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IoT Based Smart Agriculture toward Making the Fields Talk

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Abstract: *With the increase of world population, the availability of food to all inhabitants on globe is one of the significant challenges. These challenges need to be addressed by adopting innovative options to improve the soil capacity and the safety of environmental resources. The availability of real-time vital parameters related to farming such as moisture, temperature, weather, and water management as well as predictive actions against the changes in parameters can provide great help to deal with these challenges. Internet of Things (IoT) is an evolving technology, has great potential to play and prevail its miraculous role in almost every field. IoT is a network of things that are capable of self-configuring network. The development of intelligent IoT based Smart farming is day by day getting its space in developed countries. It facilitates towards precision agriculture and turning the face of agriculture production. Subsequently, it is reducing spoilage of resources such as water, operating cost. The availability and development of cost effective smart miniaturized sensors, processors and communication technologies has made IoT based smart farming feasible. In the System deals with better production and cancelling out all factors leading to crop failure and will give best results based on the necessity of the crops, which will help to deal with the requirement and crisis faced during crop productivity.*

Keywords: Node Mcu, Sensor Data, IoT Based Automation, etc.

I. INTRODUCTION

The Proposed System deals with better production and cancelling out all factors leading to crop failure. The proposed system will give results based on the necessity of the crops, which will help to deal with the requirement and crisis faced during crop productivity. Measure temperature to deal with crops which cannot bear high or low temperature. Some crops fail due to humidity, so gauging humidity is a necessity. Estimate water level so to check if the crops don't get submerged in water and get damaged. To display the reading in the system for user to find optimal solution for the better production. The System to have longer lifespan and show accurate measurement. The System should be easy for upgradation so as to simplify integrating components with enhanced features. The proposed system should have the following aspects:

- **Reliability**: The system has longer lifespan and the measurements are accurate.
- **Maintenance**: The proposed system upgraded at ease by simple integrating components with enhanced features.
- **Ease to use**: The proposed system is easy to comprehend and grasp. The usage of the system doesn't require any prior knowledge.

II. RELATED WORK

A lot of research has already been done on [1]. Aiming this act, a smart system consists of IoT and WSN (Wireless Sensor Network) is discussed in [1]. Alongside the common ambient parameters like humidity, temperature soil moisture an additional ten days weather history report is also considered in this proposed system. A transceiver KIANI sensor node developed by SIXAB and IZU-WSN Research Lab, a processing unit comprises of Texas Instruments CC1101 Low-Power Sub-1G, R Transceiver Processing unit outfits with Arduino Nano are used. The main unit is powered by 1200mah 3.7v Li-ion rechargeable battery. RPi3 is used as a gateway to collect sensors data and then transfer it to servers. The data stored in servers are made available to user via websites and mobile application. This remotely available data helps the user to make a prompt decision based on the information gave by the system.

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The system presented by [2] aims at adopting IoT in agriculture to exploit automation approach. Monitoring environmental factors plays a vital role to increase the production of the efficient crops. Two most important natural factors are considered in this study namely temperature and humidity of the field. Humidity sensor sense the water in air. The proposed system consists of temperature (TMP007) & humidity (HDC1010) sensors and CC3200 single chip. The CC3200 is a cheap and faster programmable Wi-Fi MCU that enables true, integrated IoT development. If sensor sense abnormal reading, it transmits field information about the temperature, humidity to famers. A camera is linked with this chip to take images and send to farmers via MMS and subsequently the farmer will take appropriate action.

Exploits the LM35 temperature sensor and soil moisture sensor that is deployed in field and used to monitor the water supplements. [3] proposed a system comprises of LM35 temperature sensor, moisture sensor, RPi 3 model B, IC 3208 converter, relay and a buzzer. A threshold value 2.4v is set for soil moisture; this may vary from crop to crop. If the value is found less than the set threshold (2.4v in this case) the soil is classified as dry and signal is sent to turn on the water pump. Otherwise, Soil is classified as wet and motor will be turned OFF. The data acquire from sensors are ingested to the cloud and can be accessible to farmer via his/her mobile/PC. The system let the farmer when to turn ON/OFF the water pump.

The aim of the investigation presented in [4] is to decrease the loss of water, labor and improve the productivity. Moisture sensor is used to sense the content of moisture in soil and sends moisture sensor information to Arduino. Moisture sensor is used to detect moisture in the soil. It works on the principle of open and short circuit. When the soil is dry the circuit behaves like an open circuit and close if the soil is wet. Wi-Fi module is used for communication to transmit data from sensor layer to the cloud. Data collected from moisture sensor is fed into Arduino and Arduino upload this information or values on cloud by using Wi-Fi. Threshold value is set according to the crop's need. Moisture level checked with respect to predefined threshold value. The threshold value is different for different crops. If the moisture value is less than the reference value pump is ON otherwise remains OFF. This helps in reduction of water usage.

