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Solar Based Smart Water Irrigation

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***Abstract:** Solar based Smart Irrigation System utilizes Solar Energy and advance technologies to optimize irrigation practices in an efficient and sustainable manner. The motor drivers drive the pumps to deliver the required amount of water to the irrigation system, precisely controlling the flow rate and duration. It ensures that water is distributed only when and where it is needed, reducing water wastage and promoting efficient irrigation practices. In this project, Arduino Uno acts as a central controller. It receives data from the sensors and analyzes it to determine the irrigation needs. Based on pre-programmed algorithms or user-defined parameters, the controller calculates the optimal irrigation schedule and water quantities required.*

***Keywords**: Soil moisture sensor, Solar panel, Water pump, Motor Driver, Soil Moisture content.*

I. INTRODUCTION

Traditional irrigation systems often rely on electricity which is produced by burning fossil fuel, which contribute to greenhouse gas emissions and operational costs. As the need for sustainable irrigation systems growing, solar-powered solutions have gained significant importance due to their use of renewable energy sources.

Solar based Smart irrigation systems utilizes solar energy as primary source of energy, integrated with advanced sensors, controllers, and communication technologies to monitor soil moisture levels based on weather conditions, and plant water requirements in real-time. Landscape quality must be preserved through irrigation during famine days. We should maintain proportion of irrigation ,so we can avoid wastage of water as well as overall landscape condition. This system gives precise control over the irrigation process. By incorporating motor drivers and automation using control algorithms, the system can accurately regulate the speed and flow of water.

The solar-powered irrigation system consists of several components: a solar panel, batteries, a motor driver, an Arduino microcontroller, and a soil moisture sensor. The solar panel converts sunlight into electrical energy, charging one battery that powers the motor driver. The motor driver controls the water pump, while the second battery powers the Arduino microcontroller. The soil moisture sensor measures soil moisture content, enabling precise irrigation scheduling. By reducing energy costs and water wastage, the system aims to offer long-term savings for farmers or users while ensuring healthy plant growth.

II. LITERATURE REVIEW

1) This analysis outlines the farming-related models that are required to be integrated into an smart system that plans irrigation and fertilizing as per plant requirements and uses automatic watering to monitor and maintain the correct soil moisture content.
2) Solar power, a BESS i.e battery energy storage system, and a diesel-powered generator make up the microgrid-style energy system. An energy management system (EMS) built on model predictive control (MPC) controls the microgrid.
3) In this research paper, the entire system is intended to run automatically and is built around the Arduino microcontroller. It will function automatically, making it less labor-intensive, time-consuming, water-intensive, and energy-intensive to operate than a traditional irrigation system.
4) The suggested system makes use of a single board system-on-a-chip controller which has connections to a photovoltaic cell to supply the necessary operational energy and built-in WiFi connectivity. In order to avoid the pump motors from burning out because of the level in the water borehole, the controller also keeps an eye on the underground water level.
5) This study compared an ET-based strategy and an IoT-based soil moisture monitoring (IoT-SM) method that uses moisture sensors for irrigation. Commercial production should decide the most effective irrigation scheduling method since it will produce superior fresh yields if soil moisture levels are kept close to field capacity rather than increasing the amount of dry matter.
6) This study of solar-based PV pumping for irrigation created a suitability framework using multi-dimensional study in an publicly available geographic information system (GIS) environment and tested it in the case of Ethiopia. It also took into account the availability of hydro resources and links to markets in addition to solar radiation.

III. METHODOLOGY

The system operates as follows:

1) The solar panel converts sunlight into electrical energy, charging one of the batteries.
2) The charged battery powers the motor driver, which controls the water pump's operation based on predefined schedules or sensor inputs.
3) The second battery powers the Arduino microcontroller, which receives input from the soil moisture sensor and implements intelligent control algorithms to regulate the irrigation process.
4) The soil moisture sensor measures soil moisture content, providing feedback to the Arduino for optimal irrigation based on crop requirements.

