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SOLAR POWERED WATER IRRIGATION SYSTEM

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Abstract: An intelligent irrigation system that ensures continuous functioning and effective plant watering while preserving water resources. This method uses a mechanism based on sensors to measure the moisture content of the soil and calculate the exact amount of water that plants require to adopt sophisticated sensor technology. This system optimizes water usage and fosters sustainability by autonomously watering the plants only when needed. Furthermore, the system includes various water supply monitoring features that enable it to monitor the remaining water levels in boreholes or wells. By preventing shortages and enabling proactive efforts to maintain enough water reserves, this feature guarantees that there is always enough water obtainable for plant irrigation. Furthermore, its powerful energy management system guarantees continuous operation even in the unlikely scenario of a power outage by smoothly switching back to a solar power backup system. This feature maintains proper plant water levels and ensures ongoing operation. The system's multiple components, which include solar power infrastructure, sensors, Internet of Things devices, microcontrollers for data processing, several connectivity protocols for communication, and user-friendly interfaces, all work together to enhance its overall performance. This integrated method minimizes disturbances to regular watering schedules while enabling sustainable plant care practices by providing importance to water saving and resistance against power shortages.

***IndexTerms* - Intelligent Irrigation System, Effective Plant Watering, Soil Moisture Content Measurement**

I. INTRODUCTION

This study integrates an intelligent system with sensors, water supply monitoring, and continuous operation mechanisms to present a comprehensive strategy for successful plant watering and resource management. Its primary objectives are to maximize plant hydration, save water, and guarantee uninterrupted operation—even during power outages. The automated watering system uses sensors to collect vital data, such as plant-specific information and soil moisture levels. To avoid overwatering and preserve water resources, the system uses advanced algorithms to analyze this data and determine when and how much water to send to the plants. To preserve the proper amount of water for plant irrigation, the system simultaneously keeps an eye on the water supply, especially in wells or boreholes. To watch water levels and send out notifications when they fall below predetermined thresholds, it necessitates employing sensors or monitoring equipment. This feature reduces the possibility of water shortages for plant irrigation by encouraging proactive steps to conserve water or look for alternate water sources. Moreover, the system incorporates a smooth power management mechanism to ensure continuous operation. The system automatically transitions to a solar power backup system in the case of a power loss. It guarantees uninterrupted operation over the process, preserving system operability and plant hydration. The sensors and Internet of Things devices for gathering data, the microcontrollers or controllers for processing data and making decisions, the different connectivity protocols for communication, the solar power infrastructure for a continuous energy supply, and the user-friendly interface for monitoring, manual controls, and alerts are the main components of this system. With a focus on water conservation and power outage resilience, the suggested system provides an integrated approach for successful plant watering. With the lowest possible level of disturbance to regular watering schedules, its adaptive method, which depends on real-time data analysis and other power sources, supports sustainable plant care practices.

1.1 SOIL MOISTURE SENSOR

Fig.1 Soil Moisture Sensor

By recognizing the presence of soil moisture content, the Soil Moisture sensor plays a crucial role in the automatic watering system. This sensor is essential in determining the degree of soil hydration, which helps the system pinpoint the exact time when plants need to be hydrated. Water is delivered to plants only when needed, eliminating overwatering and successfully conserving water resources thanks to the system's precise measurement of soil moisture levels.

1.2 WATER LEVEL INDICATOR

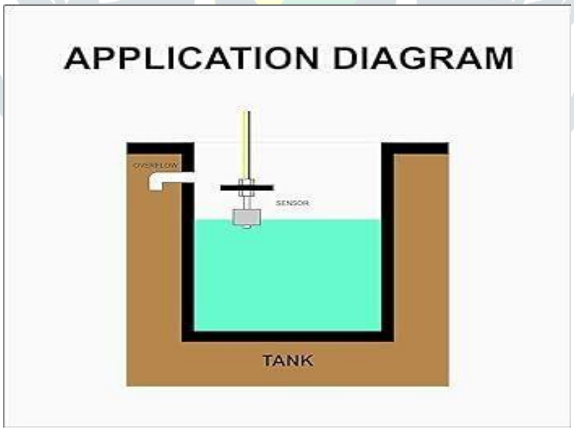

Fig.2 Water Level Indicator

One of the crucial parts of the automated watering system is the water level sensor, which can be employed to measure the liquid levels in a particular container, like a well or borehole. Its primary task is to continuously monitor the water levels and notify the system when they fall too low or rise to excessive levels. This sensor assures that the system can keep up an adequate amount of water during the watering process, which is necessary to meet the watering requirements ofthe plants.