III. PROPOSED METHODOLOGY

Indian Agriculture is diverse in culture. The production varies from place to place so for each crop there is certain condition for its production. So, Lack of information about the crop, leads to failure in production. This system will help to overcome this problem and gather all the information needed to increase its production. The system provides monitoring platform for agricultural ecosystem based on IOT.

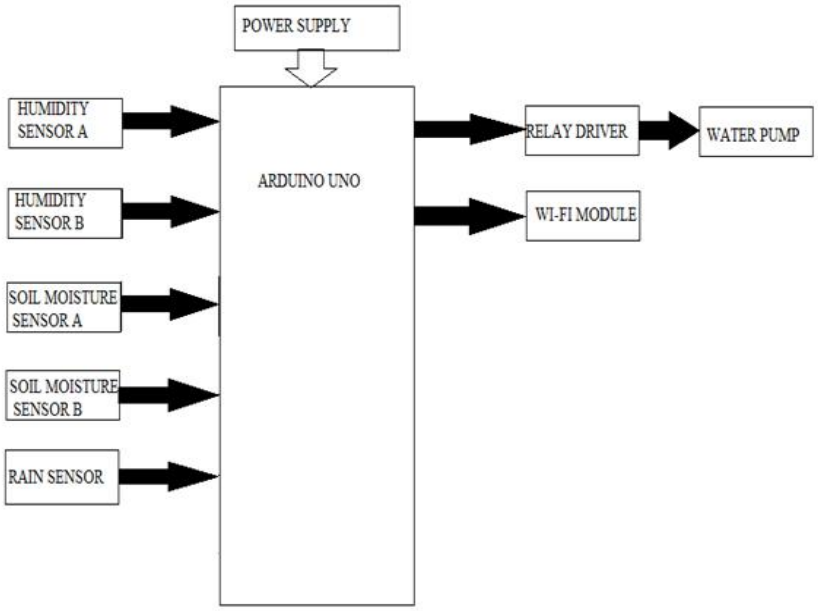

Figure 3.1

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As per systems, the crops are being monitored with the help of Arduino boards and wifi technology where in Arduino boards behaves as a microcontroller. The System purpose is to supply water when farm is dry during absence of human, it will also monitor the humidity, salinity of the soil, soil moisture and rain. It includes Arduino Nano, Node MCU sensors like soil moisture and Dht11, rain sensor, water pump, relays. Through the help of internet, the control of the system is handled and the sensors used in the project stores the parameters in timely manner. This will help the user to analyses various conditions in the place anytime. Then control the conditions or parameter of the place properly.

IV. HARDWARE COMPONENTS

1. SOIL MOISTURE SENSOR:

This **soil moisture sensor module** is used to detect the moisture of the soil. It measures the volumetric content of water inside the soil and gives us the moisture level as output. The module has both digital and analog outputs and a potentiometer to adjust the threshold level.

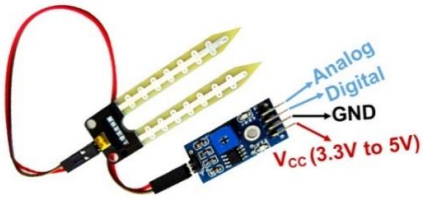

Figure 4.1

Soil Moisture Sensor Module Features & Specifications

Operating Voltage: 3.3V to 5V DC
Operating Current: 15mA
Output Digital - 0V to 5V, Adjustable trigger level from preset
Output Analog - 0V to 5V based on infrared radiation from fire flame falling on the sensor
LEDs indicating output and power
PCB Size: 3.2cm x 1.4cm
LM393 based design
Easy to use with Microcontrollers or even with normal Digital/Analog IC
Small, cheap and easily available.

Brief about Soil Moisture Sensor Module

This Moisture sensor module consists of a Moisture sensor, Resistors, Capacitor, Potentiometer, Comparator LM393 IC, Power and Status LED in an integrated circuit.

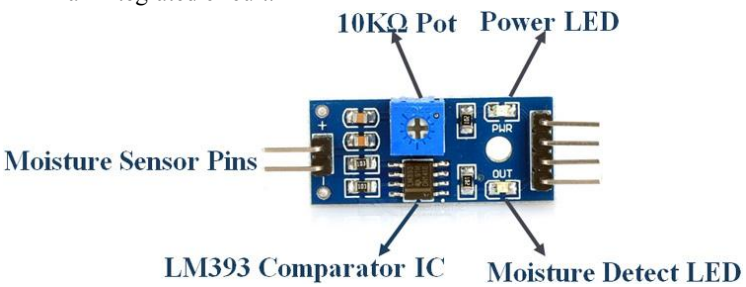

Figure 4.2

LM393 Comparator IC is used as a voltage comparator in this Moisture sensor module. Pin 2 of LM393 is connected to Preset (10KΩ Pot) while pin 3 is connected to Moisture sensor pin. The comparator IC will compare the threshold voltage set using the preset (pin2) and the sensor pin (pin3).

