INNOVATIVE AGRICULTURAL MONITORING SYSTEM VALIDATED USING MATLAB

[1]S. SRINANTHANA, [2]KAYALVIZHI, [3]S. SRIBHARATHI

[1,2,3] Students, Department of Electrical and Electronics Engineering,
Sri Bharathi Engineering College for Women,
Pudukkottai, Tamil Nadu, India.

Abstract - **The paper aims to deploy a "smart agriculture monitoring system" to minimize human involvement in farming operations. The three key subsystems – the master controller, the water pump system, and the water pump switching controller – are designed to optimize productivity. Our primary goals include developing a system with a robust design, high accessibility, and integrated wireless communication. The system will intake sensor data, process it through MATLAB software, and present a user-friendly interface. The project concludes with the implementation of an efficient water management system, ensuring stable growth conditions for plants. Our proposed concept holds significant promise, serving as an effective interface between input sensors and IoT as the output medium.**

KEYWORDS: Master controller, switching controller, Robust design, Integrated wireless communication.

INTRODUCTION:

Throughout history, Earth has faced numerous pollution factors, including chemical pollutants in water and soil, air pollution, and the impact of sun exposure on plants. Unfortunately, human negligence towards environmental preservation has led to a continuous increase in pollution. Utilizing natural resources without considering the long-term consequences has become a significant issue. Plants, playing a crucial role in the Earth's life cycle, are consumed by humans for food, oxygen, and various other needs.

As the global population is projected to reach nine billion by 2050, concerns about food safety are escalating. In response to this challenge, different methods and studies have been conducted to enhance agricultural production, leveraging advancements in life sciences and technologies. One noteworthy solution is Controlled Environment Agriculture (CEA), which includes greenhouse growing methods. These methods empower growers to control crop growth, allowing for year-round cultivation. By integrating advanced computer controllers, tools, and sensors, growers can enhance production quality, offering consumers better-tasting produce.

Desert climates, characterized by hot, humid summers and cold winters with occasional rain, present unique challenges for agriculture. While the use of cutting-edge technology in desert farms is limited, advances in pervasive computing and the Internet of Things (IoT) are gradually reaching every aspect of life, including local agricultural practices.

Irrigation, a critical aspect of agriculture, draws water from various sources such as groundwater, surface water, and non-conventional sources like treated wastewater and desalinated water. Spate irrigation, a form of surface water irrigation, involves diverting floodwater to dry river beds using dams and channels. Rainwater harvesting, collecting runoff from roofs or unused land, is another method, although it is not usually considered a form of irrigation.

Wastewater, a significant environmental concern, remains untreated in many parts of the world, causing water pollution. In agriculture, untreated wastewater is increasingly used for irrigation, posing health risks due to pathogens. The International Water Management Institute emphasizes a 'multiple-barrier' approach to mitigate risks, including ceasing irrigation before harvesting and applying water carefully to avoid contamination.

Embedded systems, combining software and hardware, play a crucial role in various applications. They are designed for specific tasks, often with real-time performance constraints. Embedded systems can be standalone devices or components within larger systems, such as the embedded system in an automobile serving a specific function as a subsystem of the car itself.

Examples range from air traffic control systems to the Gibson Robot Guitar, showcasing the versatility and importance of embedded systems in modern technology.

EXISTING SYSTEM:

The current system employs an Arduino Uno microcontroller to receive inputs from different sensors such as temperature, ultrasonic, and soil humidity sensors. The decision to water the crops is validated through a relay system. However, the system faces challenges due to the lack of uninterrupted power supply and limited sensor inputs. These shortcomings make the existing system less robust in its application and less suitable for adverse weather conditions.

PROPOSED SYSTEM:

Hydroponic systems do not serve as a panacea for mitigating unfavourable growing conditions, such as inadequate temperature, insufficient light, or pest-related issues. The basic growth requirements for hydroponically cultivated plants mirror those of their field-grown counterparts. The primary distinction lies in the method of plant support and the delivery of essential inorganic elements for growth and development.

Optimal temperature plays a pivotal role in plant growth, with deviations from the ideal range leading to abnormal development and diminished productivity. Warm-season vegetables and many flowers thrive between temperatures ranging from 60°F to 80°F, while cool-season vegetables, like lettuce and spinach, prefer temperatures between 50°F and 70°F.

Light, a fundamental requirement for plants, poses a challenge in hydroponics. Natural sunlight, a key component for traditional garden cultivation, is irreplaceable. Hydroponically grown vegetables necessitate a minimum of 8 to 10 hours of direct sunlight daily for robust production. Artificial lighting, despite being a subpar alternative, falls short due to the insufficient intensity of most indoor lights. Incandescent lamps, complemented with sunlight or specialized plant-growth lamps, may suffice for growing transplants but prove inadequate for maturing crops. Although high-intensity lamps, such as high-pressure sodium lamps, can offer more than 1,000 foot-candles of light, their exorbitant cost renders them impractical for commercial operations.