The water level sensor diligently monitors and assesses the amount of water left in the well or borehole while the system took responsibility for watering the plants. This continuous evaluation ensures that there is always enough water available to meet the needs of the plants for hydration. The technology reduces the possibility of future water shortages by actively controlling and monitoring water levels. That makes it easier to take preventative action to save water or find new water sources as needed. As a result, this proactive strategy guarantees a steady and consistent water supply for efficient plant hydration.

1.3 SOLAR PANEL

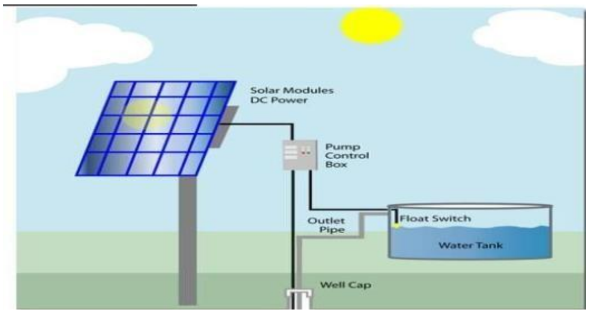

Fig.3 Solar Panel

Solar power uses photovoltaic cells to capture solar radiation and turn it into electrical energy. The further use of solar electricity provides a stable substitute energy supply for the automatic watering system. The system seamlessly transitions to the solar power backup system in the unfortunate circumstance of an electrical outage. The plants will always receive the required watering, even in the unfortunate circumstance of a power outage, and to these changing circumstances, what guarantees a constant and uninterrupted operation.

Through the use of solar power as a contingency energy source, the system reduces its dependency on conventional electricity and increases its ability to withstand power outages. This technique ensures smooth and continuous operation even in the event of variations or disruptions in the primary power source. The addition of solar power bolsters the system's capacity to sustain steady operation, guaranteeing that the plants are watered on schedule and promoting dependable and sustainable plant maintenance techniques.

2. LITERATURE REVIEW

2.1 Automatic Watering System using Soil Moisture Sensor and RTC timer with Arduino, Dr. Geetha, Dr. Y. Asnath Phamila, P Vaishnavi (2022)

With IoT technology powering it and components like Arduino UNO, RTC, and soil moisture sensors, our Automatic Watering System is a game-changing solution for agriculture. By precisely determining the moisture content of the soil and supplying the exact amount of water required for each plant, it effectively reduces water waste and transforms conventional agricultural methods[16]. Its incorporation of a timer-driven irrigation system guarantees continuous plant maintenance, accommodating various areas and plant kinds, even when you're gone for extended periods of time. This system saves energy and encourages strong, healthy plant growth with its great precision in watering and energy-efficient design. Basically, it makes plant care smoother by providing a smooth, flexible answer to the different requirements of farming and gardening.

2.2 Smart Water Protocol for the Irrigation of Urban Gardens in Smart Cities, Abdulaziz Aldegheishem, Nabil Alrajeh (2022)

The paper mainly presents an intelligent irrigation system intended for urban gardens within the framework of smart cities. It concentrates on effective water management, and this is particularly important in regions where water is scarce. The novel aspect of this is a communication protocol [17]that allows devices to communicate with each other over WiFi and LoRa technologies. In the city, test results showed low packet loss, highlighting the system's dependability. With its potential to promote sustainable water use in urban green spaces, this innovative irrigation system fits well with the larger objective of developing resource-efficient intelligent cities.

- Internet of Things (Itoh) based Smart Water Tank Level Monitoring and
- Motor Pump Control System for Prevent Water Waste

2.3 Internet of Things (IoT) based Smart Water Tank Level Monitoring and Motor Pump Control System for Prevent Water Waste, Md. Tahmidul Huque, Jafreen Afar Godhuli, SM Raziur Rahman Pushon (2023)

The tank of water flow monitoring device uses sensors to continuously check the water level, making it easier to react quickly to changing levels[11]. With this technology, customers may guarantee a regular stream of water by remotely activating the water pump via an Android application when the water levels drop below a predetermined threshold. In addition, it incorporates a fail-safe device that instantly stops the pump when the water level reaches a set point, averting dangerous overflows and needless water waste. This automatic control system encourages prudent water use and conservation by reducing the chance of water overflow accidents and ensuring an ongoing source of clean water.

