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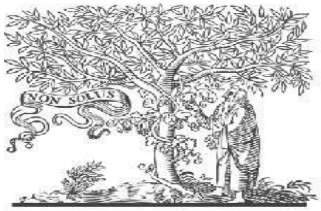

ELSEVIER SSRN

IJIEMR Transactions, online available on 02 Aug 2022. Link :http://www.ijiemr.org/downloads.php?vol=Volume-12&issue=Issue 08

10.48047/IJIEMR/V12/ISSUE 08/15

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Volume 12, ISSUE 08, Pages: 82-89

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IoT based Solar Powered Irrigation System

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***Abstract*—** Indians rely largely on agriculture for a living, which has a big influence on the country's financial situation. Our venture's goal is to develop an automated watering system that will reduce the farmer's physical involvement while increasing water utilisation for agricultural crops. This design was inspired by agriculturally oriented economies as well as weather situations that result in a scarcity of water and precipitation. Agriculturalists on agricultural land rely only on precipitation and bore wells to irrigate their property. When required, producers should physically switch the irrigation system off and on, even if another is installed in the fieldThe goal of this project is to design a system that controls the pump motor by measuring the moisture level of the soil using a mobile device. Adopting appropriate irrigation systems is crucial in agriculture. The benefit of employing this kind of equipment is that it lowers the need for personal involvement while still delivering enough water. Animals and birds can be kept out of the field as well.

Keywords— Node MCU, Moisture Sensor, LDR, Laser Gun, Ultrasonic Sensor Buzzer, LCD Display, Relay, DC Motor, Solar panel.

I. INTRODUCTION

Solar energy is an ecologically beneficial, infinite, and free resource that may be exploited to meet the world's expanding energy needs. According to the most recent available statistics, the earth's surface uses solar electricity as a substitute for expanding global energy consumption. According to the most recent available statistics, the earth's surface gets about 3 percent solar power. That sum of money is more than the whole amount of energy produced in the world. A photovoltaic module is a packaged, linked structure comprising numerous solar cells. Solar A photovoltaic system's solar array is made up of photovoltaic panels that generate and distribute direct current power for use in both industrial and private applications. The power output in DC of each module is rated using conventional test circumstances, and a typical solar cell has a maximum specification of 3.65 to 4.186 W. Solar energy, together with storage batteries, has continued to reduce in price, making it more affordable than traditional fossil fuel electricity from the power grid in many nations. Irrigation is a process that distributes water to a location in need. It aids in landscape maintenance, agricultural crop development, and a range of other jobs. As an outcome, the goal of this project is to design and build a small-scale solar irrigation system. Mechanical and electrical gadgets are used in the project. The mechanical element includes the relay, pump, or other equipment used to carry water to the field or crop, whereas the electrical component consists of the solar panel, a device for storing energy, such as a battery, and other key electronic components.

Crop irrigation based on time would also work well, but it would waste water and result in an excess, which might limit plant development and production. Soil moisture sensors can be used to provide information about when the plant requires water or the level of soil dryness. Furthermore, when not in use, this technology may save energy by functioning as a battery. Simulation software such as Proteus or Multiuse would be used to verify the circuit's operation prior to installing or manufacturing the hardware. The control is provided by a microprocessor known as the Programmable Interface Controller (PIC). The hardware of each component is made up of circuits, which include circuits for pump control, moisture sensors, solar charging, and other key circuits. Finally, everything has been combined. The use of a self-contained solar watering system can cut agricultural costs, provide a better alternative to fossil fuels, and address a variety of other issues.

