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Monitoring the Nutrient Level for Efficient Crop Productivity Using IOT

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Abstract: ***This paper introduces internet of things which connects the whole world through devices such as sensors, actuators and other embedded devices. Internet of things can be used in agriculture for efficient crop production. India is very much popular for crop production. As day by day the population increases, production of crops has to be increased. To produce more efficient crops, soil moisture, temperature and soil pH is more important. Crop growth is based on soil nutrient level and its moisture level. Hence the nutrient level has to be monitored frequently for crop production. For this there are various techniques for nutrient detection. In this paper, the nutrient level and moisture level of soil are detected and monitored using soil moisture sensor and pH sensor along with that temperature sensor and a microcontroller is used. The values are then stored and updated to cloud server for future use. Along with that an application is done for farmersin order to know the level of temperature, soil pH and moisture level frequently.***

Keywords: pH sensor, temperature sensor, soil moisture sensor, raspberry pi, cloud server

I. INTRODUCTION

Earlier days there was no scarcity for food and water as it was used in efficient manner. But now a day there is scarcity of food and water as usage of technology and medicines have been increased. Especially in agriculture field the usage of fertilizer amount has been increased and is still in use day by day. To produce more crops more amount of fertilizer are being used as it develops more crops in short period of time. When these crops are consumed by living organisms their lifetime is being decreased day by day. Due to these crops more diseases are spread among the world. The thing is that more farmers doesn't know how much of fertilizer have to be used. The other issue is that farmers do not test their soil and hence they do not know the level of nutrients in soil. Nutrients are more essential for crop's growth. Nutrients are classified into micro and macro nutrients. Macro nutrients consist of elements such as nitrogen (N), phosphorus (P), potassium (K) [5]. Micro nutrients consist of magnesium (Mg), zinc (Zn), copper (Cu), chlorine (Cl), boron (B) etc. . . . . Along with that they are supplied with air and water containing carbon, hydrogen and oxygen. Crops consume 80% of macro nutrients and 20% of micro nutrients [6]. Plants consume more amount of nitrogen content as it is more important for living organisms. Less amount of nitrogen leads to death of aquatic life and mainly for babies in mother's womb. When the nutrient level of soil is detected, farmers will be able use only particular amount of fertilizer. When nutrient level is less than 25% then 75% of fertilizer is used. When nutrient level in soil is about 50% then medium level of fertilizer has to be used. When soil nutrient level is rich of about 80% then less than 20% of fertilizer has to be used. But in today's world farmer's doesn't know how much amount of fertilizer has to be used. For an acre farmer's use 10 kilogram of fertilizer which is poisonous to human health [4]. Hence to overcome more use of fertilizers for crop's nutrient level and moisture level of soil are to be determined.

II. SYSTEM ARCHITECTURE

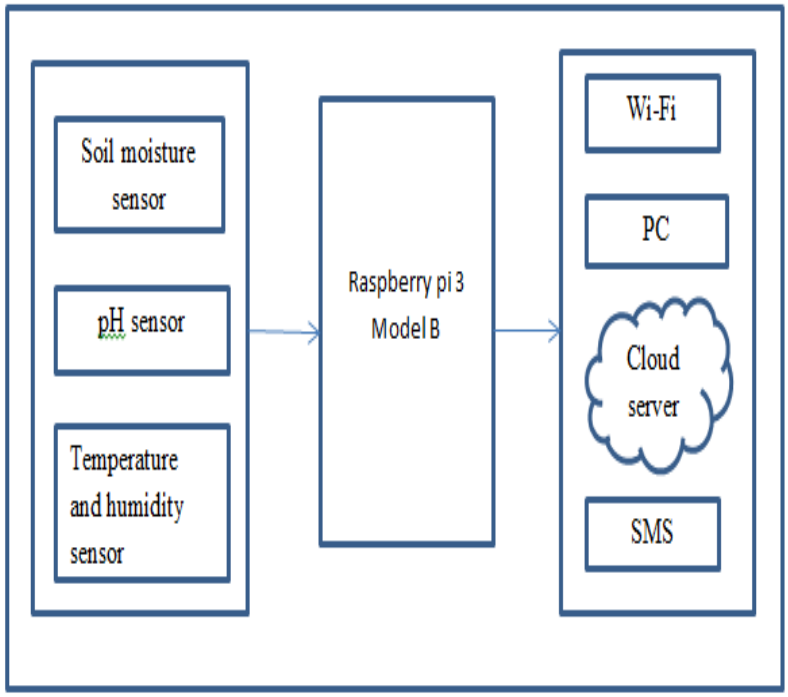
Food is more important for human health to live long life. As the population has increased, there is scarcity of food production. Hence fertilizers are used for more crop production. Due to this more amount of water is used. To avoid this fact and to detect and monitor the soil paameters we undergo the implementation fact:

A. Temperature and humidity of soil using temperature and humidity sensor
B. Moisture of soil using soil moisture sensor
C. Nutrient level of soil is determined using pH senso
D. All the data's are collected from various places through various sensors and are monitored day by da
E. The data's are uploaded to cloud server for future us
F. Farmers can be able to know the message through an android application by giving their

name and phone number or a message is sent to farmer every day.Block diagram for monitoring the nutrient level of soil for efficient crop productivity:

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III. TYPES OF SENSORS

It is based on the detailed description of hardware's in architecture design. The hardware design consists of temperature and humidity sensor, pH sensor, soil moisture sensor and Raspberry pi 3 Model B microcontrollers.

