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Field Monitoring System Using IoT

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ABSTRACT

Internet of Things (IoT) is a shared network of objects or things can interact with each other when provided with the internet connection. This is one of the ideas that have become increasing prevalent in recent years. It involves connecting things to the internet in order to retrieve information from connected things at any time and from anywhere. In IoT, sensor networks exchange information wirelessly via Wi-Fi, Bluetooth etc. Smart Agriculture helps to reduce wastage, effective usage of fertilizers and thereby increase the crop yield. In this work, a system is developed to monitor crop-field using sensors. Our project is initiated to determine the ability of sensing systems to detect Soil moisture, Temperature, Humidity, gas to measure the levels of Butane present. The data from sensors are sent and displayed in a website. The notifications are sent to farmer periodically. The farmer can able to monitor the field conditions from anywhere. This system will be more useful in areas where water is in scarce. This system is 92% more efficient than the conventional approach.

Keywords: *IoT, Raspberry Pi, Sensors*

INTRODUCTION

In the early 2000's, Kevin Ashton was laying the groundwork for what would become the Internet of Things (IoT) at MIT's Auto ID lab. Ashton was one of the pioneers who conceived this notion as he searched for ways that Proctor & Gamble could improve its business by linking RFID information to the Internet. The concept was simple but powerful. If all objects in daily life were equipped with identifiers and wireless connectivity, these objects could be communicating with each other and be managed by computers. Internet of Things (IoT) is an interconnection of physical devices like vehicles and home appliances that are accessible through the internet which enables them to connect and exchange data.

Fig 1: Internet of Things (IoT)

Paramparagat Krishi Vika Yojana

India Budget 2015-18: Rs 500cr to boost the Irrigation. The government of India has launched ParamparagatKrishiVikasYojana in order to address the critical importance of soil and water for improving agriculture production. The government would support and improve the organic farming practices prevalent in India.

Existing System

Less production of food due to the decrease in fertility of soil as the same land is cultivated every time. Farmers in traditional farming have to spent mainly about 15 hours to harvest the crops compared to high-tech farming.Time taken for the production of food is more and the farmer need to monitor the field all the time. In existing system it completely depends on weather conditions.The major problem is water scarcity, the main source of water is rainfall.

Proposed System

The main advantage is that the yield of primary crops are increased dramatically and price of food is declined.

According to the nitrogen levels in the soil we can grow the crops so that the yield will be in good condition.

Less man power is required and no need to monitor the land directly all the time.

Based on the chlorophyll levels we get an idea that which fertilizers is to be used for the crops.

Field monitoring will be made easy and modern techniques are used.

IoT is playing a significant role in technology development. The IoT enables items to be detected or controlled remotely over existing system infrastructure, making open doors for more straightforward reconciliation of the physical world into PC based frameworks, and bringing about enhanced productivity, precision and financial advantage. When IoT is enlarged with sensors and actuators, the innovation turns into a case of the more broad class of digital frameworks. IoT encompasses technologies like smart home, smart agriculture, smart grid, smart city and intelligent transportation. The goal of Internet of Things is to enable things to be connected anytime, anywhere with anything and anyone ideally using a network.

IotCharacteristics:

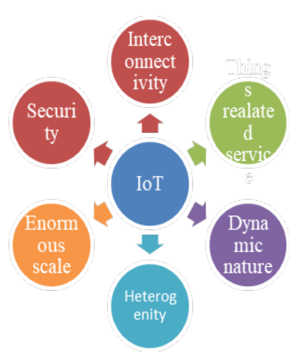

Fig 2: Characteristics of IoT

Sangkil Kim et al.[1] for the first time demonstrated soil moisture sensor on paper for agricultural purposes. A prototype made of passive RFID tag integrated with a capacitance sensor consisted of printed interdigitated capacitor (IDC) was printed on low-cost paper substrate. The sensor demonstrated shift of minimum power level due to soil moisture variation.

Slobodan Birgermajer et al. (2011) developed a novel miniature soil moisture sensor based on band-stop structures.[2] Two sensors were designed that integrated conventional RFID systems for practical large scale agricultural applications with microstrip technology used for measurement and mapping of soil moisture in available land. The proposed two novel sensors which operate at 2.54 GHz and 2.75GHz offered two times wider ranges of phase delay. Sensor solutions significantly improved phase shift ranges and sensitivities compared to conventional microstrip sensors.

