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IoT Based Farm Monitoring and Alarm System

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Abstract – The main aim of the present work is to report an autonomous IoT system that remotely monitors different parameters of the farm and takes appropriate action based on the input. Different physical parameters like temperature, humidity, and light intensity are taken into consideration as a part of crop monitoring. When a specific parameter goes beyond the threshold values, set by end-user (farmer), an audio-visual alarm is generated on remote display and corresponding action is taken based on user input. As a part of land monitoring, a monitoring system is implemented to detect possibly dangerous events like fire, smoke or flood and even an intruder. These monitoring and control actions are performed by sensor modules placed at different locations all over the farm area. They exchange data periodically with remotely placed intelligent central unit which is responsible for taking decisions based on the inputs. Finally, all this data is stored in the database and also uploaded to the cloud server.

Key words- IoT, Circus of Things, REST API, HTTPs codes, Alarm system.

1. INTRODUCTION

Agriculture in India has a significant history. Today, India ranks second worldwide in farm output. An agriculture account for about 18% of India's GDP and provides employment to 50% of countries workforce. However, Indian farming faces many problems such as:

- Lack of mechanization
- Absence of Weather conditioning and forecast
- Instability of the atmosphere
- Conditions of agricultural labourers
- No or obsolete technology

Lack of training leads Indian farmers to suffer heavy losses but this can be reduced by updating the techniques of farming which are cost effective, easy to use and apply. In the present communication, an autonomous IOT (internet of things) system implemented for remotely monitoring different parameters of the farm is reported. Different physical parameters like temperature, humidity, light intensity, fire, and smoke are taken into consideration as a part of crop monitoring. Finally, all this data is collected to a central unit from which it is uploaded to the cloud server.

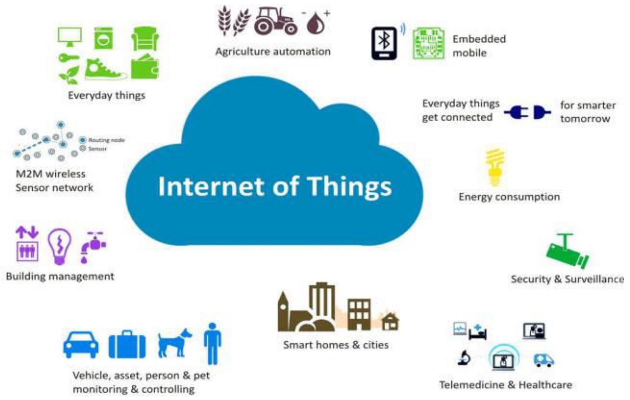


Fig -1: Applications of IoT

Many people have reported their work regarding use of technology in farming but these are not full proof solutions.

Sushanth et. al.[1] have reported a smart agriculture system that aims at making use of evolving technology i.e. IoT and wireless sensors. It monitors the different parameters such as temperature, humidity, moisture and intruder attacking farm. But the drawback of this system is, it mainly focuses on the generating irrigation schedule based on real time data. But for this application, continuous internet connectivity is required.

Rajinder Kumar et. al [2] have proposed a prototype which is able to precisely collect all the weather parameters (Temperature, Humidity, Dew Point, Absolute Pressure, Relative Pressure, Light Intensity and Rain fall amount) in real-time. The results obtained were used for two purposes, out of which the first one is data visualization and the second one is the data analysis.

Nilesh Patel et. al.[3] have developed a system that measures different environmental conditions. System uses wireless module for the data transfer, communication purpose. This system is advantageous to farmers as it not only saves water but also helps farmers in fighting the diseases. The system can be only used in open fields as well as inside greenhouse.

However, the range of wireless module is up to 25m with / without different obstacles like trees, benches, walls, cupboard, magnet, etc.

Chetan Dwarkani et. al.[4] have proposed a model based on the essential physical and chemical parameters of the soil measured, the required quantity of green manure, compost, and water is splashed on the crops using a smart irrigator, which is mounted on a movable overhead crane system. The paper proposed a novel methodology for smart farming by linking a smart sensing system and smart irrigator system through wireless communication technology. However, this work also requires continuous internet connectivity.