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II. LITERATURE SURVEY

The Internet of Things (IoT) idea dates back to the early 1990s. Mark Weiser, who wrote the renowned article "Ubiquitous Computing" in the 1970s, was probably the first to predict the upcoming arrival of an infrastructure in which everyone will have the capability of on-demand computing via a combination of both software and hardware connected by wires or radio communication. In the contemporary period, this notion has matured into a real and impending technology, one that is characterised by a hugely linked network of things or devices that can interact with one another via a network connection. In general, IoT devices acquire and evaluate data from operational technologies, physical locations, human resources, and industrial equipment. In the present world, agriculture is a high-intensity industrial activity; due to its essential nature, IoT may considerably boost it. Crops and plants as a whole are amazing biological entities. They're among the only living organisms on earth that are capable of changing artificial soil particles into nutritional food for other animals. In the presence of light, plants carry out this activity through a process called as photosynthesis. Water is required for the photosynthetic process. It promotes sweating, which is the primary means by which plants absorb moisture and nutrients from the soil. Perspiration is akin to an animal's circulatory system, which transports the fundamental elements for life functions throughout the body. It is affected by environmental factors like the presence of sunlight, air humidity, temperature, atmospheric pressure, and wind speed. When there is restricted availability of water via the ground owing to a dry season or for any other reason, a plant's circulatory system becomes imbalanced. As a result, fewer nutrients are accessible at photosynthetic sites, lowering output. If these issues are not addressed, they can lead to withering and death. Keep in mind that crops acquire water as well as nutrients from the highly localised areas around the root regions that are positioned near the plant's subterranean roots. It's not required for soil moisture to be equally distributed throughout a field or plantation. As previously noted, the IoT is projected to play a major role in agriculture, which, in his opinion, must develop fast in order to feed the planet's estimated 9.5 billion inhabitants by 2050. Research that prioritises the production of enhanced operational equipment and the optimisation of the links between software and IoT applications is projected to improve agriculture. The cumulative outcomes of this experiment will result in a model for productive and sustainable agricultural approaches. Demonstrate a few Internet of Things (IoT) applications that have gotten a lot of attention in the "Precision Agriculture" sub-domain. It tries to optimise irrigation water usage by using soil moisture probes. illustrate How cloud-based intelligence is applied for handling and assessing huge volumes of information produced by IoT deployments in agriculture. This knowledge provides important information about local weather trends and aids in crop production optimisation for certain topologies and soils. A hot and dry season, for example, may help a farmer take the necessary steps, such as altering irrigation or switching to drought-tolerant crops. India is mostly an agricultural country. The USDA estimates that India has 159.7 million hectares of agriculture, second only to the United States of America. It boasts the world's largest gross irrigated agricultural area, at 82.6 million hectares. According to the study in the report, the agriculture business It employs more than half of the working population in India and contributes 16–18% of total GDP, making it a critical source of livelihood and economic growth. According to the World Water Council, our planet is on the verge of a major water disaster. Agriculture is a big contributor to this problem due to its enormous use of water. Those who say that up to 85% of the water consumed in their country's rural agrarian sector is diverted for agricultural purposes illustrate this. A skewed tendency towards increased horticultural profitability and apathy towards diminishing horticultural profitability, as well as a decrease in water supplies, worsen water difficulties.

III. SYSTEM DEVELOPMENT

The node MCU in the block diagram is what manages the entire process. Additionally, it has a solar panel, battery, regulator, buzzer, moisture sensor, LDR, laser, and ultrasonic sensor. It also has a motor, pump, battery, relay, and battery.

Water is a critical resource that must be managed wisely. Agriculture is one of the most water-intensive industries. Irrigation is a laborious process that must be completed as quickly as possible. The goal of this article is to develop an autonomous irrigation system that monitors soil moisture and manages

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water flow using a mobile device. When finished, the project requires very little human input. The circuit is built around a soil moisture sensor and an MCU node (ESP8266). A correctly fitted soil moisture sensor may save up to 60% of irrigation water. The new approach may also be used on turf grass and small garden plants.

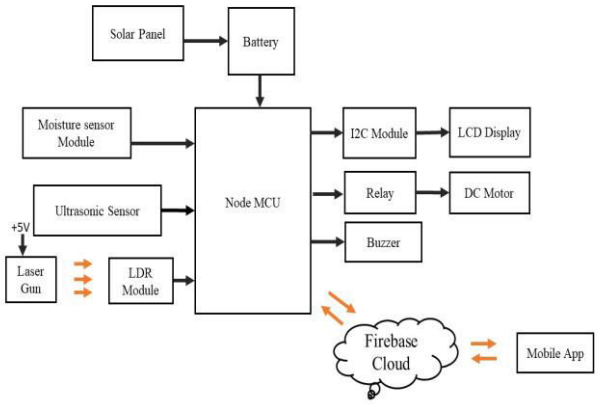

Fig: Block diagram of IoT based Solar Powered Irrigation System

1. Node MCU

The Node MCU (Node Micro Controller Unit) is a low-cost System-on-a-Chip (SoC)-based software and hardware development environment. The ESP8266 from if Systems includes all of the essential computer components, such as a CPU, RAM, networking (Wi-Fi), and even a current operating system and SDK. As a consequence, it's a fantastic choice for any Internet of Things (IoT) project.

