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A Novel Design Approach towards Next-Generation Smart Irrigation System for Agricultural Enhancement

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ABSTRACT –

The paper investigates the integration of smart technologies within Irish agriculture, a trend driven by the need for increased efficiency, profitability, and environmental responsibility. We explore the concepts of smart farming, precision agriculture, and Agriculture 4.0, highlighting their shared goal of optimizing agricultural practices. The growing global market for smart agriculture solutions underscores the potential of this approach. We examine the adoption of various technologies, including drones, automated systems, and robotics, and their potential to transform farm operations. By automating tasks and reducing reliance on manual labor, smart agriculture can free up resources for environmental practices and improve work-life balance for farm personnel. This investigation paves the way for further research on the implementation and impact of smart technologies within Irish agriculture.

***Key Words*:** Smart irrigation systems, agriculture, sustainability, water efficiency, crop yield, sensor technology, artificial intelligence, IoT connectivity, environmental impact, resilience, innovation.

1.INTRODUCTION

Agriculture, the cultivation of plants for food, fiber, and other products, has been the cornerstone of human civilization for millennia. Traditionally, agricultural practices have relied heavily on manual labor and rudimentary tools. However, the ever-growing global population and the increasing pressure on resources necessitate a paradigm shift towards more efficient and sustainable farming methods. This paper explores the transformative potential of the Internet of Things (IoT) in revolutionizing agriculture, ushering in an era of "Smart Agriculture."

Here, we delve into the concept of an IoT-based agricultural monitoring system, outlining its core components and functionalities. We present a specific system design utilizing Arduino, a popular open-source microcontroller platform, coupled with various sensors for real-time data collection on environmental parameters like temperature, humidity, and soil moisture. This data is then transmitted wirelessly to a central hub for monitoring and analysis. The system's automation capabilities, triggered by sensor readings exceeding predefined thresholds, are highlighted. For instance, the system can automatically activate irrigation pumps upon detecting low soil moisture levels or engage ventilation systems when temperatures rise beyond optimal ranges. Additionally, the paper explores user interaction through features like SMS alerts and remote monitoring via an IoT platform, enabling farmers to stay informed and manage their fields from any location. Traditional farming practices, while serving humanity for centuries, struggle to meet the demands of a growing population and resource scarcity. However, the Internet of Things (IoT) offers a revolutionary solution: Smart Farming.

This paper explores how IoT-based smart farming empowers growers and farmers to achieve significant strides in efficiency and sustainability. By leveraging a network of sensors that monitor various environmental parameters like light, humidity, temperature, and soil moisture, this system provides real-time insights into crop health and field conditions. This data becomes the cornerstone for optimizing resource utilization. Imagine a scenario where irrigation systems automatically activate based on real-time soil moisture readings, eliminating water waste and ensuring optimal hydration for crops. Similarly, smart farming can minimize fertilizer usage by precisely targeting specific areas based on sensor data, reducing environmental impact and unnecessary costs. Even operational efficiency sees a boost. Monitoring farm vehicle movement allows for route optimization, minimizing fuel consumption and unnecessary journeys. Beyond automation, smart farming empowers informed decision-making. The ability to remotely monitor field conditions from anywhere grants farmers unparalleled flexibility. They can analyze data to identify trends and potential issues, allowing them to take proactive measures. This data can also be used to track overall farm health, staff performance, and equipment efficiency, providing valuable insights for optimizing business operations.

Overall, this paper argues that IoT-powered smart farming isn't merely a trend; it's a transformative force. By enabling precise resource management, data-driven decision making, and operational efficiency, smart farming paves the way for a more sustainable and productive agricultural future.

2. LITERATURE SURVEY

Agriculture, the bedrock of human civilization, faces unprecedented challenges due to population growth and resource limitations. To address these concerns, the integration of advanced technologies like the Internet of Things (IoT) has emerged as a powerful tool for optimizing agricultural practices. This literature review explores the contributions of various scholars in understanding the transformative potential of IoT-based smart farming.

