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Smart Agricultural Environment Monitoring System using IOT

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ABSTRACT

Agriculture is the chief support of an economy and the pivotal sector for ensuring food security. The agriculture sector recorded satisfactory growth due to improved technology, irrigation, inputs and pricing policies.But now due to migration of farmers from rural to urban there is hindrance in agriculture. To overcome this problem we go for smart agricultural environment monitoring techniques using IOT. The Internet of things (IOT) is remodeling the agriculture enabling the farmers with the wide range of techniques such as precision and sustainable agriculture to face challenges in the field. IOT interconnects human to thing, thing to thing and human to human. IOT enables the objects to be sensed and controlled remotely across existing network model. The paper comprises of sensors that sense the field parameters such as phlevel,temperature, humidity,moisture and fertility in the farm. The sensed values are validated and later sent to the WI-FI module and from WI-FI module the validated data are sent to the farmer's mobile or laptop using cloud. The farmers are also notified by SMS if the field needs a care. An algorithm is developed with threshold values of temperature, humidity, moisture and fertility that are programmed into a node MCU to control water quantity. Now the farmer can automate the motor from anywhere in the world.

Keywords: IOT, Arduino, Cloud, Node MCU, Ubidots, WI-FI Module, Sensor

I. INTRODUCTION

Agricultural economics plays a role in the economics of development, for a continuous level of farm surplus is one of the wellsprings of technological and commercial growth.Many researches are done in the field of agriculture. Most projects signify the use of wireless sensor network collect data from different sensors deployed at various nodes and send it through the wireless protocol. The collected dataprovide the information about the variousenvironmental factors. Monitoring the environmental factors is not the complete solution to increase the yield of crops. There are number of other factors that decrease the productivity to a greater extent. Hence automation must be implemented inagriculture to overcome these problems. So, in order to provide solution to all such problems, it is necessary to develop an integrated systemwhich will take care of allfactors affecting the productivity in every stage. Butcomplete automation in agriculture is not achieved due to various issues. Though it is implemented in the research level it is not given to the farmers as a product to get benefitted from the resources. Hence this paper deals about developing smart agriculture using IoT and given to the farmers. In this paper, IOT technology helps in collecting information about conditions like temperature, humidity, moisture and control motor using microcontroller. IOT leverages farmers to get connected to his farm from anywhere and anytime. Agricultural crop monitoring and control can be done using ArduinoUno. Wireless sensor networks are used for monitoring the farm conditions and micro controllers are used to control and automate the farm processes. This paper is useful for farmers in maintenance and controlling of crop production.

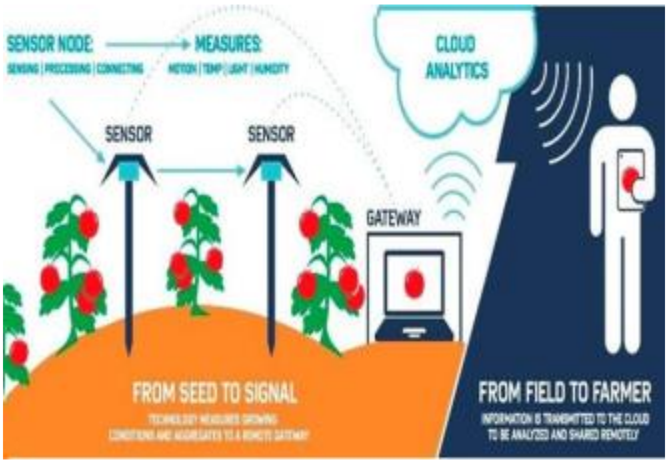


Fig.1 Automation in Agriculture

II. LITERATURE SURVEY

Sachin Kumar, Babankumar, Ritula Thakur, Manish kumarpresents the review on different concepts of soil pH detection techniques and technologies.Soil pH is a key parameter for crop productivity therefore its spatial variation should be adequately addressed to improve precision agriculture management system. Soil pH affects the soil's physical, chemical, and biological properties and processes, and thus plant growth. Soil pH, a measure of hydronium ion (H+) concentration traditionally tested in labs to decide how much fertilizer to apply to a field. Recently, with increased emphasis on precision agriculture, economics, and the environment, soil tests are also a logical tool to determine areas where adequate or excessive fertilization has taken place. In addition, they are used to monitor the impact of past fertility practices on changes in a field's nutrient status.

