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Solar Powered Smart Irrigation System

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Abstract: Irrigation system is becoming smart by using modern technologies, which is more advantageous than traditional irrigation methods. In this work, a irrigation system is developed that automates the irrigation process powered by solar energy. This system operates by automatically turning the motor on or off to allow water to flow through the pump based on the needs of the soil, as determined by a soil moisture sensor. This not only minimizes water wastage but also ensures that crops receive the right amount of water at the right time. The soil moisture sensor detects the humidity levels in the soil and transmits this data to the control modules. The system then analyses this data and activates the water pump as needed. By using solar power, this irrigation system not only conserves water but also electricity, making it a cost-effective solution to our energy needs. Additionally, solar-powered smart irrigation systems are especially beneficial for Indian farmers, providing a reliable and sustainable solution. Although this system does not function at night, we can integrate rechargeable batteries to maintain operation, ensuring continuous irrigation. In conclusion, this smart irrigation system is highly recommended for farmers in areas with limited access to a constant water supply. It promotes sustainable agriculture by being economical, eco-friendly, and efficient.

Keywords: Soil moisture sensor, Arduino, IC 7812, LCD display module, Relay module, water pump, real-time data transmission, automatic moisture sensing and water pumping.

I. INTRODUCTION

In the face of escalating concerns over energy sustainability and environmental degradation, the imperative to seek innovative solutions for agricultural irrigation becomes increasingly pressing. With the world's growing population and diminishing natural resources, the agricultural sector faces a formidable challenge which ensures food security while conserving water and energy reducing its ecological footprint. In this context, the convergence of two critical domains—solar energy and agricultural irrigation—presents a positive approach for addressing these challenges responsibly.

Solar energy stands out as a beacon of hope amidst the prevailing energy crisis, offering a renewable, environmentally benign alternative to conventional fossil fuel-based power sources. Its abundance, inexhaustibility, and emission-free nature make it an attractive candidate for meeting diverse energy needs while reducing greenhouse gas emissions and dependency on finite resources. Moreover, the declining costs of solar technologies have facilitated their widespread adoption across various sectors, including agriculture, thereby catalysing a paradigm shift towards cleaner, more sustainable energy practices.

Meanwhile, agriculture grapples with its own set of complexities, including water scarcity, erratic precipitation patterns, and escalating operational costs.

The conventional irrigation methods, reliant on finite water sources and grid electricity, not only exacerbate resource depletion but also entail considerable financial burdens for farmers. Consequently, there arises an urgent need to devise efficient, cost-effective irrigation solutions that minimize water and energy wastage while optimizing crop yield.

Through a comprehensive analysis of existing literature, coupled with empirical insights from field trials and case studies, we elucidate the efficacy and viability of solar-powered irrigation systems in enhancing agricultural productivity, resource efficiency, and environmental sustainability.

By synergizing technological innovation with ecological stewardship, we aspire to chart a course towards a greener, more equitable future for farming communities worldwide.

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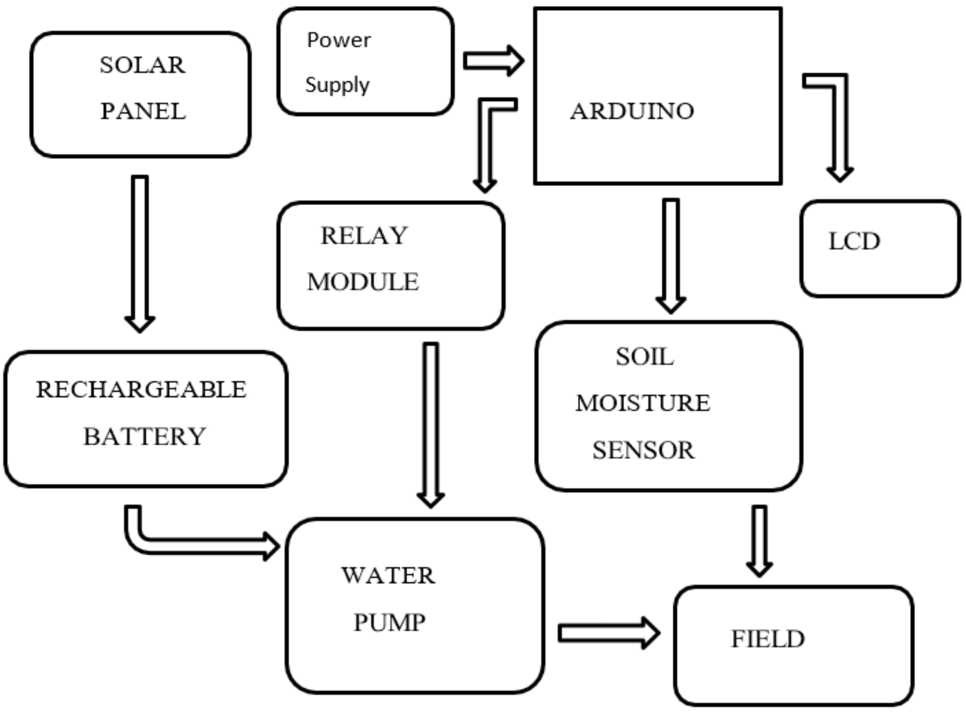
II. BLOCK DIAGRAM



III. METHODOLOGY

HARDWARE AND SOFTWARE COMPONENTS:

1. ARDUINO UNO

Figure 1: Arduino Uno

The Arduino UNO is a low-cost, flexible, and easy-to- use programmable open-source microcontroller board. This board can be interfaced with other Arduino boards, Liquid Crystal Display and motor**.** The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board has 14 digital I/O pins (six capable of PWM output), analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts.

