IOT BASED SMART AGRICULTURE FOR SUGARCANE

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Abstract : Agriculture is practiced on a large scale in India and its contribution is also maximum in the Indian economy. The traditional farming practices like dependency on monsoon, poor infrastructure and less usage of technology has affected agricultural sector. In this paper we have demonstrated IOT based smart agriculture model for sugarcane. The aim of this system is to help the farmer to take right decision, demonstrate intelligence of smart agricultural system based on IOT which helps in taking decisions for watering and whether to do liming or give gypsum based on continuous monitoring and also provide water when the farm is dry without the presence of human. Here soil and environment properties are sensed by using soil moisture sensor, soil pH sensor, soil temperature sensor, DHT11 (humidity and temperature sensor) and periodically sent to cloud through IOT. Cloud storage stores continuously the details of these parameters. Analysis on the cloud data is done through IOT based system. Analysis like, if the values of the sensor goes beyond or below the threshold values required for sugarcane set by the farmer, based on the analysis motor is turned on or off and proper suggestions are sent through SMS to the farmer. This model will help the farmer to take right decision and avoids wastage of water in irrigation process.

***IndexTerms* - Cloud, IOT, Smart agricultural system, Wi-Fi, WSN, SMS**

I. INTRODUCTION

Agriculture is the main occupation in India. As per IBEF (Indian Brand Equity Foundation), 58% of people that are living in rural areas in India are dependent on agriculture [1]. In the world, India is the second largest producer of Sugarcane (Saccharum officinarum) amongst all commercial crops in India. It is also largest consumer of sugar [2]. In India sugarcane is used to make sugar (63.4%), gud (21.8%) and khandsari (3.2%) while 11.7% of cane production is used for seeds. In sugarcane cultivation, harvesting and ancillary activities about 7.5% of rural population covering about 50 million cane farmers, their dependents and a large number of agricultural labour are involved [3]. The farmers in rural areas perform traditional farming practices like dependency on monsoon, poor infrastructure and less usage of technology which affects the agricultural sector. There are 35 million farmers who grow sugarcane and 50 million depend on employment generated by 571 sugar factories [4].

Farmer faces many challenges like getting proper expert advice, doing the necessary activities required for farming manually like irrigation, monitoring crops etc. which is time consuming and straining. Sugarcane cultivators are killing themselves due to several factors like unscientific pricing of sugarcane, harassment by money lenders and delay in receiving payments.

Water covers about 70% of planet but fresh water is only 2.5% of all water. This limited resource needs to support projected 9.7 billion population in 2050 [5]. Agriculture uses 85% of available fresh water resources worldwide and this percentage will continue to dominate because of population growth and increased food demand. The evolving problem of global water crisis: The available fresh water is getting contaminated due to anthropogenic activities like mixing of industrial waste with rivers etc. can harm the aquatic life. It is believed that sugarcane requires more water therefore it is our task to do proper water management in today's rising water crisis, as over or less use of water may damage the crop.

During germination phase (1-35 days after planting) irrigation must be given once in 7 days, during tillering phase(36-100 days after planting) once in 10 days, during grand growth phase(101-270 days after planting) once in 7 days and during maturity phase(271 days after planting up to harvest) once in 15 days irrigations should be given in accordance to the rainfall of that area [6]. The yield decreases if proper management of water and fertilizers are done. Recently, most web based models are developed to guide the farmer in agriculture but they are not very effective as these are very complicated and can't be understood by the farmer.

The intention for approaching smart agriculture is to increase agricultural productivity and good soil health. Here IOT based smart agriculture system is implemented where in real time parameters of soil and environment are monitored through soil and environmental monitoring sensors. The system consists of microcontroller and sensors like soil pH sensor, soil moisture sensor, soil temperature sensor, air temperature and humidity sensor. The data from these sensors are periodically sent to agro-cloud through IOT. Agro-cloud stores the details of these sensors and analysis is done on the stored agro-cloud data for proper management of water.

The aim of this system is to help the farmer to take right decision, demonstrate intelligence of smart agricultural system based on IOT which helps in taking decisions for watering and whether to do liming or give gypsum based on continuous monitoring and also provide water when the farm is dry without the presence of human and thus it avoids water wastage in irrigation process.