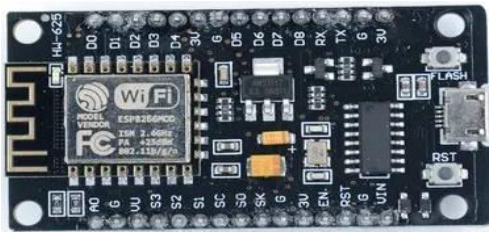

Fig: Node MCU

2. Solar cell

A solar power cell, which is made of sunlight, is an example of a power source that directly turns light energy into electricity via the photovoltaic effect. Photovoltaic cells are classified as such, whether the light source is organic or artificial. In addition to generating energy, they might be used as photographic detectors (for example, infrared detectors), detecting illumination or other kinds of electromagnetic radiation across the visible spectrum, or calculating light intensity.

Fig: Solar panel

3. Ultrasonic sensor

An ultrasonic energy sensor is an electronic device that generates ultrasound echoes and converts them into electrical signal waves in order to detect the distance between two objects. Ultrasonic waves have the ability to travel faster than electrical signals, such as audible sound. On the HC-SR04, you just need to be concerned with the four pins labelled VCC (power), Trig (transmitting), Echo (receiving), and GND (ground). The power supply is a 5-volt supply, and the output pin is trig. Echo is a sort of input pin. It has both a transmitter and a receiver. This economical sensor provides a span of measurement is 2 cm to 400 cm, with a margin of error of up to 3mm.

Fig: Ultrasonic sensor

4. LCD

An LCD (liquid crystal display) screen, additionally referred to as A digital display module may be used for a number of tasks. A 16x2 LCD screen is an essential module that may be found in a wide range of devices and circuits.. An LCD with a resolution of 16x2 can display a maximum of sixteen characters on every one of its two lines. A 5x7-pixel array provides every single letter on this LCD.

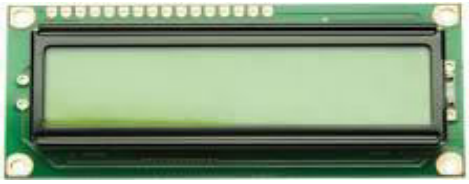

Fig: 16x2 LCD

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5. Soil sensor

A sensor that measures soil moisture serves to calculate the water content in the soil volume. It is made up of two prongs that must be placed into the substrate, an LM358 that acts as a comparator, and a pot that regulates the sensitivity of the sensor. In the absence of a moisture sensor, a circuit like this one can be used in its place. The level of sensitivity for the next device is fixed. This can also be modified by exchanging one of the resistors associated with the comparator's non-inverting terminal using a pot.

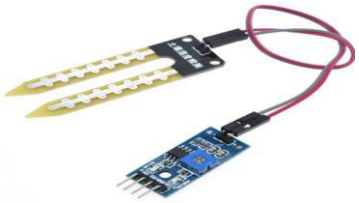

Fig: Moisture sensor

6. LASER Diode

The laser diode is an instance of a silicon component that operates similarly like diode that emits light (LED). This emits light that is coherent via a p-n junction, with all of the waves having same wavelength and timing. The laser diode producers this coherent illumination by employing a process known as "Light Amplification by Stimulated Emission of Radiation," shortened as LASER. The laser diode is an instrument that produces laser energy by using a p-n junction.

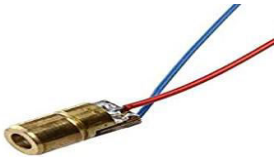

Fig: LASER Diode

7. LDR Module

An illumination-dependent resistor (LDR) is an electrical gadget that responds to light. When light rays reach it, the resistance rapidly changes. The resistance strengths of LDRs can differ by orders of magnitude. The resistance value diminishes as the light level increases. LDR resistance levels are many megaohms in low light and a few hundred ohms in bright light. Because of the impedance change, these resistors are widely used in a variety of applications. The sensitivity of the LDR varies with the wavelength of the incoming light.

Fig: LDR Module

8. Water Pump

The water pump is used to generate simulated water for a specific purpose. By attaching it to a microcontroller, it can be operated electrically. It can be switched on and off whenever necessary by sending signals. Pumping is the technique that delivers water artificially. Water pumps can be purchased in a range of designs. This concept employs a tiny water pump coupled to an H-bridge.

