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IoT Based Smart Irrigation System on Renewable Energy to Mitigate Agricultural Cost

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Abstract:- In contrast to modern figures, which indicate that around 50% of the population is employed in the irrigation sector and that, overall, about 70% of Bangladeshis rely on agriculture for their livelihood; agriculture has long been considered one of the country's primary occupations. According to a survey, a lack of water results in the waste of about 20% of agricultural land, which is then turned into a desert area for power generation. Agriculture in the majority of poor nations, like Bangladesh, depends heavily on conventional energy sources to power the motors and pumps, which causes our land to become a desert because the irrigated fields lack access to power consumption. The aim of the research scenario is focused on IoT based operating, monitoring and controlling system for temperature, humidity and soil moisture in land area with effective and efficient utilization of renewable resources which is abundantly available such as solar energy. Internet of things (IoT) is the most evolving, promising technology which enables agricultural farms to automatically maintain and monitor with less human participation. The proposed system utilizes a single board system-on-a-chip controller which has built-in WiFi connectivity with ESP8266 module and connections to a solar cell to provide the required operating power, monitoring and controlling part is used by Blynk cloud app system. The controller reads the field soil moisture, humidity, and temperature sensors, and outputs appropriate actuation command signals to operate irrigation pumps. As compared with the other existing works the proposed system delivers a smart output with less power consumption.

***Keywords**:- Solar Energy, Smart Irrigation, Innovative Water Level Management, Solar Cell, Moisture Sensor, Solar Panel, Water Pump.*

I. INTRODUCTION

Agriculture is the major backbone of Bangladesh as it satisfies the need of food for the people. The continued increase in food demand has forced indispensable needs on the farmers to increase the production of crops. As today the challenge on incorporating a cost effective and durable power source and also an efficient plant watering system also known as irrigation systems is still remaining unaddressed [1]. Despite the destruction of many agricultural regions, many people are still unwilling to give up agriculture because it provides the basic needs of the population. Numerous studies are being conducted to improve agricultural methods because there are many issues facing agriculture today. Some researchers have developed a Zigbee module to manage three sensors and relay feedback to the user via a mobile app in order to water plants appropriately [2]. Other researchers have just used a soil moisture sensor to automate drip irrigation. But they are not considered the IoT based renewable energy system in their research. The proposed system is considered the IoT based smart irrigation with renewable energy for minimizing cost of agriculture. Then proposed system is used by fuzzy logic concept for on and off the water pump from the remote monitoring location which had three sensors (soil moisture, humidity and temperature sensors) and the solar panels are connect to operate the pumps [7]. The fundamental issue with current irrigation systems is the disproportionate distribution of water to crops, which results in excessive electricity usage. The study discusses renewable energy-based irrigation systems to overcome these drawbacks and restrictions. This proposed System is designed to increase the efficiency of water and power by solar panels to make it eco-friendly. Moreover, irrigating farms requires high intervention of human, whereas in the proposed system human intervention is minimal.

II. RELATED WORK

Joaquin Gutierrez proposed an irrigation system [15] that uses photovoltaic solar panel to power system because electric power supply would be expensive. G.Parameswaran proposed a system [11] that helps the farmers to irrigate the farmland in an efficient manner with automated irrigation system based on soil humidity whereas the server or localhost using Personal Computer. V.Akubattin designed a system [12] to monitor and control the soil moisture and temperature inside a greenhouse. The system controlled by Rasberry Pi detects the soil moisture content and according to which it takes a decision watering the plant or switching the fans of green house. D.Zhang designed a system [13] based on data transmission unit (DTU), wireless radio frequency (RF) module and microcontroller, the application of RF module in the acquisition terminal improves the expandability, data of soil moisture are collected by relay station, and then transmitted to the monitoring center by the DTU using GPRS network.

III. MOTIVATION

Agriculture is the primary source of all living things in the earth. Agriculture takes up 66% of the total land area on earth and uses 80% of the clean water that is available. Due to population expansion and globalization, the mentioned level of water use rises every ten years. The irrigation system has undergone a number of technological advancements, although renewable energy and the Internet of Things (IoT) idea have not yet been fully established.