Liu Dan, Joseph Haule, Kisangiri Michael and Wang Weihong, Cao Shuntian carried out experiments on intelligent agriculture greenhouse monitoring system based on ZigBee technology. The system performs data acquisition, processing, transmission and reception functions. The aim of their experiments is to realize greenhouse environment system, where the of system efficiency to manage the environment area and reduce the money and farming cost and also save energy. IOT technology here is based on

the B-S structure andcc2530 used like processing chip to work for wireless sensor node and coordinator. The gateway has Linux operating system and cortex A8 processor act as core. Overall the design realizes remote intelligent monitoring and control of greenhouse and also replaces the traditional wired technology to wireless, also reduces manpower cost.

Nelson Sales experimented with interconnection of smart objects embedded with sensors that enabled them to interact with the environment and among themselves, forming a Wireless Sensor Network (WSN). These network nodes perform acquisition, collection and analysis of data, such as temperature and soil moisture. This type of data can be applied to automate the irrigation process in agriculture for decreasing the water consumption, which would result in monetary and environmental benefits. Authors proposed to use cloud computing which has the high storage and processing capabilities, the rapid elasticity and pay-per-use characteristics makes an attractive solution to the provided might help researchers to highlight issues in the agriculture domain.

Elias Yaacoub, K.SathishKannan, G.Thilagavathi proposed the deployment of a wireless sensor network to monitor and analyze air quality in Doha. Data stored on the server is subjected to intelligent processing and analysis in order to present it in different formats for different categories of end users.

This experiment brings out a user-friendly computation of an air quality index to disseminate the data to the general public and also the data presentation for environmental experts using dedicated software tools, for example- the R software system and its Open-air package. Depending on the target end-user the stored data can be accessed and displayed in different formats.

R.Balamurali, NarutSoontranon, Panwadee Tangpattanakul, Panu Srestasathiern, Preesan Rakwatin , Chen Xian Yi, Jin Zhi Gang, Yang Xiong have discussed precision agriculture for real-time monitoring of environmental conditions of a farm like temperature, humidity, soil PH etc. The values of monitored parameters are communicated to the remote server in order to take appropriate action, instead an actuator or an automated system can also be used to take appropriate action

based on the measured California based trace genomics provided soil analysis services to farmers.

Lead investor illumine helped to develop the system which uses machine parameters over a period of time. This paper analyzes the various routing protocols like AOMDV, AODV DSR and Integrated MAC and Routing protocol (IMR) for precision agriculture using WSN. This analysis draws conclusions that Integrated MAC and Routing Algorithm is best suitable for multi-hop routing for precision agriculture using Wireless Sensor Network (WSN) in-terms of Network life time. The network lifetime is considered as the time at which the first node in the WSN dies.The work may be enhanced to analyze other network parameters like throughput and end-end delay.

Development of Knowledge Sharing System for Agriculture Application, proposes a methodology where the data related to the agricultural field can be shared using the Knowledge sharing system. The main theme of the research is to design a methodology to share the data and it also involves inheriting of agricultural data. The methodology involves data collection by two methods. First one is the automatic environmental data collection by a sensor, and second method is the experienced data collection by a farmer. Optimal design of solar powered fuzzy control irrigation system for cultivation of green vegetable plants in Rural India, proposes methodology called fuzzy-logic that acts as a solution for irrigation control in order to cultivate the vegetable plants. Smart Farming System Using Sensors for Agricultural Task Automation, proposes a unique methodology that links smart sensing system and smart irrigator system which is collectively known as smart farming process.