A. The total parts of the system include:

1) Sensors:
a) Temperature and humidity sensor
b) Soil moisture sensor
c) pH sensor
2) Raspberry pi 3 Model B
3) Personal computer
4) USB cable
5) Monitor
6) Keyboard
7) Mouse
8) Jumper wires
9) HDMI and VGI cable

Here jumper wires are used to connect sensors and raspberry pi microcontroller. USB cable is used for switching on the microcontroller from central processing unit of personal computer. HDMI and VGI cable is used for connecting the monitor to microcontroller. Keyboard and mouse have USB attachment is also connected to raspberry pi microcontroller.

B. pH sensor

pH sensor is used to measure the pH value of any substances. pH sensor is used in industries, agriculture, manufacturing, pharmaceutical etc. . . . In this pH sensor is connected to raspberry pi microcontroller. It finds out the pH level of nutrient in agriculture soil. The data's are sensed and monitored. The data's collected from various soils are uploaded to the database which is then stored in cloud server. Based on the pH level of nutrient in soil, the usage of fertilizers can be decreased. The pH scale extends from 0 – 14 where 7 is neutral, range below 7 is acidic and range above 7 is alkaline [1].

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Figure 1: Table for detecting acidity/alkalinity of soil based on pH ranges [2]

pH ranges	Degrees of acidity/alkalinity
3-4	Very strongly acid
4-5	Strongly acid
5-6	Moderately acid
6-7	Slightly acid
7	Neutral
7-8	Slightly alkaline
8-9	Moderately alkaline
9-10	Strongly alkaline
10-11	Very strongly alkaline

C. Soil moisture sensor

Soil moisture sensor is mainly used in agriculture to determine the water level in soil for irrigation and efficient crop production. Based on the moisture of soil farmers can decide whether more amount of water is needed or not. Due to this more amount of water usage can also be reduced. For dry areas excessive amount of water is needed for more efficient crop production. Water irrigation can be done easily using this soil moisture sensor.

Figure 2: Recommended values of soil moisture content at which irrigation should occur [3]

Soil texture	Soil moisture content (%)
Sand	7
Loamy sand	12
Sandy loam	15
Loam	20
Slit loam	23
Silty clay loam	28
Clay loam	27
Sandy clay loam	24
Sandy clay	22
Silty clay	30
Clay	31

D. Temperature and humidity sensor

For planting crops weather condition is more important. Mainly temperature of soil and its humidity.Humidity is used to measure the water vapour in air as the crop occupies the carbon, oxygen and hydrogen from air and water. Along with that temperature is also important as it determines whether cultivation of crops can be done efficiently or not. For this we use temperature and humidity sensor connected with raspberry pi microcontroller as it determines the humidity and temperature of soil at a time. The collected data's are then uploaded to the server.

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Figure 3: Table for minimum temperature and humidity needed for some agricultural crops [7]

Crops	Minimum soil temperature (%F)	Humidity (%)
Rice	41	48
Wheat	37	46
Potato	45	48
Sugarcane	50	87
Soybean	59	64

IV. IMPLEMENTATION

In this all the sensors are connected to raspberry pi 3 model B microcontroller. Some sensors like pH sensors cannot be directly connected to microcontroller. Hence for that we breadboard which acts as an interface between raspberry pi and pH sensor. pH sensor from the breadboard is then connected to GPIO pins of raspberry pi using jumper wires. Raspberry pi consists of four USB ports where keyboard, mouse and some sensors can be connected directly. There 40 GPIO pins for providing input and output to the system. Through this the data's are collected using python programming. The collected data's are then stored in database which acts as the back end of software system. The data's are then uploaded to the cloud server. In cloud, thingspeak platform is used for referencing the collected data's through graph plot. Along with that an application is done where farmers can see data's everyday using their name and mobile number or a message (SMS) is sent to farmers.