IV. SYSTEM DESIGN AND TOOLS

The proposed system makes use several input and output devices, including a solar panel connected to a power source as well as temperature and humidity sensor an input devices, moisture and motor pump is an output devices. The photovoltaic system is integrated in solar panel system, providing renewable energy from solar to power the connected water pump. The ESP8266 is connected to three sensors—temperature, humidity, and soil moisture—and to the solar panels, which power the water pump. ESP8266 wi-fi connectivity allows for the remote monitoring of weather-related variables such as temperature, humidity, and soil moisture. Farmers can view the overall weather conditions in the land area by using the internet from a remote location. They may control the soil moisture situation, determining whether or not the farmed area needs water, using a cloud application on their android phone. The intended block is detailed and the proposed system is depicted below in figure-1.

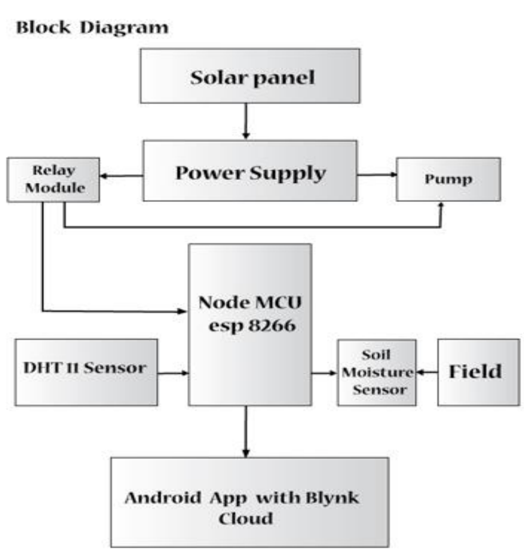

Fig 1: IoT Based Smart Irrigation System Block Diagram

A. Relay

The relay is the electrical device which used to operate a switch mechanically. It is used to control several circuits by single output. The first work of the amplifiers is that they transfers the signal [16].Relays are used as switches.

B. Solar Panel

The solar panel is a device which converts light energy obtained from the sun and converts into electrical energy for the operations of any systems [8].Solar panel is made of photovoltaic (PV) cells[16].The cells in the solar panel gets energized when the sun rays hits it. The excitement of the cells results in enlarge the heat energy and the terminals which is constructed in the back end of the supporting structure carries the generated heat energy and converts into the electrical energy and the electrical energy is carried through the wires and stored in the external battery.

C. ESP8266 WiFi Module

An ESP8266EX Wi-Fi module is controlled by using TCP/IP protocol that can access any kind of wireless connectivity network. It allows connection of different sensors to the WiFi module through GPIO pins. It processes the sensor data in minimum amount of time. The Wi-Fi module microchip is fixed with a microcontroller where the data is processed and acts as a carrier which transfers the data from the sensors and other linkage systems to the server created using Blynk cloud.

D. Sensors

In the proposed system sensors plays a crucial role in detecting the moisture content in the field, measuring the humidity content in the atmosphere, measuring the water content of the field, for detecting the remaining voltage in the external battery [16]. The list of sensors used in our system is:

➢ *Moisture Sensor*

The sensor will measure the moisture content of the soil around it. The capability of the moisture sensor detection is around 1 sq ft. If the detected moisture content is low the module displays the output through the microcontroller by transferring the data through output pins.

➢ *Temperature Sensor*

The temperature and humidity Sensor sense the temperature and water vapor in the field [16] and it ranges from of 15℃to 40℃.The function of the LM35 is direct-to-digital temperature sensor.

V. SYSTEM IMPLEMENTATION

The IoT-based smart irrigation system on solar power is depicted in Figure-2 and uses a variety of hardware, including a DHT11 sensor, Wi-Fi module, solar panel, soil moisture sensor, and relay module to sense and monitor the soil wetness, temperature, and humidity parameters in the irrigation field.

