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Floating Sun Tracking Solar Panel

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Abstract*—The future of renewable power generation is Solar power. The main problem with solar power generation is solar panels occupy more area on roof tops, open areas and they are not easy to mount. The concern with solar panels is that they are difficult to install, maintain, and clean on a regular basis. They also take up a lot of room on roofs or other open spaces. Additionally, shifting the solar panels in accordance with the position of the sun may produce up to 40% more solar electricity. Here, we suggest a of solar panel that may be placed on bodies of water, like lake pools, freeing up space on the ground. We also provide a novel technique that is sun tracking floating solar for moving solar panels in accordance with the position of the sun using LDR sensors, which would increase power production and the floating system in the water resists the solar panel from overheating. Additionally, the water is also conserved due to reduction in evaporation of water from the water body. In the upcoming 10 years, India proposes the generation 1GW and 1.75 GW of solar Photo Voltaic power from renewable energy sources. As on date around 5000MW has been commissioned in different parts of country, as per the Jawaharlal Nehru Solar Mission. To meet the target, there is a need to produce more solar energy in short span of 10 years. Floating solar Photo Voltaic plants are an emerging form of PV systems, that floats on the water bodies like canals, water reservoirs, lakes, and ponds. This paper proposes a prototype of floating sun tracking solar panel to increase the production of solar energy using floating solar panels, Raspberry Pi Pico microcontroller board, Thonny IDE software.

***Index Terms*— Raspberry Pi Pico microcontroller board, Thonny IDE, Current Sensor module, DHT11 temperature and Humidity Sensor.**

I. Introduction

The standard solar panel does not have much efficiency and the production of energy is very little. To overcome this problem, we have proposed a floating sun tracking solar panel. The floating Photo Voltaic system exploits many functions such as cooling, concentrating, and tracking. The outcomes of the system have designated an important influence on cooling and tracking on the system competence. The main advantage is large amount of solar energy production when compared to roof top solar panels and the solar panel is introduced in the water therefore due to cooling effect of water the panel will not get heated continuously[1]. This increases the efficiency of solar panel which also leads to production of large amount of energy. More electricity will be generated due to cooling effect of water in floating solar than the terrace roofing systems. The geometry of the given system has been determined with two major aspects [2]. Firstly, the module should protect as much water

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as possible to avoid water evaporation. Secondly, the size of the module is adapted to the commercially available PV modules in the market.

II. IMPLEMENTATION

Fig.1 represents the floating sun tracking solar panel flow diagram. The heart of the system is the controller, i.e., Raspberry Pi Pico RP2040. Single axis solar panel is used, which rotates in 180^0 according to this position maximum amount of energy is absorbed by the LDR. The panel rotation is done with the help of servo motor. Micro Python is used in Raspberry Pi Pico for rotating the servo motor. The floating of the panel is done with the help of vacuum filled tubes [3]. The solar panel continuously rotate in the direction of sun with the help of servo motor. Thus, the Photo Voltaic cells absorb the maximum amount of energy from the sun. Chargeable batteries are used to store energy for future needs. The floating solar panels can be installed at the existing power plants. These floating solar panels keep water bodies fresh and clean while generating the renewable energy. 16×2 LCD is used to display the generated voltage. Due to continuous rotation of panel in the sun direction there is continuous heating this reduces efficiency in solar panel. In order to overcome this, we use floating solar panel as it continuously dissipates the heat. When compared to roof top solar panels, efficiency of the floating solar panel is increased by 35%. A solar panel of 100 watts when received 10 hours of direct sun-hours per day will generate 2kWh of energy. Then the maximum energy annually produced is 730kWh [4].

