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**(Autonomous Institution Affiliated to VTU, Belagavi)**



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**SUBJECT:Electronics**

**Experiential Learning Report**

**Optimization of floating photovoltaic cells**

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**INTRODUCTION**

In recent years, the demand for renewable energy sources has been on the rise due to the increasing awareness of environmental sustainability. Solar energy, in particular, has garnered significant attention as a clean and abundant source of power. One innovative approach to harnessing solar energy is through the use of floating photovoltaic (FPV) systems, which have the potential to overcome the limitations of traditional land-based solar installations. Additionally, integrating Internet of Things (IoT) technology and solar tracking mechanisms can further enhance the efficiency and performance of FPV systems.

This project aims to explore the optimization of floating photovoltaic cells by leveraging IoT and solar tracking technologies. By integrating IoT devices, such as sensors and communication modules, with FPV systems, real-time data collection and monitoring can be achieved. Furthermore, the implementation of solar tracking mechanisms will enable the FPV cells to dynamically adjust their orientation to maximize solar exposure throughout the day, thereby increasing energy generation efficiency.

**OBJECTIVES**

The primary objectives of this project are as follows:

1. **To build a floating photovoltaic system via arduino:**

The project's primary objective is to explore the synergy between Arduino-based control systems, IoT connectivity, and solar tracking to maximize the output of floating photovoltaic cells. By leveraging Arduino microcontrollers, the project seeks to implement precise control algorithms for solar tracking, enabling the FPV cells to dynamically adjust their orientation based on real-time environmental conditions and solar position data.

2. **To make readings of the solar panel available on our mobiles/pc's via IOT:**

The integration of IoT technology will enable remote monitoring, data acquisition, and system automation, thereby enhancing the overall operability and performance of the FPV setup.

3. **To make the solar tracking via light diodes for maximum efficiency:**

The project aims to design, construct, and integrate a solar tracking mechanism specifically tailored for FPV cells deployed on water bodies. The solar tracking system will be engineered to dynamically adjust the orientation of the FPV cells, maximizing their exposure to solar radiation throughout the day. By implementing precise control algorithms and sensors, the tracking system will ensure that the FPV cells maintain an optimal angle relative to the sun's position, thereby enhancing the overall energy capture and conversion efficiency.

**PROBLEM STATEMENT**

FPVs offer advantages such as space efficiency, enhanced efficiency due to cooling effects, the albedo effect, water conservation, and reduced algae growth. These benefits make FPVs a promising technology for maximizing solar energy generation on water surfaces.

The deployment of floating photovoltaic (FPV) systems presents a promising avenue for sustainable solar energy generation on water bodies. However, the static nature of traditional FPV installations and the lack of real-time monitoring and control mechanisms pose significant challenges to maximizing energy output and operational efficiency. Therefore, the need arises for the development of an integrated solution that leverages Internet of Things (IoT) technology and solar tracking to optimize the performance of FPV cells, addressing the limitations of static orientation and manual intervention in response to varying environmental conditions and solar positions. This project aims to tackle these challenges by designing and implementing a comprehensive IoT-enabled solar tracking system tailored for FPV arrays, with the objective of enhancing energy capture, operational autonomy, and overall performance in floating solar energy generation.

**LITERATURE SURVEY:**

The literature on solar-powered floating photovoltaic (PV) systems exhibits a growing interest in enhancing their performance through innovative approaches. One such approach is highlighted in the work by Nur Amirah Abdul Jamil et al., where the authors employ an Arduino-based strategy to optimize the efficiency of a solar-powered floating PV system. Situated within the Department of Electrical Engineering and the Green and Sustainable Energy Focus Group at Universiti Tun Hussein Onn Malaysia, the study introduces smart control algorithms and monitoring systems facilitated by Arduino technology to increase the energy yield of the floating PV system. This research contributes significantly to the ongoing exploration of novel technologies for improving the effectiveness of solar energy utilization in sustainable power generation.

In a complementary study by Paritosh Sharma and Bharat Muni, the focus shifts towards the design parameters of a 10KW floating solar power plant. The authors delve into the essential aspects governing the configuration and performance of such large-scale floating solar installations. This paper likely provides crucial insights into the engineering considerations, technical specifications, and challenges associated with the design and implementation of sizable floating solar power plants. By elucidating the key parameters influencing the efficiency and reliability of these systems, Sharma and Muni contribute valuable knowledge to the broader field of floating solar technology, providing a foundation for the design and deployment of more robust and scalable solar energy solutions on water bodies.