Chandankumar Sahu et.al implemented the system in which RASPBERRY-Pi is used for control the irrigation system and connects with internet to send data to the registered mobile number. Automatic message sending isdeveloped using python programming in raspberry-pi. By using the automatic irrigation system it optimizes the usage of water by reducing wastage and reduces the human intervention for farmers.

It saves energy also as it automatic controlling the system. Automation in irrigation system makes farmer work much easier. Sensor based automated irrigation system provides promising solution to farmers where presence of farmer in field is not compulsory.

Berlin-based agricultural techstartup PEAT hasdeveloped a deep learning application called Plantix that reportedly identifies potential defects and nutrient deficiencies in soil. Analysis is conducted by software algorithms which correlate particular foliage patterns with certain soil defects, plant pests and disease. learning to provide clients with the sense of their soil's strengths and weakness Sky squirell technologies inc. Is one of the companies which brought drone technology to vineyards. The company aims to help users to improve their crop yield and to reduce cost. Users preprogrammed the drone's route and once deployed the device will leverage computer vision to record images which will be used for analysis.

III. METHODOLOGY

Wireless sensor network (WSN) refers to a group of spatially dispersed and dedicated sensors for monitoring and recording the physical conditions of the environment and organizing the collected data at a central location. WSNs measure environmental conditions like temperature, sound, pollution levels, humidity, wind, and so on.

A. Sensors

1. Temperature Sensor:

The Temperature Sensor LM35 series are precision integrated-circuit temperature devices with an output voltage linearly proportional to the Centigrade temperature.

The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 device does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55°C to 150°C temperature range.

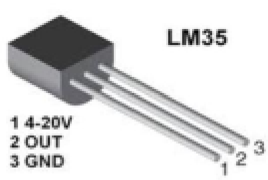


Fig.2 : Temperature Sensor

2. Humidity Sensor:

A humidity sensor (or hygrometer) senses, measures and reports both moisture and air temperature. The ratio of moisture in the air to the highest amount of moisture at a particular air temperature is called relative humidity. Relative humidity becomes an important factor, when looking for comfort. Humidity sensors work by detecting changes that alter electrical currents or temperature in the air. There are three basic types of humidity sensors: capacitive, resistive and thermal. All three types of sensors monitor minute changes in the atmosphere in order to calculate the humidity in the air.

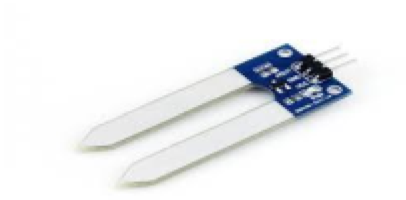


Fig. 3 : Humidity Sensor

3. Moisture Sensor:

Soil moisture sensors measure the volumetric water content in soil. Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighting of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content.

Fig.4: Moisture Sensor

4. PH Sensor:

The pH of soil is an important factor in determining which plants will grow because it controls which nutrients are available for the plants to use. Three primary plant nutrients—nitrogen, phosphorus, and potassium—are required for healthy plant growth. They are the main ingredients of most fertilizers that farmers and gardeners add to their soil. Other nutrients, such as iron and manganese, are also needed by plants, but only in very small amounts. soil can be acidic or basic, too. Soils with pH above 7 are basic or sweet. Soils with pH below 7 are acidic or sour. To measure the pH of soil, the standard method is to mix equal parts of soil and distilled water, let sit, and then measure the pH of the resulting slurry. Our regular pH Sensor has a glass bulb that performs very well in liquids, but is easier to break when used in this type of semi-solid. It can also be difficult to clean the soil out from around the glass bulb at the tip of the electrode.

Fig.5 : PH Sensor

B. SYSTEM ARCHITECTURE

The design of this system architecture is to monitor the crops with its soil condition, as shown in Fig.2. We use Arduino UNO board for implementation, along with different types of sensors ,Wi-Fi module ESP8266 as an embedded device for sensing and storing the data to cloud.