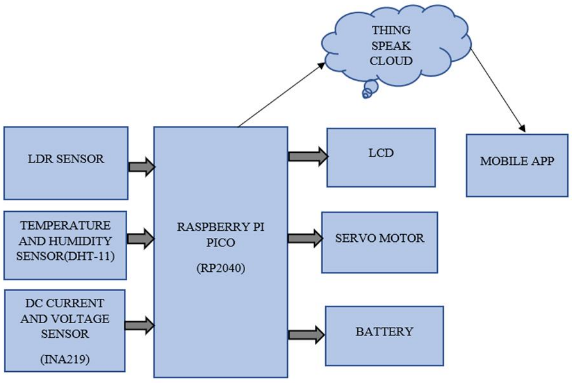


Fig.1 Functional process flow diagram

III. PROPOSED SYSTEM WORKING FLOW

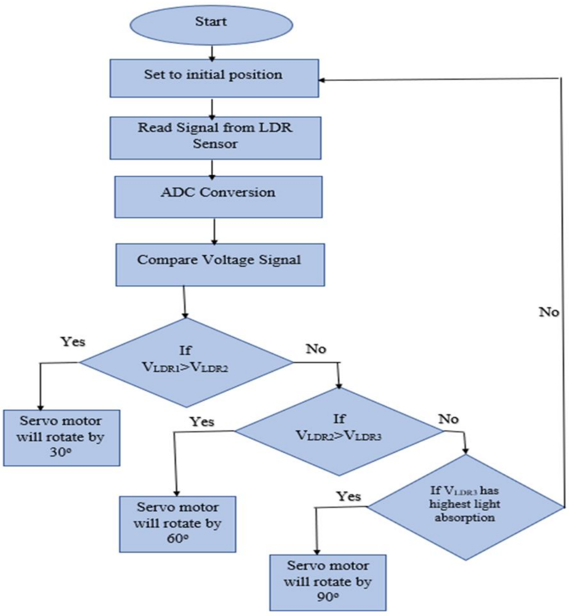


Fig.2 Flow Chart for the Working of Proposed System

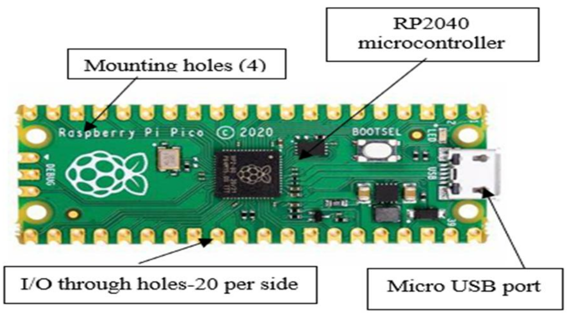


Fig.3 RP2040Raspberry Pi Pico

The flowchart diagram in Fig.2 depicts the working process of the suggested system design. Following are some quick discussions of the process flow steps:

- **Step1**: Place the Solar Panel on a roof top or in an open area.
- **Step2**: Connect the model to an external power supply for rotating the servo motor.
- **Step3**: If the LDR1 has absorbed more voltage than LDR2, the servo motor rotates in 30º Clockwise direction.
- **Step4**: If the LDR2 has absorbed more voltage than LDR3, the servo motor rotates in 60º Clockwise direction.
- **Step5**: If LDR3 absorbs the maximum voltage, then the servo motor rotates in 90º clockwise direction.

IV. HARDWARE AND SOFTWARE

A. RP2040 Raspberry Pi Pico

The RP2040 Raspberry Pi Pico shown in fig.3 is a dual-core Arm Cortex-M0+ processor with 264KB internal RAM and it supports up to 16MB of off-chip Flash [5].It has 40 I/O pins. Among 40 pins, 26 are multipurpose GPIOs and it has 8 ground pins. It has 3 pins for debugging.

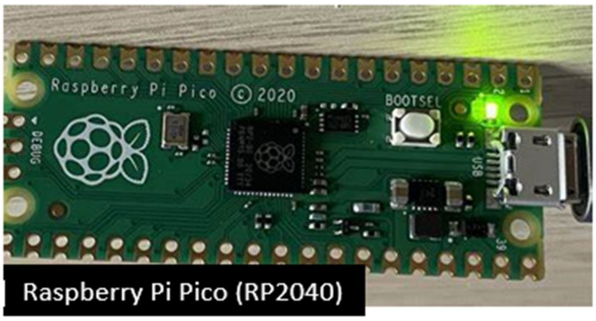


Fig.4 Pin configuration of RP2040

Fig.4 shows the pin configuration of Raspberry Pi Pico. The Raspberry Pi Pico consists of an integrated temperature sensor and low power sleep and dormant modes. Table.1 shows the specifications of Raspberry Pi Pico (RP2040).