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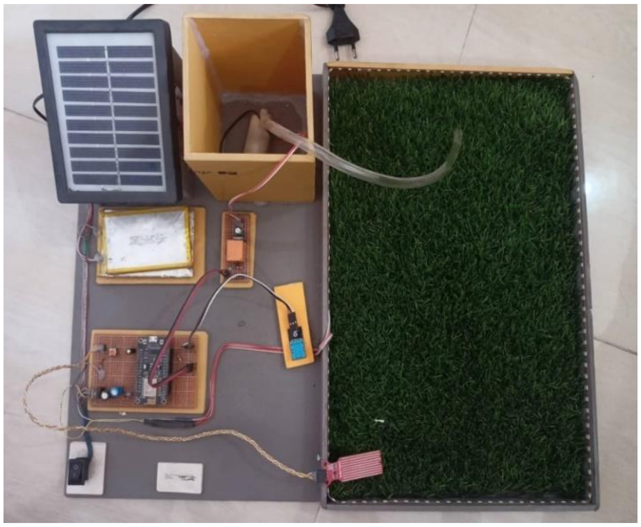
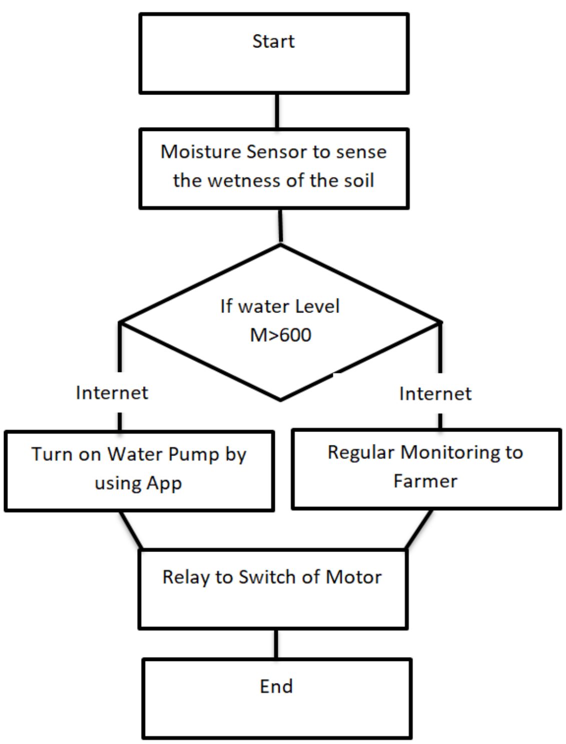


Fig 2: Implementation Scenario of Smart Irrigation System

A. Algorithm

STEP 1: Initialize the System.
STEP 2: Check the wetness level.
STEP 3: If wetness level of Moisture Sensor is M>600 then begin irrigation.
STEP 4: If wetness level of Moisture Sensor is M<=600, then send stop irrigation message to the user.
STEP 5: Desired output analysis has been obtained.



Flowchart: IoT based smart Irrigation System

B. Fuzzy logic

The sensors' input values are humidity, temperature, and soil moisture. "Hot," "Cold," are the two temperature functions that are used. Three functions—"High," and "Low"—are used for soil moisture and humidity sensors. The water motor is operated via fuzzy logic using "if" and "else" conditions. When the application message shows the temperature is high and humidity is low then water is delivered to the crops; when it is "False," there is no supply water on the field of crops. The concept is depicted by the Table-1 and Figure-3 shown at below.

Input		Output	
Humidity	Temperature	Soil Moisture	Irrigation Motor
High	Cold	High	OFF
Low	Hot	Low	ON