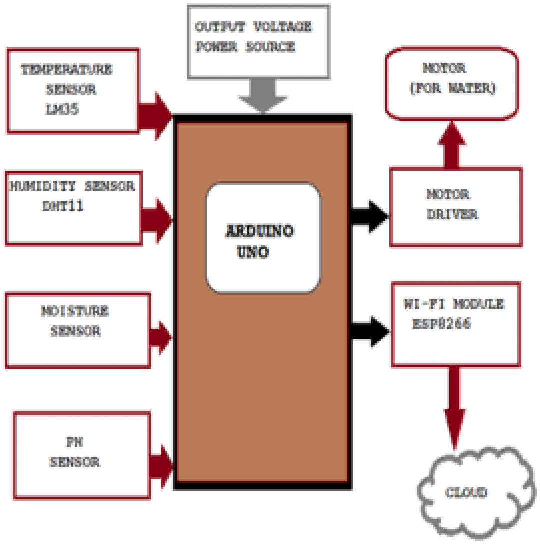


Fig.6 : Block Diagram of Smart Agriculture

Arduino UNO board consist of 12 analog input pins (A0-A11), 54 digital output pins (D0-D53) and an inbuilt ADC.Wi-Fi module is used to establish connection between embedded device and the internet to transfer the data from sensor to end user and also to to the cloud storage for future use.By crossing the threshold limit,the corresponding controlling action will be table.Every sensor device is connected to the internet through Wi-Fi.After sensing ,the data is processed and stored in the database.When the analysis of data is complete,the threshold value is set.

C. PROCESS FLOW

The data flow diagram to display the monitoring parameters is shown in Fig.4.In this data flow diagram initially the sensors and Wi-Fi module are connected to the microcontroller i.e. node MCU.The sensor data are processed using the microcontroller and embedded C in Arduino ide. The commands are sent to ESP8266 Wi-Fi module. The Wi-Fi module is checked whether it is functioning properly or not. If Yes the Wi-Fi network is connected or else the commands are received once again.

All the sensor data which is being monitored is sent to cloud.The values are plotted on the graph and the monitoring parameters are displayed on Ubidots. The various sensors used are temperature, humidity and moisture sensor. Even a threshold value can be set and the motor switches on automatically as the threshold level is met. A continuous output voltage power source is provided to the microcontroller.

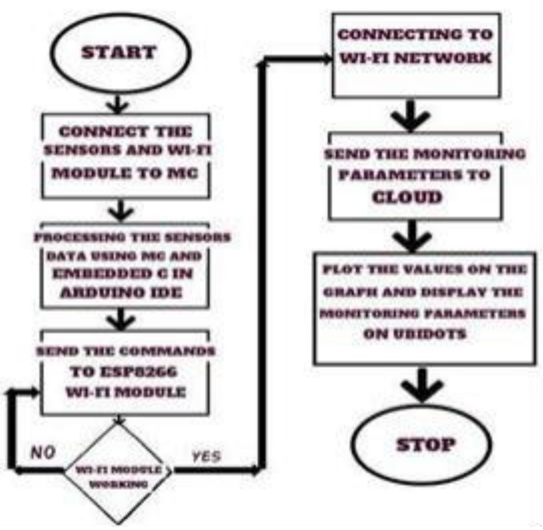


Fig.7: Overall System Flow

D. COMPUTATIONAL ANALYSIS OF SENSOR PARAMETER

Here we include some basic analytic methods to calculate the Sensors parameters like Temperature and Humidity.LM35 Temperature sensor gives output voltage 10 mv for 1°C.this sensor output is connected to any analog pin of Arduino Uno. Uno converts analog voltage into digital using on chip ADC.