TABLE I. RP2040 SPECIFICATIONS

S. No	Parameters	Specification
1	Microcontroller	RP2040
2	Operational voltage range	1.8Volts-5.5 Volts
3	Processor	Dual-Core and Arm Cortex-M0+
4	SRAM	264KB
5	Flask Memory	2MB

B. INA219 Dc voltage and current Sensor Module

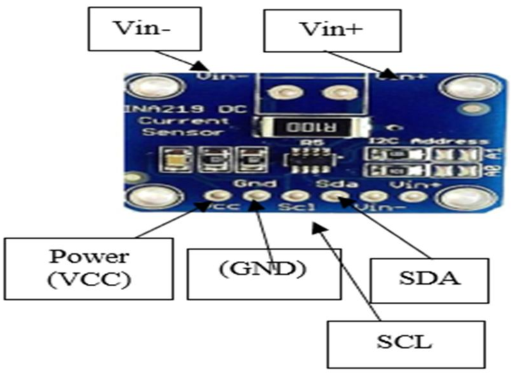


Fig.5 INA219 based Dc voltage and current Sensor Module

Fig.5 shows a INA219 based DC voltage and Current sensor module. CJMCU-219 is a zero drift I2C interface based. It is a bidirectional current/power monitoring module. It is an essential component of power monitoring system. It is capable of sensing current, voltage, power. It transmits data to host microcontroller using I2C bus protocol. The specifications of CJMCU-219 current sensor module is given in Table.2 [6].

TABLE II. CJMCU-219 SPECIFICATIONS

S. No	Parameter	Specification
1	Power Input	3 Volts to 5.5Volts
2	Target Voltage	+26V max
3	Current sense resistor	0.1 ohm 1% 2W
4	Bus Voltages	0 to 26 V
5	Compatible interface	2C- or SM Bus

C. LDR Sensor

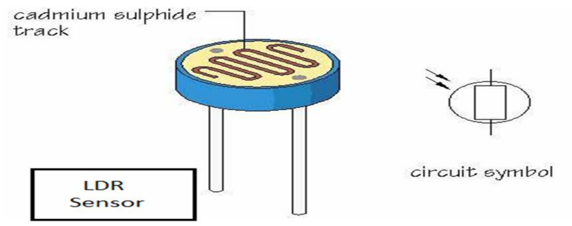


Fig.6 LDR Sensor

LDR or light dependent resistor is shown in Fig.6. It is a kind of resistor whose resistance changes depending on the amount of the light falling on its surface and it is made of a high resistance semiconductor. These resistors are used in circuits where it is required to sense the presence of light. It's operation is based on semi conductivity. LDR has a variety of functions and resistance. The electrons in the semiconductor material's valence band are stimulated to the conduction band when light strikes the object, or when photons strike it. To cause the electrons to move from the valence band to the conduction band, the incident photons must have an energy larger than the bandgap of the semiconductor material. As a result, when sufficiently energetic light impacts the device, a huge number of charge carriers are produced as more and more electrons are driven to the conduction band[7].

D. DHT-11 Temperature and Humidity Sensor

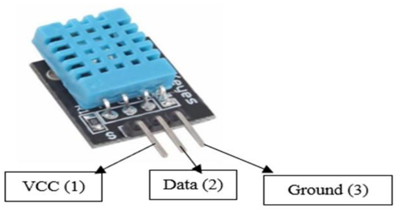


Fig.7 DHT-11 Temperature and Humidity Sensor

Fig.7 shows a digital sensor DHT11 for measurement of Humidity and temperature. The sensor is interfaced with the Raspberry Pi Pico. This DHT11 is available as both sensor and module. In this prototype we are using DHT11 sensor. DHT11 measures the surrounding air using thermistor and capacitive humidity sensor [8]. Table.3 shows the specifications of DHT11 Temperature and Humidity Sensor.

