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Solar Aquaculture with Smart Monitoring System

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Abstract: During this industrial revolution 4.0, the traditional way to carry out a job has been assisted by the intelligence device or with help of it. But for aquaculture, most of the job nowadays is still carried out in a traditional way related to water testingand the unstable power supply in a rural area has troubled the farmer a lot. Here with the help of the smart system, we can monitor the aquarium by referring to the indicator which is controlled by an Arduino and works with a temperature sensor and turbidity sensor can help farmers to reduce their job of monitoring the temperature manually. Theexistence of turbidity sensors can help farmers collect data about the water quality and help to analyze the causes of unclear water. Solar energy did play a role whereit could be a choice for fish petting where it could let fish petting or fish farming to reduce the risk of losing. A solar panel is used to provide backup energy for farmers who might face a blackout situation and a battery acts as an energy box that collects and saves the energy produced from solar panels. This project also contains a calculation related to the battery capacity and the solar panel size which can help in the future in solar aquaculture.

Keywords: Solar Energy, Inverter, Arduino Uno, UPS, Battery.

1. Introduction

Nowadays, fish culture has become a trend among young people. They treat this as their hobby and a way for them to relax after coming back from work. The work to monitor the quality of water inside the tank and the feeding time did trouble them a lot since they did have not much time to take good care of the fish [1]-[2].

Solar is an energy that can be used in every corner of the earth. Nowadays many countries are facing energy problems, especially in Europe since Russia and Ukraine started the war. So, by using solar energy to generate electricity we can reduce the reliance on traditional ways to generate it. With a combination of solar fish tanks, it helps people with no worries about petting fish [5]-[8].

Oxygen is an important element for the living things who live on Earth [7]. Living things can live depending on the content of oxygen. For fish, they need more oxygen in the water, especially in the pond and big aquariums which have more fish in a certain area. Letting the water flow to gain more

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oxygen inside the water is important to make sure fish can have a healthier place to grow.

2. Methodology

The purpose of this project is to have an aquarium system that can function well on both DC and AC currents. The Arduino is used to receive signals from the sensor and process the signal. The calculation has been made to determine the suitable size of the solar panel and battery to make sure the water pump functions according to a time limit.

2.1 Arduino UNO

The sensor related which is the temperature sensor and the turbidity sensor is connected accordingly to the Arduino and LCD screen also connected to it to make sure the process programmed can run. This is related to the monitoring process where we can monitor the condition inside the aquarium. The flowchart of the Arduino process is shown in Figure 1 where the process starts with the sensor initialization followed by temperature sensor detection to detect the temperature while the turbidity sensor works according to the coding that we have done.

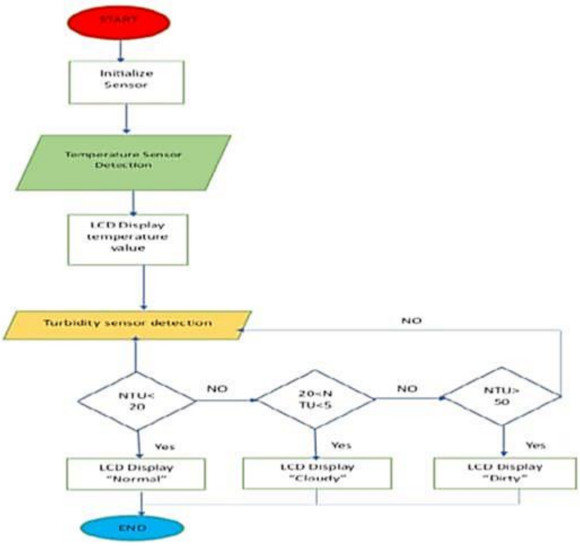

Figure 1: Flowchart of Arduino process

2.2 Converting DC to AC

An inverter is used to convert the DC current to AC current for the usage of the AC pump use in the aquarium. The UPS module permits a device to continue operating when incoming power is interrupted for at least a brief period [3]-[4]. It will help the system to work with the inverter where the battery is used when the interruption happens. the UPS is connected to both AC and DC supply, while AC voltage is the main supply voltage, and it will be converted to DC voltage by a converter. When the AC current is interrupted the module will switch the supply voltage from the AC supply to the DC supply to make sure the continuous voltage supply to the load. An inverter is needed to convert the DC voltage to AC voltage for AC load usage. Figure 2 shows the block diagram of the project.