ADC reading=analog Read (A1); (1)

Voltage= ADC reading*5/(1023) (2)

Temperature=Voltage*100; (3)

Relative Humidity = (density of water vapor / density of water vapor at saturation) x 100%.(4)

E. SENSOR DATA VALIDATION

Sensor data validation is an important process executed during the data acquisition and data processing modules. This process consists of the validation of the external conditions of the data and the validity of the data for specific purpose, in order to obtain accurate and reliable results. The sequence of this validation may be applied not only in data acquisition but also in data processing since increase, as these increase the degree of confidence of the systems, with the confidence in the output being of great importance. One of the causes for the presence of incorrect values during the data acquisition process may be existence of environmental noise. Even when the data is correctly collected, the data may still be incorrect because of noise. Therefore, very often the data captured or processed has to be cleaned, treated, or imputed to obtain better and reliable results. Following the existence of missing values at random instants of time, the causes may be the mechanical problems or power failures of sensors. At this case, data correction methods should be applied, including data imputation and data cleaning.

ALGORITHM:

Heuristic rule:

$\delta 1$ -minimum threshold

$\delta 2$ –maximum threshold

n–Total number of sensed values

Input: array of sensed data (x)

If (x[i] ≥$\delta 1$ and x[i] ≤$\delta 2$)

Then status [i] ← good

Output: status for sensed data (x)

For i←0 to ndo i←i+1

Else

Status [i] ←Not good

End if

End

F. IOT CLOUD

Ubidots offers a platform for developers that enable them to easily capture sensor data and turn it into useful information. Ubidots platform is used to send data to the cloud from any Internet-enabled device. We can then configure actions and alerts based on our real-time data and unlock the value of our data through visual tools. Ubidots offers a REST API that allows you to read and write data to the resources available: data sources, variables, values, events and insights. The API supports both HTTP and HTTPS and an API Key is required. The variables are created and unique variable ids are assigned to it. The values are plotted in a graph with the date and time in X axis and the values in the y-axis. All the values are displayed to the user with the corresponding date and time and hence the values can be viewed at any time by the user. The threshold values can be set on the Ubidots platform an email or sms or call can be sent to the user when the threshold levels are met. HenceUbidots is an Inter of Things platform which helps in monitoring all the parameters and displays the values to the user. A threshold values are also set to take corrective actions. The API key which is generated in Ubidots should be added in the Arduino code to connect to the cloud. An APIkeyisthe "Master Key"; a unique and immutable key that is used only to generate our account's tokens. A token is a temporary and revocable key which is to be used in our API request. It gets created ones an account is created in Ubidots. Tokens created in our account profile will never expire.

IV. EXPERIMENTAL ANALYSIS

The values of temperature, humidity and moisture parameters are shown in fig. below. A variable id is created for every parameter. A graph is plotted with all the values. The x axis consists of the date and time; the y axis consists of the values. The value is being analyzed by taking various reading of the temperature, humidity and moisture. The graph gives a clear view of the changes in the values with respect to date and time. As soon as the value reaches the threshold value the Wi-Fi module will send a sms to the user. If the moisture value is 0 the motor has to be switched on. When the moisture value reaches 1, the moisture content in the field is good and the motor has to be switched off.

		SMART	AGRICULTURE	SYSTEM		
DATE	TIME	SOIL MOISTURE	LIGHT INTEN.	HUMIDITY	TEMP.(°C)	TEMP.(°F)
25-10-15	16:31:01	346	32	31.21	27	80.6
25-10-15	16:31:03	347	34	31.21	17	62.6
25-10-15	16:31:04	344	33	31.21	28	82.4
25-10-15	16:31:06	388	33	31.21	34	93.2
25-10-15	16:31:07	651	32	31.21	21	69.8
25-10-15	16:31:09	651	33	31.21	30	86
25-10-15	16:31:10	651	33	31.21	27	80.6
25-10-15	16:31:12	550	31	31.21	17	62.6
25-10-15	16:31:13	418	33	31.21	17	62.6
25-10-15	16:31:15	309	33	31.21	25	77
25-10-15	16:31:16	328	32	31.21	32	89.6
25-10-15	16:31:18	344	32	31.21	26	78.8
25-10-15	16:31:19	354	35	31.21	31	87.8
25-10-15	16:31:21	357	33	31.21	28	82.4
25-10-15	16:31:22	341	33	31.21	31	87.8
25-10-15	16:31:24	352	34	31.21	36	96.8
25-10-15	16:31:25	347	32	31.21	21	69.8
25-10-15	16:31:27	352	34	31.21	17	62.6
25-10-15	16:31:28	343	33	31.21	22	71.6
25-10-15	16:31:30	351	34	31.21	35	95
25-10-15	16:31:31	347	34	31.21	31	87.8
25-10-15	16:31:33	342	32	31.21	29	84.2
25-10-15	16:31:34	339	34	31.21	31	87.8
25-10-15	16:31:36	343	32	31.21	25	77
25-10-15	16:31:37	339	31	31.21	36	96.8
25-10-15	16:31:39	345	34	31.21	22	71.6