TABLE III. DHT11 SPECIFICATIONS

S. No	Parameter	Specification
1	Operational Voltage	3.5V - 5.5V
2	Operational Current	0.3mA(measuring) 60uA (standby)
3	Output data	Serial data
4	Temp Range	+0°C - +50°C
5	Humidity Range	20% - 90%
6	Accuracy	±1°C & ±1%

E. LCD

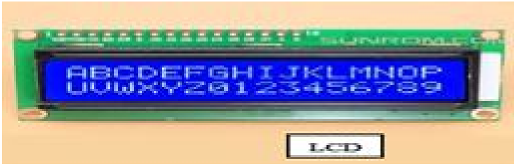


Fig.8 16X2 LCD

LCD mean liquid crystal display is shown in fig.8. This 16×2 LCD working principle is, it blocks the light rather than dissipate. It is an electronic display module used in many applications like mobile phones, calculators, and computers. The LCD used here has 16×2 display with 40 pins [9]. The main advantages of using this kind of LCD are they are inexpensive, simply programmable also there are no limitations for displaying custom characteristics.

F. MG995 Servo Motor

Fig.9 MG995 Servo Motor

Fig.9 shows a MG995 which is a heavy-duty reliable servo motor. It is a high-speed actuator with dual bearings. It is a low power, and cost effective which is feasible for Industrial production. A maximum torque of 208 oz-in is delivered at 6 volts. It has a maximum rotational speed of 0.13 seconds per $60^{o.}$ If the voltage is dropped to a smallest of 4.8 volts, it maintains a torque of 180 oz-in and rotates with a speed of 0.17 seconds per 60^{o} [10].

G. *Thing Speak IOT Platform*

Thing Speak is an IOT platform used for gathering the real-time data like location, climatic changes information and other device data. In our proposed floating sun tracking solar panel model this IOT platform is used to collect the voltage of both the floating solar panel and the static solar panel.

H. Thonny IDE

Fig.10 shows the interface of the Thonny IDE. It is the platform used for coding. We use Micro python for programming the servo motor to rotate in the direction of the sun.

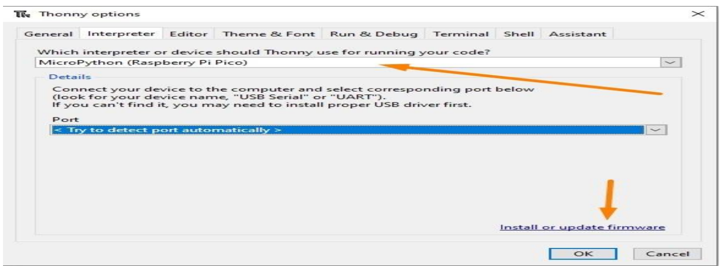


Fig.10 Interface of the Thonny IDE

I. Micro Python

Micro Python is a Python 3 programming language. It contains a small subset of Python library and is enhanced to run on microcontrollers and in obliged environments.

V. HARDWARE AND SOFTWARE INTERFACING

The software and hardware interfacing connections are depicted in Fig.11 and Fig.12 shows hardware connections. The solar panel is exposed to light after interfacing [11]. Then the panel will rotate in the direction of the sun with the help of servo motor. The amount of voltage generated is shown in the LCD display and the current, voltage and Temperature readings are taken from the thing speak cloud using the Wi-Fi module ESP8266. This is specifically for use in Internet of Things (IoT) systems. With a 32-bit processor, some RAM, and, depending on the supplier, between 512KB and 4MB of memory, the ESP8266 is a complete Wi-Fi system on a chip. This enables the chip to work as a standalone device that can run simple programmes or as a wireless adaptor that can add Wi-Fi functionality to other systems.