Thakare et.al.[5] has reported a smart irrigation system that detects moisture content in soil, PH level of soil and temperature. The moisture level of soil is sensed and according to that irrigation is done. The sensed data is transmitted with the help of IoT platform. The drawback is that, the system works on only single parameter. Figure – 1 explains the general concept of IoT. Present model proposes a part of such system for agriculture application.

2. PROBLEM STATEMENT

To minimize the agricultural losses due to conditions such as unknown weather condition, unpredictable change in temperature and to reduce emergency efforts of farmers, an IoT based system that remotely monitors different parameters such as temperature, humidity, fire etc. and informs the farmers by using alarm system is needed.

3. PROPOSED SYSTEM

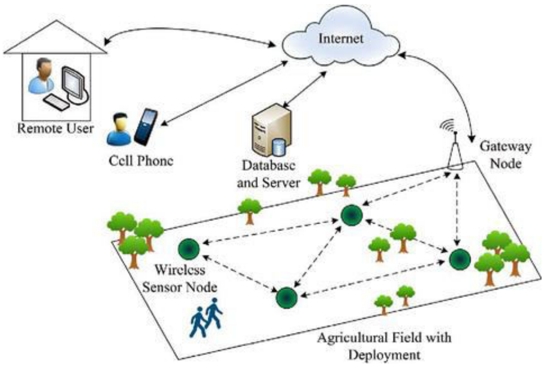


Fig -2: Block Diagram of proposed system

Figure-2 shows the block diagram of the proposed system. This proposed model has the three layers. First layer is all about the sensing the parameters by agricultural field sensors. Second layer deals about data collection, storage and exchange this data periodically with remotely placed intelligent central unit which is responsible for taking decisions based on the inputs. Third layer deals with storage of data in the database and uploading it to the cloud server. Appropriate actions can be taken by the farmer based on the data and system generated alarms.

4. SYSTEM DESIGN

Figure-3 shows the block diagram representing high level view of proposed end-to-end system:

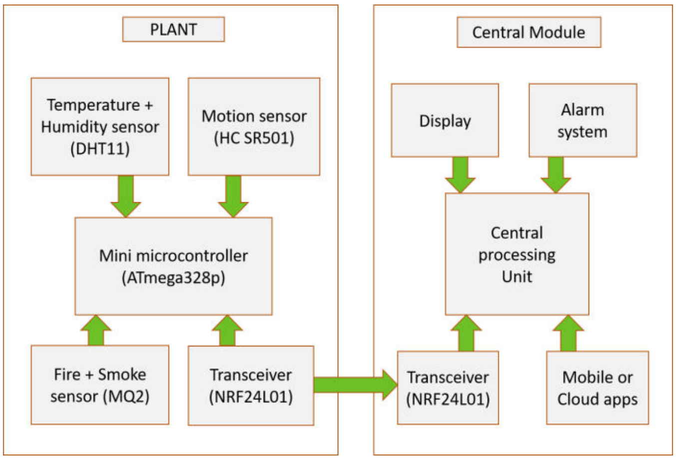


Fig -3: system block diagram

Plant monitoring is done at many places for small crops like wheat or grapes and big plants spread across a large area, like mango, banana, grapes, mud apples, pomegranate etc. It is for the first time that monitoring of medium-big plants like mango trees etc. is done which are spread across large area. Not only that, but this is also the first time that monitoring of entire farm is done. Hence, along with the application, even the technology used here is also innovative in a sense that wireless IoT is implemented with a sensor network that communicates periodically with a remotely placed central intelligent unit.

5. HARDWARE REQUIREMENT

A. *ARDUINO UNO R3*

Arduino Uno (figure – 4) is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button. It includes the whole thing required to hold up the microcontroller; just attach it to a PC with the help of a USB cable, and give the supply using AC-DC adapter or a battery to get started. The term Uno means "one" in the language of "Italian" and was selected for marking the release of Arduino IDE 1.0 software. The R3 Arduino Uno is the 3rd as well as most recent modification of the Arduino Uno. Length and width of the

Arduino are 68.6 mm X 53.4 mm. The weight of the Arduino board is 25 g.