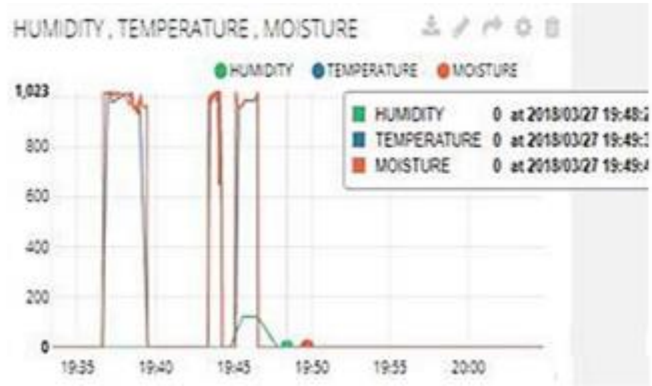


Fig. 8 : Graphical Representation of The Parametric Values

In Fig.9 the values are plotted in the graph and the analysis of the parametric values can be done. The green line indicates the humidity graph. The blue line represents the temperature graph and orange line represents the moisture graph.

V. COMPARATIVE PERFORMANCE OF EACH PARAMETER

In Fig 9, the crop yield of each year has been monitored and we find out that with the adoption of new technologies and crop monitoring systems the crop yield has increased from 20% in 2000 to 89% in 2018.

CROP PRODUCTION (IN PERCENTAGE)

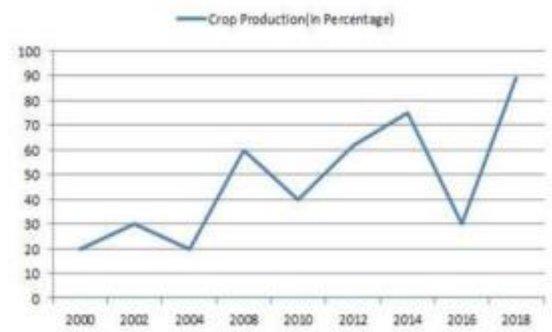
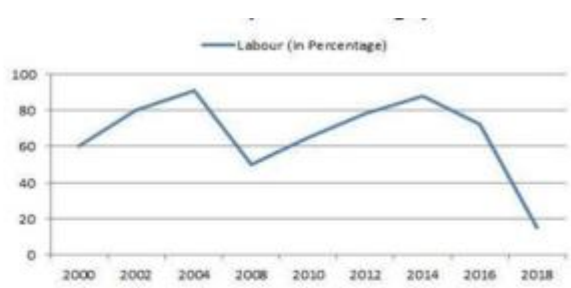


Fig.9 : Comparative Performance of Crop Production

In Fig 10, the number of laborshas been monitored and we find out that with the adoption of new technologies and crop monitoring systems the number of labors has been decreased from 60% in 2000 to 15% in 2018.

LABOUR (IN PERCENTAGE)



In Fig 11, the cost has been monitored and we find out that with the adoption of new technologies and crop monitoring systems the cost has been increased from 10% in 2000 to 90% in 2018.