JayavardhanaGubbi et al.[3] gave the information that the proliferation of devices with communicating–actuating capabilities is bringing closer the vision of an Internet of Things, where the sensing and actuation functions seamlessly blend into the background and new capabilities are made possible through access of rich new information sources.

Sheikh Ferdoush et al.[4] presented a wireless sensor network system designed with Arduino, Raspberry Pi, XBee, and a number of open-source software packages. The system has a number of attractive features, including low-cost, compact, scalable, easy to customize, easy to deploy, and easy to maintain. One major advantage of the design in the integration of the gateway node of wireless sensor network, database server, and web server into one single compact, low-power, credit-card-sized computer Raspberry Pi, which can be easily configured to run headless (i.e., without monitor, keyboard, and mouse).

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Aqeel-ur-Rehman et al. demonstrated [6] that Solutions are too complex to implement and requires major technical support, Intense Cost is involved, Lack of generalized solution to different services and problems, Majority of the research works present solution in parts like only context modeling, data acquisition, data processing and storage techniques or network related problem solutions. The complex or sometimes unavailable interlinks among part solutions reduces the impact of several researches.

In the year 2015, Arkadiusz et al.[7] presented the concept of hardware synthesis for the mobile gas detector with an Arduino microcontroller. The main aim of this project is finding the unsafe zone in the large area, where a big number of stationary detectors are unpractical or too expensive. They presented the scheme of the self-propelled robotic gas detector [9]. In the future works, appropriate software must be created. A first part is a software for the Arduino microcontroller, and the second part is software for the server.

Sangkil Kim et al. Determined [8] a step-by-step design procedure has been discussed in detail, and the performance of the design sensor tag has been experimentally demonstrated. The sensor demonstrated shift of the minimum required power level due to the soil moisture variation. The measured data was fitted to the mapping curve to extract the soil water content. Numerous agricultural applications can be stemmed from this work, such as a water level sensor or a rain fall sensor.

Noman Islam et al. [9] demonstrated that Development of low cost and rugged sensor/actuator nodes, Generalized solutions to different problems, Complete frameworks to develop systems from acquisition to the modeling and the decision support.

10. Nishanth et al. [10] Solutions in part should be supported with comprehensive details of other compatible procedures that could make the intended resolution complete.

Birgermajer et al. [11] developed a novel miniature soil moisture sensor based on band-stop structures. Two sensors were designed that integrated conventional RFID systems for practical large scale agricultural applications with microstrip technology used for measurement and mapping of soil moisture.

3. HARDWARE AND SOFTWAREREQUIREMENTS

3.1 Hardware Requirements

- Arduino (Nano)
- Raspberry Pi 3 Model B v1.2(40 Pins)
- Jumper Wires
- Buzzer
- Sensors
  1. Gas Sensor
  2. Soil Moisture Sensor
  3.DHT11 Sensor

Arduino Nano

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.0) or ATmega168 (Arduino Nano 2.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package

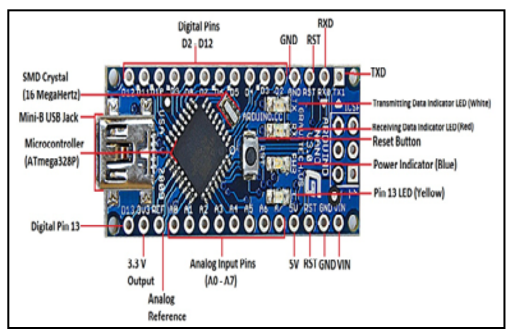

Fig 3: Arduino Nano

Raspberry Pi 3

Raspberry Pi 3 has the ability to interact with the outside world and has been used in a wide range of digital maker projects, from music machines and parent detectors to weather stations. It's capable of doing everything you'd expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games.

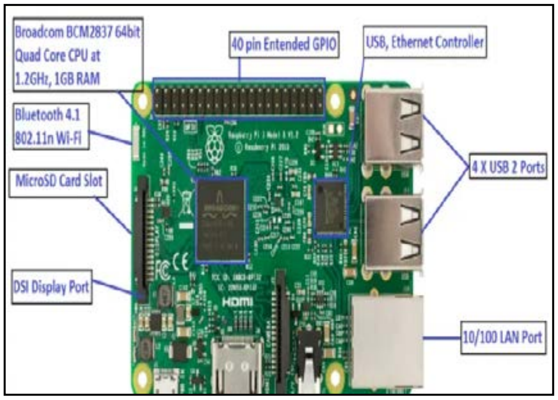

Fig 4: Raspberry Pi3

Soil Moisture Sensor

Water contained in soil is called soil moisture. Soil water is the major component of the soil in relation to plant growth. If the moisture content of a soil is optimum for plant growth, plants can readily absorb soil water. Soil water dissolves salts and makes up the soil solution, which is important as medium for supply of nutrients to growing plants. A soil moisture sensor measures the quantity of water contained in a material, such as soil on a volumetric or gravimetric basis. This sensor can be used to test the moisture of soil, when the soil is having water shortage. By using this sensor, one can automatically water the plant.