Fig: Water pump

9. Buzzer

For instance, a beeper or buzzer can be electromechanical, piezoelectric, or electromechanical. The basic function of this gadget is to transform an audio signal into sound. The pin and design of the buzzer are shown below. It includes two positive and two negative pins. The terminal that is positive for this can be distinguished by a '+' mark or through an extended terminal. The positive terminal gets six volts, while the other end is represented by the "-" sign or shorter terminal and is connected to the grounded terminal.

Fig: Buzzer

10. Solar Battery

A photovoltaic battery is a component that can be included in a solar energy system for storing excess electricity produced by the panels on your roof. You can subsequently use this saved energy to supply power to your residence when the solar cells fail to generate enough electricity, such as at night, on days with clouds, or when there are power outages. The aim of a solar battery is to allow you to utilise a greater amount of the energy from the

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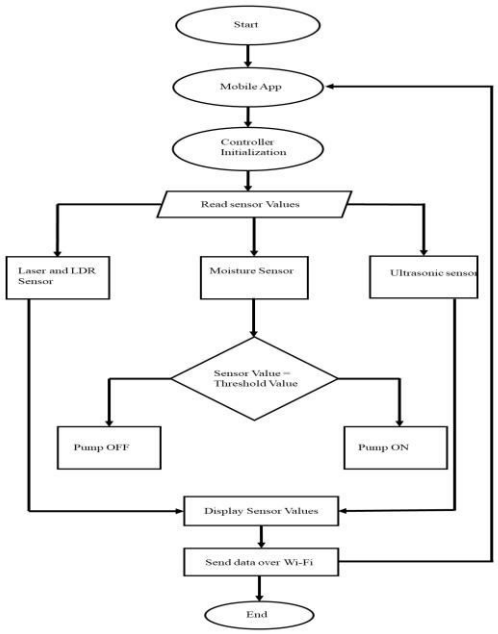
sun that you create. When you lack battery backup, any extra sunlight goes onto the lines, meaning you're producing energy and transferring it to others but not entirely using the power generated by the solar panels.

Fig: Battery

IV. FLOW CHART



V. PROPOSED METHODOLOGY

A. Working Principle

In this system, A photovoltaic panel transforms sunlight into power, which is subsequently saved in a battery made from sunlight. The battery is the fundamental component that provides the charge for all of the other components to function.

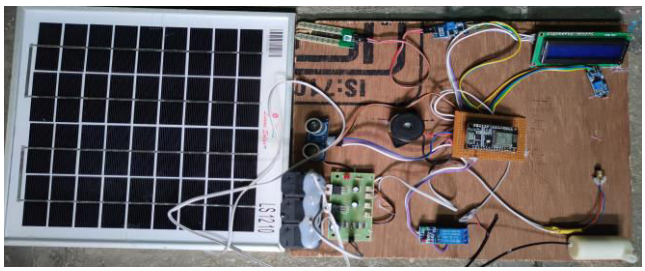
The heart of the IOT-based solar-powered irrigation system is the Node MCU. This is how the entire system is organised. The operational components, such as the comparator, LCD display, relay, and so on, First, The sensor for moisture will identify the quantity of liquid in the ground and send the results to the comparator. Where it compares the moisture content to determine whether the field requires the moisture content or not. On the LCD, the moisture content and motor status will be displayed. And the relay serves as a switch for the DC motor pump. It provides a suitable amount of water for the soil. If the amount of water in the substrate reaches the standard setting, the controller will turn off the motor. Whenever the water content of the ground is less than the pre-set value, controller will turn on the motor pump via the mobile application.

The Node MCU (Micro Controller Unit) includes a Wi-Fi module. Which is connected to web applications via an internet connection. In this system, we are uploading moisture content, buzzer, and motor pump status information to a web application, which will be accessed by the smartphone and used to regulate the irrigation operation without leaving the field.

We use a laser light and an LDR module to safeguard the crops and field from animals. We placed the laser light, which always falls on the LDR, We also employed an ultrasonic sensor to keep birds out of the field. If an obstruction occurs, the buzzer will sound an alarm.

This is the main working principle of the “IOT based Solar Powered Irrigation System”.