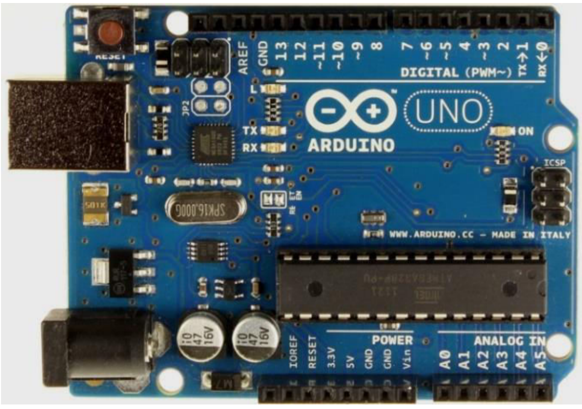


Fig -4: ARDUINO UNO

B. *NRF24L01 Transreceiver Module*

- The nRF24L01 (figure-5) is a wireless transceiver module, meaning each module can both send as well as receive data. They operate in the frequency of 2.4GHz, which falls under the ISM band and hence it is legal to use in almost all countries for engineering applications.
- The modules when operated efficiently can cover a distance of 100 meters (approximately 300 feet) which makes it a great choice for all wireless remote controlled projects.
- The module operates at 3.3V hence can be easily used with 3.2V systems or 5V systems. Each module has an address range of 125 and each module can communicate with 6 other modules hence it is possible to have multiple wireless units communicating with each other in a particular area. Hence mesh networks or other types of networks are possible using this module.

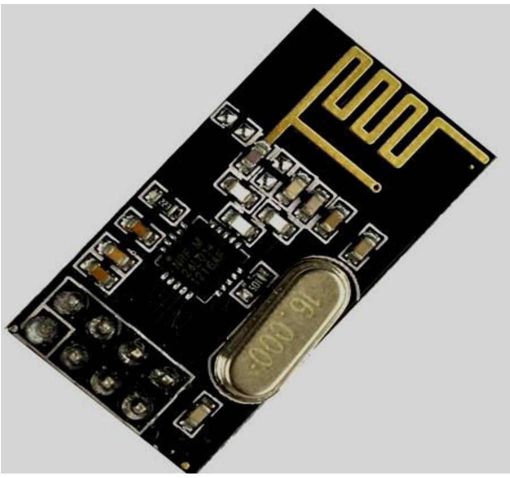


Fig -5: Transceiver

C. *Humidity and Temperature sensor*

DHT11 (figure-6) is a commonly used Humidity and Temperature Sensor. The sensor comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The sensor is also factory calibrated and hence easy to interface with other microcontrollers. The DHT11 sensor can either be purchased as a sensor or as a module. The sensor will come as a 4-pin package out of which only three pins will be used whereas the module will come with three pins as shown above. The only -difference between the sensor and module is that the module will have a filtering capacitor and pull-up resistor inbuilt, and for the sensor, you have to use them externally if required.

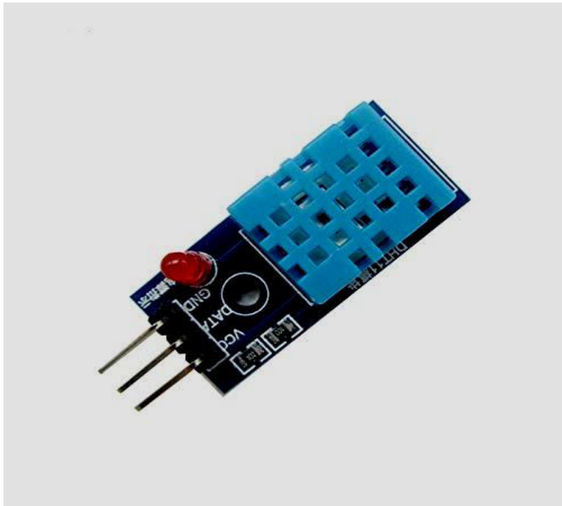


Fig-6: Humidity and Temperature sensor

D. *MQ 2 GAS SENSOR*

The MQ-2 Gas sensor (figure-7) can detect or measure gasses like LPG, Alcohol, Propane, Hydrogen, CO an even methane. The module version of this sensor comes with a Digital Pin which makes this sensor to operate even without a microcontroller and that comes in handy when you are only trying to detect one particular gas. When it comes to measuring the gas in ppm the analog pin has to be used, the analog pin also TTL driven and works on 5V and hence can be used with most common microcontrollers. Power the module with 5V and power LED on the module to glow and when no gas it detected the output LED will remain turned off meaning the digital output pin will be 0V.

