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Solar Based Water Irrigation System Using Rf Remote Control

Mr.Raj Sanap[1], Mr.Raj Zolage[2], Mr. Sahil Raut[3], Mr. Rushikesh Rajvir[4], Pro.Ronita Pawn[5]
[1,2,3,4] *UG students, Department of Electrical Engineering, Pillai HOC college Of Engineering and Technology, Rasayani , Maharashtra,India*
[5]*Assistant Professor.Department of Electrical Engineering, Pillai HOC college Of Engineering and Technology, Rasayani , Maharashtra,India*

***Abstract*—Agriculture is highly dependent on efficient water management, and automation can significantly improve resource utilization. This project presents a Smart IoT-Based Irrigation System that integrates RF 315MHz wireless communication, NodeMCU (ESP8266) microcontrollers, solenoid valves, and a solar-powered battery system to enable remote and manual control of irrigation.The system consists of two main components: the transmitter unit (controller side) and the receiver unit (actuator side). The transmitter unit includes a NodeMCU, an RF 315MHz transmitter, and six push buttons to control four solenoid valves, an "All ON" button, and an "All OFF" button. The receiver unit consists of a NodeMCU, an RF 315MHz receiver, and a 4-channel relay module to operate the solenoid valves. Additionally, a 1-channel relay is used to control a water pump, which is activated only on the receiver side to draw water. The system is powered by a 12V 1.3Ah battery, which is charged using a 12V 10W solar panel, ensuring energy efficiency and sustainability. A voltage sensor continuously monitors the battery level, and the data is uploaded to ThingSpeak, allowing users to track battery performance in real time. The system is integrated with an IoT-based control panel via Kodular, enabling users to operate the irrigation system remotely. This smart irrigation system enhances water conservation by allowing precise control over water distribution. The combination of manual RF-based control and remote IoT-based monitoring provides a reliable, scalable, and cost-effective solution for farmers. The solar-powered design ensures uninterrupted operation in rural areas with limited electricity access.Overall, this system improves agricultural productivity, reduces water wastage, and promotes sustainability through automation, IoT integration, and renewable energy utilization.**

I. INTRODUCTION

Water is one of the most critical resources in agriculture, and its efficient management is essential for improving crop yield and sustainability. Traditional irrigation systems often lead to excessive water usage, manual labor, and inefficient resource allocation. With the advancement of technology, smart irrigation systems are being developed to automate water distribution, minimize wastage, and optimize farming efficiency.

This project introduces a Smart IoT-Based Solar-Powered Irrigation System that utilizes NodeMCU (ESP8266), RF 315MHz communication, solenoid valves, and a solar power setup to enable both manual and remote irrigation control. The system is designed to provide farmers with a cost-effective, automated, and energy-efficient solution for managing water distribution in agricultural fields.

II. SYSTEM ARCHITECTURE

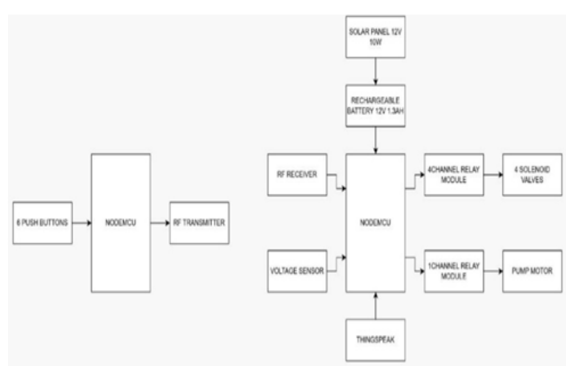


Figure 1

Power Supply: A solar panel array powers the system. A solar charge controller regulates the voltage and current from the panel to protect the battery and ensure consistent power supply.

Control Unit: The central control unit consists of a microcontroller (e.g., Arduino or ESP8266/ESP32) which interfaces with RF modules and the ThingSpeak IoT platform.

Communication Modules:
RF Remote: Allows manual control of solenoid valves for immediate field intervention.

ThingSpeak Platform: Facilitates real-time monitoring and automatic control based on predefined conditions (e.g., soil moisture, temperature).