Precision Through Sensors: Zhang et al. (2022)

Zhang et al. (2022) delve into the core components of an IoT-based smart agriculture system. They highlight the importance of various sensors, including those for temperature, humidity, soil moisture, and even crop health. This network of sensors provides real-time data on crucial environmental parameters, enabling farmers to gain a deeper understanding of their fields. Their work emphasizes the role of these sensors in facilitating informed decision-making and automation capabilities within the system.

Optimizing Resource Use: Mondela et al. (2020)

Mondela et al. (2020) focus on the impact of IoT on resource management in smart farming. Their research highlights how sensor data can be used to optimize water usage through automated irrigation systems. This not only reduces water waste but also ensures crops receive the precise amount of water needed for optimal growth. Additionally, they discuss the potential for minimizing fertilizer application by targeting specific areas based on sensor readings, leading to cost savings and reduced environmental impact.

Data-Driven Decision Making: Ait Aissa et al. (2019)

Ait Aissa et al. (2019) explore the role of data in smart farming. They emphasize the importance of the data collected by various sensors, not just for automation but also for empowering informed decision-making. Their work highlights the ability of farmers to remotely monitor field conditions and analyze data trends. This allows for proactive measures to be taken in response to potential issues identified through data analysis. Furthermore, they suggest that this data can be used for broader farm management purposes, such as tracking staff performance and equipment

3.MATERIALS AND METHODOLOGY

DHT11 (temperature and humidity) sensor sense environmental temperature /humidity and sends to Arduino. Soil moisture sensor sense soil moisture Dry and Wet conditions. Arduino takes all these sensor values and displayed on LCD. At the same time Arduino sends to server through WIFI (Esp8266/IOT module). Farmer can monitor all these values from anywhere. Also Farmer can control AC pump for soil moisture, DC fan for temperature and heating element (heater) for humidity from IOT server.

