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Smart Irrigation and Management of Cash Crops using IoT

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Abstract: Smart Irrigation systems are helpful, particularly for the individuals who travel. Whenever introduced and modified legitimately, they can even spare our cash and help in water protection. Dead yard grass and plants should be removed and that can be costly however the investment funds from programmed water system frameworks can go past that. Watering with a hose or with oscillator squanders water. Programmed water systems frameworks can be customized to release increasingly exact measures of water in a focused zone, which advances water protection since the sending and utilization of wired frameworks in remote zones is generally unfeasible because of mind-boggling expenses, remote is the best arrangement. In this study,a solution to demonstrate the feasibility of Automatic Irrigation and continuous monitoring system especially for cash crops is proposed. We have connected the field sensors to the Internet through Wi-Fi or Ethernet or Modem and controlled via a web page which is accessed using the Static IP address. The Field side irrigation controller node is composed of a NodeMCU, sensors and solenoid valves. The sensing parameters can be displayed as values in the web server and continuous monitoring can be done through PC, Laptops and Android Phone.

Index terms: Flask, Node MCU, Raspberry Pi 3 Model B, TEG

I. INTRODUCTION

Cash crops are profit crops like cotton, pulses (green pea) are grown to sell for profit. Our Country India has Monsoon dependent agriculture. Cash crops need continuous water supply and hence there is a great need of automation for the irrigation control. A smart Irrigation system has to be proposed which would monitor the irrigation system of the field remotely by the user through a smartphone or through internet. Agriculture is the basic need of life for human beings as it provide food including cash crops and also other grains.

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It plays an indispensable role in Indian Economy. We have witnessed that Agriculture is the backbone of our country.According to the survey by United Nations – Food and Agriculture Organisations, the food production all over the world should be increased by 70% in 2050 for evolving population. It also provides employment opportunities to many people. The farmers are still using the traditionalmethods for agriculture which results in low yield of crops.

The crop yield can be improved by using automation. Food prices are continuously increasing because crop rate is declined. It has pushed over 40 million people into poverty since 2010. There are number of factors which are responsible for this, it may be due to water waste, low soil fertility, fertilizer abuse, climate change or diseases, *etc*.Hence there is a necessity to implement the engineering and newer technologies like IOT in this field of agriculture. Many methods have been done to automate the working process inagriculture. In [1] they have developed an automatic irrigation system which used photovoltaic cells. This method is not feasible for a long time because it cannot guarantee power all through the day .But our system uses rechargeable batteries so as to power it for a long time. In [2] the author used GPS location for exact water supply and used Arduino and GSM.In our method, there is no need of GPS as sensors are placed accurately in the field.In[3] paper, different possible methods of automatic irrigation system was discussed.An irrigation system with WSN was implemented. We have implemented using Wi-Fi using NodeMCU and Raspberry Pi Web Server. In [4] paper, Zigbee is used for irrigation and used GSM for Network.We have used In Built Wi-Fi which is low cost. Considering all the scenario, we have developed a system which monitors the field data and also controlling the field operations. We have integrated the field sensors to the Internet with and controlled via a web page using Raspberry Pi which is accessed using the Static IP address. The web server is secure that there will be login credentials provided to the user and continuous monitoring of the field is done by refreshing the field values automatically every 10 seconds. We have also provided a Emergency Switch in the Webserver such that it can be turned OFF at the time when the user needs so that the entire field irrigation is stopped until is being turned ON again. This is used in situations especially where there is a possibility of rain in the field. The temperature, humidity and soil moisture values of field are displayed in Web Server