II. LITERATURE SURVEY

In this section we exchange observations on contributions done by researchers in this field.

Hemlata Channe, Sukhesh Kothari, Dipali Kadam [7] have proposed a system in which soil and environmental properties are sensed and periodically sent to agro-cloud through IOT (Beagle black bone). Big data analysis is done for fertilizer requirements and best crop sequence analysis can be done. But Beagle bone/raspberry pie are software based program, if delay issues occurred then Operating System gets corrupted.

K. A. Patil and N. R. Kale [8] have recommended a model for real time monitoring system for soil properties like moisture, temperature, pH by collecting real time data of agricultural production for this Ubi-Sense motes are installed and decision support system is implemented for crop monitoring and sms will be sent to the farmer and advises on weather pattern can also be given. Remote Monitoring System is expensive in smaller areas and special training is required to analyze the image.

M.Mahendran, G. Sivakannu, Sriraman Balaji [9] have designed greenhouse monitoring system where plant module, sensor module, processor module and actuator module is used. User sends the crop details, the sensor collects information about the climate, processor module checks for necessary limit for the crop and if data not normal then it activates actuator to take proper decision and also sends sensed data image details, environmental details and date. The Sensor Module shows detected sensor values of CO2, light and temperature. The processor module shows sensor detected values and initiates or terminates the process of actuator and then various action is taken by the actuator.

Based on humidity, temperature and moisture level control of motor is done by K. Jyostsna Vanaja, Aala Suresh, S. Srilatha, K. Vijay Kumar, M. Bharath [10]. The moisture level is sensed by sensor and its value is converted into digital form and given to Arduino Nano. If moisture level falls below a certain level then the motor is turned on automatically.

Through IOT nodes placed in the field, A. T. Abagissa, A. Behura and S. K. Pani have suggested a system in [11] which assemble data like humidity, temperature light, soil moisture and speed of wind from the environment and performs automatically the required activities. Arduino based GSM module is adopted which will update current weather condition and environmental status and also gets suggestion from the system.

G. Sushanth and S. Sujatha [12] have introduced a system which monitors soil temperature, soil moisture, humidity and movement of animals using respective sensors and send to Arduino for further processing, Wi-Fi module updates data on cloud, GSM module is also used .Whenever values goes above the threshold value set, the decision logic decides whether farmer action is needed or not then notification is sent to farmer and based on his decision motor is turned on or off.

To improve productivity of crop, R. N. Rao and B. Sridhar [13] have implemented a Raspbery Pi based on automatic irrigation IOT system. Based on the information sent by the sensors, system can estimate the quantity of water needed. For this two sensors like soil moisture and temperature are used for getting data to the base station and based on these parameters condition motor turns on and also calculates the water quantity which is required for irrigation.

For doing automation of various agriculture tasks, a GSM based smart agriculture system is suggested by Chetan Dwarkani M, Ganesh Ram R, Jagannathan S and R. Priyatharshini [14]. Here automation is proposed by smart irrigator that moves on mechanical bridge slider arrangement. Through GSM module the smart irrigator receives signal from smart farm sensing system and sensed data is transferred to irrigator system to perform automatic actions.

N. Putjaika, S. Phusae, A. Chen-Im, P.Phunchongharn and K.Akkarajitsakul [15] have introduced Intelligent farming system in which the system uses statistical data from sensors, Kalman filtering theory is applied for accurate data. For predicting weather condition a set of decision tree model is developed which helps in making automatic decision on whether watering and roofing systems should be on or off.

III. SYSTEM DESIGN

Developing a Smart agricultural system based on IOT for Sugarcane requires incorporation of software and hardware components. As mentioned in figure1, the system consists of ATMEGA328, Power supply unit, Oscillator circuit, LCD Display, Relay-motor circuit, sensors like LM 35 temperature sensor, soil moisture and pH sensor, humidity and temperature sensor (DHT11 sensor), Wi-Fi module i.e. ESP8266. The software consists of Arduino IDE which has been programmed to send a notification to the farmer whenever the parameters sensed are above/below the threshold value set by him.