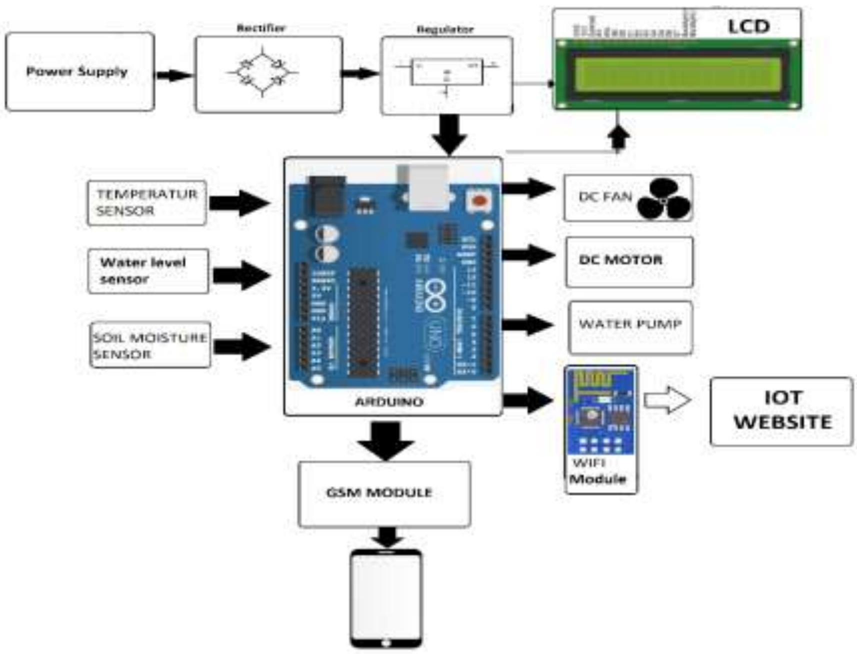

Figure 1 Block Diagram for Smart Irrigation System using IOT

An IoT-based smart agriculture system utilizes a network of sensors and actuators to automate tasks and monitor field conditions. The core of this system lies in a microcontroller unit (MCU) like the Arduino Uno, which acts as a central processing unit. Various sensors collect real-time data on environmental parameters. These include temperature sensors for monitoring ambient temperature, soil moisture sensors to gauge water content in the earth, and water level sensors to track available water supplies. The MCU analyzes this data against predefined thresholds specific to the crop and environment. If, for instance, the soil moisture sensor detects a drop below the optimal level, the MCU triggers the DC motor controlling the water pump, initiating irrigation. Similarly, the system can activate a DC fan based on temperature sensor readings, ensuring proper air circulation and maintaining ideal growing conditions. This automation not only optimizes water usage but also minimizes manual labor for farmers. Additionally, an LCD display provides real-time data on various parameters, while communication modules like GSM and WiFi enable remote monitoring through SMS alerts or data transmission to an IoT platform. This empowers farmers with greater control and the ability to make informed decisions based on real-time insights. In essence, IoT-based smart agriculture systems transform farming practices by automating tasks, promoting efficient resource use, and offering real-time data for informed decision-making.

4. Operation of an IoT-based Smart Irrigation System with Arduino Uno and ESP8266

This system automates irrigation, ventilation, and heating based on real-time environmental data and user control, promoting efficient resource use and optimal crop growth conditions.

Hardware Components:

- **Microcontroller:** Arduino Uno - Processes sensor data, controls actuators, and communicates with the ESP8266.
- **Crystal Oscillator:** 16 MHz - Provides a stable clock signal for accurate timing within the Arduino.
- **LCD Display:** 16x2 LCD - Displays sensor readings, system status, and user interface for manual control.
- **WiFi Module:** ESP8266 - Enables wireless communication for data transmission to an IoT platform and potential remote control.
- **Temperature & Humidity Sensor:** DHT11 - Measures ambient temperature and humidity levels.
- **Relays:** 12V - Act as electronic switches to control high-voltage AC devices like the pump and heater.
- **Electromagnetic Coil Pump:** AC Pump (230V) - Powerful pump activated by the relay for water delivery.
- **Fan:** DC Fan (12V) - Manages air circulation and temperature control when activated by the relay.
- **Heater:** 230V AC Heating Filament - Provides warmth for temperature regulation when switched on by the relay.
- **Power Source:** 12V 2 Amp Adaptor - Supplies power to the entire system except the AC pump and heater.

System Workflow:

1. **System Startup:** Upon power-up, the Arduino initializes and establishes communication with the ESP8266 module.
2. **Sensor Data Acquisition:** The Arduino reads data from the DHT11 sensor, acquiring temperature and humidity values.
3. **Data Processing and Decision Making:** The Arduino compares the sensor readings against predefined thresholds for temperature, humidity, and soil moisture (assuming an additional soil moisture sensor is integrated).
4. **Actuator Control:** Based on the comparison:
   - **Irrigation:** If the soil moisture falls below the threshold, the Arduino activates a relay, energizing the AC pump for automatic irrigation.
   - **Ventilation:** If the temperature rises above the threshold, the Arduino energizes a relay controlling the DC fan to promote air circulation and cooling.
   - **Heating:** If the temperature falls below the desired minimum (applicable in specific climates), the Arduino activates a relay connected to the heater to maintain warmth.
5. **Data Display and User Interface:** The LCD displays current temperature, humidity, and potentially soil moisture readings. Additionally, it can offer a user interface for manual control of irrigation, ventilation, and heating (optional).
6. **Remote Monitoring (Optional):** The ESP8266 can be programmed to transmit sensor data and system status to an IoT platform for remote monitoring and potential cloud-based control via a smartphone or web interface.