II. EXPERIMENTAL PROCEDURE

A. Block Diagram

The Smart Irrigation system has two blocks, Field Side and Control SideThe field block diagram of IoT based smart irrigation system is given in Figure 2.1.It depicts the overall system flow happening in the field side. Node MCU has a WiFi module ESP8266 and some associated circuit. ESP8266 module has a micro controller with WiFi. ESP8266 is programmed using Arduino IDE which is a WiFi chip with 32bit microcontroller. ESP8266 is a system on a chip (SoC) design with components like the processor chip. The processor has around 16 GPIO lines, some of which are used internally to interface with other components of the SoC, some of which are used internally to interface with other components of the SoC, like flash memory. DHT 11 sensor is used for measuring the temperature and humidity values of the field. There is a solenoid valve which is used for the water flow which is connected to the relay for the effective operation. We have used a 5v single channel relay for the solenoid valve for the effective operation when it is connected to NodeMCU. The Soil Moisture Sensor, DHT 11 sensor, solenoid valve are connected to NodeMCU and power unit is provided for the 5v supply toNodeMCU and 12 V for Solenoid Valve. We have used rechargeable batteries for the power supply and the figure 2.1 shows field side block diagram of the proposed system.

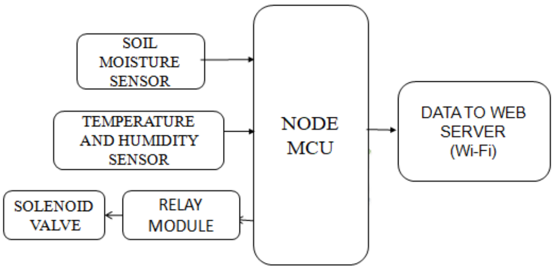

Figure.1 Field Side Block Diagram

The control side block diagram of IoT based smart irrigation system is given in Figure 2.2.It depicts the overall system flow happening in the control side. The control side consists of a Raspberry Pi 3 which is connected to the internet by using either Ethernet or Wi-Fi. The NodeMCU wirelessly transfer the sensor data to the Raspberry Pi by ping with the IP of Raspberry Pi. This is done by programming in Arduino IDE. The steps can be discussed later. Then webserver is created on the Raspberry Pi. This is an apache web server with static IP. The Web Server is designed using Python Web Development Library called Flask. The web server is designed in such a way that the user can access in any internet enabled devices that may be either smartphone or Laptop or PC or Tablet. The Web Server is secured such that the user can only login and monitor the status of the field. The real time conditions are monitored such that the page automatically refreshes every 10 seconds. The newer feature that we have included in the Web Server is that there is an emergency switch which is used to turn ON and OFF the entire system for the user needs. The status of the emergency switch is also displayed in the Web Server. The purpose of the emergency switch is that the user can turn OFF the automatic irrigation system of the field at the time of rainy season or any natural calamities. The system can be turned ON again by the press of a button. Thus the smart irrigation system makes the user easier to control the field irrigation remotely and the figure 2.2 shows the control side block diagram of our proposed system.

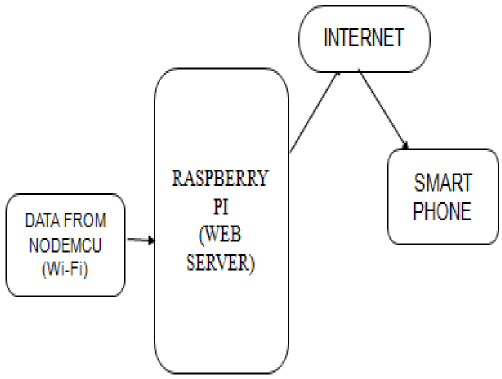

Figure.2 Control Side Block Diagram

B. Flow Chart

Fig.3 is the flow chart of the proposed model.TheNodeMCU is turned ON in the field side which is connected to the field sensors and the solenoid valve.The sensors are initialized and the NodeMCU is connected to the access point.In the field side, the soil moisture value is compared with the threshold.In the control side, NodeMCU is connected to the Raspberry Pi and the data is sent to the web page. In the web server, there will be different messages of working of Solenoid Valve. When the soil moisture value is less than 60%, the solenoid valve is LOW and moisture value above 60%, the solenoid valve is HIGH which results in water flow. There is also an emergency switch in the web server which can manually turn off the system

III. HARDWARE DESCRIPTION

A. Raspberry Pi

Fig.4 is Raspberry Pi (RPi)board is a family of SoC (System of Chips) with an ARM processor. It is a minicomputer PC which can be utilized in electronic applications or ventures. It additionally plays top notch video and it has a worked in Ethernet Connection so one get simple availability, at any rate for the most widely recognized sheets. Furthermore, much of a stretch include Wi-Fi network by module a Wi-Fi dongle on one of the USB port. This higher-specification variation expands the GPIO stick tally from 26 to 40 pins. There are 4 USB 2.0 ports in RPi Model B.RPirequiring 5V supply and ADC Pin is just 3.3V. The GPIO pin 8 and 9 transmits and receives information flag.