Figure 4: Raspberry pi connected with temperature and humidity sensor (DTH11)



Figure 5: Raspberry pi connected with soil moisture sensor

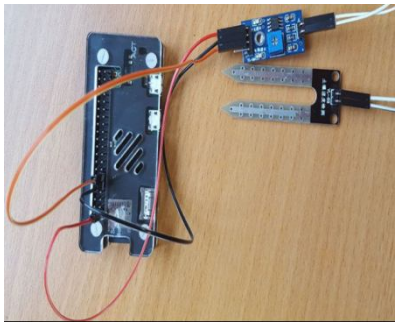
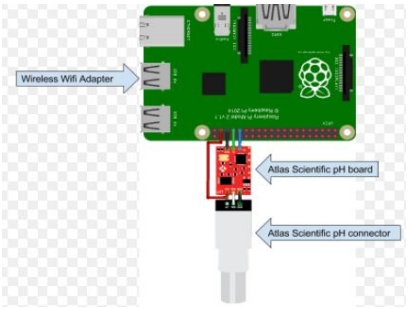


Figure 6: Raspberry pi connected with pH sensor

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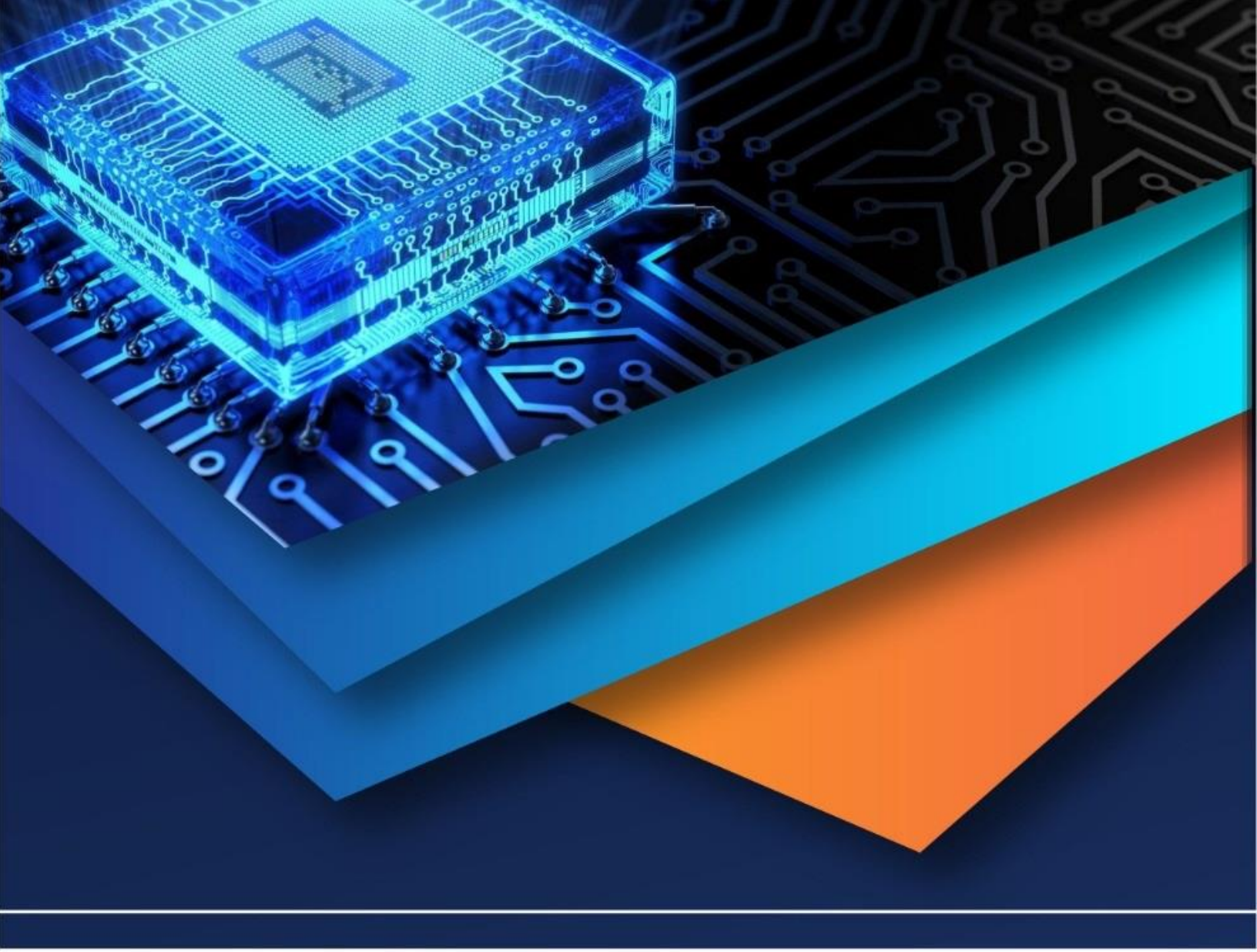
V. CONCLUSION AND FUTURE WORK

From this way of implementation we can determine the exact value of temperature, humidity, pH and moisture of soil. Previously the implementation has been done using ZigBee [8] but disadvantage is the data loss occurs. To avoid the data loss, use various sensors as it does the work the in fraction of seconds and determines the accurate value. Also another advantage of sensors is that it has longer lifetime. The minimum lifetime of sensor is three years and can be used on any type of soil. Here the whole nutrient level is monitored. Based on the pH level of nutrients in soil fertilizers can be added. Natural fertilizers like cow dung can be used to more healthy life for human beings. In future, pH value of each nutrient in soil can be determined and monitored using electrochemical sensor and determines each pH value of nutrients accurately.

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