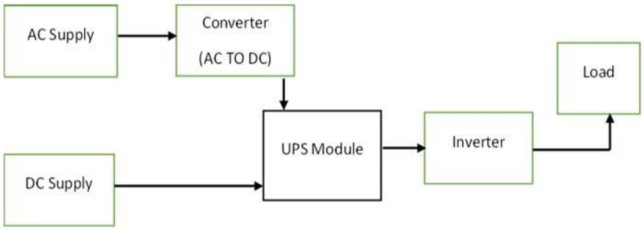

Figure 2: Block Diagram of the circuit

2.3 Equations

To calculate the size of solar panel needed to sufficient the load some formula is used to determine it [6]. The first is to calculate the complete time of operation from a full charged battery (Theoretical), followed by calculating the complete time of operation from a full charged battery (Practically obtained result). Lastly, is to calculate the total power of solar panels needed. Equation 1 is used to calculate the theoretical value of the complete operation time and Equation 2 shows the way to find out the value of the Practical result and Equation 3 illustrates the way to find got total power of solar panel needed.

$$TC = Watt - hour\ of\ battery/Power \qquad Eq\ 1$$

$$TC * 80\%\ Depth\ of\ Discharge \qquad Eq\ 2$$

$$\frac{Watt - hour\ of\ battery}{Sun\ Hour} \qquad Eq\ 3$$

3. Results and Discussion

This section will be divided into three sections, the first of which will address the monitoring system and the availability of solar energy for the aquarium and, last, the presumption that the water pump can run onsolar power for 4 hours each day as a backup source. The whole setup for the solar energy tank prototype is shown in Figure 3. The aquarium is where the white polystyrene box is, and the monitoring system is on top of the aquarium.

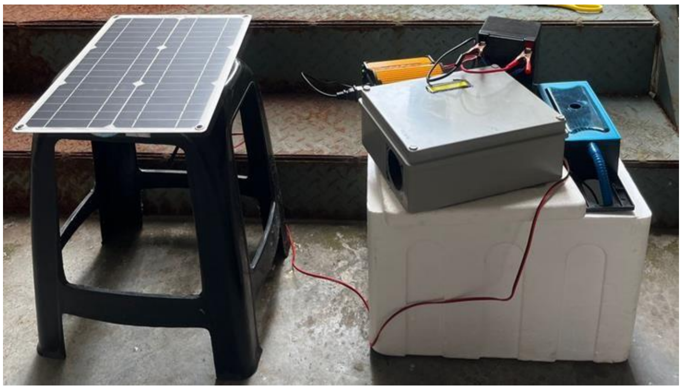

Figure 3: Entire Setup of The Project

3.1 Monitoring System

To monitor the condition in an aquarium, the coding is set and uploaded to Arduino UNO for running.The code is successfully run after compiling and uploading to Arduino UNO hardware. All related parts that related including the sensor and display unit functioned well and the result was satisfying. The result did illustrate the LCD screen can show the value detected when the sensor detected the scenario. Figures 4-7 show the monitoring results.

AquariumV1.ino

```
//Library LCD
#include <LiquidCrystal_I2C.h>

//Analog Sensor (Turbidity)
#include <Wire.h>

//Library Temperature
#include <DallasTemperature.h>
#define ONE_WIRE_BUS A0 //pin for sensor
OneWire oneWire(ONE_WIRE_BUS);
DallasTemperature sensors(&oneWire);
float TemperaturePin = A2;
int TurbidityPin = A1;

byte customChar[8] = {
  0b00000,
  0b01010,
  0b11111,
  0b11111,
  0b01110,
  0b00100,
  0b00000,
  0b00000
};

```

Figure 4: Coding for Monitoring System

AquariumV1.ino

```

LiquidCrystal_I2C lcd(0x27,16,2);
void setup() {

  // initialize the LiquidCrystal_I2C
  lcd.init();
  lcd.backlight();
  Serial.begin(9600);
  lcd.setCursor(0,0);
  lcd.print("INITIALISE.....");
  delay(1000);
  lcd.createChar(0, customChar);
  lcd.setCursor(0,0);
  lcd.print("Aquarium");
  lcd.setCursor(10, 1); // move cursor to (2, 0)
  lcd.write((byte)0);
  delay(3000);
  lcd.clear();
  Serial.println("Aquarium Monitoring");
  Serial.println("------------------");
  delay(1000);
  }
  void loop()
{
  // After we got the temperatures, we can print them here.
```

Output Serial Monitor

Figure 5: Coding for Monitoring system

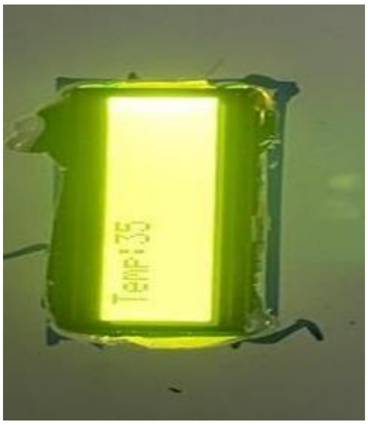

Figure 6: Monitor Showing Reading of Temperature.

