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Solar Powered Automatic Plant Irrigation System for Agriculture using IoT

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Abstract - Every nation's economy depends on agriculture, which has historically been the most significant aspect of human existence. Proper utilization of water, predicted plant development, and improved crop fields all depend on the right atmospheric conditions plus further sources. Traditional irrigation techniques, such the overhead sprinkler kind, are not very effective. They cause significant water waste. An automated irrigation system helps farms and, indirectly, the environment by conserving water. Around 85% of the water resources that are available globally are used for irrigation. This need is anticipated to rise in the coming years due to population growth. In an automation system, sensors are used to monitor the crop's access to water, and irrigation is controlled. Temperature and soil moisture should be the main points of attention. Using the Internet of Things (IoT) and a controlled monitoring system, this irrigation system is mobile integrated and smart. This project's primary goal is to use a smartphone to monitor and control the water supply for the plants. The Indian farmer uses solar-powered intelligent irrigation equipment. This system includes a water pump that is driven by solar energy and uses a moisture sensor to automatically regulate the water flow. This technology saves water by minimizing water losses and saves electricity by minimizing the amount of grid power used. This project involves very little labor-intensive work. Because of IoT, data can be accessible from anywhere in the globe, control can be accomplished online, and users will receive constant notifications via Android app. Aerial conditions are required for plant growth, improved crop fields, and the efficient use of water and other resources. The user can be informed of any change in the motor condition. The goal of this project is to create the simplest, ready-to-install circuit possible for tracking and analyzing soil moisture data [1].

Keywords: Automated irrigation, IoT, Smart agriculture, solar power.

1. INTRODUCTION

Millions of people around the world rely on agriculture to provide them with food, raw resources, and a means of subsistence. However, farmers confront a variety of difficulties, such as a lack of water, erratic weather patterns, and the necessity for effective irrigation methods. Technology improvements, notably the Internet of Things (IoT), have created new opportunities in agriculture to address these issues. The Solar Powered Automatic Plant Irrigation System is one such innovation that harnesses the power of solar energy and the Internet of Things to offer an effective and sustainable solution for irrigation in agricultural settings. With the help of this method, farmers should use less manual labour and get better agricultural yields [3].

Being a clean and sustainable energy source, solar energy is a great option for a system that automatically waters plants. It ends the system's reliance on grid electricity, lowering operating costs and improving the system's environmental friendliness. Sunlight is captured by solar panels, which then transform it into electricity that may be stored in batteries to enable continued operation even when there is little sunlight.

The system may be monitored and operated remotely thanks to the incorporation of IoT technology. The moisture content, temperature, and other pertinent factors are measured by sensors buried in the soil, which provides real-time information on the plant's water needs. This information is wirelessly relayed to a central control unit, which analyses it and activates the watering system as needed. With the help of automation, water is delivered to plants exactly when they need it, preventing both under- and over-irrigation. This IoT watering system powered by solar has numerous advantages. First off, it reduces water wastage and conserves this priceless resource by delivering the proper amount of water at the right time to optimize water usage. Second, it promotes plant growth by maintaining ideal soil moisture levels, which improves crop output and quality. Thirdly, farmers can maintain tabs on the health of their crops and act quickly if there are any problems or irregularities thanks to the remote monitoring and control capabilities [2].

2. LITRATURE REVIEW

Shiraz Pasha, B. R., & Yogesha, D. B. (2014) et. al Microcontroller based automated irrigation system. The International Journal of Engineering And Science (IJES). The Microcontroller-based Automated Irrigation System efficiently monitors and manages all drip irrigation system functions. The Microcontroller Based Automated Irrigation System is a useful instrument for exact soil moisture control in highly specialized greenhouse vegetable production, as well as a simple and precise irrigation approach. It also saves time,

eliminates human mistake in adjusting available soil moisture levels, and maximizes net earnings [5].

Tusher, M. M. I.,et. al (2019) Solar Based Automatic Irrigation System with GSM Module. The main components are an ATmega 2560 microprocessor, sensors, a GSM module, an LCD, and a solenoid valve. Finally, the pump has been set to operate based on the amount of water required. As a result, it is possible to save a particular quantity of water and power, which has been calculated. The manual and automatic operation modes were also proven.

Seal, Binoy, et al. (2014) "Solar Based Automatic Irrigation System." International Journal of Research in Advent Technology 2.4. On the basis of LDR sensor data, the developed single axis solar tracker device orients the PV panel in accordance with the position of the sun. The irrigation pump can be controlled in a variety of ways [7].