Table-1: Weather Monitoring in Land Area Corresponding Irrigation Motor On Off

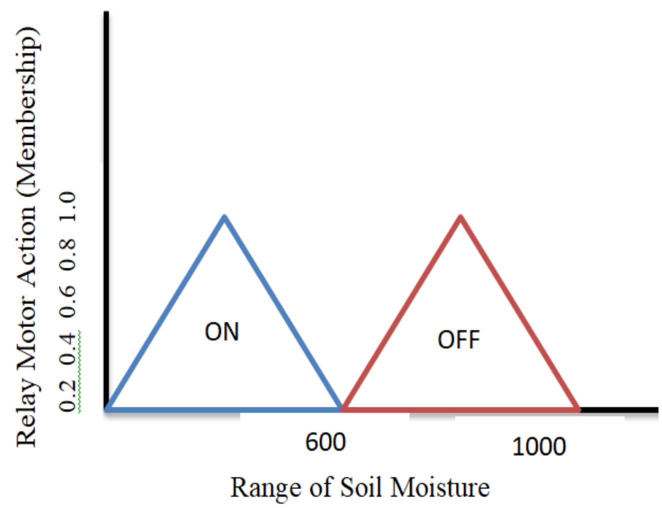


Fig 3: Fuzzy Logic Concept from Soil Moisture and Relay Motor Action

C. Relationship between temperature and humidity

Temperature and Humidity are different but they are related to each other. The relation between humidity and temperature formula simply says they are inversely proportional. If temperature increases it will lead to a decrease in relative humidity, thus the air will become drier whereas when temperature decreases, the air will become wet means the relative humidity will increase.

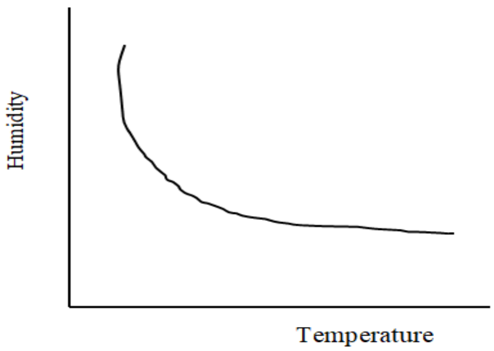


Fig 4: Inverse Relationship of Temperature and Humidity

VI. RESULT AND DISCUSSION

Table-2 gives us the quantity of water used by IoT based smart irrigation system. If water quantity level is 500-600 then the motor is off and when level is 1000-1200 then water is supplied by irrigation system. At the same time it is monitored of temperature and humidity sensor data in cloud.

Moisture Sensor (water quantity level)	Temperature Sensor (degree in celsius)	Humidity Sensor (RH-gm/kg)	Relay Motor Action
500-600	25-28	40-60	OFF
1000-1200	30-35	< 30	ON

Table-2: Controlling Water Pump using this Cloud Data.

Through the IoT WiFi module that is integrated into the system to send the field values from the design system to the cloud, the proposed design is directly connected with the Blynk cloud. The following sensors are used to gather data from the field, and the data is organized in the designed application that is connected to the IoT. The field temperature is picked up by the temperature sensors, which then display it in degrees Celsius. The field's water quantity is continuously analyzed by the moisture sensor. Farmers are not necessary to available at irrigation field and the status of the system (Figure-3.) can be observed by the remote user from our designed and implemented IoT based smart irrigation system application.

Fig 3: IoT Based Data Stored and Viewed in Cloud

VII. LIMITATION

The proposed system is unable to forecast when to harvest, when animals will enter the field, or what the plants' nutritional levels would be. Furthermore, water is supplied to such crops as needed owing to the fuzzy logic. The proposed approach will not take into account simultaneous rain and water supply conditions.

VIII. CONCLUSION AND FUTURE SCOPES

A successful automated smart irrigation system has been developed that can analyze the soil's conditions and determine whether or not to irrigate the farm using fuzzy logic and a variety of sensors, including soil moisture and DHT sensors. Additionally, we were able to deploy the system without the usage of electricity because we powered all of the sensors with solar energy using an ESP8266 module. This system's design aims to overcome the issues with conventional irrigation systems, which result in significant resource waste. By implementing an automated function that allows users to monitor the condition of the soil, the requirement for water pumping, and other factors from a distance, the issue of unneeded manpower was eliminated. The proposed approach is

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affordable and is simple to install in locations large enough to grow crops, such as gardens and roofs. As the tendency nowadays is to rely more and more on renewable energy sources, having solar energy as the main source of power was an additional benefit. The integration of the wifi module improved the design's adaptability by allowing for more flexibility and the adding of more sensors with only a small amount of additional programming. This concept can be scaled up in the future to accommodate actual farm sizes, support the operation without required human intervention and manpower for irrigation, and can also be used to reduce the cost of the equipment used to install and operate the irrigation system.

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