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# SOLAR POWERED IRRIGATION SYSTEM WITH IOT- CONNECTIVITY AND FARM MONITORING

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Abstract: -The Internet of Things (IOT) is a network of physical objects or 'objects' embedded with computers, software, sensors, and network communication that allows the capturing and sharing of data by these objects. Agriculture/Horticulture assumes a significant part in Indian economy. Using an Arduino-based microcontroller and sensors, the Solar-Powered Smart Irrigation System aims to provide an IoT solution for automating the watering method. It is an energy-efficient and environmentally friendly device that uses photovoltaic cells to produce electricity and then uses water pumps to supply water to the plants. The watering process is regulated by sensors that measure the moisture content of the soil. When the sensor crosses a threshold value, the device is regulated by the main microcontroller unit. The device also includes temperature and humidity sensors to keep track of the atmosphere in the location. Another sensor is used to track the level of the water tank, which acts as a storage space for the system's water supply. IoT integration allows automatic irrigation to be accessed and controlled remotely via a mobile application and a wireless communication system. These smart irrigation techniques take the place of the conventional irrigation method, reducing the need for manual intervention and errors. The problem faced in farming are water deficiency and high costs. These issues can be resolved using new system called smart automated irrigation system. Because this system has 3 different sensors like temperature, soil moisture and luminosity. These sensor senses the soil level when moisture of the soil is less than the expected level, the water is pumped to the crop to make it moisture.

Keywords—GSM, Amazon web server, GPRS, Renesas controller

## I. INTRODUCTION

Water is an essential component and plays a major role in every life. In India, agriculture is facing a lot of drought issue and it can be resolved to some extent with the usage of new technology. The technology should be user friendly which is reasonable in price as well as it should be efficient, and it can be achieved by using renesas board. Nowadays, it is easy to send alert message to IOT platform through smart phones and computer. The entire architecture is divided into two sections. The first section includes configuring renesas controller and interfacing with temperature, moisture and luminosity sensors. The second section includes establishing the IOT platform and attaching to the server. In order to establish the faster transmission GPRS is used. Theproposed model consists of two motors -one used for water pump and another for seed sowing. Farmer can switch on or switch off the motor based on the condition of the field. The proposed system is developed to eliminate the problems faced in existing system.According to the recent statistics [1], the land used for crop cultivation in India is decreasing at an accelerating rate. Outdated irrigation techniques and availability of water resources are the primary reasons for incoherent production. Hence, technological solutions for agriculture task automation are the need of the hour. Simplified irrigation mechanisms reducing water wastage are very essential, which encourage precision agriculture. Technological solutions for irrigation and agricultural task automation are driven by electric power. Throughout a year India receives solar radiation on an average 3000 hours of sunshine (i.e., 4-7kWh of solar radiation per sq. meters). Hence solar driven technological solutions for agriculture task automation can yield better benefits for Indian environmental conditions. Many such technological solutions have been addressed in the literature that achieve agriculture task automation and help in remote monitoring the farmland. Some of them are discussed as follows. A smart irrigation controller is developed using microcontroller, which transmits the data using XBee link to a remote server. However, the developed system can monitor moisture only at a single point. Hence, to monitor a given farm area, large number of sensors must be deployed which increases the cost of the system. XBee can communicate in a limited range of 50 m.

The irrigation methods used since ages includes:

a. Surface irrigation
b. Sprinkler irrigation
c. Drip/Trickle irrigation
d. Sub-surface irrigation

The methods are inefficient because they waste water and can also spread disease such as fungal growth in the soil due to excessive moisture. With globalisation transforming the planet into a global village, the irrigation system will benefit from the integration of Information and Communication Tools (ICTs) and the use of the Internet of Things (IoT) into the traditional method of irrigation.In recent years, IoT-based automation systems have grown in popularity and effectiveness [5]. Through combining automation with the irrigation process, water can be used more efficiently and effectively, resulting in significant reductions in waste.The available source is monitored via sensors in the automation system, and watering is done as needed using a microcontroller-controlled irrigation

system. Solar energy, the most plentiful and renewable source of energy on the planet, powers the entire process of a smart irrigation system. Solar power generation via PV modules is not only energy-saving, but also environmentally friendly and, in the long run, cost-effective.

