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IoT based Automatic Irrigation System with Soil Nutrients N, P, and K Measurement using Arduino

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***Abstract*—The internet of things is a network of physical objects is connected to the internet for collecting and exchange data. The basis of this project is to create an IoT based automatic irrigation system with soil nutrient measurement. It uses an arduino microcontroller which is programmed to control the entire system. Soil moisture sensor used for measure the moisture level of the soil if the moisture level is below the predefined level then the motor is automatically on then it reaches the desired level then the motor is automatically off. Then the soil nutrient like potassium phosphorus and nitrate are measured by using TCS230 colour sensor. Soil PH and temperature are additionally measured. Then the irrigation status and nutrient status send to the user mobile by using ESP8266 WiFi module. This will help to reduce water wastage, reduce human effort, and increase plant life time.**

***Index Terms*— Arduino, Soil moisture sensor, IoT (Internet of things), TCS 230 colour sensor, PH sensor, LM35 temperature sensor.**

I. INTRODUCTION

Today's world agriculture plays an important role for protection of food because from our beginning of the day to the end of the day food is an essential one for all living things that foods are produced by the farmers. Farmers are meeting many problems for production of crops, in that problems water and fertilizer are the important consideration in the agricultural fields. Because many farming states affected by drought problem because of change of the monsoon. So before we affected by those kind of problems we take prevention action for facing this water shortage problem by using automatic irrigation system. Automatic irrigation is done by using soil moisture sensor [1][2][8]. Water not only a big issue, now a day many factories dumped chemical waste to the river water that change pH level of the water. Mostly farmers are depended on the river water for agriculture. When we irrigate that water to the plant that change the pH value of the soil but soil nutrient change happened by the farmers. Farmers use more fertilizer for crop growth that changes the nutrient level of the soil. Researchers develop different methods to find the soil nutrients. 1.Electrochemical method in this method sensor consist of two electrodes ISE and ISFET ion selective membrane is placed on top of the insulating layer of FET, so the threshold voltage of ISFET is chemically modulated and measured voltage is related to concentration of the targeted ions[5]. In optical method optical light passes through the soil sample then the reflected light varies according to its soil properties [15]. So "IoT based automatic irrigation system with soil nutrient measurement" is developed for increasing crop yield, reduce the manual labour, and reduce much amount of water usage and save money.

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II. System Architecture

Arduino uno is heart of this project. It controls entire system of our project, the data from the soil moisture sensor, colour sensor, temperature sensor, and pH sensor are sending to the WiFi module through the arduino controller. 5V power supply is provided for entire system. The data from the sensors collected by using ESP8266 WiFi module then the data send to the user mobile and it is received by user mobile.

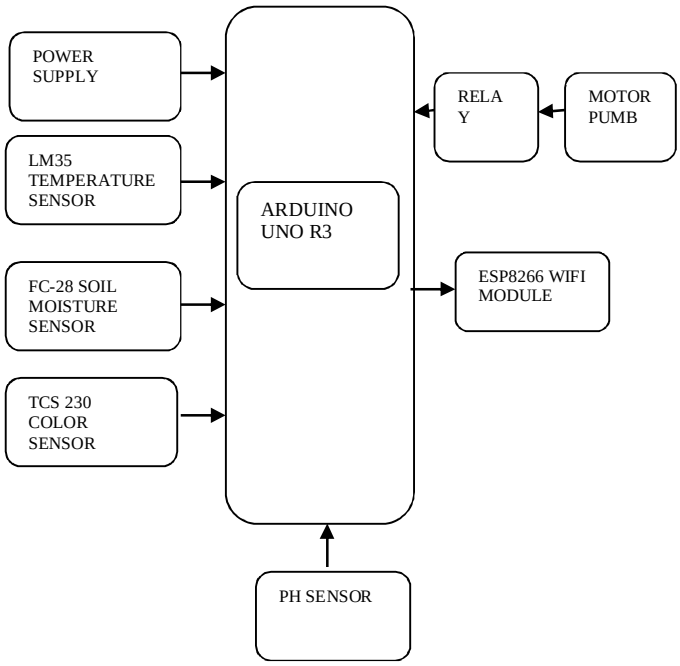

Figure 1. Block diagram

III. Hardware Usage

Different type of sensors used in this system. The sensors names are given below.
Soil moisture sensor
TCS230 colour sensor
PH sensor
Temperature sensor
Pin Description

1. Arduino is a board which is used to interface sensors.
   TX ⟶ 1
   RX ⟶ 0
2. Soil moisture sensor can be connected in both analogue mode and digital mode. In our project sensor is connected in analogue mode.
   Soil moisture sensor A0 ⟶ Arduino A0
3. TCS230 colour sensor can be connected in both analogue mode and digital mode. In our project sensor is connected in digital mode.
   TCS230 S3 ⟶ Arduino 6
   TCS230 S2 ⟶ Arduino 7
   Output ⟶ Arduino 8
4. PH sensor is connected in digital mode.
   PH sensor TX ⟶ Arduino 2