COST (IN PERCENTAGE)

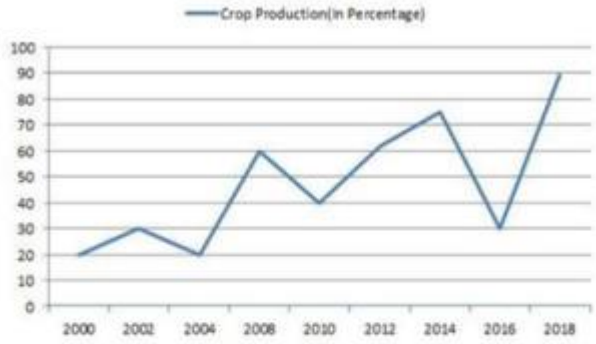


Fig.10 : Comparative Performance of Cost

In Fig 12, the accuracy has been monitored and we find out that with the adoption of new technologies and crop monitoring systems the accuracy has been increased from 20% in 2000 to 98% in 2018.

ACCURACY (IN PERCENTAGE)

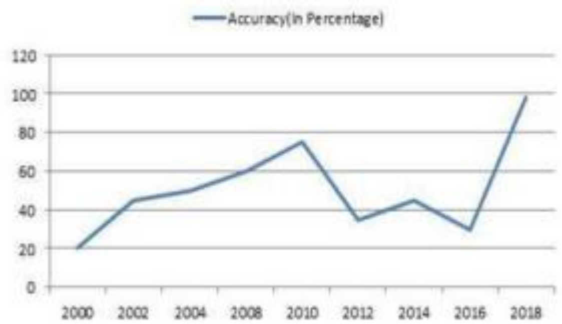


Fig.11 : Comparative Performance of Accuracy

In Fig 13, all the parameters have been monitored and we find out that with the adoption of new technologies and crop monitoring systems the crop yield has increased from 20% in 2000 to 89% in 2018, the number of labors has been decreased from 60% in 2000 to 15% in 2018, the cost has been increased from 10% in 2000 to 90% in 2018,the accuracy has been increased from 20% in 2000 to 98% in 2018.

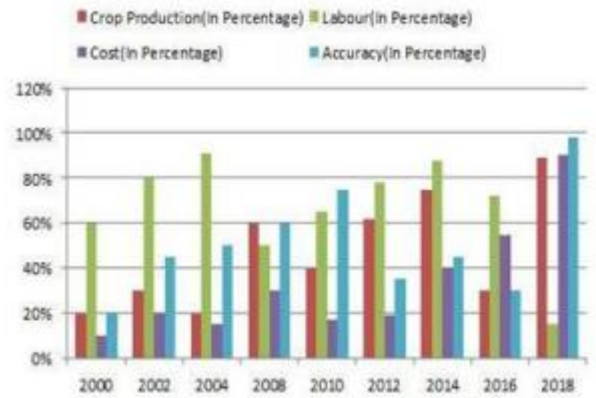


Fig.12 : Overall Performance of Each Parameter

VI. CONCLUSION

Thus the system is useful to monitor the parameters for agriculture such as temperature, humidity, moisture, leaf growth, spray the water and pesticides through the motor pump via IOT module. The system reduces the manual work, man power. This set up was carried out using Arduino UNO, Temperature and Humidity sensor, soil moisture sensor, ultrasonic sensor and IoT module. The Thing Speak page can be developed to control the system through the mobile. Damage caused by predators is reduced and also be used to increase the productivity. The system is integrated with ultrasonic sensor to monitor the health of the plants, one can observe their plants anytime, anywhere in the web.

VII.FUTURE ENHANCEMENT

In Future, new hardware, like the corn-tending robot, is making strides by pairing Data-collecting software with robotics to fertilize the corn, apply seed cover-crops, and collect information in order to maximize yields and minimize wastes. IoT sensors capable of providing farmers with information about crop yields, pest infestation and soil nutrition are invaluable to production and offer the precise data.

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