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Better Performance of a Smart Irrigation System using the Best Combination of Sensors and Digital Communication Devices

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Abstract: ***Once upon a time, India is rich in vegetation and agriculture. Now, the current scenario is totally different. Every Indian has been trained to work in different fields. In our day to day life, water has increased its demands in overall world which results in water scarcity. This kind of factors affects the regular plantation fields and home gardening. In this connection, we have proposed a methodology to overcome this problem. In the proposed research, a kit with probes and sensors is developed to measure the moisture and humidity level of plants in order to ensure the required water quantity. A solenoid valve is controlled through automation by pre-setting the values of moisture. If the moisture level goes down below certain value, then the solenoid valve is set to open and the water flows. On keeping the sensors on the top of the soil would not sense the parameters effectively which leads to unreliable results. So, in our suggested 0technique, the sensors are placed just below the soil surface, which is nearby closer to the roots of the plant, for getting the significant outcomes. The humidity sensor measures the humidity present in the air and indicates the probability of rain. This feature helps the farmers and the other gardeners in their routine work. This leads to make our country as green and rich in agriculture. There are two more sensors used viz., the flow sensor for measuring the flow rate as well as the volume of water used and the ultrasonic sensor for measuring the water level in the tank for control purpose. The sensors' data can be communicated to the remotely located user through digital communication devices such as NodeMCU (Arduino) and Internet of Things - Blynk platform.***

Keywords: ***Agriculture, Sensor, Humidity, Moisture, Flow, Ultrasonic, Arduino, IoT-Blynk.***

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I. INTRODUCTION

The usage of water in agriculture is at the core of any discussion of water and food security. Worldwide, over 330 million hectares are equipped for irrigation. Agriculture is the backbone of India. In olden days, every Indian was trained to do agriculture. Now-a-days, the usage of water for various processes is dramatically increasing which leads to water scarcity [1]. This is the right time for providing a solution for water scarcity. Knowing where the water is needed widely and where the limiting of the water quantity is required may help to get significant results [2]. Controlling the unwanted water usage in agriculture will definitely save some appreciable quantity of water for its later use. This can be effectively accomplished by coupling the sensor instrumentation technology with digital controllers. Serial communications are used to transfer the values of the agricultural parameters to the users.

II. MATERIALS AND METHODS

A. Proposed methodology - An Overview

In the proposed research, the water content present in the soil is measured by using a moisture sensor and the humidity present in the air is measured by using a humidity sensor. The block diagram of the proposed methodology is shown in fig.1. The measured values are given to the microcontroller that makes the process for budgeting the water supply and sends the data to the user. Based on the measured values, the signals from the controller control the water outlet. The manual access of the farmers directly to the crops can be reduced by gathering the field data from any location. This could be automated through the serial communications.