Soil moisture sensor is implemented to measure the moisture of the soil. Soil pH sensor checks the acidity and basicity of soil, DHT11 sensor measures temperature and humidity of air, LM 35 sensor measure soil temperature. Sensors sense soil and environment parameters and forwards the data to micro-controller for further processing. The ATMEGA328 micro-controller controls all activities and acts like IOT gateway which transmits this data to the cloud using the Wi-Fi module (ESP8266). The cloud will continuously store the details of the sensor and IOT based system will analyze and proper suggestion is sent through SMS.

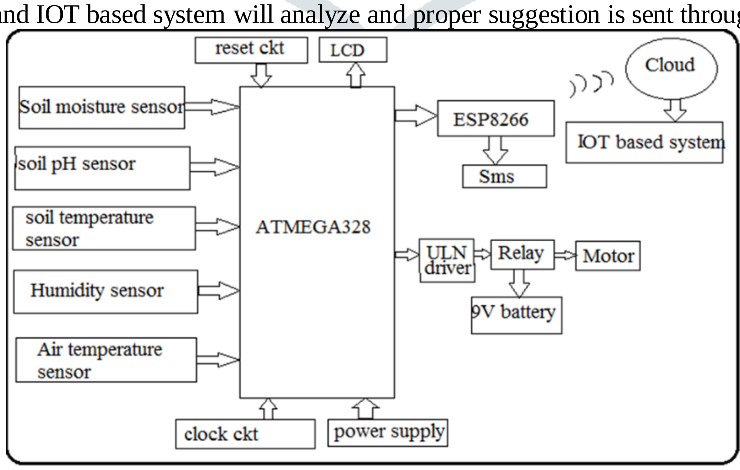

Fig.1 Block diagram of proposed system

The PIN-OUT configuration of the system is shown in Table 1. The sensors are directly connected to ATMEGA328 micro-controller. DHT11 (humidity and temperature sensor) is connected to Pin 9, LCD is interfaced to pins 3, 4, 5, 6, 7, 8, soil moisture sensor is interfaced to Analog pin A_0, Soil pH sensor is connected to analog pin A_2, LM35 temperature sensor is interfaced with Analog pin A_1, Wi-Fi module is interfaced with digital pins 0, 1 and relay is connected to digital pin 10 of ATMEGA328 micro-controller.

Table 1: PIN-OUT configuration of the system

Sr. no.	Description	Pin number connected to ATMEGA micro-controller
1	DHT11 sensor	Pin 9 (digital)
2	LCD Display	Pins 3, 4, 5,6,7,8 (digital)
3	Soil moisture sensor	Pin A_0 (Analog)
4	Soil pH sensor	Pin A_2 (Analog)
5	LM35 temperature sensor	Pin A_1 (Analog)
6	Wi-Fi module	Pins 0,1(digital)
7	Relay	Pin 10 (digital)

IV. SYSTEM IMPLEMENTATION

System is implemented in three phases:

- Sensing
- Processing at ATMEGA328 microcontroller
- Cloud interface
- Response

Sensing phase

The sensing phase involves sensing of soil and environment parameters which includes soil moisture, soil pH, soil temperature, humidity and air temperature. All these sensors are attached to the ATMEGA328 micro-controller which acts as IOT gateway as it has the ability to transmit the data to cloud. This transmission is executed by Wi-Fi module ESP8266. The sensed data of sensors will be displayed on LCD.

Processing at ATMEGA328 micro-controller

Processing phase occurs in ATMEGA328 micro-controller. Sensors sense the parameters of soil and air and forward data to ATMEGA328 microcontroller which acts like IOT gateway. Temperature sensor provides analogue output which is converted into Celsius by multiplying the given value with 0.391234. Soil pH sensor produce analogue 0-5 V output is mapped to 0 to 14 value. Soil moisture sensor provides analogue 0-5 V output which is mapped in percentage. Humidity sensor gives output in percentage.

Cloud Interface

For cloud interface PHP coding is used and cloud is connected to micro-controller through Wi-Fi module. Based on continuous monitoring data gets stored in text file. Here www.iotsystem.in is our domain name in which all sensors data will get uploaded. Whenever we will call the domain through browser we can access it.