## II. BACKGROUND AND RELATED WORK

In paper [1],a novel technique for smart agriculture was proposed by developing a smart sensing framework and irrigator equipment using wireless sensor . This method focuses on testing external parameters such as soil moisture, pH, and nutrient levels, and then supplying the required amount of water to the crops through an irrigator system mounted on a crane system based on the calculated parameters. Mobile integrated smart automated irrigation scheme with soil and temperature sensors is defined in paper [2]. The main goal of this framework is to control water and care for plants via cell phone, allowing farmers to water plants without having to be near them and to check the motor and temperature status on their phones. In a paper [3], the authors proposed an automated smart irrigation system using Arduino and Raspberry Pi, in which user inputs are refined on the Raspberry Pi and on or off messages are received by the Arduino microcontrollers via ZigBee technology from the Raspberry Pi. The aim of this system is to send an email to water the plant without requiring human intervention to control watering. Irrigation control with system protection was proposed in paper [4], with the main goal of this system being to maintain the required amount of water in the field while throwing up the excess water using two pumps and wireless messaging to phone. The device consists of a water sensor that is both cost efficient and useful in determining the amount of water in the field. A password lock system has been used to provide protection for the pumps and other equipment. An Arduino-based irrigation system with WIFI technology was proposed in paper [5], and the system consists of soil moisture, PH, and temperature sensors that sense the values from the soil and supply water accordingly. Arduino collects data from sensors and sends it to the cloud. Irrigation device for vegetable crop using soil moisture sensor, air humidity sensor, and air temperature sensor was proposed in paper [6]. The primary aim of this project is to address the shortcomings of the conventional approach. This device has a command control accuracy of 96 percent. According to all the journals, no system currently exists that combines automatic irrigation and seed sowing in a single system. By referring all the papers no system provides the integration of automated irrigation as well as seed sowing in a single system and we achieved this in our proposed system.

## III. CHALLENGES

Some of the components are not readily available in New Zealand, so the materials were outsourced to China and the United States. Shipment delays and costly airfreights are encountered, causing the project prototype to be delayed. Even if the components are thoroughly examined, it is possible that they are short-circuited, resulting in burnt boards and components also makes situation complicated. Some components are loosely connected during the breadboard implementation to test the circuit, making it difficult to troubleshoot the issue with allow the components connected. Thepinout of the soil moisture sensor leads to different connection resulting in sensor misreading the values and no output reading. To prevent voltage regulation issues between the modules, the microcontroller and the relay have separate power supplies. Implementation of the Arduino IDE software for circuit programming, including variable definition and proper component library use for proper communication with the Arduino microcontroller.

## IV. OBJECTIVE

Create an energy-efficient and cost-effective system utilizing renewable resources by designing and implementing a solar-powered smart irrigation system using an IoT approach. To collect information by integrating the device with various sensor parameters such as temperature and humidity sensors, soil moisture sensors, and tank storage capacity sensors. IOT technology will be used to control and track the devices.

## V. METHODOLOGY

As shown in Figure 1, the system consists of three sensors: a soil moisture sensor, a luminosity sensor, and a temperature sensor. The moisture content of the soil is detected by the soil moisture sensor. The light intensity on the plant is determined by the luminosity sensor. Every sensor is designed to have the threshold value acquired in an experimentation premise, as well as the threshold value. These sensors are attached to a renesas microcontroller with 58 I/O pins and a 16-bit resolution. The whole Internet of Things computer is mounted on a robot. The proposed mechanism is set up such that the moisture sensor detects moisture content that is greater than or equal to the threshold value, at which point the plant should be watered. This framework includes a GSM module that connects to the Renesas to initiate mobile contact between the client and the device. The client can monitor the creation of the robot, just like seed sowing operation, by sending an instant message to the controller after adding a sim card to the GSM module. This device also makes use of GPRS to send all the data to the cloud. We use this portal to migrate data obtained from sensors in regular intervals of time. Amazon Web Services offers a cloud storage platform for those on metered payments. We used coffee as a test case and gathered knowledge from previous years in India's farmers entryway. This is necessary in order to compare the threshold data with gathered data for temperature, moisture, and the aim of managing the overflow of water, as well as to understand how much water we saved. This is an Arduino-based microcontroller device that manages the overall operation and functionality of the system. Sensors are used to transmit real-time data for monitoring processes such as temperature and humidity sensor-based climate conditions, soil moisture content, and water storage power. Sensor parameters are set to set point values to ensure proper watering when the microcontroller controls the water pump. The aim of this project is to use renewable energy and technicaladvancementto increase overall efficiency and sustainability. With the implementation of IoT in the agricultural sector, it will be possible to develop strategic and well-managedirrigation practices. This will have a positive impact on the atmosphere and help to address concerns about climate change.