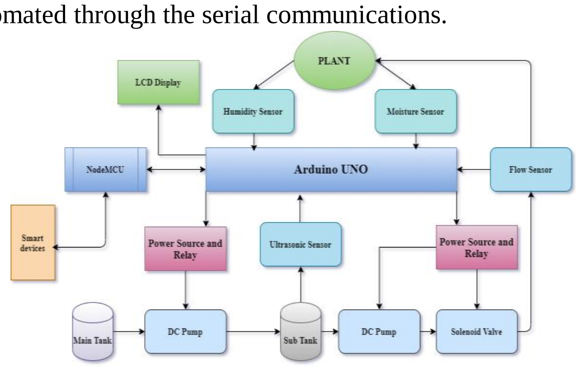

Fig.1. Block diagram of the proposed methodology

B. Proposed methodology - Description

The proposed prototype monitors the amount of soil moisture and humidity. A predefined range of values of soil moisture is set and can be varied with soil type or crop type. Initially, the values from the moisture sensor and the humidity sensor are fed to the microcontroller unit. Here, the Arduino Uno acts as a microcontroller unit. It processes the values and displays it on the LCD display. A set point value is given to the microcontroller unit for the moisture parameter and the action of the solenoid valve takes place according to the measured values of moisture. In case, the moisture value of the soil deviates from the specified range, the watering system is turned on/off. On the condition of dry soil and high soil temperature, the suggested irrigation system will be activated in order to pump water for watering the plants. The moisture sensors are placed inside the soil and not on the base, so that the value of moisture nearer to the roots becomes precisely known. For an instance, if the value of the moisture present in the soil which is nearer to the roots of the plants is less than the set point, then the solenoid valve opens and the water flows into the area of plants. Once the level of moisture reaches the set point, then the controller sends a signal to close the solenoid valve which stops the flow of water. There is also a flow sensor that measures the output flow of water used and sends the data to the microcontroller unit. This flow sensor measures the flow of water per minute and shows the volume delivered. In this system, the node MCU is embedded for serial communication purposes. It helps to transfer the data to the web server through a cloud generated by the IoT – Blynk platform so that it can be viewed any time when connected to the same network. There is another one sensor called ultrasonic sensor which is positioned in the irrigation – based water tank to control and pump the supply of water to the plants. This results in a seamless water flow to the plants and crops. Therefore, it is observed that the moisture level and the water level form the control parameters that are well measured in a closed loop arrangement for the purpose of effective control.

III. HARDWARE DESCRIPTION

A. Arduino Uno

The Arduino Uno is equipped itself as an open source microcontroller panel with microchip ATmega328P advanced by Arduino.cc. It can be interfaced with various sensors and different measurement points of the circuits [3]. The Arduino Uno microcontroller board consists of 6 numbers of analog pin inputs, 14 numbers of digital pins and 6 analog pins, a power jack, a USB connection and an In-Circuit Serial Programming (ICSP) header. It is designed under Integrated Development Environment (IDE). It also has inbuilt transmitter and receiver pins and a crystal oscillator. A reset button is present in it to reset the program. This microcontroller board can be operated based on the user defined function and the program uploaded.

B. NodeMCU - ESP8266

It comprises firmware that operates on the ESP8266 Wi-Fi SoC as of Espressif Systems, and hardware which is configured on ESP-12 module. The firmware employs the Lua scripting tool [4]. The other parts are 10-bit ADC module, Universal Asynchronous Receiver / Transmitter (UART) interface, PWM outputs for softening the intensity of LEDs or scheming the motors, and finally the Serial Peripheral Interfaces and I2C interfaces for connecting all kinds of sensors and peripherals.

C. Soil Moisture Sensor

Here, the soil moisture sensor used is FC-28. It computes the volumetric amount of water content present in the soil. It is made up of two metal probes like capacitance. When the soil has deficiency of water content, then the output of the sensor will be at high level, else there will be a low level output. This sensor reminds the users for watering their crops and also monitors the moisture content of the soil. It has been widely used in agriculture, land irrigation and botanical gardening. The amount of water content present in the soil can be determined based on the voltage developed by the soil. This is mainly due to the fact that the water acts as an electrolyte and produces electricity.

D. Humidity Sensor

A humidity sensor measures and specifies both the relative humidity of air and the temperature of air. The ratio of the amount of moisture truly existing in the air to the topmost level of moisture at a specified temperature of the air is called relative humidity. The humidity sensor operates by perceiving the changes that adjust electric currents or temperature of the air [5]. The humidity sensor has three types viz., Capacitive, Resistive and Thermal. Each type of the sensor has its own calibration curve. In the proposed system, capacitive type humidity sensor is used.

E. Flow Sensor

The flow sensor measures the flow or consumption of liquid which is flowing through a pipe or a conduit. Here, YF –S201is used as a flow sensor. This water flow sensor comprises a synthetic control device casing, a rotor and a Hall Effect sensor. When the water runs through the rotor, the speed of the rotor changes with respect to diverse flow rates and the Hall Effect sensor delivers the resultant pulse signal as an output.

F. Ultrasonic Sensor

In the proposed schematic, HC- SR04 is used as an ultrasonic sensor. It is seated on the apex of the water tank which is used for water storage with respect to agricultural purposes. The sensor sends an ultrasonic pulse into the tank and it is reflected back to the sensor.

The sensor computes the time delay between the transmitted and reflected signals. Based on this time difference, the microcontroller unit calculates the distance to the surface of the liquid in the tank which in turn leads to the determination of water level in the tank.

G. LCD Display

A Liquid Crystal Display (LCD) is a photo-electronic modulation device which employs liquid crystals in order to generate a detectable pattern. The 16×2 LCD deciphers a display of 16 characters per line in 2 such lines. It has totally 32 characters and each character is made up of 5×8 Pixel Dots.