3. PROPOSED METHODOLOGY

The main working principle of this system is to connect the soil moisture sensor, which was previously embedded into the plant, to the microcontroller, which is also connected to the solar panel, in order to extract regulated power from solar panel at different irradiation and to maintain correct charging voltage and current in order to charge the battery and increase its life. The microcontroller sends a signal to the relay module, which then activates a pump and delivers a specific amount of water to the plant, if the soil moisture level falls below a predetermined threshold. When there is enough water delivered, the pump stops operating.

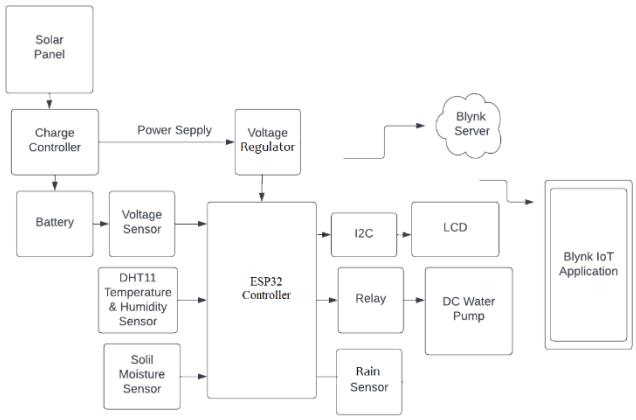

Fig -1: Block Diagram

Because all of the components are connected to the microcontroller and switch on together when the power is turned on, the working concept of this system is straightforward and easy to execute. The soil moisture sensor monitors the soil's moisture level and, if it is low, immediately activates the motor. On the LCD at the same time, the moisture content value and motor information are displayed. Similar to this, the engine immediately shuts off and information is displayed on the LCD when the soil moisture sensor detects a high moisture content [4].

We would simultaneously receive all the information about what is happening on our mobile device using the Blynk IoT application, such as whether the engine is running or not and the amount of soil moisture present. An ESP32 wi-fi module that is connected to the internet and transmits data to our phone enables all of this. We can infer that our project is built on IoT because everything is automated over the internet. The automated system is therefore operational. The pump can also be turned on and off manually if the automatic system fails, however doing so necessitates a journey out to the field [6].

4. COMPONENT DETAILS

ESP32 Controller

ESP32 is a low-cost System on Chip (SoC) Microcontroller from Espressif Systems, the developers of the famous ESP8266 SoC. It is a successor to ESP8266 SoC and comes in both single-core and dual-core variations of the Tensilica's 32-bit Xtensa LX6 Microprocessor with integrated Wi-Fi and Bluetooth. The good thing about ESP32, like ESP8266 is its integrated RF components like Power Amplifier, Low-Noise Receive Amplifier, Antenna Switch, Filters and RF Balun. This makes designing hardware around ESP32 very easy as you require very few external components. Another important thing to know about ESP32 is that it is manufactured using TSMC's ultra-low-power 40 nm technology. So, designing battery operated applications like wearables, audio equipment, baby monitors, smart watches, etc., using ESP32 should be very easy.

Fig -2: ESP32 Controller

LCD

Fig -3: LCD 16x2

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. The 16 x 2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols. This LCD has two registers, namely, Command and Data. The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable,

Soil Moisture Sensor

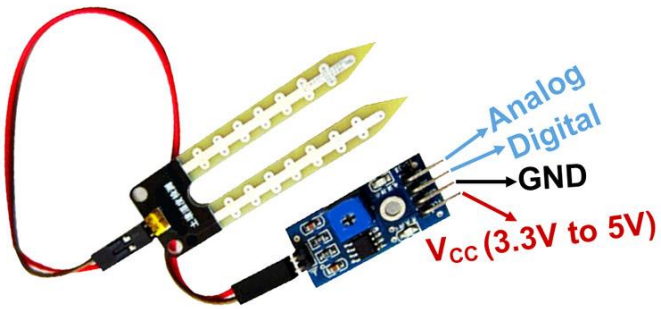

Fig -4: Soil Moisture Sensor

The soil moisture sensor is one kind of sensor used to gauge the volumetric content of water within the soil. As the straight gravimetric dimension of soil moisture needs eliminating, drying, as well as sample weighting. These sensors measure the volumetric water content not directly with the help of some other rules of soil like dielectric constant, electrical resistance, otherwise interaction with neutrons, and replacement of the moisture content. The relation among the calculated property as well as moisture of soil should be adjusted & may change based on ecological factors like temperature, type of soil, otherwise electric conductivity. The microwave emission which is reflected can be influenced by the moisture of soil as well as mainly used in agriculture and remote sensing within hydrology.

