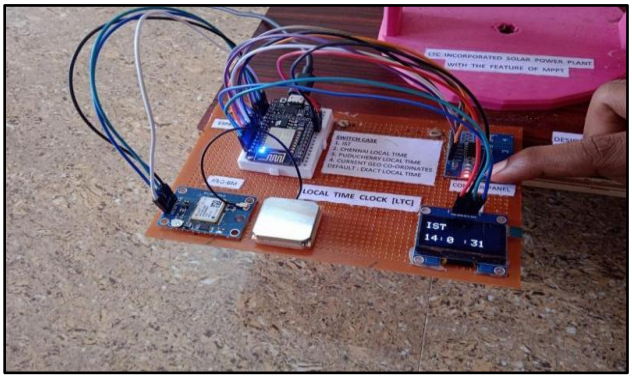

FIGURE 8: INDIAN STANDARD TIME [IST]

When 2 is pressed in the switch case control panel, it shows the Chennai Local Time.

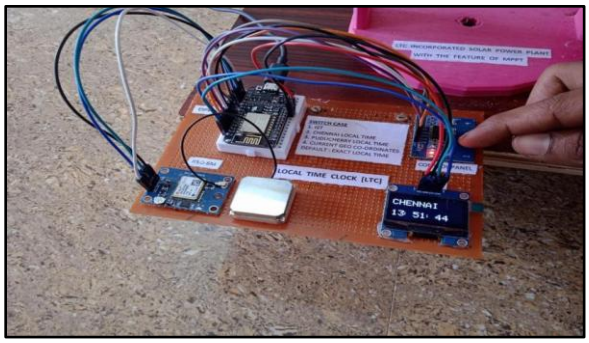

FIGURE 9: CHENNAI LOCAL TIME

When 3 is pressed in the switch case control panel, it shows the Puducherry Local Time.

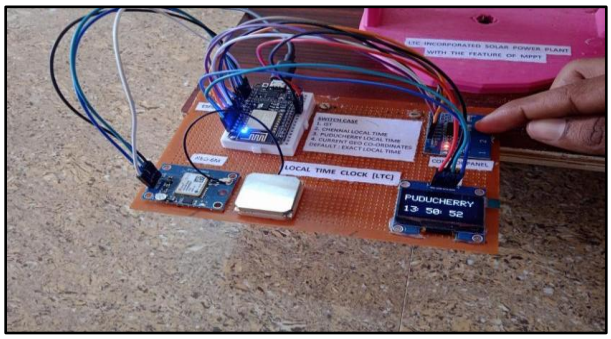

FIGURE 10: PUDUCHERRY LOCAL TIME

When 4 is pressed in the switch case control panel, it shows the Current Geo-Coordinates.

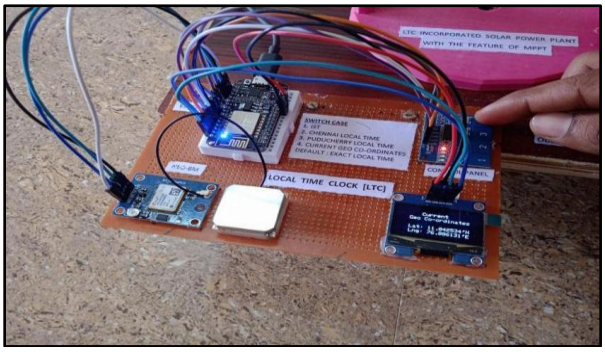

FIGURE 11: CURRENT GEO-COORDINATES

In Position control panel, when the particular time input is triggered, the solar panel will be aligned to the corresponding orientation.