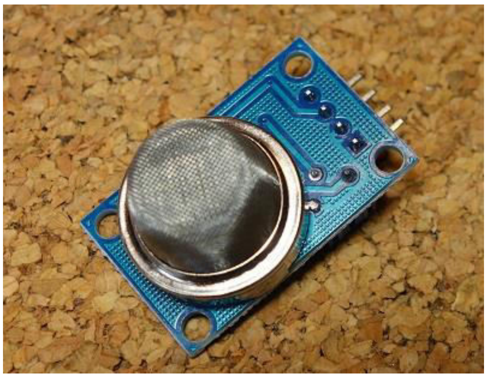


Fig-7: MQ2 Gas and Smoke sensor

E. HC SR 501 PIR Sensor

The PIR sensor (figure-8) stands for Passive Infrared sensor. It is a low cost sensor which can detect the presence of Human beings or animals. This sensor has three output pins Vcc, Output and Ground.

Fig-8: PIR Sensor

F. LED

An LED (figure-9) is used for visual indication. The color of the LED is determined by the energy band gap of the semiconductor.

Fig-9: LED

G. Buzzer

A buzzer (figure-10) is a small yet efficient component to add sound features to the system. It is very small and compact 2-pin structure hence can be easily used.

Fig-10: Buzzer

H. 9 Volt Battery

A9-volt battery (figure-11), sometimes referred to by its original designation as aPP3battery, is shaped as a rounded rectangular prism and has a nominal output of nine volts. Its nominal dimensions are 48mm × 25mm×15mm (ANSI standard 1604A).

Fig-11: 9 volt battery

6. SOFTWARE REQUIREMENT

A. IDE (Arduino 1.8.10 Version)

The Arduino integrated development environment (IDE), is a cross platform written in the programming language Java. The Arduino IDE supports the languages C and C++ using special rules to organize code. The Arduino IDE supplies a software library called Wiring from the Wiring project, which provides many common input and output procedures. A typical Arduino sketch consists of two functions that are compiled and linked with a program sub main () into an executable cyclic executive program:

1. Setup (): a function that runs once at the start of a program and that can initialize settings.

2. Loop (): a function called repeatedly until the board powers off.

B. *IDLE Python 3.8 32 bit version*

IDLE (Integrated Development and Learning Environment) is an integrated development environment (IDE) for Python

IDLE can be used to execute a single statement just like Python Shell and also to create, modify and execute Python scripts. Python is simple and accessible language for learning and implementing the process.

It is portable, expandable and embeddable which makes it compatible for many computers available in the market. It is a platform independent language.

It offers much support and provides libraries for the language. Python is an interpreted language, which means that one can start a program immediately after making changes to its file. This leads to the fact that the finalization, processing and debugging of programs is much faster than in many other languages.

Using this coding language one can reduce the volume of data that one has to deal with and that is accessible in the cloud.

Python recognize user requirements. User can easily study it, fix errors and start coding in it quite simply, as well as transfer it from one machine to another.

One of the greatest benefits of Python is its support for universal external libraries that also comprise IoT libraries.

The advent of the IoT is driven by the development of wireless and sensor technologies and entails the emergence of completely new tasks, such as:

- To develop new network communication standards in the IoT
- To lower the cost of successful sensor integration.
- To manage energy consumption, etc.