PH sensor RX ⟶ Arduino 3

5. LM 35 temperature sensor is connected in analogue mode.
   LM 35 Vout ⟶ Arduino A1

A. Arduino Uno-R3

Arduino uno is an open source microcontroller board. Operating voltage of this board is 5V. It has 14 digital input output pin and 6 analog pins. This board contains inbuilt Atmega328 controller, reset button, voltage regulator, transmitter, receiver, LED indicator, USB port, Power port. And it has 2KB SRAM, and 32KB flash memory. Baud rate for arduino communication 9600bps.
In arduino uno ADC play a major role for interfacing sensors with microcontroller. Analogue to digital converter is used to interface analogue sensors with arduino. The board has 6 ADC channel from A0 to A5. Whatever analogue value from 0-5V it reads it converts in the range from 0 to 1023 in digital value.

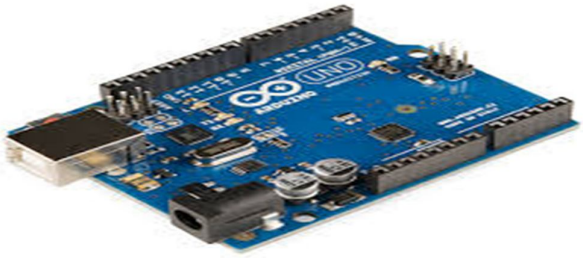

Fig 2. Arduino uno board

B. Arduino compiler

Arduino code to get onto the arduino board. First the arduino environment performs some minor pre-processing to turn your sketch into a C++ program. It then gets passed to a compiler (avr-gcc), which turns the human readable code into machine readable instructions.

C. Soil Moisture Sensor

Soil moisture sensor or hygrometer is usually used to detect the humidity of the soil. It consists of two probes which are used to measure the volumetric content of the water. Two probes allow the current to pass through the soil and then it gets resistance value to measure moisture level. When there is more water the soil will conduct more electricity which means there will be less resistance, so the moisture level will be higher. The Hygrometer has 4 pins VCC, Ground, D0, and A0. It is used to connect soil moisture sensor with arduino.

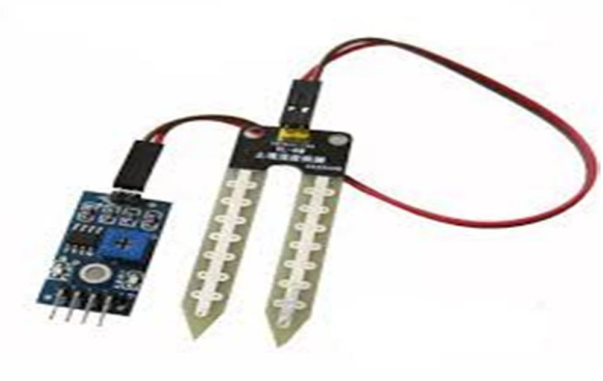

Fig 3. Soil moisture sensor

D. Ph Sensor

PH is a measure of acidity and alkalinity of a soil. The pH scale range from 0-14. The basic principle of this pH meter is to measure the concentration of hydrogen ions. The PH meter measures the difference in electrical

potential between a glass electrode and a reference electrode and display the result converted into the corresponding value.

Fig 4. PH sensor

E. Tcs230 Colour Sensor

The TCS230 colour sensor works by shining a white light at an object and then recording the reflected colour. It can also record the intensity of the reflection through red green and blue colour filter. The photodiodes converts the amount of light to current. The TCS230 senses colour light with the help of an 8*8 array of photodiodes. Then using a current to frequency converter the readings from the photodiodes are converted into a square wave with a frequency directly proportional to the light intensity.

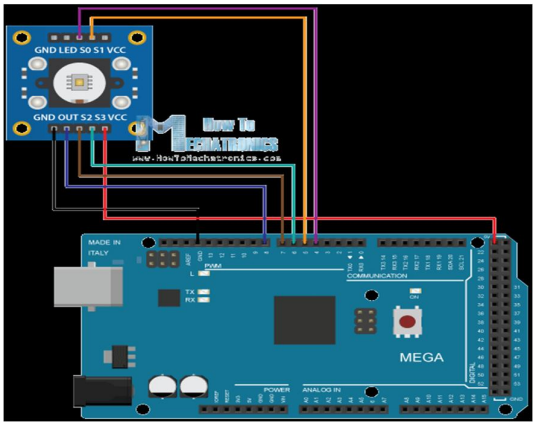

Fig 5. TCS230 color sensor

F. Esp8266 Wifi Module

ESP8266 WiFi module is a low cost WiFi enabled chip it act as a communication device that provides communication between the hardware setup and mobile phone. It has self contain SOC with TCP/IP protocol stack. So it gives any microcontroller access to our WiFi network. This module has 6 pins to communicate with arduino. It works 2.4 GHZ frequency.