The soil moisture sensor consists of two probes which are used to measure the volumetric content of water. The two probes allow the current to pass through the soil and then it gets the resistance value to measure the moisture value.

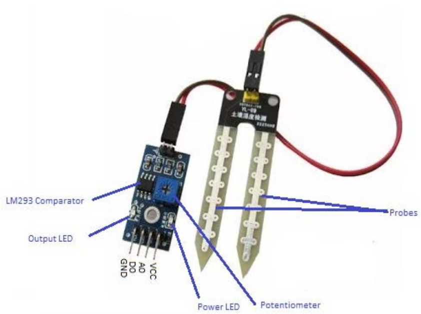

Fig 5: Soil Moisture Sensor

Temperature & Humidity Sensor

A humidity sensor senses, measures and reports the relative humidity in the air. It therefore measures both moisture and air temperature. Relative humidity is the ratio of actual moisture in the air to the highest amount of moisture that can be held at that air temperature.

Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability.

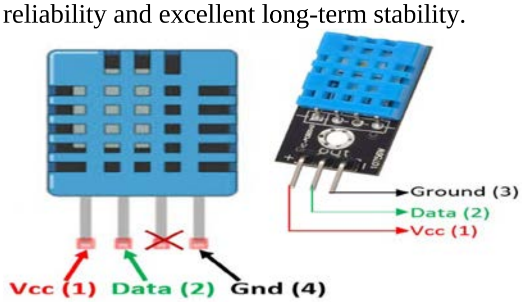

Fig 6: Temperature & Humidity Sensor

Gas Sensor

Nitrogen gas sensor use a small heater inside with an electro-chemical sensor. They are sensitive for a range of gasses and are used indoors at room temperature. They are useful in gas leakage detection of LPG, propane, methane, i-butane, alcohol, Hydrogen, and smoke.

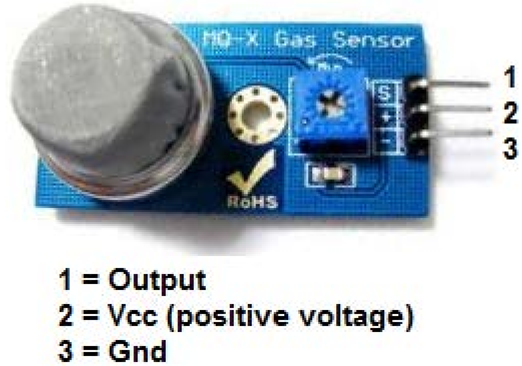

Fig 7: Gas Sensor

3.2 Software Requirements

- Raspbian OS
- VNC Viewer
- Node Red
- Embedded C
- Node.js
- IBM Bluemix

Node RED

Node-RED is a programming tool for wiring together hardware devices, APIs and online services in new and interesting ways. It provides a browser-based editor that makes it easy to wire together flows using the wide range of nodes in the palette that can be deployed to its runtime in a single-click.

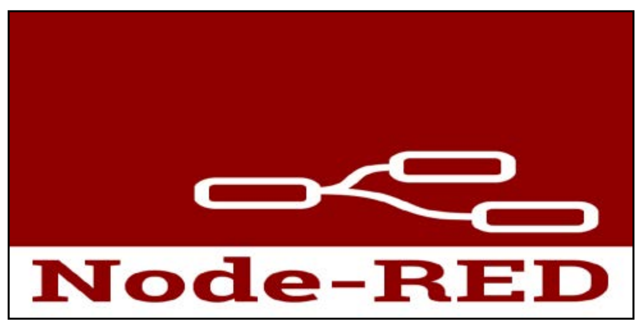

Fig 8: Node RED

Node.js

Node.js is a JavaScript runtime built on Chrome's V8 JavaScript engine. Node.js uses an event-driven, non-blocking I/O model that makes it lightweight and efficient. Node.js package ecosystem, npm, is the largest ecosystem of open source libraries in the world. .js is the conventional filename extension for JavaScript code, the name "Node.js" does not refer to a particular file in this context and is merely the name of the product. Node.js has an event-driven architecture capable of asynchronous I/O. These design choices aim to optimize throughput and scalability in web applications with many input/output operations, as well as for real-time Web applications

Fig 9: Node.js

IBM Bluemix

It is open source software in which projects are motivated by creative interest, independent of commercial ventures. Projects are perfect for evolving a cloud platform that many independent developers use to prototype, implement, deploy, and iterate applications based on shifting business priorities. IBM Bluemix is a cloud platform developed by IBM. It supports several programming languages and services as well as integrated to build, run, deploy and manage applications on the cloud.