Oladimeji Ibrahim, affiliated with the University of Ilorin, presents a comprehensive study focused on the design and construction of an Arduino-based solar power parameter-measuring system equipped with a data logger. The primary objective of the research is to develop a reliable and efficient system capable of accurately measuring and logging crucial parameters related to solar power generation. Leveraging Arduino technology, the author implements a set of sensors and control mechanisms to monitor factors such as solar irradiance, temperature, and voltage, providing a robust solution for real-time data acquisition. The integration of a data logger enhances the system's functionality by enabling the storage and analysis of collected data, facilitating a deeper understanding of solar power system performance. This paper contributes to the field of solar energy research by offering a practical and customizable solution for monitoring and analyzing key parameters in solar power systems.

Authored by Ayman Amer, Hani Attar, Samer As’ad, Sameh Alsaqoor, Ilhami Colak, Ali Alahmer, Malik Alali, Gabriel Borowski, Moayyad Hmada, and Ahmed Solyman, this collaborative work explores the potential, advantages, and challenges associated with floating photovoltaics (FPV). The paper provides a comprehensive assessment of harnessing solar energy on water bodies, examining the feasibility and benefits of deploying PV systems on aquatic surfaces. The authors analyze the unique advantages of FPV, including increased energy yield, reduced land usage, and potential synergy with water management practices. Simultaneously, they address challenges such as system stability, environmental impact, and cost considerations. By evaluating the multifaceted aspects of FPV technology, this paper contributes valuable insights to the discourse on alternative solar energy solutions, informing researchers, policymakers, and industry professionals about the opportunities and challenges inherent in the implementation of floating photovoltaic systems.

**Description of our project:**

* **material used**:

1. Arduino Board.
2. Jumper Wires.
3. LDR's
4. HC05 Bluetooth Module
5. Current Sensor
6. Resistors
7. Plastic Base
8. Servo Motor
9. Battery
10. Solar Panel
11. Humidity Sensor (DHT11)
12. Thermocol

* **Advantages of using a FPV with solar tracking**:

Space Efficiency: FPVs are installed on water bodies, which means they don't require valuable land space. This makes them an ideal choice for areas where land availability is limited.

Enhanced Efficiency: FPVs can be more efficient than ground-mounted solar panels due to the cooling effect of the water. The water helps to keep the panels cool, which increases their efficiency and power generation capacity.

Albedo Effect: The presence of water beneath FPVs creates an albedo effect. This effect occurs when sunlight reflects off the water surface and increases the overall solar radiation reaching the panels. As a result, FPVs can generate more electricity compared to regular solar cells.

Water Conservation: FPVs can help conserve water by reducing evaporation from the water bodies they are installed on. The panels provide shade and reduce direct exposure to sunlight, which helps to minimize water loss through evaporation.

Reduced Algae Growth: The shading effect of FPVs can also help reduce the growth of algae in water bodies. Algae growth can negatively impact the efficiency of regular solar cells by blocking sunlight. FPVs help to mitigate this issue and maintain optimal performance.  
  
Solar tracking is more efficient because it allows solar panels to follow the path of the sun throughout the day, maximizing their exposure to sunlight. This results in increased energy production and higher efficiency. Solar tracking systems can improve the performance of solar panels by about 25 to 35 percent when compared to fixed panels. By continuously adjusting the orientation of the panels to face the sun, solar tracking systems ensure that the panels receive optimal sunlight at all times. This is particularly beneficial in areas with high variations in terrain or where the sun's position changes significantly throughout the day. Reliable data sources also emphasize the importance of using solar trackers coupled with solar panels to produce more renewable energy. With the ability to track the sun's movement, solar tracking systems offer a reliable and effective solution for maximizing the efficiency of solar energy generation.

* **Circuit diagram for the Solar Tracking Unit of the Project:**



* **Basic working of the project:**

With the help of the current and humidity sensors we are able to measure the values for current, voltage and temperature.  
   
And with the help of remotexy and the bluetooth module we are able to get the sensor readings on mobile phones and PC's.   
  
The LDR's in the Solar tracking unit detects the presence of sunlight and with the help of this information the servo motor tilts the solar panel towards the sunlight.