IV. ABOUT BLYNK APPLICATION

Blynk is a podium with IOS and Android applications for controlling Arduino, Raspberry Pi etc., through the internet. It has a digital instrument soft panel where we can form a comprehensible graphical interface of our project by dragging and dropping gadgets. It is the well-known IoT base for connecting our instruments to the cloud, for designing apps to control them, and operate our deployed devices at a graduated system [6]. The data is transferred to the cloud by assigning the variable to a particular pin in the application and call the pin later to read the data in the variable.

V. EXPERIMENTAL ANALYSIS

The proposed system is experimentally analyzed by interfacing the hardware with the software and the internet. A secure Wi-Fi connection is required to connect the Node-MCU to the internet. The experimental hardware implementation of the system is given hereunder in the Fig. 2.

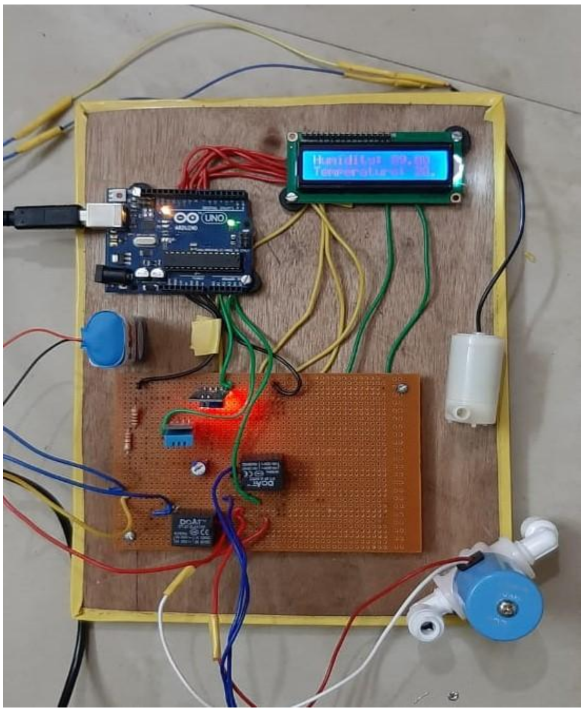

Fig. 2. Experimental Hardware Setup

Fig. 3. Blynk Application Interface

The data from the sensors are transferred to the Blynk cloud via Node-MCU. The Blynk application interface shown in Fig. 3 displays the numerical values for humidity, temperature, volumetric flow and moisture. The water level in the tank is represented in the tank itself. There are two more on / off switches for controlling the pump and the solenoid valve.

VI. A SCINTILLATING ANALYTICAL COMPARISON MADE!

Here, we are going to conduct an analytical comparative study of our innovative smart irrigation system vis-à-vis their peer methods discussed in the journal papers, available in the reference section, with a view to telling ours from the others and thereby establishing the superiority of ours over the others!

Unlike the other existing systems, the proposed arrangement has additional features viz., on / off control for the pump to deliver water at an accurate volumetric flow and an additional LCD display to show the real time temperature and humidity data to the users and the farmers. There is also an automatic level control system in the water tank provided. The amount of water used is also measured and the entire data is sent to the remotely situated user via Blynk application.

The Table – I given hereunder describes the specific qualities of our project when it comes to in comparison with the other existing systems.

Table – I: Analytical comparative study

Feature / Ref. Number	Data measuring	Data monitoring	Water level control	IoT – Blynk
Reference Number - 1 (2015)	YES	NO	YES	NO
Reference Number - 4 (2018)	YES	NO	YES	YES
Reference Number - 5 (2019)	YES	NO	NO	YES
Proposed Methodology	**YES**	**YES**	**YES**	**YES**

VII. CONCLUSION

By all counts and proven results, the proposed research has been experimentally verified successfully. The irrigation for the plants could be controlled automatically based on the requirement. The designed system could also be used to display the humidity level and the temperature. This kind of information provides greater help to the farmers, gardeners and botanists by saving their valuable time on watering the crops and gardens. In also the absence of the farmers, this system will automatically supply the required water to the plants and crops. Hence, it is concluded that the recommended smart irrigation system has successfully provided the seamless and budgeted irrigation and an automatic field data monitoring system via Blynk application.

As a future scope, this system can be further extended by properly splitting a larger agricultural field into a matrix form and by placing a controller in each cell of the matrix. This type of advancement leads to obtain the more information of a specific cell and brings the paramount importance in the agricultural field.

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