Proper spacing between plants within a greenhouse is crucial to ensuring each receives ample light. The spacing requirements vary, with factors like pruning influencing the space needed. For instance, a single-stem-pruned tomato plant necessitates 4 square feet, while European seedless cucumbers require 7 to 9 square feet. Leaf lettuce plants should be spaced 7 to 9 inches apart within rows and 9 inches between rows. Winter cultivation in a greenhouse proves less successful due to reduced light intensity during shorter days and cloudy weather.

Providing an adequate water supply poses challenges in certain hydroponic systems. While water culture systems facilitate easy water provision, aggregate culture methods may encounter difficulties. In hot summer months, large tomato plants can consume up to half a gallon of water daily. Insufficient moisture in the aggregate can lead to root drying and death, impacting plant recovery and reducing production even after moisture restoration.

Water quality presents another challenge, with excessive alkalinity or salt content disrupting nutrient balance and impeding plant growth. Softened water, containing elevated sodium levels, proves harmful. Water exceeding 0.5 million or 320 parts per million in salt content can cause nutrient imbalances. Customized nutrient solutions may help address this issue, but it requires expertise in balancing salts.

Plants also demand oxygen for respiration, a process vital for water and nutrient uptake. In soil, oxygen is typically abundant; however, in hydroponics, plant roots in water can deplete dissolved oxygen quickly, potentially causing damage or death. Aeration through air bubbling is a common method to supplement oxygen. Aeroponic or continuous flow systems often negate the need for additional oxygen.

In summary, while hydroponic systems offer advantages, they necessitate meticulous attention to temperature, light, spacing, water provision, water quality, and oxygen supply to ensure optimal plant growth and productivity.

TRANSMITTER:

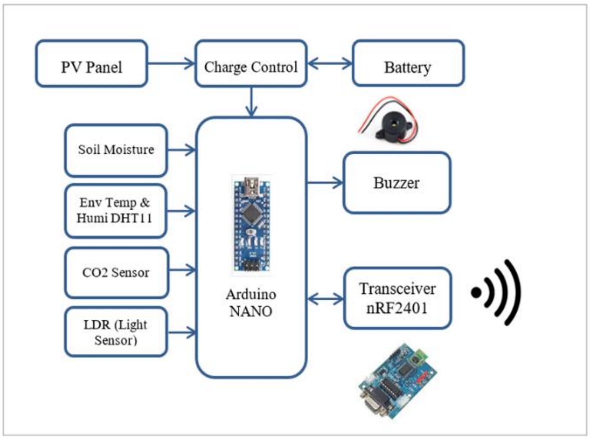

Fig: Transmitter block diagram

RECEIVER:

Green plants rely on the absorption of specific minerals through their roots to sustain their survival. In garden settings, these minerals are sourced from the soil and supplemented through the application of fertilizers like manure, compost, and fertilizer salts. The crucial elements required in substantial quantities include nitrogen, phosphorus, potassium, calcium, magnesium, and sulphur. Additionally, micronutrients such as iron, manganese, boron, zinc, copper, molybdenum, and chlorine are essential, albeit in minimal quantities.

In a garden, plant roots are naturally surrounded by soil, providing the necessary support for their growth. Conversely, hydroponically grown plants require artificial support, typically achieved through the use of string or stakes. Consequently, the measurement of humidity and temperature plays a crucial role in regulating environmental conditions vital for plant survival. These measurements are essential for weather analysis and forecasts, particularly in the realm of agriculture. To safeguard plants from drought and extreme temperatures, monitoring and controlling humidity and temperature levels become imperative.

Utilizing a soil moisture sensor aids in detecting the water content in the soil around the plants. The sensor offers two output configurations, namely high and low, providing valuable information about soil hydration.

The prototype incorporates a pump housed within a single available tank. This pump serves dual purposes – irrigation and cooling. For irrigation, the pump initiates the flow of water through a hose and subsequently through water sprinklers.

The decision to continue or cease pump operation depends on the readings from plant humidity and water level sensors. In the cooling system, water is sprayed among the straw, and a fan contributes to cooling the plants.

Automation extends to shading, where a motor is employed to adjust shutters, thereby regulating the amount of sunlight entering the greenhouse based on the plant's measured needs. Additionally, remote monitoring capabilities allow users to check the farm's status from a distance. Users can access sensor readings and measurements, and the receiver system enables manual control when needed.