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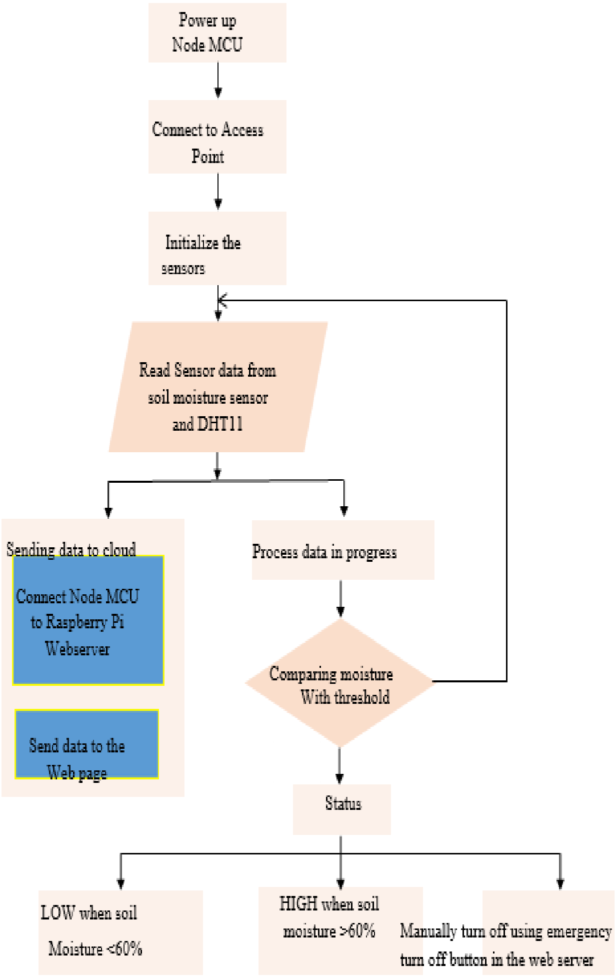

Figure.3 Flow Chart

Figure.4 Raspberry Pi

B. Node MCU

Node MCU is a board that has esp8266 with USB to UART converter that programs esp8266. ESP8266 offers a total and independent Wi-Fi organizing arrangement, enabling it to either have the application or to off burden all Wi-Fi organizing capacities from another application processor. This chip inserts anultra low power Micro 32-bit CPU, with 16-bit thumb mode. The memory controller contains ROM, and SRAM. It is gotten to by the CPU utilizing the iBus, dBus and AHB interface.ESP8266 on-board handling and capacity abilities enable it to be incorporated with the sensors and other application explicit gadgets through its GPIOs with insignificant advancement in advance and negligible stacking amid runtime.

With its high level of on-chip incorporation, which incorporates the receiving wire switch which, control the executive converters, it requires insignificant outer hardware, and the whole arrangement, including front-end module, is intended to possess negligible PCB territory. Fig 5 shows the pins of NodeMCU.

