

Supplementary Information:

Integration of Solar Panels and Arduino for Aquaponic System Automation and Solar Energy Efficiency

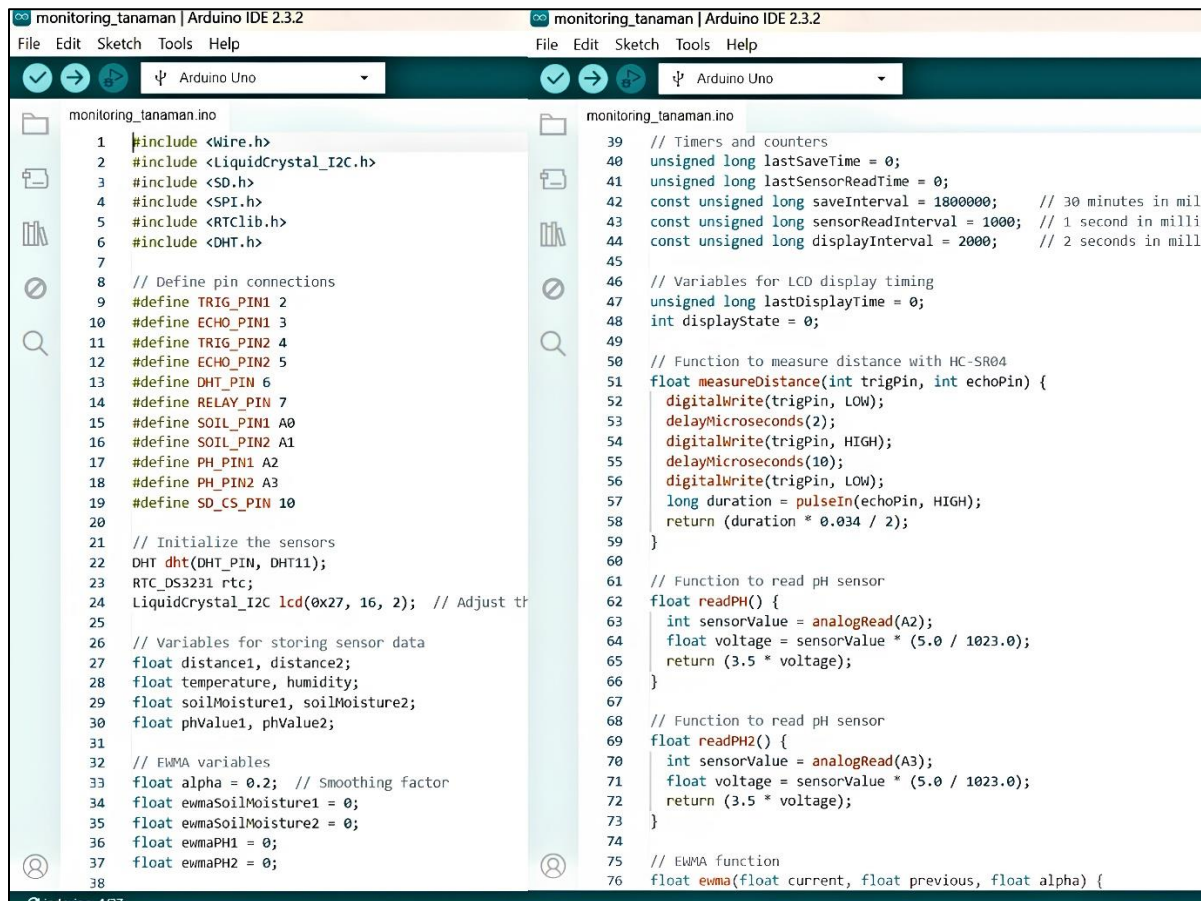
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Content:

Figure S1. Program code developed with Arduino IDE for plant management. Here is a visual representation of part of the code for the management of plant monitoring and automation.



```
monitoring_tanaman.ino
1 #include <Wire.h>
2 #include <LiquidCrystal_I2C.h>
3 #include <SD.h>
4 #include <SPI.h>
5 #include <RTCLib.h>
6 #include <DHT.h>
7
8 // Define pin connections
9 #define TRIG_PIN1 2
10 #define ECHO_PIN1 3
11 #define TRIG_PIN2 4
12 #define ECHO_PIN2 5
13 #define DHT_PIN 6
14 #define RELAY_PIN 7
15 #define SOIL_PIN1 A0
16 #define SOIL_PIN2 A1
17 #define PH_PIN1 A2
18 #define PH_PIN2 A3
19 #define SD_CS_PIN 10
20
21 // Initialize the sensors
22 DHT dht(DHT_PIN, DHT11);
23 RTC_DS3231 rtc;
24 LiquidCrystal_I2C lcd(0x27, 16, 2); // Adjust th
25
26 // Variables for storing sensor data
27 float distance1, distance2;
28 float temperature, humidity;
29 float soilMoisture1, soilMoisture2;
30 float pHValue1, pHValue2;
31
32 // EWMA variables
33 float alpha = 0.2; // Smoothing factor
34 float ewmaSoilMoisture1 = 0;
35 float ewmaSoilMoisture2 = 0;
36 float ewmaPH1 = 0;
37 float ewmaPH2 = 0;
38
monitoring_tanaman.ino
39 // Timers and counters
40 unsigned long lastSaveTime = 0;
41 unsigned long lastSensorReadTime = 0;
42 const unsigned long saveInterval = 1800000; // 30 minutes in mil
43 const unsigned long sensorReadInterval = 1000; // 1 second in milli
44 const unsigned long displayInterval = 2000; // 2 seconds in mill
45
46 // Variables for LCD display timing
47 unsigned long lastDisplayTime = 0;
48 int displayState = 0;
49
50 // Function to measure distance with HC-SR04
51 float measureDistance(int trigPin, int echoPin) {
52     digitalWrite(trigPin, LOW);
53     delayMicroseconds(2);
54     digitalWrite(trigPin, HIGH);
55     delayMicroseconds(10);
56     digitalWrite(trigPin, LOW);
57     long duration = pulseIn(echoPin, HIGH);
58     return (duration * 0.034 / 2);
59 }
60
61 // Function to read pH sensor
62 float readPH() {
63     int sensorValue = analogRead(A2);
64     float voltage = sensorValue * (5.0 / 1023.0);
65     return (3.5 * voltage);
66 }
67
68 // Function to read pH sensor
69 float readPH2() {
70     int sensorValue = analogRead(A3);
71     float voltage = sensorValue * (5.0 / 1023.0);
72     return (3.5 * voltage);
73 }
74
75 // EWMA function
76 float ewma(float current, float previous, float alpha) {
```

Figure S2. Program code developed with Arduino IDE for fish pond management. Here is a visual representation of part of the code for managing fish pond monitoring and automation.

```

monitoring_kolam | Arduino IDE 2.3.2
File Edit Sketch Tools Help
Arduino Uno
monitoring_kolam.ino
1 #include <Wire.h>
2 #include <LiquidCrystal_I2C.h>
3 #include <Servo.h>
4 #include <RTClib.h>
5 #include <SD.h>
6 #include <OneWire.h>
7 #include <DallasTemperature.h>
8
9 //tds
10 #define TdsSensorPin A1
11 #define VREF 5.0 // analog reference voltage(Volt)
12 #define SCOUNT 30 // sum of sample point
13
14 int analogBuffer[SCOUNT]; // store the analog value
15 int analogBufferTemp[SCOUNT];
16 int analogBufferIndex = 0;
17 int copyIndex = 0;
18
19 float averageVoltage = 0;
20 float tds = 0;
21 float temperature = 16;
22
23 //ph
24 float calibration_value = 18.25;
25 int phval = 0;
26 unsigned long int avgval;
27 int buffer_arr[10], temp;
28 float ph_act;
29
30 // Definiskan alamat LCD I2C (umumnya 0x27 atau 0x3C)
31 LiquidCrystal_I2C lcd(0x27, 20, 4); // Mengatur LCD
32
33 // Definiskan pin untuk sensor HC-SR04
34 #define TRIG_PIN1 2
35 #define ECHO_PIN1 3
    
```

```

monitoring_kolam | Arduino IDE 2.3.2
File Edit Sketch Tools Help
Arduino Uno
monitoring_kolam.ino
37
38 // Definiskan pin untuk modul SD
39 #define SD_CS_PIN 10
40
41 // Definiskan pin untuk sensor suhu DS18B20
42 #define ONE_WIRE_BUS 8
43
44 #define EC_Isolator 1 // 3906 PNP TYPE TRANSISTOR THIS is used to control
45 #define EC_GND_Wire A3 // 2N2222 NPN TRANSISTOR THIS IS USED TO CONTROL
46
47 #define RELAY_PIN 7
48
49 // Buat objek untuk servo, RTC, dan sensor suhu
50 Servo servo;
51 RTC_DS3231 rtc;
52 OneWire oneWire(ONE_WIRE_BUS);
53 DallasTemperature sensors(&oneWire);
54
55 // Variabel untuk menyimpan waktu terakhir data disimpan
56 unsigned long previousMillis = 0;
57 const long interval = 1800000; // 30 menit dalam milidetik
58
59 // Variabel untuk pergantian tampilan LCD
60 unsigned long previousLcdMillis = 0;
61 const long lcdInterval = 5000; // 5 detik dalam milidetik
62 bool showUltrasonic = true;
63
64 // Variabel untuk menyimpan nilai EWMA
65 float ewmaPh = 0;
66 float ewmaTds = 0;
67 const float alpha = 0.1; // Faktor smoothing untuk EWMA
68
69 // Fungsi untuk mengukur jarak menggunakan sensor HC-SR04
70 long getDistance(int trigPin, int echoPin) {
71 // Bersihkan pin Trig
    
```