Buzzer

Fig -5: Buzzer

A buzzer is a small yet efficient component to add sound features to our system. It is very small and compact 2-pin structure hence can be easily used on breadboard, Perf Board and even on PCBs which makes this a widely used component in most electronic applications.
There are two types of buzzers that are commonly available. The one shown here is a simple buzzer which when powered will make a Continuous Beep. sound, the other type is called a readymade buzzer which will look bulkier than this and will produce a Beep. Beep. Beep. Sound due to the internal oscillating circuit present inside it.

DHT11 Temperature & Humidity Sensor

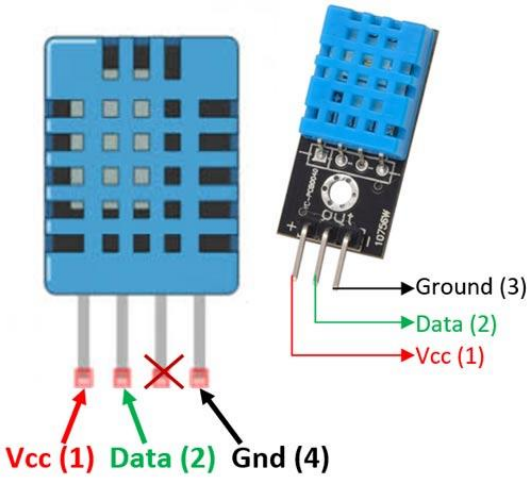

Fig -6: DHT11 Temperature & Humidity Sensor

The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin (no analog input pins needed). It's fairly simple to use but requires careful timing to grab data. The only real downside of this sensor is you can only get new data from it once every 2 seconds, so when using our library, sensor readings can be up to 2 seconds old.

Rain Sensor

Fig - 7: Rain Sensor

Rain sensor is one kind of switching device which is used to detect the rainfall. It works like a switch and the working principle of this sensor is, whenever there is rain, the switch will be normally closed. The rain sensor module/board is shown below. Basically, this board includes nickel coated lines and it works on the resistance principle. This sensor module permits to gauge moisture through analog output pins & it gives a digital output while moisture threshold surpasses.

Battery

Fig - 7: Battery

A battery can be defined as an electrochemical device (consisting of one or more electrochemical cells) which can be charged with an electric current and discharged whenever required. Batteries are usually devices that are made up of multiple electrochemical cells that are connected to external inputs and outputs. Batteries are widely employed in order to power small electric devices such as mobile phones, remotes, and flashlights. Historically, the 'term' battery has always been used in order to refer to the combination of two or more electrochemical cells. However, the modern definition of the term 'battery' is believed to accommodate devices that only feature a single cell.

5. RESULT

The implementation of a Solar Powered Automatic Plant Irrigation System for Agriculture using IoT offers numerous benefits, including improved water management, enhanced crop yield, water conservation, energy efficiency, cost savings, remote monitoring and control, flexibility, improved farm management, and positive environmental impact. These results make the system a valuable tool for modern and sustainable agriculture practices. The integration of IoT technology enables farmers to remotely monitor and control the irrigation system. Real-time data on soil moisture, temperature, and other relevant parameters can be accessed through a central control unit or mobile application, allowing farmers to make informed decisions and adjust irrigation settings as needed. The solar power aspect of the system reduces reliance on grid electricity and non-renewable energy sources. Solar panels capture sunlight and convert it into electricity, powering the irrigation system. This promotes sustainable and eco-friendly agricultural practices.

6. CONCLUSION

By minimizing manual labor and allowing farmers to concentrate on other crucial farming tasks, this technology provides convenience to farmers. By lowering the carbon footprint associated with traditional irrigation techniques and minimizing the effects of water scarcity and unpredictable weather, it also helps to promote sustainability and resilience in agriculture. In conclusion, a possible answer to the problems faced by farmers in agriculture is the Solar Powered Automatic Plant Irrigation System using IoT. This system provides effective, sustainable, and remotely controlled irrigation through the use of IoT technology and solar energy, which helps with water conservation, crop productivity, and farm management. Through its use, smart and resilient agriculture can be developed, ensuring food security and environmental sustainability in the face of global concerns.

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