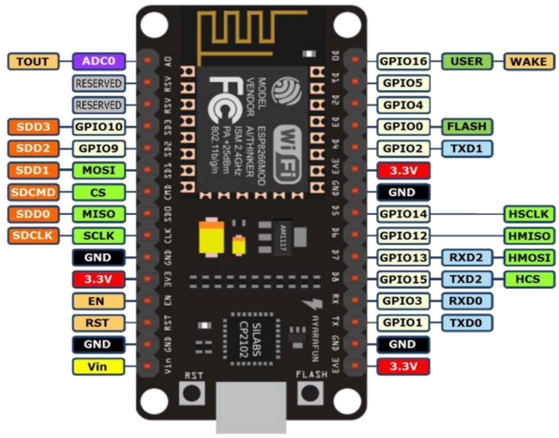

Figure.5 Node MCU

C. DHT 11

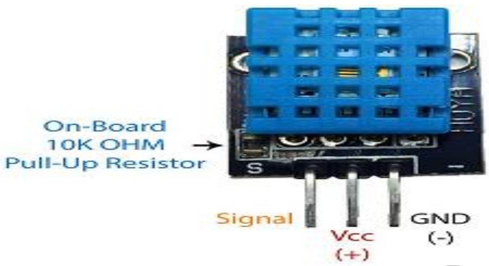

Figure.6 DHT 11

The DHT11 is an ordinarily utilized Temperature and humidity sensor. The sensor accompanies a devoted NTC to quantify temperature and a 8-bit microcontroller to yield the estimations of temperature and mugginess as sequential information. The sensor is likewise plant aligned and consequently simple to interface with different microcontrollers. The sensor can gauge temperature from 0°C to 50°C and moistness from 20% to 90% with an exactness of ±1°C and ±1%. So on the off chance that you are hoping to quantify in this range, at that point this sensor may be the correct decision for you. The DHT11 stick outline is appeared in Fig 6.

D. Fc-28 Soil Moisture Sensor

Soil moisture sensors measure the volumetric water content in soil. Since the direct gravimetric estimation of free soil sogginess requires removing, drying, and weighting of a model, soil moisture sensors measure the volumetric water content by suggestion by using some other property of the earth, for instance, electrical resistance, dielectric consistent, or relationship with neutrons, as a go-between for the moisture content.

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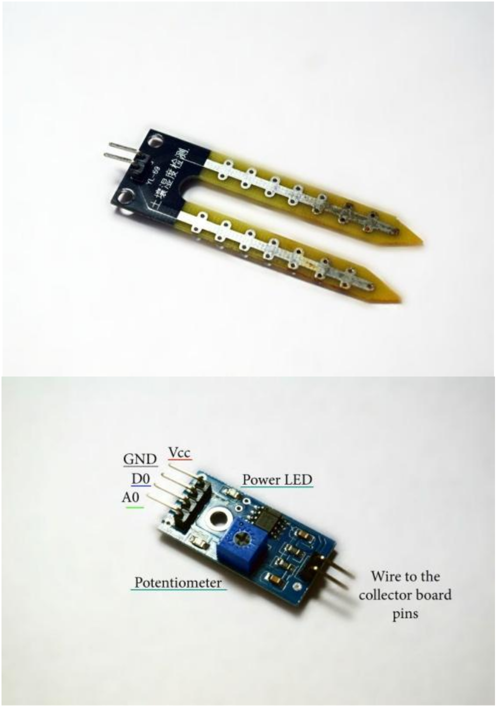

Figure.7 FC-28 Soil Moisture Sensor

The association between the conscious property and soil moistness must be balanced and may change dependent upon normal components, for instance, soil type, temperature, or electric conductivity. Reflected microwave radiation is affected by the earth moisture and is used for remote distinguishing in hydrology and cultivating. Advantageous test instruments can be used by farmers or plant pros.

E. Single Channel Relay

Figure.8 Single Channel Relay

A relay is an electrically worked gadget. It has a control framework and (additionally called info circuit or information contactor) and controlled framework (likewise called yield circuit or yield cont performer). It is regularly utilized in programmed control circuit. To say it basically, it is a programmed change to controlling a high-current circuit with a low-current flag. Fig 9 depicts the working of relay.

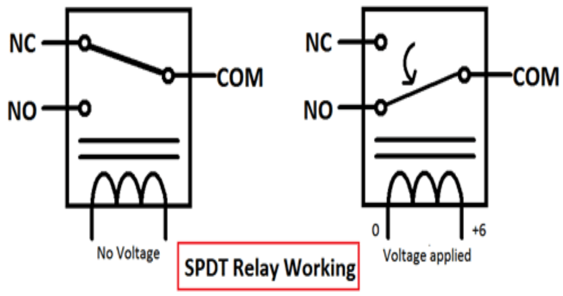

Figure 9. Working of a relay

IV. RESULTS AND DISCUSSION

The field side sensors are connected and the farm setup is made shown in Fig.10We have used Green Peas one of the cash crop in India. The Solenoid Valve is powered by 12V DC rechargeable battery. At the control side, the web server is started where the Raspberry Pi connected to the Internet through Wi-Fi having static IP Address.