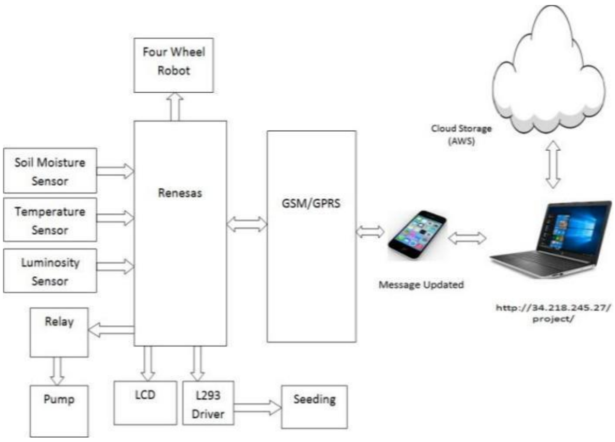


Fig 1: Block diagram of Proposed System

## VI. IMPLEMENTATION

The Arduino Uno is the main component of the solar powered smart irrigation system and is photovoltaic cells and battery that acts as the main power supply. The microcontroller system will initialize all connected devices, including sensors, relays, the water pump, and the wireless module once the power is connected. The data is sent wirelessly and displayed on the mobile application interface once the parameters from the temperature and humidity sensor, soil moisture sensor, and tank storage capacity level have been recorded. The controller will begin the process of irrigating the plants once the soil moisture content is determined by the soil moisture sensor. The set moisture levels for the soil are represented by the threshold limit of 30%-55 percent. The valves are opened in this manner to water the plants because the soil moisture content is poor. If the desired moisture content is reached, the valves are turned on. When the moisture content falls below the threshold, the microcontroller can send a signal to the relay to switch off the valves. The tank's maximum filling level is between 30 and 90 percent. When the storage tank's capacity falls below a threshold, such as 10%, the sensor alerts the microcontroller that it needs to be refilled with water. The water pump will draw water from the source and push it through the input valve, filling the tank with pressure.relaywillbe used to switch on the valve. Reaching the maximum level at 90 percent, the relay will close the valve. For effective water use, water would be supplied to the storage from river sources or ground water systems. The acquired data is shown on a wirelessly transmitted mobile application that shows whether the valve is open or closed.

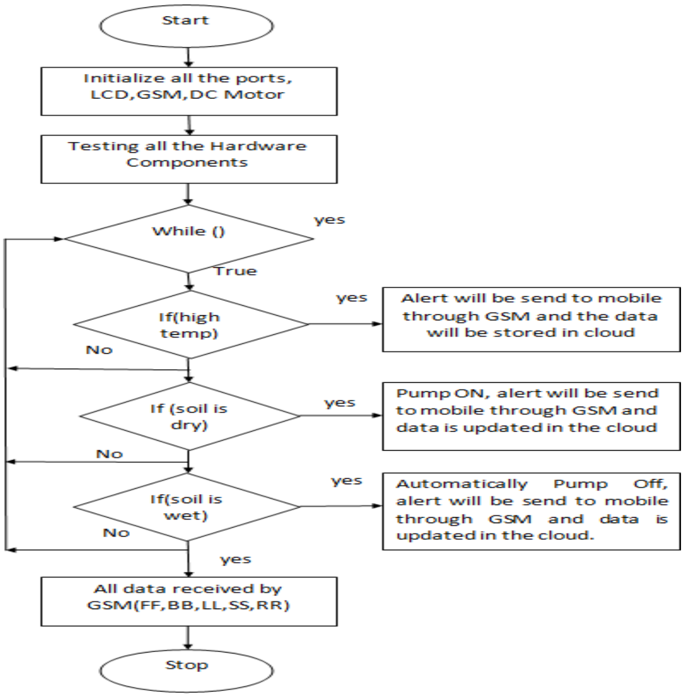


Fig 2: Flow chart of Proposed System

## VI. HARDWARE COMPONENTS

The solar powered smart irrigation system has the following components:

*A.* The Arduino Uno: is the unit's main controller and is an open-source framework that can be used in any development environment. It is an 8-bit ATmega328P microcontroller-based microcontroller module. There are 14 digital input/output pins, 6 analogue input pins, a USB link, a power jack, and a reset button on the board. The device also includes a crystal oscillator, voltage regulator, and serial communication modules.

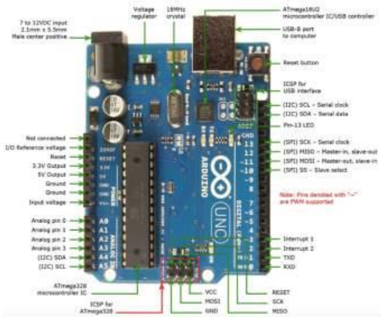

**Fig 3: Arduino Uno**

*B.* Solar Panels – Photovoltaic arrays use solar energy to produce electricity. The IEC61215:1993 solar panel uses low iron tempered glass and EVA film with TPT back sheet to encapsulate cells in compliance with IEC61215:1993 requirements.