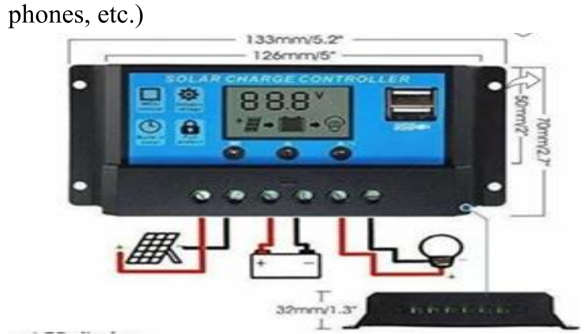
Actuators: Four solenoid valves are used, each controlling irrigation in a separate field zone. These valves are triggered based on commands from the microcontroller.

III. HARDWARE COMPONENTS

1)Solar Pannel

12V 10W solar panel is used in the Smart IoT-Based Solar-Powered Irrigation System to Harvest solar energy and charge the 12V 1.3Ah lead-acid battery. This ensures a sustainable, Off-grid power supply for the NodeMCU, RF module, relays, and solenoid valves. The panel Consists of photovoltaic (PV) cells that convert sunlight into DC electricity, which is then Regulated to safely charge the battery. With an average output of 10W per hour under optimal Sunlight conditions, it provides efficient energy generation for the system. This eco-friendly and cost-effective solution reduces reliance on external power sources and supports continuous Irrigation automation.

2) Solar Charger Controller
A solar charge controller is an essential component in any solar power system. It regulates the
Power going from the solar panels to the battery bank to prevent overcharging, over-Discharging, overvoltage, and short circuits.
Type: PWM (Pulse Width Modulation)
Display: LCD with control buttons
USB Ports: Dual USB (for 5V DC output to charge phones, etc.)



Connection Terminals (Bottom Panel):
From left to right:

1. Solar Panel (+)
2. Solar Panel (-)
3. Battery (+)
4. Battery (-)
5. Load (+)
6. Load (-)

3) Battery
A 12V 1.3Ah lead-acid battery is a rechargeable sealed battery commonly used in small-scale Power applications. In the Smart IoT-Based Solar-Powered Irrigation System, it serves as the Primary energy storage unit, powered by a 12V 10W solar panel to ensure continuous Operation. The 1.3Ah (ampere-hour) capacity means it can supply 1.3A for one hour or 0.65A For two hours before requiring a recharge. This battery provides stable voltage to the NodeMCU, RF module, and relays, ensuring system reliability. It is maintenance-free, Compact, and durable,

4) Microcontroller ESP 8266MOD
The ESP8266 Wi-Fi module plays a central role in enabling IoT-based control and monitoring of the irrigation system through the ThingSpeak platform. It

acts as the brain of the system by receiving data from sensors (if used), sending it to the cloud, and receiving control commands to operate the solenoid valves.
Key Functions of ESP8266 in This Project:

1. Wi-Fi Connectivity:
Connects to a local Wi-Fi network to communicate with ThingSpeak or other cloud platforms.Enables remote monitoring and control of the irrigation system from anywhere.
2. Cloud Data Handling (ThingSpeak):
Sends data (like Battery voltage or valve status) to ThingSpeak. Receives control commands from ThingSpeak based on sensor thresholds or manual user input.
3. Solenoid Valve Control:
Controls 4 solenoid valves through relay modules.
Each GPIO pin from the ESP8266 is used to trigger a specific relay that opens or closes a solenoid valve for each field.
4. Dual Control Mode Integration:
Works with both RF remote and ThingSpeak-based control.Uses input from the RF receiver module to switch valves in manual mode.

Technical Details:
Model: ESP8266 NodeMCU or ESP-01
Operating Voltage: 3.3V (use level shifter or regulator when needed)
Programming: Arduino IDE using the ESP8266 board package
GPIOs Used: 4 pins for controlling relays, others for RF module and sensors

5) Relay module
Channels: 4 (for 4 solenoid valves)
Operating Voltage: 5V (driven through a regulator or level shifter if needed)
Relay Type: SPDT (Single Pole Double Throw)
Max Load: Typically, 10A @ 250VAC or 10A @ 30VDC
Trigger Voltage: 3.3V or 5V depending on module (compatible with ESP8266)
Functions in the Project:

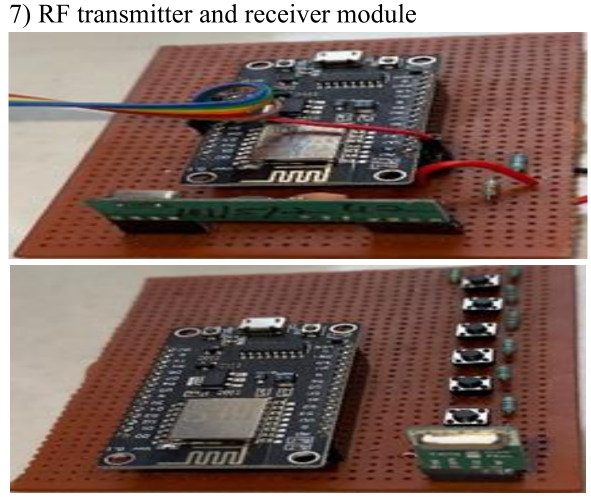
1. Solenoid Valve Control:
Each of the 4 solenoid valves is connected to one relay channel.When the ESP8266 sends a HIGH or LOW signal to a relay input pin, the relay turns the valve ON or OFF.This isolates the ESP8266 from the higher-voltage valve circuit.

2. Manual and IoT Control Integration:
The relay module receives commands either from the RF remote (manual mode) or ThingSpeak (automatic mode) via the ESP8266.This allows flexible control of the irrigation system.

6) Solenoid valve

A solenoid valve is an electromechanical device used to control the flow of water in an Irrigation system. In the Smart IoT-Based Solar-Powered Irrigation System, four solenoid Valves are connected to a relay module, allowing automated water distribution. When activated, an electric current energizes the solenoid coil, creating a magnetic field that opens or closes the Valve. These valves ensure precise control of water flow, reducing wastage and optimizing Irrigation efficiency. They operate on DC voltage, making them compatible with the 12V Battery-powered system. Their fast response time, durability, and reliability make them ideal for automated agricultural applications.

7) RF transmitter and receiver module



The RF 315MHz module is a wireless communication module used for short-range data Transmission. In the Smart IoT-Based Solar-Powered Irrigation System, it enables Communication between the transmitter (push buttons + NodeMCU) and the receiver (NodeMCU + relay module) to control solenoid valves remotely. The RF transmitter sends Signals when a button is pressed, and the RF receiver processes them to activate or deactivate the corresponding relay. It operates at 315MHz frequency, offering a range of up to 100 meters in open space. This low-power, cost-effective, and easy-to-integrate module ensures efficient Wireless control in smart irrigation applications.
ThingSpeak: Used to collect and analyze sensor data. Commands can be sent based on thresholds or user input via web dashboard.

Firmware: Programmed using Arduino IDE or similar tools. The code handles RF signal decoding, valve switching logic, and data communication with ThingSpeak.

8) DC Pump

Power Source: 12V battery charged by the solar panel

Control Method: Controlled via relay module connected to ESP8266

Flow Management: Pump provides pressure, solenoid valves direct water to specific fields

IV. SOFTWARE AND COMMUNICATION

ThingSpeak: Used to collect and analyze sensor data. Commands can be sent based on thresholds or user input via web dashboard.

Firmware: Programmed using Arduino IDE or similar tools. The code handles RF signal decoding, valve switching logic, and data communication with ThingSpeak.

V. OPERATION

1. Manual Mode: The RF remote sends signals to the microcontroller to open or close specific solenoid valves.
2. Automatic Mode: Sensor data uploaded to ThingSpeak triggers automatic valve control based on environmental thresholds.
3. Power Management: The charge controller ensures that solar energy is efficiently stored and used to power the microcontroller and solenoid valves.

VI. RESULTS AND BENEFITS

- Reduced reliance on grid electricity.
- Remote accessibility and automation via IoT.
- Efficient water usage tailored to field needs.
- Dual control mode (manual and automatic) for flexible operation.

VII. FINAL PROJECT MODEL

VIII. CONCLUSION

In this paper smart irrigation model is successfully proposed and implemented using different circuits it is demonstrated with different figures, for consideration of the reliability, low cost, efficiency and wastage of electricity and as option for electric power we implemented the smart irrigation system. A in this paper we proposed model which is automatically control which is helpful to the farmers to irrigate the farm properly. This model will give the proper indication whether the sufficient amount of water is provided or not it will also reduce the wastage of water. Farmer can operate the motor or regulate the motor by cell phone from anywhere. We are using the non conventional energy source hence there is no wastage of electricity, farmers do not depend upon the electric supply.

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