Packages used in the program are as follows:

1. Sys: The sys module provides information about constants, functions and methods of the Python interpreter. dir (system) gives a summary of the available constants, functions and methods.
2. Time: The time module handles time related tasks. It displays time, date and day when data is stored in local file.
3. Requests: The request module allows one to send HTTP requests using Python.
   The HTTP request returns a Response Object with all the response data (content, encoding, status, etc).
4. JSON: JSON is syntax for storing and exchanging data. Python has a built-in package called json, which can be used to work with JSON data.
5. Serial: This module encapsulates the access for the serial port. It provides backend for Python running on Windows, OSX, Linux, BSD (possibly any POSIX compliant system) and Iron Python. The module named "serial" automatically selects the appropriate backend.

C. *Circus of things*

Circus of things is the platform used for IoT in present work to monitor data at any place and any time. Circus of Things is an open-source IoT community platform for data logging and remote data exchange. Circus of things work around an open REST API to achieve all the features .Experiments, libraries and example code are all accessible to edit, use and improve. The design is based on handling one concept (Signal) with just two REST API commands. It uses following concepts:

- ***Signal is the main concept***

  A Signal is a register that stores a runtime value that is written by anything (board, app, and web) and read by others; leading into a seamless communication.

  Signal contains the geo-coordinates that are runtime as well. Geo-coordinates may be ignored if location feature is not needed.

  Signal also contains a set of static parameters or metadata intended to make the Signal comprehensive for the user.

  The starting point is the Workshop where the user can create, edit, delete, and list his /her own signals. There is a limitation on 10 signals per user. There the activity logs and raw data can be downloaded. Feed the Signals or read with API and libs from the things.

  Once Signals are defined, user can use them in different panels at the Dashboard. Use one panel for every different experiment, it will let the user monitor and control the Signals that belong to user, shared privately with user or published by others. Actuators and Views are user interface objects that let execute Write and Read actions manually.

  In a Panel, toggle to "Graph Mode" to see the timeline graphs in real-time or toggle to "Map Mode" to trace the tracks in real-time. The work flow is as shown in figure-12

  One needs a token to be authenticated at Circus. This token is given by the circus of things platform and then it is needed to Copy this token and paste it in our remote devices' scripts.

  All connections are encrypted, based on SSL. Communication libraries usually handle this part in a transparent way for the use.

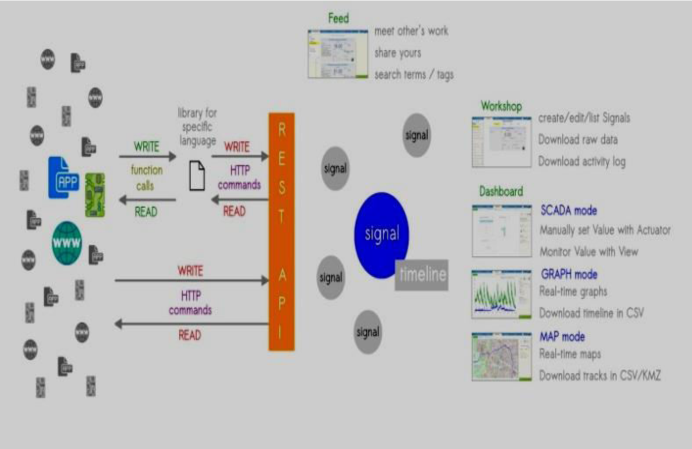


Fig-12: Work flow

One needs a token to be authenticated at Circus. This token is given by the circus of things platform and then it is needed to Copy this token and paste it in our remote devices' scripts. All connections are encrypted, based on SSL. Communication libraries usually handle this part in a transparent way for the use.

- ***REST API***

The write and read commands are defined in REST API and might be implemented (or not yet) for the particular things used in library collection.

REST suggests creating an object of the data requested by the client and sending the values of the object in response to the user. For example, if the user is requesting for a movie in Bangalore at a certain place and time, then an object can be created on the server side.

So, there is an object and the state of the object is sent. This is why REST is known as Representational State Transfer.

If one has to define REST, then, Representational State Transfer REST is an architectural style as well as an approach for communications purpose that is often used in various web services development.

The architectural style of REST helps in leveraging the lesser use of bandwidth to make an application more suitable for the internet.

- ***Methods of REST API***

Every one working with the technology of the web does CRUD operations. When one says CRUD operations, it is meant that one creates a resource, read a resource, update a resource and delete a resource. Now, to do these actions, one can actually use the HTTP methods, which are nothing but the REST API Methods. Refer (figure-13) below.