**Remotexy code used in the project:**

#include <Servo.h>

#include<DHT11.h>

//Define the LDR sensor pins

#define LDR1 A0

#define LDR2 A1

//Define the error value. You can change it as you like

#define error 10

const int currentPin = A4;

int sensitivity = 66;

int adcValue;

int offsetVoltage = 2500;

double adcVoltage = 0;

double currentValue = 0;

//Starting point of the servo motor

int Spoint = 90;

//Create an object for the servo motor

Servo servo;

#define DHTPIN 8

DHT11 dht11(DHTPIN);

void setup() {

//Include servo motor PWM pin

servo.attach(11);

//Set the starting point of the servo

servo.write(Spoint);

delay(1000);

Serial.begin(9600);

}

void loop() {

//Get the LDR sensor value

int temperature = dht11.readTemperature();

Serial.print("temp:");

Serial.print(temperature);

Serial.println(" .C ");

adcValue = analogRead(currentPin);

adcVoltage = (adcValue / 1024.0) \* 5200;

currentValue = ((adcVoltage - offsetVoltage) / sensitivity);

Serial.print("Raw Sensor Value = " );

Serial.print(adcValue);

Serial.print("\t Voltage(V) = ");

Serial.print((adcVoltage)/1000,3);

Serial.print("\t Current = ");

Serial.println(currentValue,3);

int ldr1 = analogRead(LDR1);

//Get the LDR sensor value

int ldr2 = analogRead(LDR2);

//Get the difference of these values

int value1 = abs(ldr1 - ldr2);

int value2 = abs(ldr2 - ldr1);

//Check these values using a IF condition

if ((value1 <= error) || (value2 <= error)) {

} else {

if (ldr1 > ldr2) {

Spoint = --Spoint;

}

if (ldr1 < ldr2) {

Spoint = ++Spoint;

}

}

//Write values on the servo motor

servo.write(Spoint);

  delay(80);

}

Output of the above code is:



**RESULT**

**FUTURE PROSPECTS OF THE PROJECT:**

The integration of Floating Photovoltaics (FPV) with the Internet of Things (IoT) holds promising prospects for the future, bringing together renewable energy technology and smart connectivity. Here are some potential future developments and benefits:

* Enhanced Monitoring and Control: Integration with IoT allows real-time monitoring and control of FPV systems. Sensors placed on floating platforms can collect data on environmental conditions, system performance, and potential issues. This data can be transmitted through the IoT network, enabling remote monitoring and control, optimizing energy production, and facilitating timely maintenance.
* Data Analytics for Optimization: IoT-enabled FPV systems can leverage data analytics to gain insights into energy production patterns, environmental factors, and system efficiency. Analyzing this data can help optimize the positioning of solar panels, predict maintenance needs, and improve overall system performance. Machine learning algorithms may be employed to continuously enhance efficiency based on historical and real-time data.
* Grid Integration and Energy Management: IoT connectivity allows FPV systems to be integrated with smart grids. By communicating with the grid, FPV installations can adjust their energy production in response to demand fluctuations and grid conditions. Additionally, energy storage systems integrated with IoT can optimize energy distribution and storage, contributing to grid stability.
* Remote Diagnostics and Maintenance: IoT sensors on FPV platforms can detect anomalies or malfunctions in real-time. This enables predictive maintenance, reducing downtime and increasing the lifespan of the equipment. Maintenance teams can be alerted to potential issues remotely, and in some cases, automated systems could address minor problems without human intervention.
* Environmental Monitoring: IoT sensors on FPV installations can monitor water quality, biodiversity, and other environmental factors. This information can contribute to ecological sustainability by ensuring minimal impact on aquatic ecosystems and providing valuable data for environmental conservation efforts.
* Security and Anti-Theft Measures: IoT integration can enhance the security of FPV systems by providing real-time surveillance and alert systems. Anti-theft measures can be implemented through the use of GPS tracking and sensors to detect unauthorized access or tampering.

**CONCLUSION**

In conclusion we were successfully able to integrate IOT with a floating photovoltaic cell which gave us important information like temprature of the solar panel, current and voltage generated on our mobile phones and PC's in real time, and the solar tracking system successfully points the solar panel towards the Sun maximising the amount of sunlight recieved by the solar panel.

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