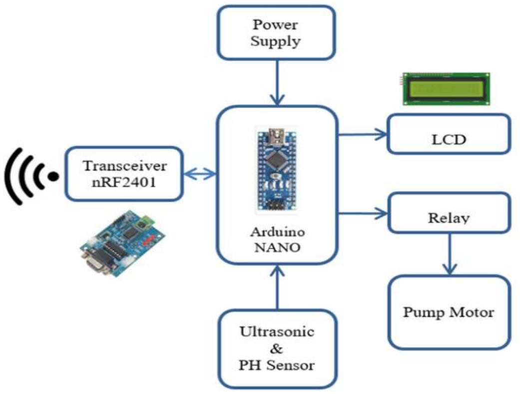

Fig: Receiver block diagram

MASTER CONTROLLER PROGRAM:

```
//TRANSMITTER
#include <Wire.h>
#include <LiquidCrystal.h>
const int RS = 7;
const int E  = 6;
const int D4 = 5;
const int D5 = 4;
const int D6 = 3;
const int D7 = 2;
LiquidCrystal lcd(RS, E, D4, D5, D6, D7);
#include <SoftwareSerial.h>
// Temp and Humidity
#include "DHT.h"
#define DHTPIN1 A1     // Digital pin connected to the DHT sensor
#define DHTTYPE1 DHT11   // DHT 11
DHT dht1(DHTPIN1, DHTTYPE1);
//Moisture Level
int soil_moi,sensor_analog1;
```

```
const int sensor_pin1 = A2;
// Air Quality
int aqv = A3;
int air = 0;
//LDR
int ld  = A5;
int ldr = 0;
int buzzer = 13;
void setup() {
  // put your setup code here, to run once:
  pinMode(sensor_pin1, INPUT);
  pinMode(ld, INPUT);
  pinMode(aqv, INPUT);
  pinMode(buzzer, OUTPUT);
   Serial.begin(9600); // opens serial port, sets data rate to 9600 bps
//Humidity
  dht1.begin();
   lcd.begin(16,2);
  lcd.setCursor(0,0);
  lcd.print("AGRI SENSOR TX");
  lcd.setCursor(0,1);
  lcd.print("MODULE 1 ");
  delay(1500);
  digitalWrite(buzzer, HIGH);
  delay(250);
  digitalWrite(buzzer, LOW);
  lcd.clear();
}
void loop() {
  // put your main code here, to run repeatedly:
 sensor_analog1 = analogRead(sensor_pin1);
  soil_moi = ( 100 - ( (sensor_analog1/1024.00) * 100 ) );
  //Humidity Sensor
  delay(100);
  int ehum = dht1.readHumidity();
  int etemp = dht1.readTemperature();
  air = analogRead(aqv);
  ldr = analogRead(ld);
 lcd.setCursor(0,0);
  lcd.print("T:");
  lcd.print(etemp);
  lcd.print("  ");
 lcd.setCursor(6,0);
  lcd.print("H:");
  lcd.print(ehum);
  lcd.print(" ");
  lcd.setCursor(12,0);
  lcd.print("L:");
  lcd.print(ldr);
  lcd.print(" ");
  lcd.setCursor(0,1);
  lcd.print("S:");
  lcd.print(soil_moi);
  lcd.print(" ");
 lcd.setCursor(6,1);
  lcd.print("A:");
  lcd.print(air);
  lcd.print(" ");
  if (soil_moi < 25){
  digitalWrite(buzzer, HIGH);
    delay(200);
    digitalWrite(buzzer, LOW);
  }
  else{
    delay(100);
    digitalWrite(buzzer, LOW);
  }
  Serial.print("H ");
  Serial.print(etemp);
  Serial.print(",");
  Serial.print(ehum);
  Serial.print(",");
  Serial.print(soil_moi);
  Serial.print(",");
  Serial.print(air);
  Serial.print(",");
  Serial.print(ldr);
  Serial.print("!");
  Serial.println();
  delay(1000);
}
```