Figure 10. Farm Setup

To interact with the device from any remote location a webpage is created as shown below.

On typing the Static IP in any device, it automatically redirects to a login page as shown in Fig 11.

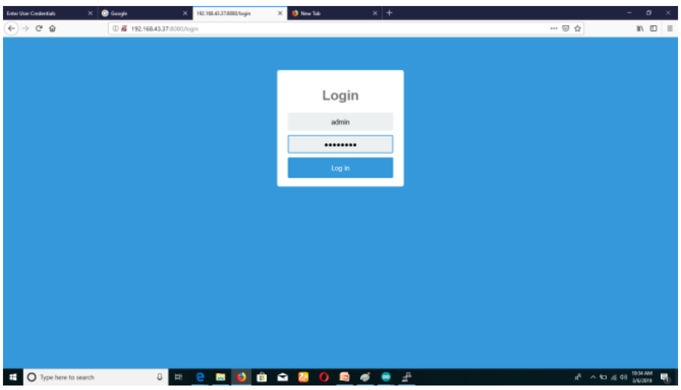

Figure 11. Login Page of WebServer

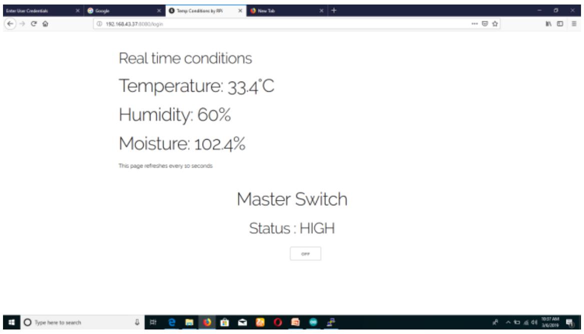

Figure 12. Sensor values of the cash crops

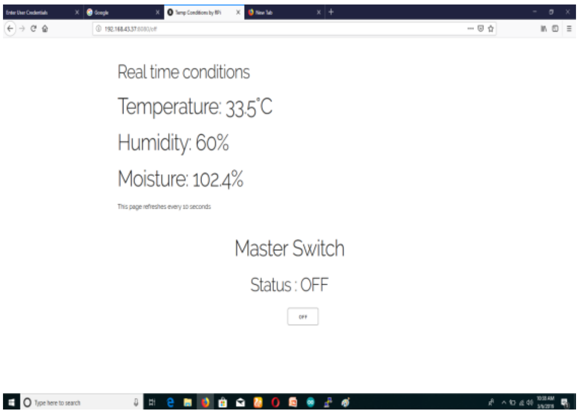

Figure13. Toggling water switch by master

The User after logging in, the sensor data is continuously monitored and refreshes automatically every 10 seconds as shown in Fig 12 where master switch is initially HIGH. Now the master switch is turned OFF so as to turn off the entire automatic irrigation system manually. This is achieved in Fig 13 with master switch state as LOW. The entire webserver is designed using Flask, A python Web Development Library.

V. CONCLUSION & FUTUREWORK

This designed system can be made more useful in the large area of farmland such as tea, coffee, rubber estates where the irrigation has to be supplied in large area. The manual labor is reduced considerably and the maintenance cost is also low although the initial expenses may be high. The main thing is that entire is done automatically and also monitored in all stages of cultivation. The emergency switch also used to turn OFF and ON the field irrigation system manually. This irrigation system can be also used for spraying fertilizers and pesticides at necessary time given the user remotely. The future work can be done in this system is by applying machine learning techniques and predict the exact time of water flow for the field which considerably reduces the water use and useful especially in drought areas. Also the web server has a Static IP and secure that a farmer can easily use to monitor the field.

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