IBM Bluemix includes IBM's Function as a Service (FaaS) system, or Server less computing offering, that is built using open source[8] from the Apache OpenWhisk incubator project largely credited[9] to IBM for seeding. This system, equivalent to Amazon Lambda, Microsoft Azure Functions, Oracle Cloud Fn or Google Cloud Functions, allows calling of a specific function in response to an event without requiring any resource management from the developer.

Fig 10: IBM BlueMix Cloud

4. SYSTEM DESIGN

System design involves in the working and connecting the sensors to arduino (nano) , the overall setup is connected to raspberry pi with the help of jumper wires through GPIO pins.

The internal process involves with the software components.

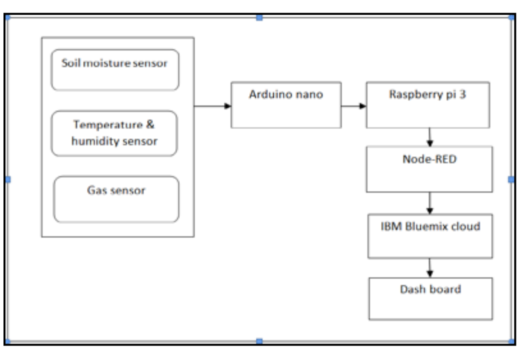

Fig 11: Block Diagram

The working system should install the VNC Viewer, in which it is initiated with a username and password.

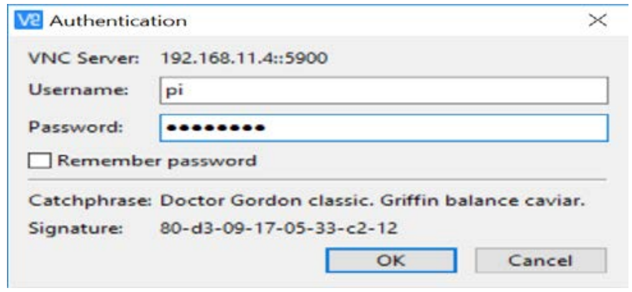

Fig 12: VNC Authentication

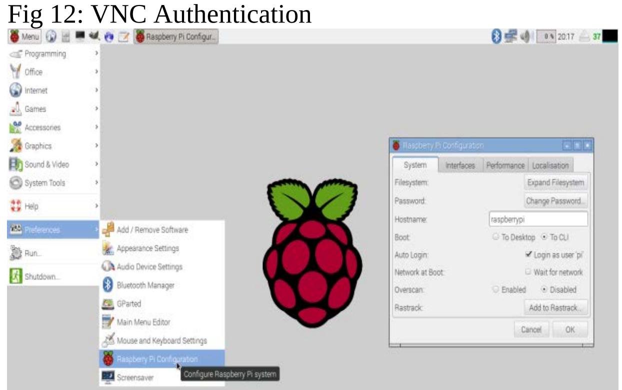

Fig 13: Connecting the VNC Viewer

After starting the VNC Server, open the browser and the local-host address is given as-localhost:127.0.0.1/

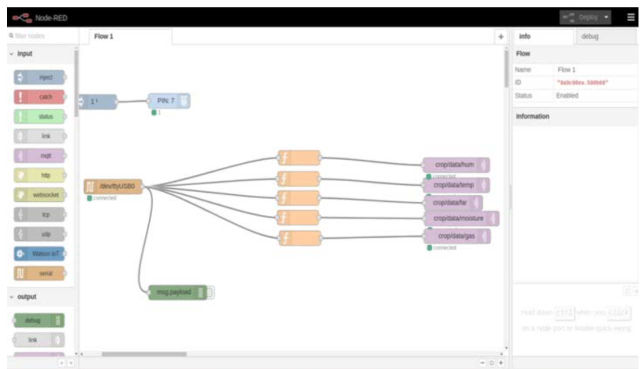

Fig 14: Components Connecting to Node RED

In Browser, node red is connected to the IBM Bluemix cloud along with the involvement of MQTT protocol and mosquito server.