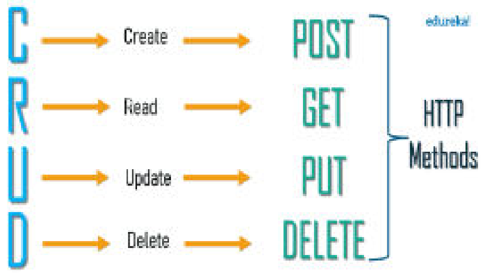


Fig-13: Methods of REST API

- ***HTTP Status Codes:***

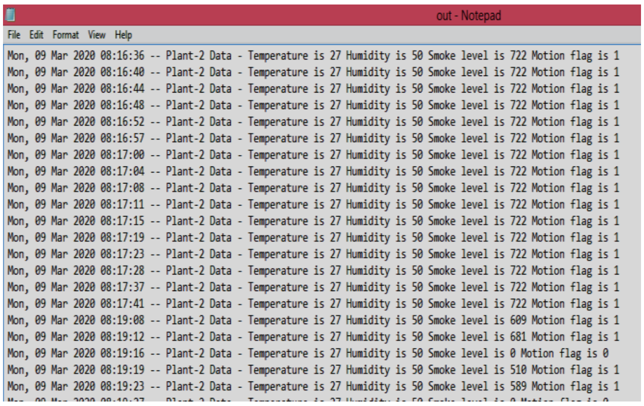
The Status-Code element in a server response is a 3-digit integer where the first digit of the Status-Code defines the class of response and the last two digits do not have any categorization role. There are 5 values for the first digit as shown in figure -14.

S.N.	Code and Description
1	**1xx: Informational** It means the request has been received and the process is continuing.
2	**2xx: Success** It means the action was successfully received, understood, and accepted.
3	**3xx: Redirection** It means further action must be taken in order to complete the request.
4	**4xx: Client Error** It means the request contains incorrect syntax or cannot be fulfilled.
5	**5xx: Server Error** It means the server failed to fulfill an apparently valid request.

