International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

Integrated Agriculture System Using IoT

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Abstract: ***Internet of Things (IoT) has brought revolution in each and every field of human life by making it intelligent, smart and automated. 70% of India is covered by agriculture. But most of agriculture is done by traditional way due to which it is not so improved. So, we need to use various technologies to improve agriculture. This paper aims to making use of new technologies like IoT and Smart agriculture in order to improve the efficiency of existing agriculture system. Smart agriculture is automated technology which uses IoT technology in order to automate the processes in farm. In this paper, sensor response technology and wireless communication of sensors over internet is studied and reviewed. The features of this paper includes better utilization of water resources, improve the quality of farming, gives alert through SMS, advice on weather and crop etc. The system reduces human efforts as well as monitor and control agriculture system remotely.***

Keywords: Internet of Things (IoT), automation

1. Introduction

In today's technical advancements, we have seen IoT is one of the promising technologies which can make our daily chorus easier. IoT is rapidly gaining popularity in various fields like medical, transportation, houses etc. Agriculture is one such field which has not come in limelight yet from IoT community. We focus to have end to end solution for making agriculture, the Smart Agriculture. There are some of challenges involved are maintaining right moisture levels, pH levels in soil. To avoid soil corrosion, we need to maintain water level and pH of water [2]. In India, water shortage is one more problem which farmers need to deal during summers. Many times crops die due to improper water supplies. Hence we propose Integrated Agriculture System to solve above problems. We will have smart irrigation system in our solution, which will solve water scarcity problem to some extent. Now a day's weather is changing drastically. Many times due to natural disasters, farmers have to face many problems and loss, so due to weather monitoring system he may get to know about it in some extent and he can take proper actions in such situations[3]. Monitoring is an important aspect of agriculture. Our Integrated Agriculture System composed of IoT and cloud computing. This system mainly contains system which handled remotely by android application and weather monitoring system which gives daily updates about environment nearby field. Major objective of system is to collect real time data of weather conditions nearby farm and provide information related to crops, any drastic change in environment i.e weather patterns through SMS or notifications on interface. This system has potential to automate processes and give information for analysis purpose for decision making to make it Smart Agriculture.

2. System Overview

2.1 LiteratureSurvey

Smart farming: IoT based smart sensors agriculture stick for live temperature and moisture monitoring using Arduino, cloud computing & solar technology [1]:

IoT is a network of things which make a self-configuring network as new devices get added. As Intelligent Smart Farming is developing day by day, new IoT devices are come into account in order to improve and automate the processes of farming which are not only enhancing the agriculture production but also making it cost-efficient. Their aim/objective is to propose a IoT based Agriculture Stick which assists farmers to get to know about live weather conditions like temperature, humidity etc of farm area in order to improve the quality and quantity of crop being produced and also for decision making. The Agriculture stick proposed by authors is integration of Arduino Technology and various sensors and live information can be obtained online from Thingsspeak.com. The advantage of this system is the ease of its use. They mounted sensors in stick, which farmers have to put in field whenever they want to test parameters of field. The product being proposed by them is tested on Live Agriculture Fields giving high accuracy over 98% in data feeds. The drawback of this system is they use only two sensors which limits its applications. If they use more sensors, then it will increase its scope of application. Another one is if they use better interface like android application it will become easy for farmer to monitor data.

A model for smart agriculture using IoT [2]:
Now a days climate is changing rapidly, many changes such as irregular rainfall, rise in temperature and many hazardous gases are mixing into air. Due to this Indian farmers are focusing on smart agriculture rather than traditional way. Smart agriculture is an integration of automation of agricultural processes using Internet of Things and wireless sensor network. Since IoT developing rapidly it is focusing on wireless communication. They have been studied and reviewed sensor response technology and wireless integration of IoT in real time. And based on that they proposed Remote Monitoring System (RMS) which is combination of internet and wireless sensor network. The objective of this system is to collect the real time data of agriculture field that provides benefits like alerting users through SMS and suggests on weather pattern, crops etc.

Smart Agriculture System Using GSM [4]:
Agriculture is continuously playing a major role in Indian Economy. The liberalization and globalization of Agriculture field is changing the socioeconomic environments of the population. Irrigation system is one of the most important part of Agriculture. Many new concepts related to it are developing to allow automation in Agriculture to flourish and deliver its full potential. They not only focuses on the implication of single new technology which is developing but also focuses at the wider issues for the complete development of system. The system basically deals with Real time atomization of agricultural environment which ultimately cause social modernization of Indian agricultural system. This system is implemented by using advanced processor ARM7TDMI and GSM which is used toautomate the irrigation system. GSM plays an important role of controlling the irrigation on farm and alerts user through coded signals.