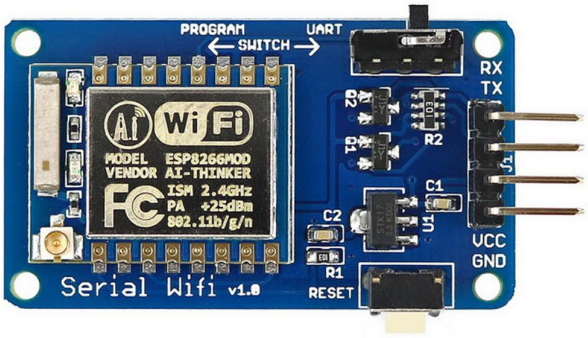

Fig 6. ESP8266 WIFI module

IV. EXPERIMENTAL RESULT

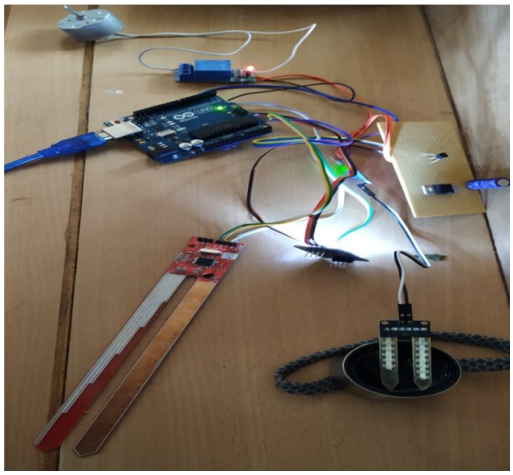

Fig 7. Initial setup

This is the hardware setup of the project. All the components are connected with arduino. Sensors collect the data from the environment then send to the arduino controller.

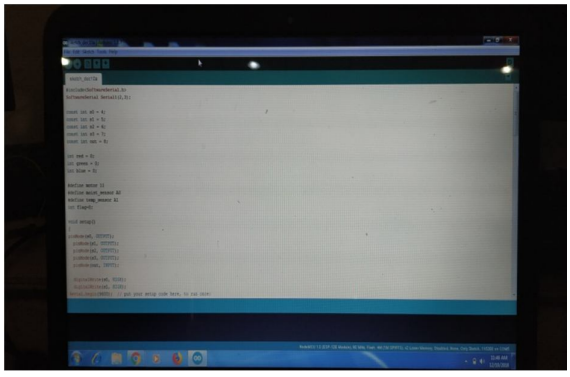

Fig 8. Program snapshot

This hardware system works according to the program. The program uploaded to the arduino by using arduino software.

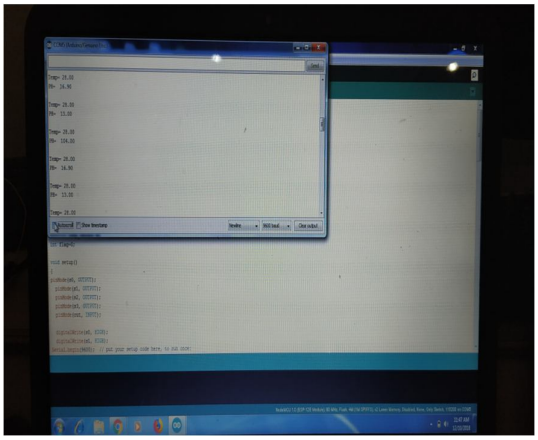

Fig 9. Output snapshot of temperature sensor and PH sensor

Output of the project is shown in the serial monitor by using arduino software.

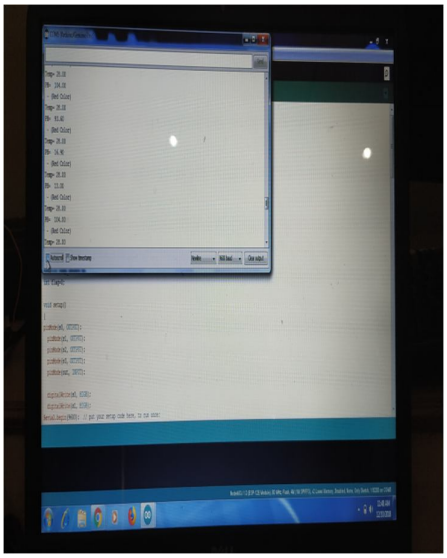

Fig 10. Output snapshot of TCS230 colour sensor

V. Conclusion

These systems reduce the wastage of water during the irrigation and reduce the much amount of fertilizer usage. Over fertilization reduce the plant lifetime, so the measurement of soil nutrient increases the plant lifetime as well as reduce the use of over fertilizer. The main objective of this project is to reduce much amount of water usage, increase plant life time, save money and reduce human effort.

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