5. TESTING

The components are tested respectively.

On the dash board, a threshold value will be fixed and the testing is done respectively.

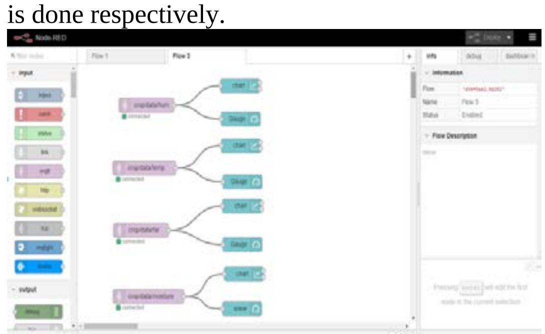

Fig 15: Node-RED flow

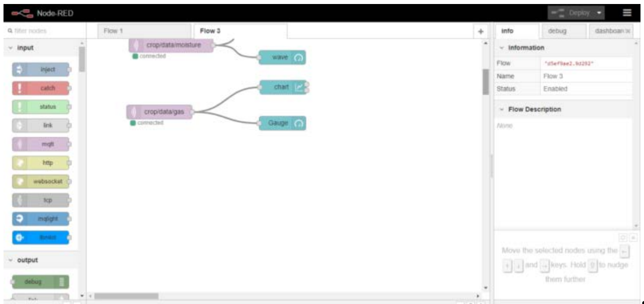

Fig 16: Node-RED flow

6. RESULTS

Each crop varies in its values, so a threshold value is kept and checked with the overall equipment. Each sensor is checked for a crop or a plant and the values are noted. If the obtained value is less than the considered threshold value, then the crop/plant is unhealthy and should need its required resources. If the obtained value is greater than the considered threshold value, then the crop/plant is completely healthy.

OUTPUT before testing with sensors will appear as follows

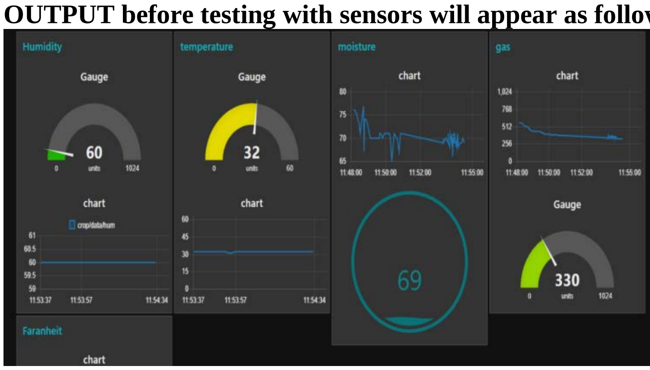

Fig 17: Results Before Testing

Fig 18: Results Before Testing

OUTPUT after testing with sensors will appear as follows:

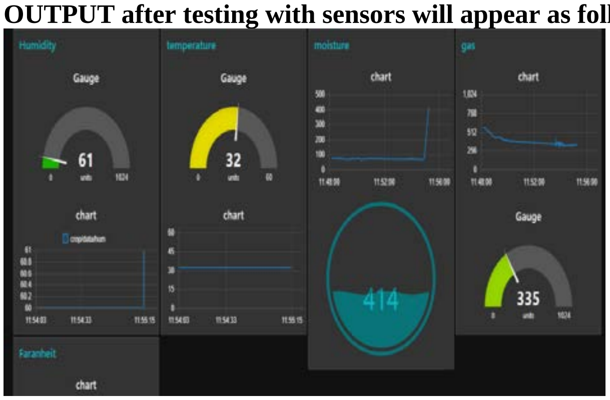

Fig 19: Results After Testing

7. CONCLUSION AND FUTURE WORK

IoT agricultural applications are making it possible for farmers to collect information. Farmers must understand the potential of IoTmarket for agriculture by installing smart technologies to increase competitiveness and sustainability in their productions. The demand for growing population can be successfully met if the farmers implement agricultural IoT solutions in a successful manner.

This project gives the information about the in-situ levels of moisture, temperature, humidity and gas content in the soil. These are very useful for the farmers to effective use of water, fertilizers etc.

This project can be extended to calculate the nitrogen levels, chlorophyll levels in a crop or a plant that are very essential for plant growth. Furthermore, farmers can analyze the situation by receiving text messages.

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