To maintain the optimum level of moisture of our plants we use Moisture sensor. We can implement this system in our garden as well as indoor plants. The soil moisture module has an LM393 voltage Comparator. Through this device we can convert analog input to digital output. When the moisture level is low and the LED is off, it will be high using the LM393 voltage comparator. The comparator will be low and the LED will turn on when the moisture level is high. We can monitor the Analog IN using pin A0 and a microcontroller board to figure out how much moisture is in the soil. For a large farm, a driver is required to supply the water pump with enough current. The DC power generated by the solar panels needs to be converted to the appropriate voltage and current levels for driving the motor, for this a Motor driver is used. By utilizing motor drivers in solar-based smart irrigation systems, the energy efficiency and control of water pumping and distribution are enhanced. The system can adapt to changing environmental conditions, optimize water usage, and reduce the reliance on conventional energy sources, resulting in a more sustainable and efficient irrigation solution.

IV. SYSTEM SPECIFICATION

A. Software Specification

1) Arduino IDE

This is an official and an open source application primarily utilized for authoring and compiling code into Arduino modules. The person lacking with any earlier knowledge may start learning as compilation of code is very easy in mentioned software. Operating system namely Linux, MAC, Windows can effortlessly access it. Arduino IDE functions on Java Platform. Java Platform contain built-in commands and functions necessary for compiling, debugging and modifying the code.

B. Hardware Specification

1) Arduino UNO

Arduino UNO is among the standard boards of Arduino. In italian language UNO means 'one'. It was labeled as UNO to denote first release of Arduino software. Also it is the earliest USB board commenced by Arduino. It is contemplated as the potent board among all and is used in numerous projects. Arduino UNO has ATmega328P microcontroller. As compered to other existing Arduino boards it is simpler to use Arduino UNO. This Arduino board consist digital and analog Input or Output pins, shields, circuits. It include a power jack, 14 digital pins, 6 analog input pins, an ICSP i.e In- Circuit Serial Programming header, a USB connector. It is coded according to IDE (Integrated Development Enviroment) which can be operated on either online and offline platform.

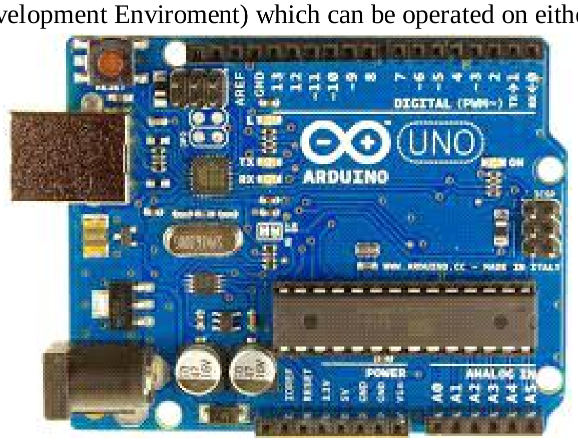

Fig 2: Arduino UNO

2) Soil Moisture Sensor

Soil moisture sensors are integrated into irrigation systems to provide streaming data on soil water content phases. Derived data is used by the control algorithm to determine when and how much to irrigate. By continuously monitoring soil moisture, the sensor allows for precise irrigation scheduling based on actual soil conditions, helping to optimize water usage and prevent over-irrigation or under-irrigation.

To provide accurate results, soil moisture sensors must be calibrated. Establishing a correlation between the sensor's output and the actual soil moisture content is known as calibration. To achieve this, field tests should be conducted and sensor results should be compared to gravimetric or volumetric measurements of soil moisture.

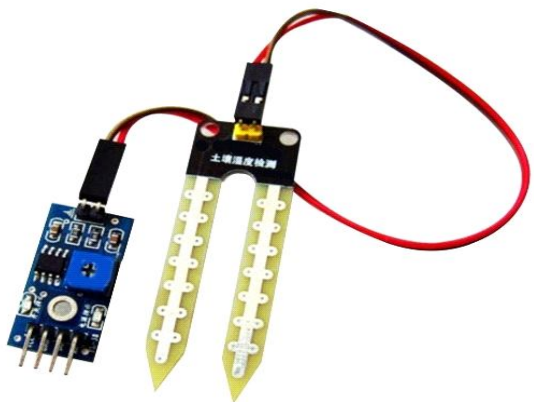

Fig 3: Soil moisture sensor

3) Motor Driver

The operation and motion of an electric motor are controlled by a motor driver, sometimes referred to as a motor controller. It serves as an interface between the motor and a microcontroller or control system, supplying the signals and power required to run the motor in response to the appropriate control inputs. Various applications, such as robotics, automation systems, electric cars, industrial machinery, and home appliances, frequently use motor drivers. The type of motor being used (DC motor, stepper motor, brushless DC motor, etc.), the necessary performance requirements, and the complexity of the control system all affect the choice of motor driver. In general, motor drivers are essential for precisely managing the performance of electric motors by supplying the power and control signals required to produce the specified motor speed, direction, and torque.