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2. SOLAR PANEL

Figure 2: solar panel

A 12v solar panel is an essential component of solar photovoltaic systems, harnessing sunlight to generate electricity efficiently. Comprising multiple solar cells connected in series, these panels produce an output voltage of approximately 12v under optimal sunlight conditions.

3. BREADBOARD

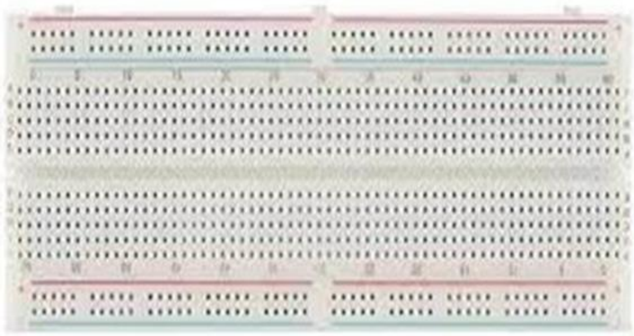

Figure 3: breadboard

A breadboard is a solderless device for temporary prototype with electronics and test circuit designs. Most electronics components in electronic circuits can be interconnected by inserting their leads or terminals in to the holes and then making connections through wires where appropriate

4. JUMPER WIRES

Figure 4: Jumper wires

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Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points each other without soldering.

5. RECHARGEABLE BATTERY

Figure 5: Rechargeable Battery

A 3.7V rechargeable battery is a type of lithium-ion battery widely employed in portable electronic devices due to its compact size and energy efficiency. With a voltage output of 3.7 volts, these batteries are suitable for powering various gadgets such as smartphones, tablets, and digital cameras. They are favoured for their rechargeable nature, allowing users to recharge them multiple times, thus reducing the need for frequent battery replacements.

6. LCD DISPLAY MODULE

Figure 6: LCD pin Configuration

When opposed to cathode ray tube (CRT) technology, LCD technology allows for significantly thinner displays. Two polarized panel filters and electrodes are among the components that make up a liquid crystal display.

LCD technology is utilized in notebooks and other electronic devices such as small computers to display images.

Features of 16×2 LCD module

- Operating Voltage is 4.7V to 5.3V.
- Current consumption is 1mA without backlight.
- Alphanumeric LCD display module, meaning can display alphabets and numbers.
- Consists of two rows and each row can print 16 characters.
- Each character is built by a 5×7pixel box.
- Can work on both 8-bit and 4-bit mode.
- It can also display any custom generated characters.
- Available in Green and Blue Backlight.

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7. CHARGING CIRCUIT MODULE

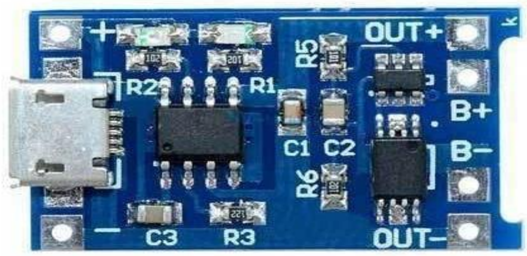

Figure 2.7 Charging circuit

The charging circuit controls the flow of electricity from the solar panel to the rechargeable battery, managing the charging process to prevent overcharging and extend the battery's lifespan. This TP4056 1A Li-ion lithium Battery Charging Module With Current Protection – Type C is a tiny module, perfect for charging single cell 3.7V 1 Ah or higher lithium-ion (Li-Ion) cells such as 16550s that don't have their own protection circuit.

8. RELAY MODULE

Figure 2.8 Relay module

Power relay module is an electrical switch that is operated by an electromagnet. The electromagnet is activated by a separate low-power signal from a micro controller. When activated, the electromagnet pulls to either open or close an electrical circuit.

9. WATER PUMP

Figure 2.9 Water pump

Submersible Pump Motor which can be operated from a 3- 9V power supply. It can take up to 120 litres per hour with very low current consumption of 220mA. To keep the water cleans so as not to block the pump rotor, the pump should be cleaned regularly to keep the pump clean.

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10. SOIL MOISTURE SENSOR

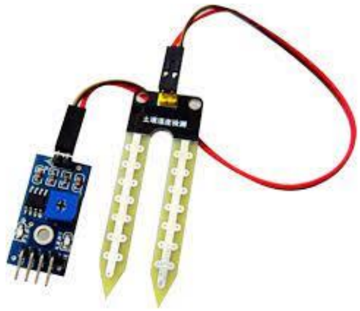

Figure 2.10 Soil Moisture Sensor

By monitoring soil moisture levels using these sensors, farmer can ensure optimal crop growth while reducing water usage simultaneously.