IOT Based Smart Weather Station Using Raspberry-PI3 [5]:
This system proposed weather monitoring which monitors temperature, humidity, rain gauge, wind velocity and wind direction at respective place and displays the data as per the user's requirement. The user can access this real time data through internet. This automated weather station measures the weather conditions without human interaction using sensors. The weather conditions are required to be monitored continuously to maintain the healthy growth in crops and prevent them from damage. It is also necessary for the safe working environment in industries. The proposed system of this paper describes the implementation of weather monitoring station. It uses IEEE 802.11 b/g (Wi-Fi) for communication. 802.11 b/g is wireless communication technology. It basically observes the weather conditions and update the information to the web interface. Raspberry pi3 is used for sending immediate alert message or e-mail to the mobile phone, when the values of parameters updates. We can add more sensors to measure many aspects of weather as well as soil. Using these values, we also analyse current weather conditions and predict what shouldwe have to do to avoid the dangerous situations which may come in future.

2.2 Proposed Work

The proposed Integrated Agriculture System mainly includes the two parts: hardware and software. The flowchart of System is as follows:

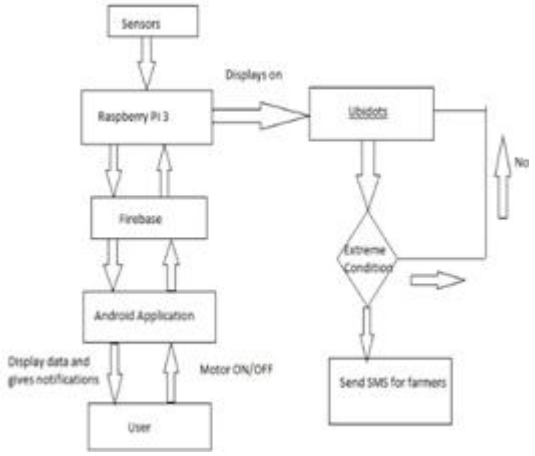

Figure 1: Flow Chart of System

Hardware: The hardware part encompasses of processor Raspberry pi 3, the sensors which are DHT11, MQ7, raindrop sensor, soil moisture sensor, wind speed and direction sensor. The sensors will sense the data in the farm and will send it as input to the Ubidots platform and Firebase database over cloud. The data received will be input to the system for the next controlling actions. The API reference key generated over Ubidots and Firebase act as interfacing medium between hardware and software.

Classification of Sensors

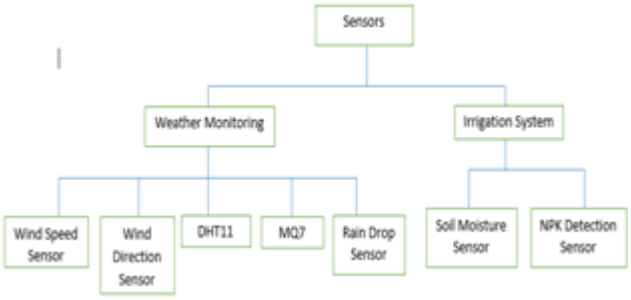

Figure 2: Classification of Sensors

1) Raspberry Pi 3: The Raspberry Pi is a sequence of small single board computers. It has 40 GPIO (General Purpose Input Output) pins for the connection of the sensors. The main way for communicating with additional devices is Ethernet port of raspberry pi.

2) MQ2: MQ2 is used to detect gas leakage may be at home or in industry. The characteristics of MQ2 are- it is highly sensitive and it has fast response time. Due to these properties values can be taken immediately. For adjusting the sensitivity of MQ2, potentiometer is used.Specifications:-
- Operating Voltage is +5V.
- Can be used to Measure or detect LPG, Alcohol, Propane, Hydrogen, CO and even methane.
- Analog output voltage: 0V to 5V
- Digital Output Voltage: 0V or 5V (TTL Logic)
- Can be used as a Digital or analog sensor

3) DHT11: DHT11 is a temperature and humidity sensor. Though DHT11 is very slow, it is better option for doing some basic data logging. It is made up of two parts, one is capacitive humidity sensor and another one is thermistor. Specifications: -
- Ultra low cost
- 5V power and I/O
- 2.5mA maximum current during conversion.
- Good for 20 to 80% humidity readings with 5% accuracy