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1. Moisture Sensor:

The moisture sensor consists of two probes that are used to detect the moisture of the soil**.** The moisture sensor probes are coated with immersion gold that protects Nickel from oxidation. These two probes are used to pass the current through the soil and then the sensor reads the resistance to get the moisture values.

2. Preset (Trimmer pot):

Using the onboard preset, you can adjust the threshold (sensitivity) of the digital output.

3. How to Use Soil Moisture Sensor Module?

Moisture sensor module consists of four pins i.e., VCC, GND, DO, AO. Digital out pin is connected to the output pin of LM393 comparator IC while the analog pin is connected to Moisture sensor. The internal Circuit diagram of the Moisture sensor module is given below.

Sing a Moisture sensor module with a microcontroller is very easy. Connect the Analog/Digital Output pin of the module to the Analog/Digital pin of Microcontroller. Connect VCC and GND pins to 5V and GND pins of Microcontroller. After that insert the probe inside the soil. When there is more water presented in the soil, it will conduct more electricity that means resistance will be low and the moisture level will be high.

This DFRobot DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high-performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness. This DFRobot DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high-performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness.

2. DHT 11 (HUMIDITY AND TEMPRATURE SENSOR):

The **DHT11** is a commonly used **Temperature and humidity sensor that** comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data.

Figure 4.3

1. DHT11 Specifications

Operating Voltage: 3.5V to 5.5V
Operating current: 0.3mA (measuring) 60uA (standby)
Output: Serial data
Temperature Range: 0°C to 50°C
Humidity Range: 20% to 90%
Resolution: Temperature and Humidity both are 16-bit
Accuracy: ±1°C and ±1%

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2. Difference between DHT11 Sensor and Module

The **DHT11 sensor** can either be purchased as a sensor or as a module. Either way, the performance of the sensor is same. The sensor will come as a 4-pin package out of which only three pins will be used whereas the module will come with three pins as shown above.

The only difference between the sensor and module is that the module will have a filtering capacitor and pull-up resistor inbuilt, and for the sensor, you have to use them externally if required.

3. Where to use DHT11 Sensors

The **DHT11** is a commonly used **Temperature and humidity sensor.** The sensor comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The sensor is also factory calibrated and hence easy to interface with other microcontrollers.

The sensor can measure temperature from 0°C to 50°C and humidity from 20% to 90% with an accuracy of ±1°C and ±1%. So, if you are looking to measure in this range then this sensor might be the right choice for you.

4. How to use DHT11 Sensor:

The DHT11 Sensor is factory calibrated and outputs serial data and hence it is highly easy to set it up. The connection diagram for this sensor is shown below.

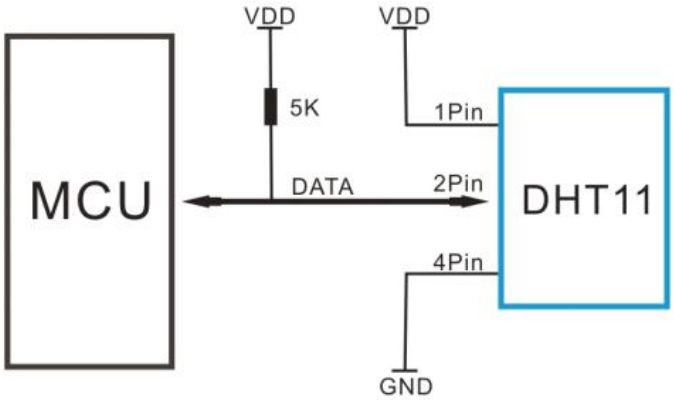

Figure 4.4

As you can see the data pin is connected to an I/O pin of the MCU and a 5K pull-up resistor is used. This data pin outputs the value of both temperature and humidity as serial data. If you are trying to interface DHT11 with Arduino then there are ready-made libraries for it which will give you a quick start.

3. ESP 8266(NODE MCU):

ESP8266 is Wi-Fi enabled system on chip (SoC) module developed by Espresso system. It is mostly used for development of IoT (Internet of Things) embedded applications.

