

IoT-Based Solar-Powered Smart Irrigation and Agricultural Field Monitoring System

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Abstract: *The proposed project, IoT Based Solar Powered Smart Irrigation and Agriculture Field Monitoring System, is designed to improve agricultural productivity and water management through the integration of Internet of Things (IoT) technology and renewable solar energy. The system utilizes a wireless sensor network to continuously monitor important environmental and field parameters such as soil moisture, temperature, humidity, water level, rainfall, and animal intrusion. The collected data is processed using the ATmega328 microcontroller and transmitted to the IoT cloud through the ESP8266 WiFi Module for real-time monitoring and control.*

Keywords: Internet of Things (IoT), Smart Irrigation System Solar Powered Agriculture, Precision Farming Wireless Sensor Network

I. INTRODUCTION

An IoT-based solar-powered smart irrigation and agriculture field monitoring system is a modern way to help farmers manage their fields more efficiently. This system uses solar energy to power its sensors and devices. This makes it eco-friendly and suitable for remote areas where electricity may not be available. It collects real-time data from the field with various sensors that measure soil moisture, temperature, humidity, and weather conditions. The information is sent wirelessly to a central Cloud Storage. This allows farmers to monitor their Farm and soil conditions from anywhere. When the soil moisture drops below a certain level, the system can automatically turn on a water pump to irrigate the crops. It turns off the pump when enough moisture is detected, so no manual work is needed. By using solar power and IoT technology, this system helps save water, reduce energy use, lower farming costs, and improve agricultural productivity. It also supports sustainable farming by ensuring crops receive the right amount of water at the right time, even in areas with limited infrastructure.

II. LITERATURE REVIEW

Balaji Banu [1] developed a wireless sensor network (WSN) for agricultural monitoring aimed at improving crop yield and quality by continuously observing environmental conditions such as water level, humidity, and temperature.

Liu Dan [2], Joseph Haule and & Cao Shuntian each investigated greenhouse monitoring systems leveraging ZigBee technology to enable intelligent, remote greenhouse control.

Joseph Haule [3] together with Dragoş Mihai Ofirim, Bogdan Alexandru Ofirim explored the automation of irrigation using WSNs, emphasizing that irrigation scheduling driven by real-time soil moisture data can deliver major water savings and improved crop quality.

Vijay Kumar [4] and collaborators (Lin Zhang et al. [13], focused on rural farming applications where multi-sensor motes monitor parameters such as leaf wetness, soil moisture, soil pH, and atmospheric pressure.

G. Nisha [5], Chun-ling Fan and Yuan Guo [10] proposed a distributed wireless sensor-based automated irrigation framework that collected soil moisture and temperature across fields and used ZigBee to relay sensor values to a microcontroller implementing threshold-based irrigation logic.



III. BLOCK DIAGRAM

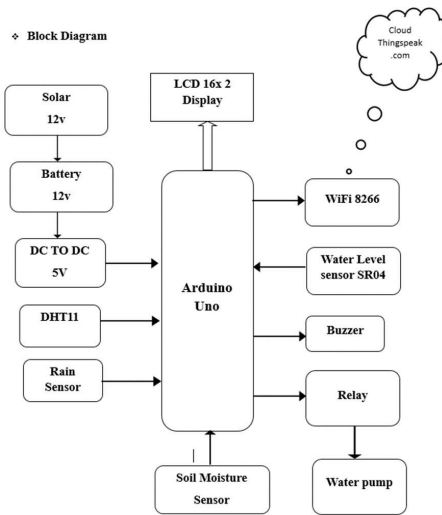


Fig -1: Block Diagram

IV. SOFTWARE AND HARDWARE PLATFORM

Hardware Used :-ATmega328P, Microcontroller, ESP8266 Wi-Fi Module, Soil Moisture, Sensor, Rain Sensor, DHT11 Sensor, Ultrasonic Sensor (HC-SR04), Relay Module, Buzzer, LCD Display (16x2), LM2596 Buck Converter, Solar Power Unit.