Fig- 14: HTTP Status codes

7. RESULT

The prototype monitoring at transmitter and receiver of the plants executes successfully. System gives data of any plant at any time and any place with the help of IoT and also stored in local file for backup. System gives real time data with time and date. All sensors work good. If any parameter goes beyond the threshold value, an audio-visual alarm is generated to alert the user. The data which is uploaded on the cloud server can be shred publically or privately. Following are the results of data monitoring. The data is stored in local file and also uploaded to the cloud server is shown in figure 15 and it is as follows:



```
out - Notepad
File Edit Format View Help
Mon, 09 Mar 2020 08:16:36 -- Plant-2 Data - Temperature is 27 Humidity is 50 Smoke level is 722 Motion flag is 1
Mon, 09 Mar 2020 08:16:40 -- Plant-2 Data - Temperature is 27 Humidity is 50 Smoke level is 722 Motion flag is 1
Mon, 09 Mar 2020 08:16:44 -- Plant-2 Data - Temperature is 27 Humidity is 50 Smoke level is 722 Motion flag is 1
Mon, 09 Mar 2020 08:16:48 -- Plant-2 Data - Temperature is 27 Humidity is 50 Smoke level is 722 Motion flag is 1
Mon, 09 Mar 2020 08:16:52 -- Plant-2 Data - Temperature is 27 Humidity is 50 Smoke level is 722 Motion flag is 1
Mon, 09 Mar 2020 08:16:57 -- Plant-2 Data - Temperature is 27 Humidity is 50 Smoke level is 722 Motion flag is 1
Mon, 09 Mar 2020 08:17:00 -- Plant-2 Data - Temperature is 27 Humidity is 50 Smoke level is 722 Motion flag is 1
Mon, 09 Mar 2020 08:17:04 -- Plant-2 Data - Temperature is 27 Humidity is 50 Smoke level is 722 Motion flag is 1
Mon, 09 Mar 2020 08:17:08 -- Plant-2 Data - Temperature is 27 Humidity is 50 Smoke level is 722 Motion flag is 1
Mon, 09 Mar 2020 08:17:11 -- Plant-2 Data - Temperature is 27 Humidity is 50 Smoke level is 722 Motion flag is 1
Mon, 09 Mar 2020 08:17:15 -- Plant-2 Data - Temperature is 27 Humidity is 50 Smoke level is 722 Motion flag is 1
Mon, 09 Mar 2020 08:17:19 -- Plant-2 Data - Temperature is 27 Humidity is 50 Smoke level is 722 Motion flag is 1
Mon, 09 Mar 2020 08:17:23 -- Plant-2 Data - Temperature is 27 Humidity is 50 Smoke level is 722 Motion flag is 1
Mon, 09 Mar 2020 08:17:28 -- Plant-2 Data - Temperature is 27 Humidity is 50 Smoke level is 722 Motion flag is 1
Mon, 09 Mar 2020 08:17:37 -- Plant-2 Data - Temperature is 27 Humidity is 50 Smoke level is 722 Motion flag is 1
Mon, 09 Mar 2020 08:17:41 -- Plant-2 Data - Temperature is 27 Humidity is 50 Smoke level is 722 Motion flag is 1
Mon, 09 Mar 2020 08:19:08 -- Plant-2 Data - Temperature is 27 Humidity is 50 Smoke level is 609 Motion flag is 1
Mon, 09 Mar 2020 08:19:12 -- Plant-2 Data - Temperature is 27 Humidity is 50 Smoke level is 681 Motion flag is 1
Mon, 09 Mar 2020 08:19:16 -- Plant-2 Data - Temperature is 27 Humidity is 50 Smoke level is 0 Motion flag is 0
Mon, 09 Mar 2020 08:19:19 -- Plant-2 Data - Temperature is 27 Humidity is 50 Smoke level is 510 Motion flag is 1
Mon, 09 Mar 2020 08:19:23 -- Plant-2 Data - Temperature is 27 Humidity is 50 Smoke level is 589 Motion flag is 1
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Fig-15: Data stored in local file

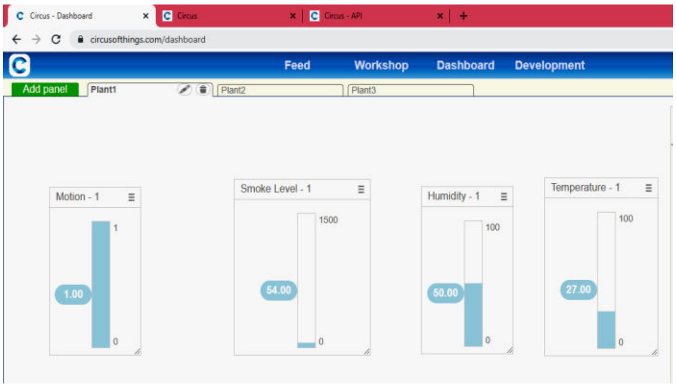

Fig-16: Plant1 data uploaded to the cloud server

- ***Data Acquisition and Testing Scheme***

Laboratory level testing for various parameters is done as follows:

1. It was decided to sense and measure some parameters like CO, proximity of an intruder as well as Temperature and Humidity. For this purpose, after literature survey, proper sensors were selected and interfaced with Arduino UNO, checked for connectivity of each pin of sensor with respective pin of Arduino UNO.
2. After all the sensors were interfaced to Arduino, required codes were generated, uploaded and tested. Later on , Transreceiver module nRF24l01was used to transmit and receive data with the central module and was tested for all sensors and microcontroller.
3. Initially, the sensors were tested under laboratory conditions as follows :
   - For MQ2 sensor, we had set the fire and observed the results. To test for CO, the sensor was kept near a vehicle as it gives emission of CO. No table of figures entries found.
   - For testing HC SR 501, we varied the sensitivity to check whether the intruder is detected or not.
   - For testing the humidity sensitivity of DHT11 sensor, it was exposed to various amounts of water vapours and to test its temperature sensitivity, it was brought in vicinity of objects with different temperatures. Obtained parameters were calibrated by comparing with other standards available.