- ESP8266 comes with capabilities of 2.4 GHz Wi-Fi (802.11 b/g/n, supporting WPA/WPA2)
- General purpose input/output (16 GPIO)
- Inter-integrated circuit (I^2C) serial communication protocol
- Analog-to-digital conversion (10-bit ADC)
- Serial peripheral interface (SPI) serial communication protocol
- I^2S (inter-IC sound) interfaces with DMA (direct memory access) (sharing pins with GPIO)
- UART (on dedicated pins, plus a transmit-only UART can be enabled on GPIO2)
- Pulse-width modulation (PWM)
- It employs a 32-bit RISC CPU based on the Ten silica Extensa L106 running at 80 MHz (or overclocked to 160 MHz). It has a 64 KB boot ROM, 64 KB instruction RAM and 96 KB data RAM. External flash memory can be accessed through SPI. ESP8266 module is low-cost standalone wireless transceiver that can be used for end-point IoT developments.

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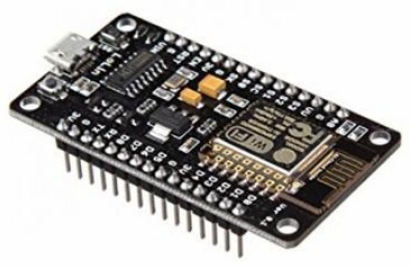

Figure 4.5

Pulse-width modulation (PWM):

It employs a 32-bit RISC CPU based on the Ten silica Extensa L106 running at 80 MHz (or overclocked to 160 MHz). It has a 64 KB boot ROM, 64 KB instruction RAM and 96 KB data RAM. External flash memory can be accessed through SPI. ESP8266 module is low-cost standalone wireless transceiver that can be used for end-point IoT developments. To communicate with the ESP8266 module, microcontroller needs to use set of AT commands. Microcontroller communicates with ESP8266-01 module using UART having specified Baud rate.

There are many third-party manufacturers that produce different modules based on this chip. So, the module comes with different pin availability options like:

ESP-01 comes with 8 pins (2 GPIO pins) – PCB trace antenna. (Shown in above figure)

ESP-02 comes with 8 pins, (3 GPIO pins) – U-FL antenna connector.

ESP-03 comes with 14 pins, (7 GPIO pins) – Ceramic antenna.

ESP-04 comes with 14 pins, (7 GPIO pins) – No ant.

For example, the figure below shows ESP-01 module pins.

4. RAIN SENSOR:

The rain sensor module is an easy tool for rain detection. It can be used as a switch when raindrop falls through the raining board and also for measuring rainfall intensity. The module features, a rain board and the control board that is separate for more convenience, power indicator LED and an adjustable sensitivity though a potentiometer. The analog output is used in detection of drops in the amount of rainfall. Connected to 5V power supply, the LED will turn on when induction board has no rain drop, and DO output is high. When dropping a little amount water, DO output is low, the switch indicator will turn on. Brush off the water droplets, and when restored to the initial state, outputs high level.

Specifications

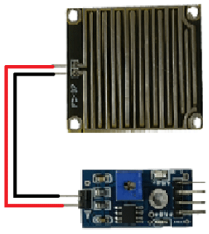

Figure 4.6

- Adopts high quality of RF-04 double sided material.
- Area: 5cm x 4cm nickel plate on side,
- Anti-oxidation, anti-conductivity, with long use time;
- Comparator output signal clean waveform is good, driving ability, over 15mA;
- Potentiometer adjust the sensitivity;
- Working voltage 5V;
- Output format: Digital switching output (0 and 1) and analog voltage output AO;
- With bolt holes for easy installation;
- Small board PCB size: 3.2cm x 1.4cm;

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- Uses a wide voltage LM393 comparator

Interfacing the raindrop sensor with a microcontroller like 8051, Arduino, or PIC is simple. The rain board module is connected with the control module of the raindrop sensor as shown in the below diagram. The control module of the raindrop sensor has 4 outputs. VCC is connected to a 5V supply. The GND pin of the module is connected to the ground. The D0 pin is connected to the digital pin of the microcontroller for digital output or the analog pin can be used. To use the analog output, the A0 pin can be connected to the ADC pin of a microcontroller. In the case of Arduino, it has 6 ADC pins, so we can use any of the 6 pins directly without using an ADC converter. The sensor module consists of a potentiometer, LN393 comparator, LEDs, capacitors and resistors. The pin out image above shows the components of the control module. The rain board module consists of copper tracks, which act as a **variable resistor**. Its resistance varies with respect to the wetness on the rain board. The below fig shows the rain board module.

V. CONCLUSION

In this Proposed System, the smart irrigation system is cost effective for optimizing water resources for agricultural production. The system can be used to switch on/off the water sprinkler depending on the soil moisture levels thereby making the process simpler to use. Through this project it can be concluded that there can be considerable development in irrigation. Thus, this Proposed System is a solution to the problems faced in the existing process of irrigation.

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