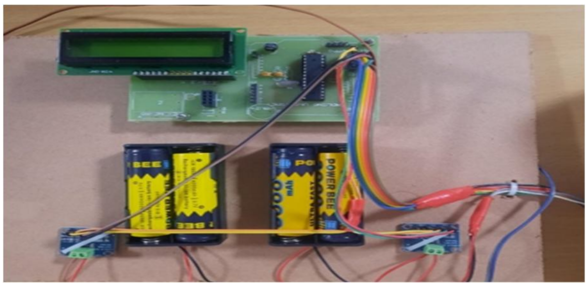


Fig.11 Hardware and Software Interfacing

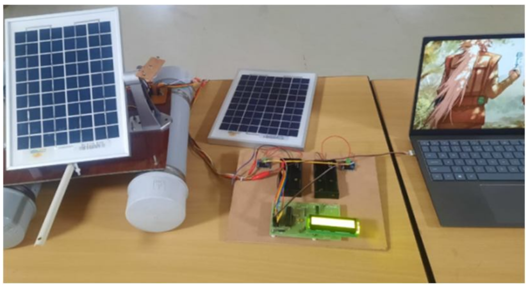
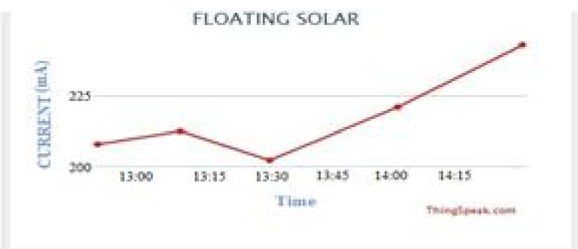


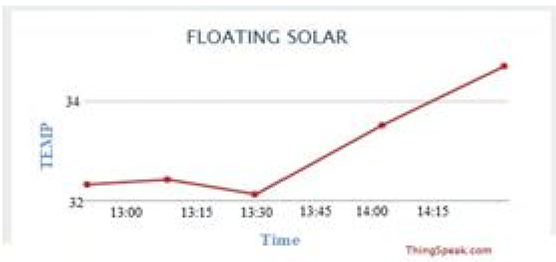
Fig.12 Hardware connectional diagram

VI. RESULT

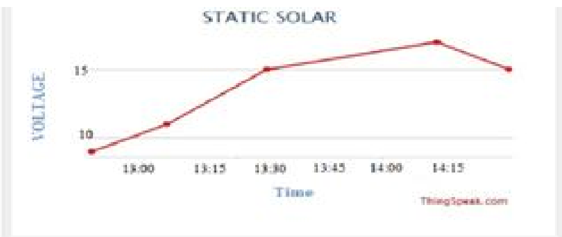
There were two solar panels tested. The other is a floating sun tracking solar panel, while the first is a static rooftop solar panel. The static solar panel is positioned at a 33-degree angle since this will ensure that its power production is maximised. From 8 AM to 6 PM, the test was conducted continuously across three days, with measurements being made continuously. In this test, a load was used to compute the solar panel's current and voltage (battery of capacity 15V-17V). Figures 13,14,15 shows the voltage, current and temperature readings of the static solar panel and Figures 16,17,18 shows the voltage, current and temperature readings of Sun Tracking Floating solar panel in Thing Speak IOT platform and the readings were taken for every 15 minutes from 8:00 AM to 5:00 PM. The following results shows that the floating sun tracking solar panel is more efficient than static solar panel.



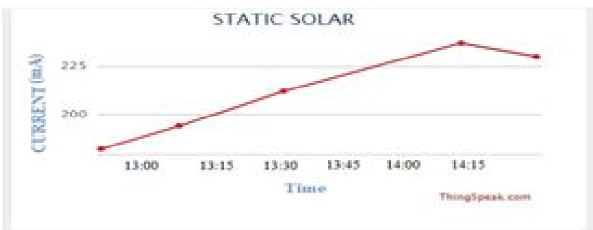
(a)



(b)

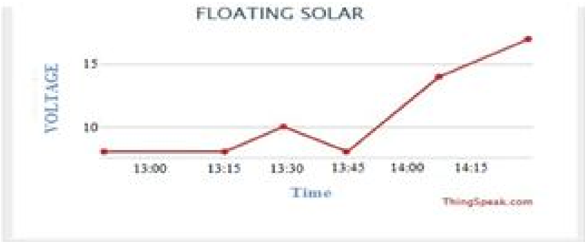


(c)