WATER PUMPING SYSTEM PROGRAM:

```
//RECEIVER
#include <Wire.h>
#include <LiquidCrystal.h>
 const int RS = 7;
```

```
 const int E  = 6;
 const int D4 = 5;
 const int D5 = 4;
 const int D6 = 3;
 const int D7 = 2;
 LiquidCrystal lcd(RS, E, D4, D5, D6, D7);
#include <SoftwareSerial.h>
SoftwareSerial PHSerial(10, 11); // RX, TX
//pH
String ph;
int phvalue = 0;
// Ultrasonic pins numbers
const int trigPin = A0;
const int echoPin = A1;
// defines variables
long duration;
int dCm;
#include <String.h>
#include <TextFinder.h>
TextFinder finder(Serial);
const int no_of_fields = 5;
int fieldID = 0;
int values[no_of_fields];
 int relay = 12;
  void setup() {
 // put your setup code here, to run once
  Serial.begin(9600); // opens serial port, sets data rate to 9600 bps
 PHSerial.begin(9600);
 pinMode(trigPin, OUTPUT);
 pinMode(echoPin, INPUT);
 pinMode(relay, OUTPUT);
 lcd.begin(16,2);
 lcd.setCursor(0,0);
 lcd.print("AGRI RECEIVER");
lcd.setCursor(0,1);
  lcd.print("MODULE 2");
delay(2000);
 lcd.clear();
}
  void loop() {
 // put your main code here, to run repeatedly:
 for(fieldID = 0; fieldID  < 5; fieldID ++)
 {
  values[fieldID] = finder.getValue();
  }
int data1 = values[0]; int data2 = values[1];
int data3 = values[2];
int data4 = values[2];
int data5 = values[2];
 //pH Value
for(int i=1; i<=2; i++) {
String phdata = PHSerial.readStringUntil(':')
 if(phdata) != "
 ph = PHSerial.readStringUntil('$');
 phvalue = ph.toFloat();
//phvalue = phvalue-30;
 //Serial.print("PH:");
  //Serial.println(phvalue);
  } }
  // Ultrasonic Sensor
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
   delayMicroseconds(10);
   digitalWrite(trigPin, LOW);
   duration = pulseIn(echoPin, HIGH);
   // Calculating the distance
   dCm= duration*0.034/2;
  \\ lcd.setCursor(0,0);
    lcd.print("PH:");
lcd.print(phvalue);
 lcd.setCursor(6,0);
 lcd.print("W:");
 lcd.print(dCm);
  if(data3 <= 20){
      digitalWrite(relay, HIGH);
    }
    else{
      digitalWrite(relay, LOW);
    }
            Serial.print("123 ");
    Serial.print(data1);
    Serial.print(" ");
    Serial.print(data2);
    Serial.print(" ");
    Serial.print(data3);
    Serial.print(" ");
    Serial.print(data4);
```

```
    Serial.print(" ");
    Serial.print(data5);
    Serial.print(" ");
    Serial.print(phvalue);
    Serial.print(" ");
    Serial.print(dCm);
    Serial.println();
    delay(750);
}
        void serialmotor
}
```

CONCLUSION AND HARDWARE SETUP

The proposed, agricultural monitoring system is need for the hour to reduce the human intervention in farming. This demonstrates the advantage of building the rules with mathematical equations and linguistic variables. This process is aimed to educate the farmer on the use of an integrated technology system to monitor and control operations. The system can also create an excellent set of decision-makers with reduced manual contribution. Furthermore, the outcomes help us to understand more about the significance of each variable to obtain healthy plants. This achievement leads to a smart water management. For future enhancement, we would like to attain more data so that we can run training and testing of the data.

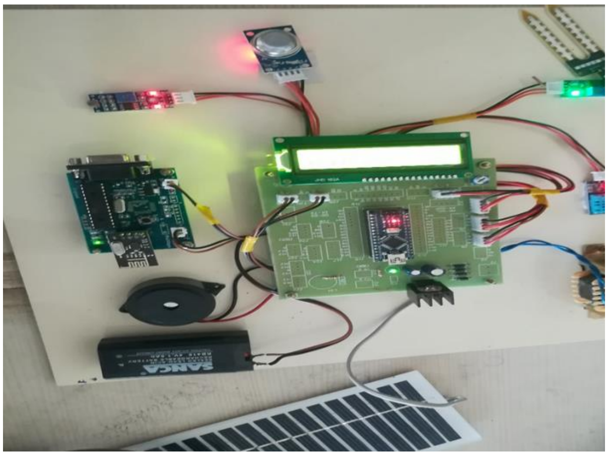

Fig: Master Controller – Hardware Setup

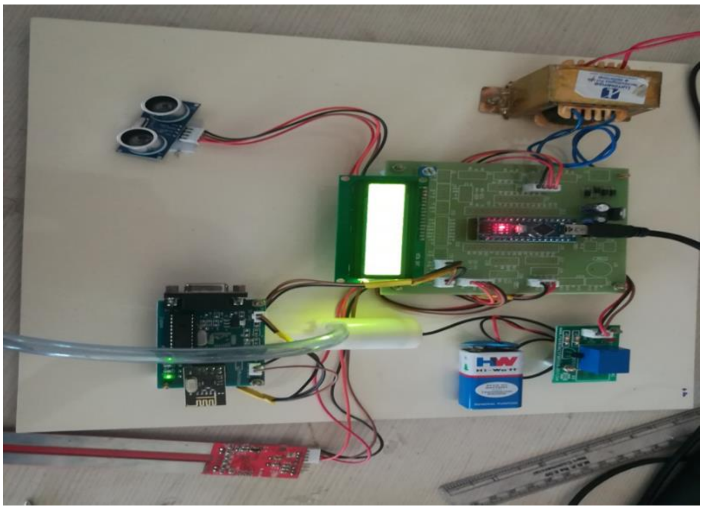

Fig: Water Pumping System

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