B. Proposed System



VI. RESULTS

This technology is designed specifically for people living in rural areas. There is little or no power grid connection in such locations, and residents irrigate their farms with diesel engines. Farmers, on the other hand, will not have to pay for fuel if we use a smart irrigation system with an electrical AC pump. Furthermore, the smart system's maintenance costs are quite low.

This mechanism works successfully in theory and in ideal cases. However, long-term field research is required to confirm the system's benefits. Overall, in our ideal case

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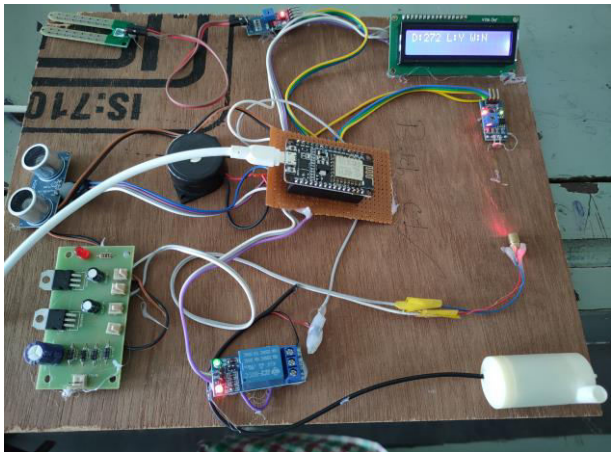
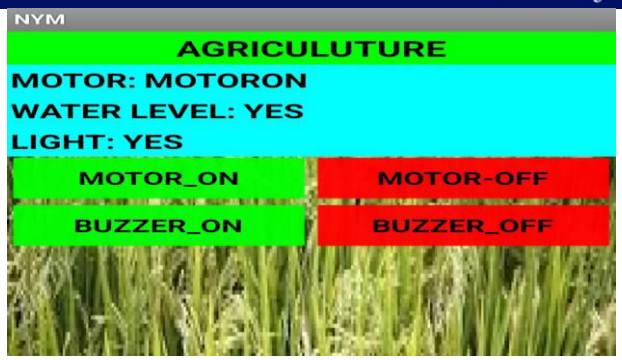
study, we discovered that this method had the following advantages:

- The system is very easy to run and user-friendly for people from all sectors.
- There is no requirement for long-term maintenance.
- The maintenance cost is very low.
- The system does not require grid support (it is powered by solar energy).
- There is no gasoline cost.
- The use of solar energy produces no pollution.

The technology shown here is intended to reduce water waste in irrigation while also making the irrigation system easier, more automatic, and more effective. Using this method has a number of advantages, including new directions for our irrigation system. Installing a smart irrigation system saves time and ensures that water is used wisely. Aside from the water squandered in the typical irrigation system, power is also wasted. The proposed system optimizes the utilization of these two resources.

The proposed technology provides an effective and dependable means of irrigation. It is useful to understand when the water requires irrigation and when irrigation is taking place due to continuous updates of soil conditions and environmental elements. Furthermore, in arid locations with insufficient rainfall, the system may properly manage water and assure higher crop output by accurately watering. Thus, by supplying the farmer with information about the crops and surrounding environment, operating the water pump, and monitoring the field, the system will reduce human interference. As a result, it is envisaged that this smart technology would be a valuable addition to the modern agriculture sector.





VII. CONCLUSION

Various circuits are used to successfully implement the irrigation model. We built and implemented this concept with cheap cost, dependability, an additional source of energy with management in consideration. Because the suggested approach is regulated, it will help farmers irrigate their land appropriately. The system frequently guarantees that the paddy field has enough water, preventing both under- and over-irrigation. Farmers can turn on and off the motor remotely from anywhere using their mobile phone. Solar electricity supplies enough energy to power the system. The proposed concept may be a feasible alternative to eliminate the need for energy and simplify the irrigation system for our farmers.

VIII. FUTURE SCOPE

Irrigation is essential for producing high-quality crops during the seasonable and non-seasonable seasons. One of the most significant current agricultural methods for raising output in the shortest period of time is an efficient irrigation system. In the future, we are going to be able to install an irrigation system to safeguard fields via dual levels of security for the whole day as well as watering automation via the Internet of Things and entirely automated manual handling in agriculture. One of the advantages is that users (or farmers) can easily grasp the notion of IoT and sensors for smart irrigation.

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