 

**Fig 4: Solar Panels**

*C.* Soil Moisture Sensor: The capacitive soil moisture sensor tests and senses the soil moisture level using capacitive sensing to determine whether the plants need water. In comparison to other moisture sensors, it is a corrosion-resistant material. It has a high sensitivity and accuracy and runs on 3.3V-5V.

**Fig 5: Soil Moisture Sensor**

D. The ESP8266 WIFI module is well-known for its use in the Internet of Things. This module's operating voltage is 3.6V. It is a self-contained SOC that uses the TCP/IP protocol to communicate with a microcontroller over a WiFi network.

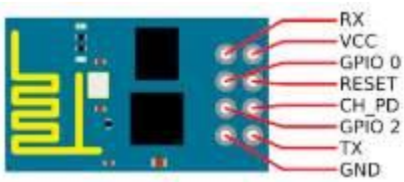


**Fig 6: The ESP8266 Wi-Fi Module**

*D.* Water Pump: 1) There are two pumps in the system: one for the water storage tank and the other for the rest of the system. 2)for watering plants, where the water is drawn from a storage tank and released via valves.

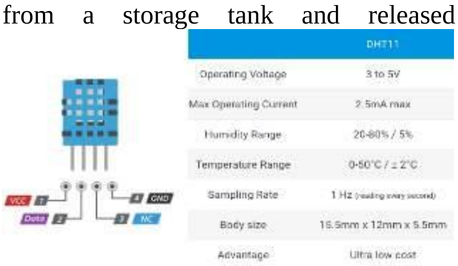


**Fig 7: Water Pump**

## VII. RESULT and DISCUSSION

The moisture content of the soil is recorded by a soil moisture sensor. The pump is automatically turned on when the moisture level falls below the threshold level, and it is turned off when it exceeds the threshold level, and the temperature sensor detects the temperature from the earth. If there is an overcast day, the Luminosity sensor detects the sun. SMS is sent to control the system to drop the water. The entire project process is displayed on LCD screen and solar energy produce the power for the movement of robot unit through sun light. This system also uses the GPRS in order to send all the information from renesas to cloud.

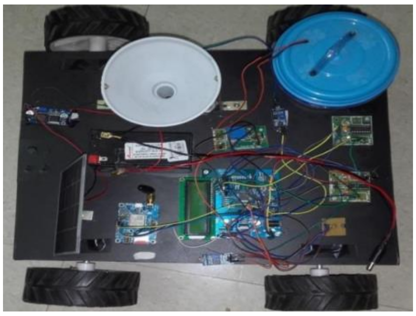

**Fig 8: proposed model**

The soil is dry then an alarm message is sent "DRY DETECTED" then automatically the motor is turned on. Once it reaches the threshold value then the alarm message is sent "WET DETECTED" to the mobile then the motor is turned off.

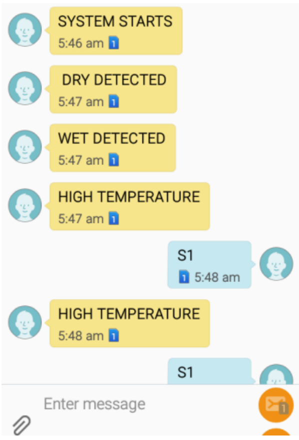


**Fig 9: ss of alter message.**

If the temperature is more than the threshold value, then alarm message is sent as "HIGH TEMPERATURE" to the mobile and it can be controlled automatically also manually.

**Table 1.** Moisture sensor voltage w.r.t water content in the soil

| Soil Cup No. | Weight of soil, (Kg) | Added water quantity, (l) | Moisture sensor output voltage, (V) | Soil moisture, (%) |
|---|---|---|---|---|
| 1 | 20(dry) | 0 | 4.5 | 0 |
| 2 | 20 | 12 | 3.1 | 38.67 |
| 3 | 20 | 24 | 2.6 | 52.48 |
| 4 | 20 | 36 | 2.1 | 66.29 |
| 5 | 20 | 48 | 1.4 | 85.63 |
| 6 | 20(wet) | 60 | 0.88 | 100 |