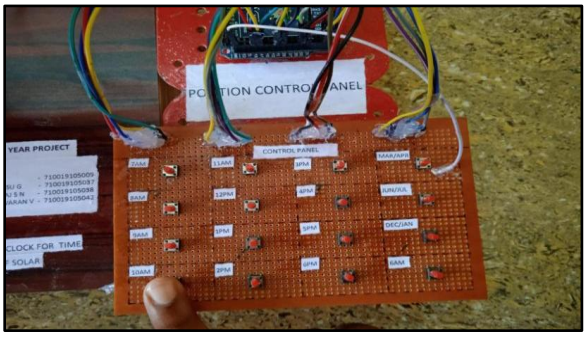

FIGURE 12: POSITION CONTROL PANEL

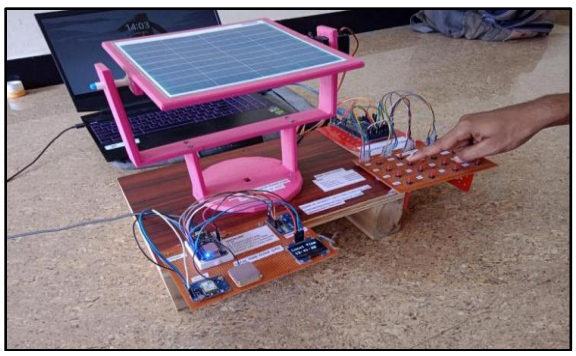

FIGURE 13: LTC INCORPORATED WITH SOLAR PANEL

A) TABULATION:

As on the month of May-2023,

TABLE 1: EXPERIMENT RESULTS WITH EXISTING SYSTEM

Time (Hrs)	PV Array O/P (V)
6	7.85
7	8.25
8	8.49
9	9.34
10	9.46
11	10.12
12	10.49
13	10.12
14	10.04
15	9.84
16	9.41
17	8.57
18	8.35

TABLE 2: EXPERIMENT RESULTS WITH PROPOSED SYSTEM

Time (Hrs)	PV Array O/P (V)
6	8.26
7	8.54
8	8.81
9	9.52
10	9.72
11	10.37
12	10.84
13	10.44
14	10.32
15	10.18
16	9.79
17	8.82
18	8.67

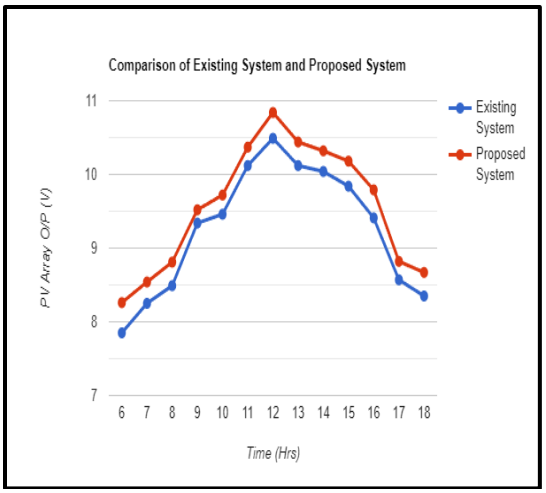

FIGURE 14: COMPARISON OF EXISTING SYSTEM AND PROPOSED SYSTEM

B) ANALYSIS:

By the experiment with existing system and proposed system, we could see the difference in maximum power obtained from the proposed system and existing system. The proposed model yields nearly **3-4 %** more than the existing system. Most of the existing systems are costly and complicated to handle which can be a great disadvantage. Our proposed system of incorporating the local time with solar panel is easy, efficient and flexible to handle.

C) FUTURE SCOPE:

- Our project can be also implemented on a large sized solar farm. Thus we can obtain a huge amount of solar power using MPPT.
- The Apparent local time can also have applied to our day to day activities.
- If the apparent local time clock clicks among the people. It may replace the standard time clock.
- Using ALT, determining the error free meteorological parameters and space study also become easier in future.

CONCLUSION

Local time calculation is an essential one and the synchronization of local time with different places might also be important. In comparison with other sun trackers, this has low cost, simplified hardware structure and exact controlling algorithm are advantages of this system. The power loss is due to mis-alignment between the solar panel and beam of light. This will not be a concern in the LTC incorporated solar panel. Incorporation of Local time clock with the solar power plant improves efficiency and flexibility of the tracking system.

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