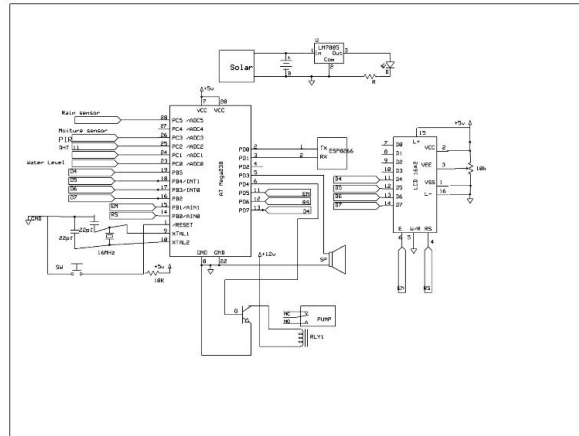
Software Used:- Thing speak (IOT CLOUD) Scada (L And K Smartcomm), Advantech Edgelink Studio, Proteus.



Fig -2: Project Image



V. SIMULATION DIAGRAM



VI. WORKING PRINCIPAL

System Initialization: When powered ON, the microcontroller initializes all sensors, LCD, relay, Wi-Fi, and cloud connectivity.

1. Sensor Data Collection:

- o The Soil Moisture Sensor continuously monitors soil wetness.
- o The Rain Sensor detects rainfall conditions.
- o The DHT11 Sensor measures temperature and humidity.
- o The Ultrasonic Sensor reads the water level in the tank.

2. Decision Logic:

- o If soil is dry and no rain is detected, the Arduino activates the relay, turning ON the water pump.
- o When soil becomes wet or rain starts, the pump automatically turns OFF.
- o The system ensures efficient water usage and prevents wastage.

3. Output Display & Alerts:

- o The LCD displays real-time messages such as:
 - “Soil Dry — Pump ON”
 - “Soil Wet — Pump OFF”
 - “Rain Detected”
- o The Buzzer provides audible alerts for major events like rain detection or pump activation.

4. Cloud Data Transmission:

- o Using the ESP8266 Wi-Fi module, sensor readings are transmitted to ThingSpeak.com, an IoT analytics platform.
- o Users can view live graphs, download data, and monitor system performance remotely via mobile or web dashboard.

5. Remote Monitoring:

- o Authorized users can log into ThingSpeak to visualize:
 - Soil moisture trends
 - Humidity & temperature variations
 - Water tank level



- Pump activity logs

VII. ADVANTAGES AND APPLICATIONS

Advantages

- Reduces water wastage through intelligent control

Multiple Field Support:

Expand the system to control and monitor multiple irrigation zones simultaneously using wireless sensor networks (WSN).

- Operates autonomously without human supervision
- Real-time data accessible from anywhere
- Powered by renewable energy (solar)
- Improves agricultural efficiency and productivity

Applications

- Smart agriculture and greenhouses
- Remote irrigation systems
- Water resource management
- Smart city environmental monitoring

VIII. CONCLUSIONS

The proposed IoT-Based Smart Irrigation and Environmental Monitoring System successfully demonstrates an efficient, automated, and intelligent water management solution for modern agriculture. Using sensors such as Soil Moisture, DHT11 (Temperature and Humidity), Rain Sensor, and Ultrasonic Water Level Sensor, the system continuously monitors environmental parameters and intelligently controls the water pump through a relay interface. The inclusion of the ESP8266 Wi-Fi module enables seamless connectivity with the ThingSpeak Cloud, allowing users to observe real-time data and irrigation status remotely via any internet-enabled device.

IX. FUTURE SCOPE

Although the current system performs effectively for small- to medium-scale applications, there are several potential enhancements and extensions that can be implemented in future work:

Mobile App Integration:

Develop an Android/iOS app for real-time system control, notifications, and data visualization instead of relying only on the ThingSpeak interface.

AI and Machine Learning:

Implement predictive analytics to forecast soil moisture levels, rainfall probability, or irrigation needs based on historical data.

Advanced Sensor Modules:

Integrate pH, EC (Electrical Conductivity), and nutrient sensors for a more comprehensive analysis of soil health.

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