4. At the receiver side, it was tested that system alerts the user and also gives real time data to the user if any dangerous or hazardous situation occurs.
5. It is also ensured that the data is uploaded to the cloud server and also stored in local file for backup purpose.
6. Before doing actual field testing, plants which were available in home garden were used as objects. Receivers were placed in indifferent rooms of home and it was verified that the data gets uploaded to cloud server (figure-16) and also alarm is generated when any undesirable condition occurred.

- ***Comparison with the currently available system and financial viability***

In the present communication automatic monitoring is reported instead of manual monitoring. If one acre farm land monitoring is considered, then this automatic monitoring system is better than the manual system which is high cost and less reliable. Normally, in 1 acre, 100 big plants are planted.

Cost requirements for monitoring of 100 plants are described in the following table. The required components are microcontroller, transreceiver, sensors like DHT11, MQ2, HC SR 501, 9volt battery at the transmitter side in bulk quantity and there is a requirement of one receiver i.e. central processing unit which consists of one microcontroller, transreceiver, one LED and one buzzer.

So if one buys all these required components in bulk quantity from alibaba.com which is online e-commerce shop which offers components cost as follows:

Table-1: COST OF COMPONENTS

Name of the component	Required no of component	One component cost(In RS)	Required component cost (In Rs)	Shipping cost (In Rs)
Arduino UNO R3	101	173.20	17493.82	1634.49
nRF24l01 Transreceiver	101	42.36	4273.43	605.09
DHT11	100	50.68	5067.79	1459.82
MQ2	100	111.95	11195.25	1754.93
HC SR 501	100	43.88	4388.04	226.97
9 volt battery	101	18.11	1910.07	5673.49
Total Cost		440.18	44328.4	11354.79

Shipping cost can be reduced by placing the bulk order of all the components simultaneously.

Run time cost for components - is (one has to replace batteries in every six months) 7583.56 Rs

Maintenance cost is nearly about 10000 Rs which is for 3 years.

The cost for soldering and Packaging of product is nearly about 5000 Rs.

Total cost, including component cost, manufacturing cost, installing cost and maintenance cost is 73766.75 Rs. Considering other costs and a little profit, the price of the product could be approx. 125000 Rs.

Now if manual monitoring is considered then for one acre, one requires at least 3 workers to monitor the entire farm for 24 hours. If the salary for one worker as per minimum wages act is 9000 Rs per month then net annual salary will be Rs. 324000. Now a days, villages are facing severe scarcity of manual labour, day by day it is becoming difficult to have the manual labour as there is a tendency of all to move towards cities.

Thus ROI (Return on Investment) period for the system is even less than one year and then onwards, this system will save at least Rs. 300000 per year as the wages go on increasing each year. This is a substantial amount for a farmer which makes our system financially viable.

CONCLUSION

Farming plays vital role in next few years in country. Today's farming makes very less use of technologies. There is a need to adopt modern technologies. The proposed smart farming and IoT will help to the profit of the farmers. Present system works in different domains of farming to improve time efficiency, water and soil management, crop monitoring etc and provides smart farming technologies for the user with the help of IoT. The system is suitable for Indian agricultural scenario and gives real time data.

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REFERENCES

1. G. Sushanth1, S.Sujatha 2, "IoT Based Smart Agriculture System" IEEE 2018.
2. RajinderKumar M. Math, Nagraj V. Dharwadkar, " IoT Based Low-cost Weather Station and Monitoring System for Precision Agriculture in India" IEEE pp 81-86, 2018.
3. Nilesh R. Patel, Swarup S. Mathurkar, Rahul B. Lanjewar, Ashwin A. Bhandekar, "Microcontroller Based Drip Irrigation System Using Smart Sensor", IEEE 2013.
4. Chetan Dwarkani M, Ganesh Ram R, Jagannathan S, R.Priyatharshini, " Smart Farming System Using Sensors for Agricultural Task Automation", IEEE pp 49-53, 2015.
5. Sujit Thakare, P.H.Bhagat "Arduino-Based Smart Irrigation Using Sensors and ESP8266 WiFi Module", IEEE pp 1085-1089, 2018.