2.4 A wireless soil moisture sensor powered by solar energy, Mingliang Jiang, Mouchao Lv, Zhong Deng, Guoliang Zhai (2017)

This work develops a novel wireless soil moisture sensor that runs on solar power and uses frequency domain impedance modification to provide smooth real-time data transfer. By the inclusion of embedded electrodes into a supporting rod, this sensor allows for the detection of soil moisture at various depths[6]. Its energy-efficient design is well suited for continuous observation of moisture levels over large agricultural areas. The experiment's conclusions confirm the usefulness of this sensor in farming settings and shed light on how it could been be deployed to understand soil properties, improve crop management techniques, and possibly reduce size in the future. This sensor is a priceless instrument for continuous, real- time moisture level data gathering because of its quick battery charging time and extended operating range (30 to 40 days ina "wireless" mode).

2.5 Smart Water Level Monitoring System for Farmers

This chapter argues for an Internet of Things-based solution and emphasizes how important it is for agriculture to have reliable and affordable water level measurement equipment. The primary purpose of the equipment is to monitor water levels[3] precisely and reliably. The data is gathered and stored in an efficient database. Farmers can improve their water resource management techniques by the benefit of this type of information accessibility. This Smart Water Level Monitoring System offers remote monitoring capabilities from any place or positions itself as an easy-to-use, affordable, and highly effective way for farmers to manage and maximize their farm water resources.

3. BLOCK DIAGRAM

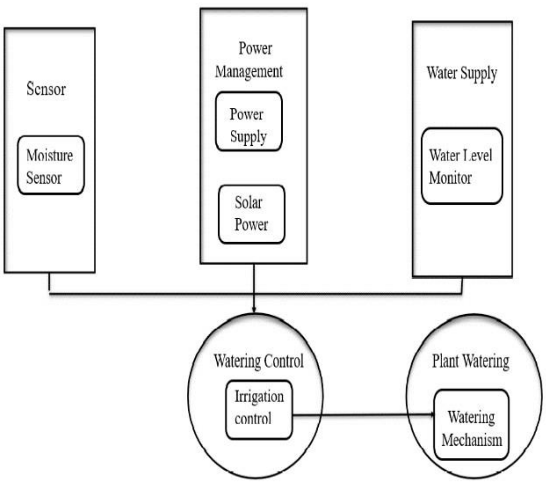

Fig.4 Block Diagram of Water Irrigation System

3.1 SENSOR TECHNOLOGY

Irrigation system innovation hinges heavily on sensor technologies, especially soil moisture sensors. These sensors are carefully inserted into the soil to monitor and measure the moisture content. They provide essential real-time data by continuously measuring the wetness of the soil, enabling the system for irrigation to make precise and knowledgeable decisions about when and how much to water. The system is triggered to initiate irrigation as soon as these sensors identify a threshold that indicates the need for watering. By make ensure that plants receive water exactly when they need it, this clever use of sensor technology helps reduce unnecessary water waste and prevent overwatering.

3.2 MONITORING SYSTEMS

A stable and sustainable water supply for plant irrigation depends on the monitoring systems into the irrigation infrastructure. The purpose of these monitoring devices is to supervise and control the water level in wells or boreholes, which are one of the primary sources of water. Maintaining an appropriate and steady flow of water is crucial for satisfying the plants' irrigation needs, and this is made possible by the ongoing monitoring of residual water levels. These systems actively participate in proactive preventive assessment of water levels through continuous surveillance. This alertness allows the system to respond quickly in the event that the water levels fall below preset levels.

3.3 SOLAR POWER BACKUP

Using solar energy as a backup energy source is a robust way to guarantee continuous operation, which is particularly crucial when there are power interruptions. The system automatically switches to solar power in the case of a primary power source breakdown, ensuring an ongoing and reliable source of electricity. Through the utilization of solar power cells, solar energy is captured and used as a sustainable alternative energy source that allows the irrigation system to run off of the primary electrical system. This configuration ensures that the system will always function as intended, which means that it will continue to be able to water the plants even in the event of traditional power supply outages. It supports an ecologically conscientious irrigation strategy, all of which contribute to a more environmentally responsible and sustainable way of caring for plants.