4) Soil Moisture Sensor: It measures the water presence in soil. Because the direct chemical testing of soil moisture requires to remove the soil, drying of soil, and also weighting of soil. This sensor measures the water presence indirectly by using properties of the soil like resistance, dielectric constant and interaction with neutrons. Specifications: -
- Comparator LM393 chip and stable
- Interface 4-wire Description
- Power: 3.3V to 5V

5) Raindrop Sensor: The rain drop sensor module is tool used for rain detection. It is used as a switch i.e. either rain is there or not, when raindrop falls to the sensor. It is also used for measurement rainfall intensity. It has features like a rain board and the control board. They are separated for more understanding, power indicator LED & adjustable sensitivity.
Specification: -

- Power: - 3.3 to 5V
- Dimensions: - 5.5 cm x 4.0 cm x 0.8 cm.
- Digital switch o/p and analogvoltage o/p
- Anti-oxidation &anti-conductivity.
- LM393 comparator, Comparator o/p signal, driving ability = 15mA.

6) Wind Speed Sensor: An wind speed sensor(anemometer) is a device used to measure wind speed which is a weather station instrument. This anemometer is made to sit outside & measure wind speed.
Specifications: -
Output: - 0.4V - 2V

- Testing Range: - 0.5m/s - 50m/s
- Start wind speed: - 0.2 m/s
- Resolution: - 0.1m/s
- Accuracy: - Worst case 1 meter/s
- Max Wind Speed: - 70m/s

7) Wind Direction Sensor: Wind direction tells the direction on compass from which the wind exudes, from the North or West. Wind direction is generally reports in degrees, and delineate the direction from which the wind exudes. A direction of zero degrees is due North on a compass. Specifications: -

- Type: - Wind Vane with potentiometer
- Output: - 4 to 20 mA
- Range: - 0 to 360°
- Sensitivity: - 1 m/s (2.2 mph)
- Operating Voltage: - 10 to 36 VDC
- Sensor Size: - 21.5 cm x 26.7 cm
- Weight: - 1lb.

8) MQ135: Thesensitive material of MQ135 gas sensor is SnO2. The conductivity of MQ135 is higher along with rise of the gas concentration, when there exist the target combustible gas. The benefits of using this sensor is it has low cost and it is suitable for various application.
Specifications:-

- Wide detecting scope
- Fast response and High sensitivity
- Stable and long life
- Operating Voltage is +5V
- Detect/Measure NH3, NOx, alcohol, Benzene, smoke, CO2, etc.
- Analog output voltage: 0V to 5V
- Digital output voltage: 0V or 5V (TTL Logic)
- Preheat duration 20 seconds

Figure 3: Integrated Agriculture System Architecture

Software: This part mainly comprises of the dashboard and android application. The dashboard is nothing but the graphical and detailed information about farm i.e. overview of farm. It will provide the information regarding with captured data. The data will be in the format of graph or chart of table. It works for the monitoring the farm by an authority. If the farmer wants to control motor automatically then the android application will serve the purpose of both the monitoring and control on irrigation system.

1) **Ubidots Cloud:** data is represented in graphical formats, pi charts, tabular form. It displays real time data of soil moisture, temperature, humidity, rain, wind speed, wind direction and if the soil moisture is below extreme level then it will send SMS to farmer for turning on the motor.
2) **Android Application:** The data is displayed on Android Application and gives notifications to farmer regarding with the moisture content, temperature, humidity, wind speed, wind direction. From application farmer can remotely turn on and turn off motor based on the soil moisture content.

3. Implementation

Implementation part of integrated agriculture system includes four parts software Program Implementation, hardware implementation, and Android application and Cloud platform. Each implementation part is described in detail in following sections.
Software requirements:
1) Ubidots Cloud platform
2) Firebase
3) Android Application
Hardware requirements:
1) Raspberry Pi 3
2) DHT11 sensor
3) Soil moisture sensor
4) Rain drop sensor
5) Wind Direction sensor
6) Wind Speed sensor
7) MQ2 sensor
8) MQ135 sensor

A. Software Programs: The program source code is written in such a way that operations of the development board can be controlled. The Raspberry pi board is used along with raspsbian operating system. The source code is written in Python language. The source code mainly contains code to control the sensors and to send data collected by sensors on cloud platform and to database.

B. Android Application: There are many ways to provide user interface for the system but now a days many farmers have android phones so we developed Android application for the farmers. The Application contains mainly three parts. In one part farmer can control the irrigation using button to switch on or off the water pump. Another part contains the current information about weather, soil contain and these values can be used for analysis purpose in which the environmental values are captured and sent on application using firebase database. And third part contains the documentaries or articles about current researches and technologies in agriculture.