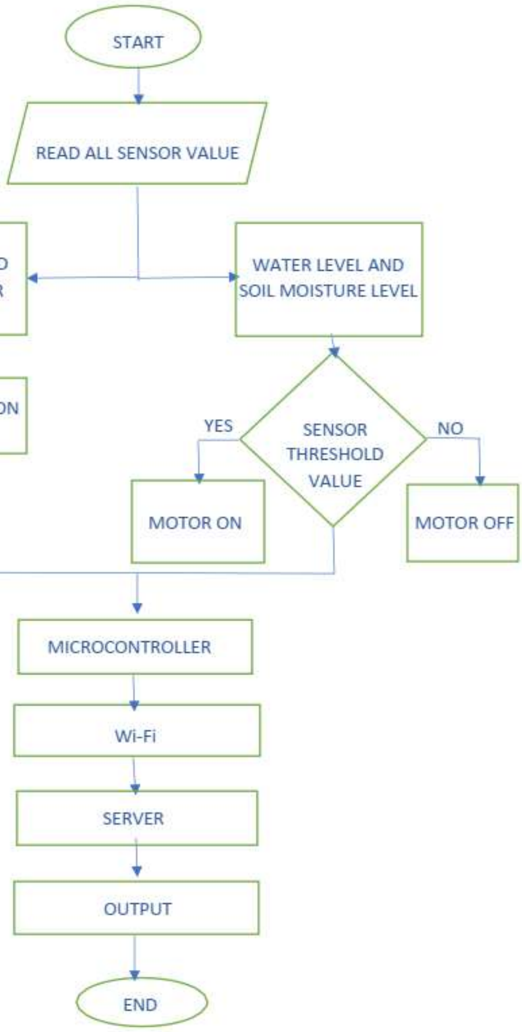

Fig. 15 Flowchart of the project

Additional Considerations:

- **Safety:** Ensure proper isolation between the low-voltage Arduino system and the high-voltage AC pump and heater using relays and appropriate wiring practices.
- **Power Consumption:** The AC pump and heater will have a significant power draw compared to the rest of the system. Consider using them judiciously and exploring alternative low-power heating solutions if applicable.
- **Scalability:** This design can be expanded to include additional sensors (e.g., soil moisture) and actuators for a more comprehensive environmental control system.

This IoT-based smart irrigation system offers a data-driven approach to agriculture, optimizing resource utilization and creating a more controlled environment for improved crop growth. The potential for remote monitoring and control adds further convenience and flexibility for farmers.

5. HARDWARE DESIGN

- Atmega 328 Microcontroller
- 12V DC motor
- Relay module
- Jump wire

6. CONCLUSIONS

In conclusion, the system leverages soil moisture sensors to monitor water content in the ground. This real-time data is then used to automatically activate or deactivate irrigation sprinklers, eliminating the need for frequent manual checks and adjustments. The core functionality can be further enhanced by incorporating a pump directly into the system. This upgrade would enable fully automated water delivery based on sensor readings, ensuring optimal moisture levels for crops without human intervention. Recognizing the potential benefits of remote management, the authors propose the possibility of integrating farmer control. By incorporating features like remote on/off functionality for the pump, farmers gain the flexibility to initiate or stop irrigation cycles even when they're not physically present on the farm. This not only saves time and effort but also empowers farmers to react promptly to changing weather conditions. The potential applications of this technology extend beyond irrigation. The document explores the broader concept of utilizing IoT (Internet of Things) in various agricultural tasks. Imagine a future where IoT-based systems manage livestock health, detect fires promptly, and regulate farm environments – all while minimizing human intervention. This not only reduces the physical demands on farmers but also holds promise for increased efficiency and productivity across diverse agricultural practices.

REFERENCES

[1]Oikonomou, G & Gavras, A. (2014, March). Enabling reliable and secure IoT-based smart city applications. In 2014 IEEE International Conference on Pervasive Computing and Communication Workshops (PERCOM WORKSHOPS) (pp. 111-116). IEEE.

[2] Shah, J., & Mishra, B. (2016, January). IoT enabled environmental monitoring system for smart cities. In 2016 International Conference on Internet of Things and Applications (IOTA) (pp. 383-388). IEEE.