4. ARCHITECTURE AND WORKING

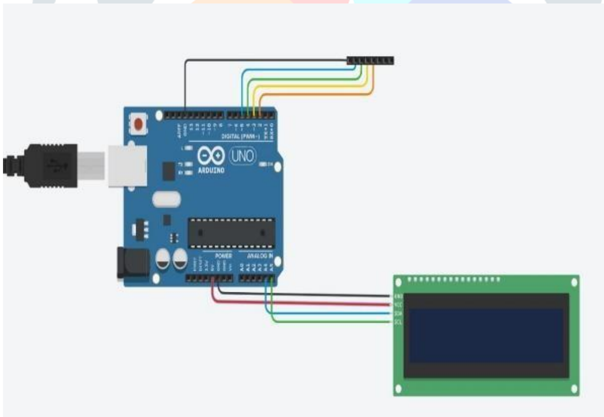

Fig.5 Architectural Diagram

1. **Photovoltaic Panels:** The system incorporates carefully placed solar panels to effectively collect sunlight and transformit into electrical power for the irrigation system.
2. **Hydration Sensors**: Used to continuously monitor and measure soil moisture levels, soil moisture detectors are positionedclose to plant roots.
3. **Automatic Watering Mechanism**: The system regulates watering when the moisture sensors register a drop in soil moisture below a predetermined threshold.

4. **Indicator of water level**: "When plants have been hydrated, real-time tracking of the water level takes place, guaranteeing ongoing observation for ideal hydration." With the help of this feature, water levels may be measured concurrently with the irrigation system running, preserving the perfect balance for plant growth and sustenance."

5. **Photovoltaic-Powered Back Up**: The system also has the capacity to use solar energy. It smoothly transitions to solar power in the event of unexpected power interruptions or fluctuations, maintaining the irrigation system's functionality.

6. **Continuously Hydration Flow**: The quick conversion to solar energy ensures regular watering, preventing power outages that may otherwise interrupt plants' access to the essential water supply.

7. **Impact concerning the environment**: Because the system is primarily solar-powered, it has a far smaller carbon footprint and a lesser an environmental impact than conventional watering systems that rely on electricity. It promotes sustainability through the use of renewable energy sources.

8. **Reliability**: Developing a trustworthy farming solution is the primary objective. The system's architecture minimizes dependency on traditional electrical sources and provides constant amounts of water to the plants by utilizing solar energy, a reliable and environmentally beneficial energy source.

5. RESULTS AND DISCUSSION

Assisting users in understanding the tank's condition from empty to full for prompt repair, the multi-level sensor system in a tank plays a crucial role in delivering accurate information about the water level. Because of its flexible sensing capabilities, users can optimize resource utilization by managing the water supply at various stages, eliminating overflows and shortages.

Fig.6 Schematic Diagram

The code provided checks the water level in a tank using four sensors. It calculates the amount of water in the tank bycomparing the results from various sensors.

1. The tank is empty if all sensors have HIGH readings and no water.
2. The tank may have about 25% water if the first sensor indicates water (LOW reading) and the others do not.
3. Indicates that there is roughly 50% water in the tank if the first two sensors detect water and the rest do not.
4. If the last sensor is dry and the other three are wet, the tank is around 75% chock-full with water.
5. A full tank is indicated if all sensors display water (LOW readings on all).

Based on various combinations of sensor data, from empty to full, these criteria aid in estimating the water levelin the tank.

The RTC study presents a fixed-time watering scenario when plants get pre-set irrigation timings. There's a chance that this strict timetable will not coincide closely with the plant's actual water requirements, which could result in over- or underwatering. Conversely, our paper's variable timing strategy enables watering at any moment, improving water delivery in response to current plant and situational conditions, making the irrigation system more dynamic and responsive. In addition, our research presents the ability to track the levels of water tanks during irrigation, which will help farmers better manage their water resources. Despite the lack of precise percentages, the adaptability and real-time tracking elements point to possible advantages over scheduled watering plans.

6. CONCLUSION

An innovation for successful plant watering is demonstrated by the intelligent irrigation system's integration of soil moisture sensors, water level monitoring, and solar power backup. The melding of these technologies results in precise measurements of soil moisture, continuous watering during blackouts by harnessing solar energy, water conservation through precise plant requirements, and less reliance on traditional power sources. Optimal resource management, improved plant health, and compliance with sustainable farming practices have been rendered possible by data-driven insights. The exact evaluation of the soil's moisture content, along with automation and sensor technology, creates customized watering plans that provide timely and consistent irrigation for increased agricultural productivity and sustainability.

7. FUTURE ENHANCEMENT

Future developments for the intelligent irrigation system will include cloud-based data storage and integration with mobile phone control. Users can modify watering schedules, track soil moisture levels, and access real-time system status from any location by enabling remote system management using a mobile application. Cloud-based system data storage allows for a comprehensive analysis of soil moisture patterns, water usage efficiency, and crucial system events, offering insightful information for well-informed decision-making. This combination of cloud data storage and mobile control makes plant care techniques more effective, encourages water conservation, and improves user accessibiliy.

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