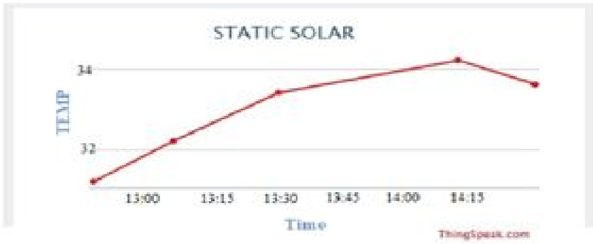


(d)

Fig.19 shows the final output voltage displayed on the LCD. The power rating of the solar panel used in the prototype is 5W,12V which is useful for charging small electronic devices. 25-35% energy is generated in floating solar panel when compared with roof top solar panel. The solar panel used in the prototype is of area 27 X 19 sq.cm ,which generates a maximum energy of 11 volts. The standard roof top solar panel with the same power rating generates a maximum of 9 volts.



(e)



(f)

Fig.13(a) Graphical representation of Voltage for Static Solar Panel in Thing Speak (b)Graphical representation of Current for Static Solar Panel in Thing Speak (c)Graphical representation of Temperature for Static Solar Panel in Thing Speak (d) Graphical representation of Voltage for Floating Sun Tracking Solar Panel in Thing Speak (e) Graphical representation of Current for Floating Sun Tracking Solar Panel in Thing Speak (f) Graphical representation of Temperature for Floating Sun Tracking Solar Panel in Thing Speak

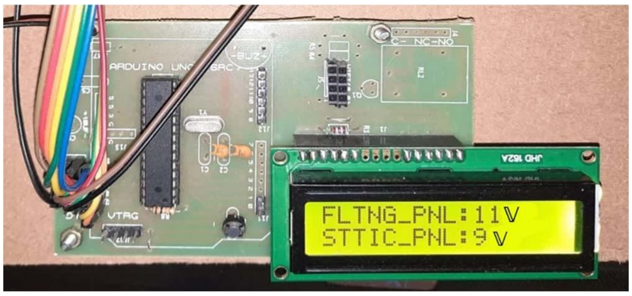


Fig.19 Final output voltage displayed on the LCD

Table.6 shows the real time statistical data of the prototype floating Sun Tracking Solar Panel. The current, voltage, and temperature readings are taken from 8:00 AM to 5:00 PM continuously. The sun tracking panel rotates in the direction, when the maximum light falls on the panel, due to absorbance of the light by LDR sensor the servo motor runs, this causes change in the position of the solar panel which leads to absorption of maximum energy.

TABLE VI. REAL TIME STATISTICAL DATA OF FLOATING SUN TRACKING SOLAR PANEL AFTER TESTING

Solar panel position with respect to Sun Tracking	Time	Temperature(°C)	Current (mA)	Voltage (V)
30°	8:00 AM	27	193	9
30°	9:00 AM	28	199	10
60°	11:00 AM	32	203	11
60°	12:00 PM	35	260	18
60°	1:00 PM	34	221	13
60°	2:00 PM	33	234	15
90°	4:00 PM	31	203	11
90°	5:00 PM	30	198	10

VII. CONCLUSION

The concept of floating sun tracking solar panel is neoteric. In this study, we provide an easy-to-understand explanation of the solar tracking mechanism used to increase solar gain energy. We also discuss how inexpensive it is to operate and maintain a solar tracker. The tracking system is used to locate the solar panel in sun direction to produce the maximum amount of energy. The floating system is used to cool the solar panel which is heated continuously due to sun tracking. The cooling system dissipates the heat absorbed by the solar panel so that it works efficiently and produces more amount of energy when compared to standard roof based solar panels. The floating solar panel generates a maximum voltage of 11 volts while a roof top solar panel generates a maximum voltage of 9 volts for a standard 5W solar panel.

FUTURE SCOPE

As the renewable energy resources are free, proper management is needed and we need to discover more technologies for energy production through these free resources. Other types of sensors as well as solar panels can be employed in water reservoirs, lakes that may perform better than the traditional paradigm. For maximum absorption of light from the sun we can use anti reflective coatings on the solar panel. By using them the destructive interference will be eliminated from incident light waves from the sun. Thus, the maximum amount of light is transmitted to the solar panel which increases the amount of energy production.

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