[3] Pasha, S. (2016). ThingSpeak based sensing and monitoring system for IoT with Matlab Analysis. International Journal of New Technology and Research, 2(6).

[4] Khan, R., Khan, S. U., Zaheer, R., & Khan, S. (2012, December). Future internet: the internet of things architecture, possible applications and key challenges. In 2012 10th international conference on frontiers of information technology (pp. 257-260). IEEE.

[5] https://components101.com/development-boards/nodemcu-esp8266- pinout-features- and-datasheet

[6] Kumar, N. S., Vuayalakshmi, B., Prarthana, R. J., & Shankar, A. (2016, November). IOT based smart garbage alert system using Arduino UNO. In 2016 IEEE Region 10 Conference (TENCON) (pp. 1028-1034). IEEE.

[7] Kumar, S., & Jasuja, A. (2017, May). Air quality monitoring system based on IoT using Raspberry Pi. In 2017 International Conference on Computing, Communication and Automation (ICCCA) (pp. 1341-1346). IEEE.

[8] Talari, S., Shafie-Khah, M., Siano, P., Loia, V., Tommasetti, A., & Catalao, J. (2017). A review of smart cities based on the internet of ˜ things concept. Energies, 10(4), 421.25

[9] Ma, Y., Yang, S., Huang, Z., Hou, Y., Cui, L., & Yang, D. (2014, December). Hierarchical air quality monitoring system design. In 2014 International Symposium on Integrated Circuits (ISIC) (pp. 284-287). IEEE.

[10] Ahlgren, B., Hidell, M., & Ngai, E. C. H. (2016). Internet of things for smart cities: Interoperability and open data. IEEE Internet Computing, 20(6), 52-56.

[11] https://creativestudio1973.blogspot.com/2019/11/temperature-andhumidity-sensor.html

[12] https://www.instructables.com/Measuring-Humidity-Using-SensorDHT22

[13] https://www.naukri.com/learning/articles/iot-in-agriculture-howconnected-devices-are-shaping-the-future-of-farming/

[14] https://www.xenonstack.com/use-cases/iot-smart-farming

[15] https://creativestudio1973.blogspot.com/2021/05/nokia-5110-lcddisplay-interface-with.html

APPENDIX

```
#include <Adafruit_GFX.h>

#include <Adafruit_PCD8544.h>

#include <DHT.h>

float t, h, m1, m2;

Adafruit_PCD8544 display = Adafruit_PCD8544(6, 5, 4, 3, 2);

#define DHTPIN 12

#define DHTTYPE DHT22
```

```
DHT dht (DHTPIN, DHTTYPE);
void setup()
{
Serial.begin(9600);
while (!Serial) continue;
display.begin();
display.setContrast(35);
display.clearDisplay();
display.setTextSize(1);
display.setTextColor(BLACK);
display.setCursor(0, 0);
display.println(" IoT Based");
display.println("Smart Farming");
17
display.display();
delay(2000);
display.clearDisplay();
display.display();
pinMode(13, OUTPUT);
pinMode(11, INPUT);
digitalWrite(13, LOW);
dht.begin();
}
void loop() {
float h = dht.readHumidity();
float t = dht.readTemperature();
float m = abs(100-(analogRead(A0)/10.23));
if (isnan(h) || isnan(t)) {
Serial.println("Failed to read from DHT sensor!");
return;
}
int it = t*100;
int ih = h*100;
int im = m;
bool pc = digitalRead(11);
digitalWrite(13, pc);
display.clearDisplay();
18
display.setCursor(0, 0);
display.println("Smart Farming");
display.print("Temp: ");
display.println(t,1);
display.print("Hum: ");
display.println(h,1);
display.print("Soil: ");
```

```
display.println(m,0);
if (pc == 1)

display.print("Pump on");

display.display();
// Send Data to Cloud

StaticJsonDocument<200> doc;

doc["it"] = it;

doc["ih"] = ih;

doc["im"] = im;

doc["pc"] = pc;

serializeJson(doc, Serial);

delay(500);
}
```