11. IC 7812

Figure 11: 7812 Voltage Regulator

The above figure shows 7812 Voltage regulator. It is a popular linear regulator IC that provides a stable output voltage of +12 volts. It's part of the 78xx series of voltage regulators, known for their reliability and ease of use.

12. ARDUNIO IDE SOFTWARE

Figure 12: Arduino IDE Software

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. This environment supports both C and C++ languages.

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IV. RESULTS & DISCUSSION

The solar-powered smart irrigation system operates efficiently based on the soil's moisture level. When the soil moisture level exceeds 950, indicating dryness, the motor initiates to start running and start pumping the water to field. Conversely, when the soil moisture level falls within the range of 400 to 950, signifying medium level of moisture present in the soil, the motor stops the operation, conserving energy and preventing over-watering. Additionally, if the soil moisture level drops below 400, indicating saturation, the motor remains off to prevent waterlogging. This smart system optimizes water usage, promoting sustainable irrigation practices while maintaining soil health for optimal plant growth.

The solar power smart irrigation system project presents several significant advantages. Firstly, it promotes sustainable agriculture by efficiently utilizing water resources, which is crucial for mitigating the impact of droughts and water scarcity on crop production. Additionally, by harnessing solar energy, the system reduces reliance on fossil fuels, contributing to a cleaner environment and lower carbon footprint. Moreover, the integration of smart technology enables precise monitoring and control of irrigation, leading to optimized crop growth and increased yields. Furthermore, the use of solar power makes the system more cost-effective in the long run, as it eliminates recurring energy costs and reduces dependency on grid electricity. Overall, this project represents a holistic approach towards addressing agricultural challenges while embracing renewable energy solutions.

V. CONCLUSION

By the solar powered smart irrigation system, there are various benefits for the government and the farmers. For the government a solution for energy crisis is proposed. By using the automatic irrigation system it optimizes the usage of water by reducing wastage and reduces the human intervention for farmers. Proposed system is easy to implement and environment friendly solution for irrigating fields. The system was found to be successful when implemented for bore wells as they pump over the whole day.

Solar pumps also offer clean solutions with no danger of bore well contamination. This system demonstrates the feasibility and application of using solar to provide energy for the pumping requirements for irrigation. The managerial implications of the smart solar powered irrigation system are that the system conserves electricity by reducing the usage of grid power which will cost more. It will also offer rural farmer a lower cost of running irrigation. Lastly the system also conserves water by reducing water losses due the manual irrigation.

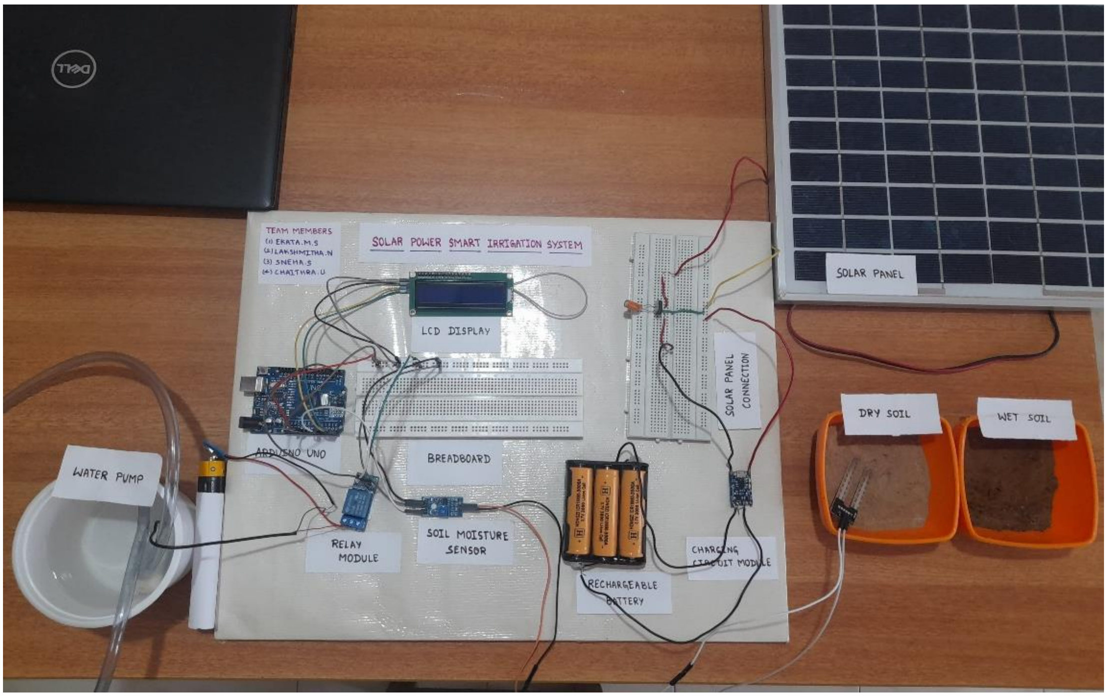

Figure 13: Final setup of the system

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