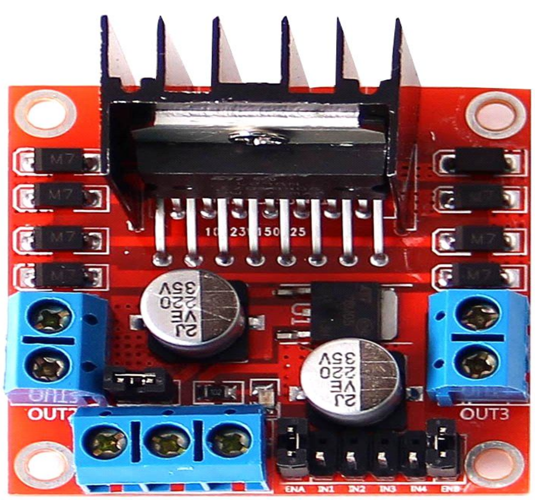

Fig 4: Motor Driver

4) Solar Panel

The photovoltaic effect, which is the phenomenon of turning sunlight into electricity, is used by solar panels. Certain substances, especially semiconductors, with the capacity to absorb photons (light particles) and release electrons, exhibit this effect.The solar cell is the fundamental component of a solar panel. The semiconductor material's electrons become energised and liberate themselves from their atomic bonds when photons from sunshine impact the solar cell and transfer their energy to it. A vital part of solar power systems, solar panels are frequently utilised to provide clean, sustainable energy.

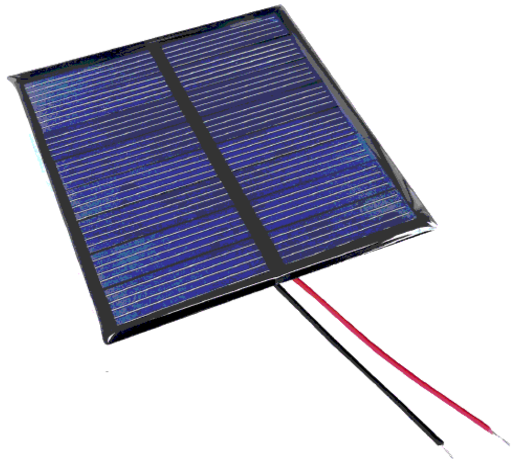

Fig 5: Solar Panel

V. RESULT AND DISCUSSION

Garden plants have been used for testing the smart watering system. The plant needs 600 to 800 mm of water every day. By digitally calculating the relevant resistor values, the Arduino code's humidity and temperature ranges were set to 300-700 and 450-800, respectively. Additionally, the system has proven cost-effective and effective in conserving water and reducing water loss. By including a webs caper that can forecast the weather and irrigate plants/crops accordingly, you can improve your project. Less water is released for plants when rain is anticipated. Installing water meters to estimate the amount of water used for irrigation. A solenoid valve or stepper motor can be used to change the amount of water flow. Wireless sensors are also available. By analyzing the data based on the soil and meteorological conditions, it is possible to make a region- or area-wise prediction to provide more precise agricultural recommendations for which crop can be cultivated. The farm owner are needed to train and support to assist them in deploying and maintaining the system. This can include documentation, online resources, and technical support to address any issues or questions that arise during the installation and operation phases. Commercial farmers often have limited technical expertise, so the interface should be user-friendly and provide clear data visualization, and offer features like scheduling, alerts, and historical data analysis. To enable scalability of the product, the system shall allow components to be easily added, removed or upgraded as per the need of customer.

VI. CONCLUSION

The execution of a solar-based smart irrigation system provides numerous advantages to both farmers and governments alike. It effectively minimizes the need for manual intervention in agricultural irrigation processes while simultaneously offering a solution to the prevailing energy crisis. This technology enables governments to address their energy challenges by utilizing solar power, a renewable and sustainable energy source. It helps to optimize water usage by delivering the right amount of water precisely when and where it is needed. This prevents over-irrigation and reduces water wastage, ensuring the efficient use of this valuable resource. Even though there is high capital requirement at initial stage, but the inclusive benefits are high and are cost effective in the long term.

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