Response

For monitoring water requirements, threshold values of temperature sensor, humidity sensor and soil moisture sensor are set whereas for monitoring fertilizers threshold values of pH sensor is set. pH range for sugarcane is 5.0-8.5 [16], the temperature required during ripening phase is 12^0C-14^0C [17]. The relative humidity during ripening phase is 45-65% [16]. The soil moisture is not allowed to fall below 50% during the entire growing season [18]. Analysis on the cloud data is done through IOT based system. Analysis like, if the values of soil temperature > 14^0C, humidity < 60% and soil moisture < 50% satisfying all the above condition then "Give water and Motor on" message will be sent to the farmer else "motor off" message is sent. Also if pH is less than 5 then "Liming is required" and if pH is more than 9.5 then "Give gypsum" these messages should be sent to the farmer.

V. RESULTS

The smart agriculture system using IOT has been experimentally proven to work satisfactorily by monitoring the values of humidity, temperature, soil pH, soil moisture, soil temperature sensor and display its data on LCD as well as cloud. Based on analysis and comparing with the threshold values set by him proper suggestions is sent through SMS successfully. Figure 2 describes the experimental setup of the system.

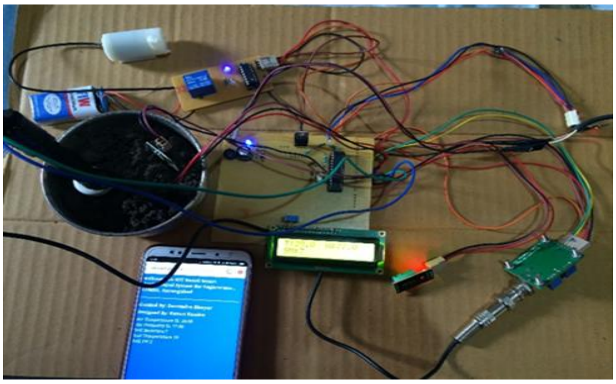

Fig. 2 Experimental setup

In Figure 3 cloud interface is shown wherein all the monitored data of sensors gets updated on the webpage.

Fig. 3 Cloud Interface

Figure 4 shows the screenshot of the suggestion sent through sms based on analysis done by IOT based system

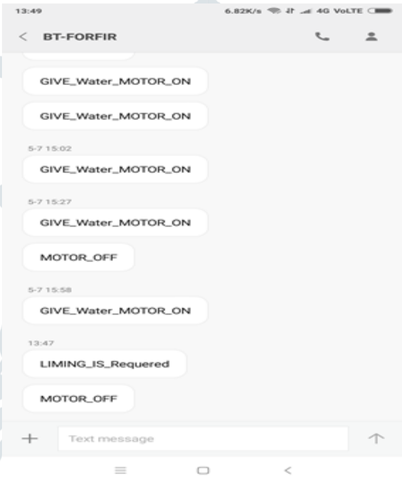

Fig. 4 Screenshot of suggestion sent through Sms

Table 2 demonstrate real time monitoring of soil and environmental parameters sensor's data took at different timings of different days. Here soil and air temperature are measured in degree Celsius, soil moisture and humidity is calculated in percentage, soil pH value is measured from 0- 14 value.

Table 2: Real time readings of soil and environmental parameters sensors

Sr. no.	Time	Soil Temp. (^{0}C)	Air temp. (^{0}C)	Soil pH	Soil Moisture (%)	Humidity (%)
1	5:25 pm	19	35	8	58	48
2	7 pm	16	34	5	58	46
3	5:21 am	17	31	8	58	56
4	8 am	16	30	8	54	62
5	9:40 am	14	30	7	60	60
6	1:47 pm	19	29	2	7	76

VI CONCLUSION

IOT based smart agriculture system proves to be helpful for farmers as over or less usage of fertilizer and irrigation is not good for agriculture. Threshold values for climatic conditions like humidity, temperature, moisture can be fixed on the basis of environmental conditions of that particular region. Through real time monitoring of soil and environmental parameters, it helps in taking decisions related to fertilizer requirement by monitoring pH of soil as well as provide water when the farm is dry without the presence of human and thus it avoids water wastage in irrigation process. In the absence of this system, the farmer has to manually monitor the crops condition which is time consuming and straining.

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