C. Hardware Implementation: Hardware implementation is done by using circuit diagram. Different sensors are connected using bread board to raspberry pi.

Figure 4: Proposed System

4. Results

The results of given proposed system are displayed on two platforms. One is on cloud platform i.e. ubidots and another one is Android Application. The snapshots of results are as follows:

Ubidots

It helps to easily catch sensors data & turn that data into useful information. On ubidots the results are in the form of graphical notation and it is used for administrative purpose to handle the system in efficient manner.

4.1 Result of Proposed System

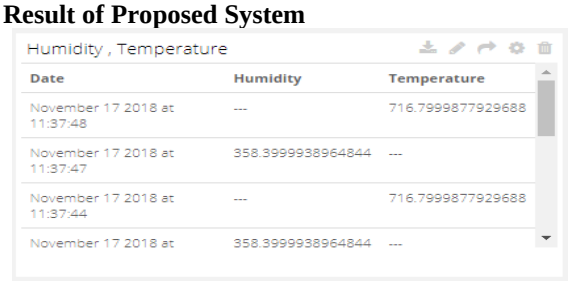

Figure 5: Ubidots Dashboard

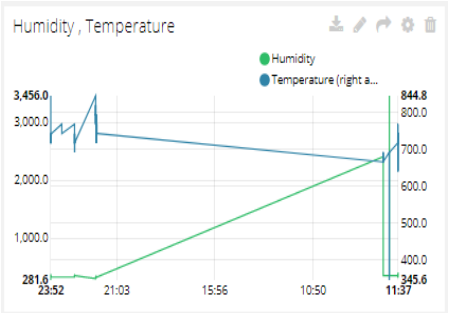

Figure 6: Variation Graph of Temperature and Humidity

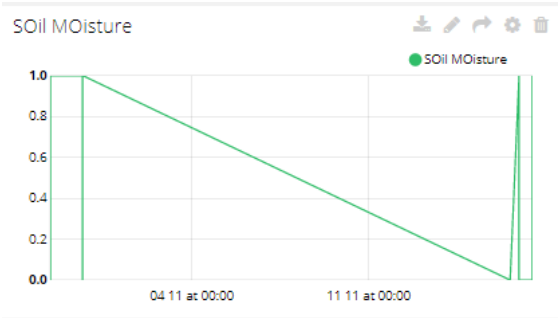

Figure 7: Variation Graph of Soil Moisture

4.2 Android Application:

It is cloud connected android app provide user interface to the system. This application consist of different modules such as recent article, status of motor and weather system. Snapshots of these modules are as follows:

Figure 8: Page 1: Recent Articles

Figure 9: Page 2: Motor status(ON/OFF)

Figure 10: Page 3: Weather Status

4.3 Result of Existing System

Figure 11: Pictograph of temperature

Figure 12: Pictograph of humidity

Table 1: Comparison between two systems

Parameters/ Specification	Existing System (Novel Smart IoT based Agriculture Stick)	Proposed System (Integrated Agriculture System)
Technology	Arduino	IoT
Platform	Things speak	Ubidots
Developed for	Monitoring purpose	Live Monitoring and Automation
Sensor limitation	Uses only two sensors	Uses various sensors on single hardware.
Performance	High accuracy in data feeds.	High efficiency and accuracy in fetching the live data and controlling components remotely.
Advantage	Farmers are getting live data for productive environment observing which will sanction farmers to do clever farming and increase their yield, quality of products.	This system will aid farmers in increasing the agricultural yield by suggesting crops suitable for respective weather and reduces wastage of water.
Disadvantage	It has such interface which is not easy for farmers to monitor data. Unclear interface with complex nature.	As integrated system, it uses two raspberry pi components instead of one for fault tolerance purpose because of that it is quite complex in nature.

5. Conclusion

The proposed Integrated Agriculture System is developed for Live Monitoring and Automation. The Live Weather Monitoring i.e. monitoring of temperature, humidity, rain, wind speed, wind direction and Automated Irrigation System based on soil moisture has been proposed using Raspberry Pi 3 and Cloud Computing. This system has high-efficiency and accuracy in fetching the live data and controlling motor remotely. The Integrated Agriculture Systembeing proposed will aid farmers in increasing the agricultural yield by suggesting crops suitable for respective weather and reduces wastage of water by using an automated irrigation system. It will always give a helpinghand to farmers to get correct live feed of data. Thisreduces75% human efforts by controlling remotely.

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