 

| Inputs | | Output | |
|---|---|---|---|
| Humidity | Temperature | Soil moisture | Irrigation motor |
| High | Cold | High | Off |
| High | Hot | Low | On |
| High | Hot | Medium | Off |
| High | Hot | High | Off |
| High | Very hot | Low | On |
| High | Very hot | Medium | High |
| High | Very hot | High | High |

**Table 2: shows the output.**

Many experiments were performed based on the set-up to understand the functional behavior of soil moisture sensors, battery charging voltage, and battery discharging voltage when operating the pump solely on battery power. While the pump is drawing power from the batteries, the batteries are discharging voltage, and the SPV is keeping the batteries charged. The voltage produced by the moisture sensor in response to the addition of water is shown in Table 1. The moisture sensor, which outputs a voltage proportional to the amount of water in the soil, can be used to calculate soil moisture. While the soil is fully dry, the sensor's voltage output is 4.5V, and when the soil is completely wet, the voltage output is 0.88V. As a result, 4.5V corresponds to 0% moisture and 0.88V corresponds to 100% moisture.

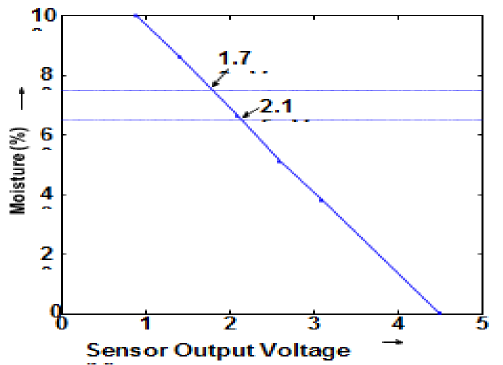


Fig 10: Sensor voltage output vs. Soil moisture

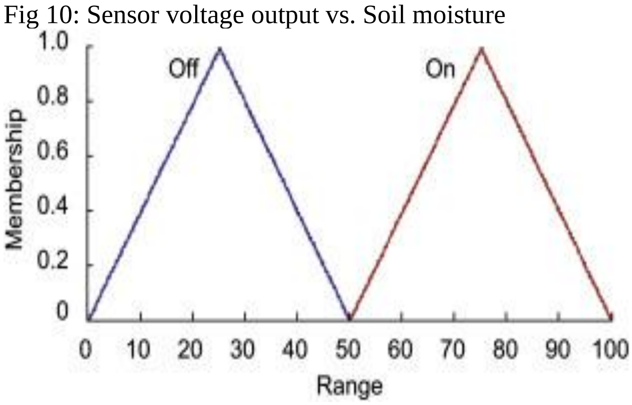


Fig 12: Output function for the irrigation motor

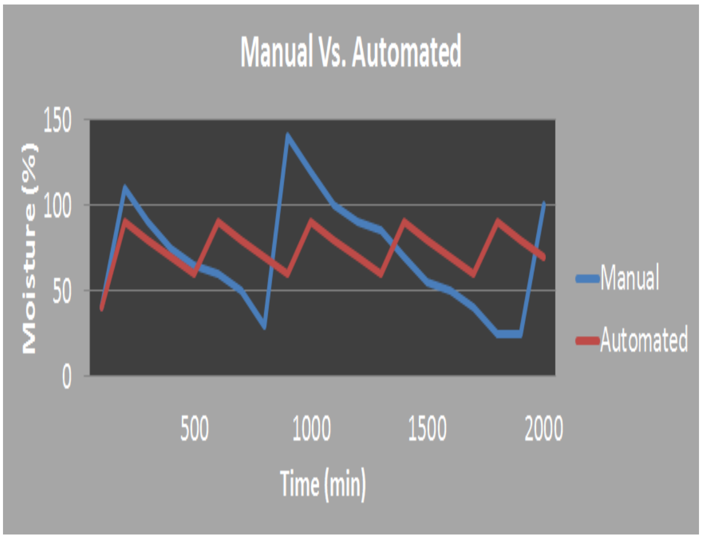


Fig 11: Irrigation Manual vs. Automated

## VIII. CONCLUSION

We here by conclude that agriculture play important Role in Indian economy the main issue which are faced in farming are water deficiency and high cost these major issues can be solved using smart automated irrigation system. So, we proposed anRenesas based Smart farming using solar panel as we all know it easy to send alter message to IOT platform through Smart phones and computer. Farmer can also switch on or switch off the motor manually based on the condition of the field.

## IX. FUTURE WORK

Alarm framework can be utilized so as to alarm the farmers if there arise an occurrence of any abnormal activites , this can accomplished by utilizing sensors around the field and introducing a live observation so as to recognize unordinary behaviour by image processing.

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