Figure 7: Monitor Showing Reading of Turbidity

3.2 Solar Energy to Aquarium

Solar energy was made as a backup plan or emergency supply to the aquaculture system in this project, with the help of the UPS Module when a blackout situation happens in a fish farm or housing area there will be a backup energy supply to the water pump to make sure the water circulation in the pond or tank is enough to maintain the oxygen level in fish habitat. The result did show the inverter's success in converting energy from the battery to supply the water pump work and keep the water circulation. The AC water pump did function with the supply voltage converted from the inverter and no sign of failureduring the system run. The solar panel charged the 12V lead acid battery with 12Ah during the daytime. The energy is controlled by the solar charger controller to make sure it will not harm the battery during charging process. Figures 8-9 show the real system.

Figure 8: Water Pump is connected with Inverter

Figure 9: Solar Panel of the system

3.3 Battery Capacity and Solar Panel Power for Water Pump Can Work for 4 Hours Per Day as Backup Supply

Table 1 shows the list of battery capacity to operate from 1 up to 12 hours and the power of solar panel needs to charge the battery to let it fulfill work time. There is the recommended battery capacity to be used. It shows battery capacity in operating 1 hour is around 1.04Ah and the value increases by increasing the operating time until 12 hours showing a value of 12.5Ah capacity needed. All power of solar panels is shown in Table 1 is recommended to oversize it twice due to uncertainty of sun hour in different locations. Figure 10 illustrates the graph of battery capacity and power of solarpanels against hours, and it shows the battery capacity did increase while the operation hours increased and also the power of solar energy required increased when operation hours increased.

Table 1: List of Battery Capacity, Recommend Battery Capacity and Power of Solar Panel

Operating Hour	Battery Capacity (Ah)	Power Of Solar Panel (W)
1	1.04	2.5
2	2.08	5.0
3	3.13	7.5
4	4.16	10
5	5.21	12.5
6	6.25	15.0
7	7.29	17.5
8	8.33	20.0
9	9.38	22.5
10	10.42	25
11	11.46	27.5
12	12.5	30

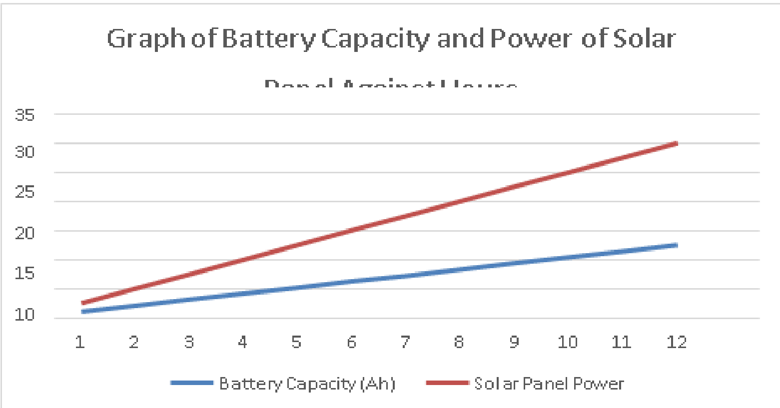

Figure 10: Graph of Battery Capacity and Power of Solar Panel Against Hours

4. Conclusion

This project aims to integrate aquaculture with a smart monitoring system and solar energy, with the goal of collecting data to promote the use of solar energy in aquaculture. This integration would lead to reduced pollution, improved aquatic environments, and clean water sources for the future. The project focuses on facilitating fish monitoring through smart systems, reducing manual effort and mitigating the risk of fish loss. It also addresses the issue of power outages by providing a cost-effective alternative to diesel generators. By utilizing solar energy, the project aims to minimize pollution and reduce reliance on traditional energy sources. Additionally, it assists individuals in determining the appropriate battery and solar panel specifications for their specific system size. Overall, this project aims to enhance efficiency, sustainability, and environmental preservation in the aquaculture industry.

Acknowledgement

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