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Crop Monitoring to Measure Internal Quality of Onion

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Abstract: As food being the major survival for human beings, the quality of food plays a vital role, so agriculture becomes the base for all food ingredients. The fruits or vegetables that are obtained from the farm must have a better quality. The quality depends on the techniques used for the effective growth of the crops. There are various techniques which are used to monitor the growth of each plant. One such technique is the Internet of Things, which connects things and people together. This helps the farmers to produce good products and also consumers to have good healthy food. This paper proposes a method in which sensors are used to monitor the growth of onions by implementing smart farming to produce maximum yield and healthy onions.

Keywords: Internet of things, Sensors, Onion, Weather Monitoring, Soil Monitoring, Crop Monitoring, Fertilizers.

I. INTRODUCTION

Indian Farmers and Consumers depend on agricultural produce. Each farmer thinks to produce a quality vegetable or fruit and the consumer feels whatever we eat should be a quality one. Both sides, quality plays a major role. The quality is a term which can be easily measured. To measure the quality each and every step of a crop's growth has to be monitored. The Internet of things, which connects people and things together through the internet helps a common man to accomplish his task very easily. The various sensors that are present can be used to measure every activity in a farm. This allows the farmers to control the farming activities from anywhere.

Onion is the important ingredient in our day to day food. There are varieties of onions that are grown all over the world. In India there are few varieties that are grown in major regions. The period of time between the onion sow and harvest can be used to measure the quality of onion.

Smart farming could be implemented in a large scale of farm to get the maximum yield and healthy onions. It involves automatic irrigation, pest detection, fertilizer supplies, monitoring the climatic conditions.

II. RELATED WORKS

There are various IoT applications that have been implemented in rural areas of South Africa and Zambia for various agricultural activities like crop monitoring, detection of pests at an early stage, weather forecasting, livestock farming and rural financing [1]. An automated irrigation system that effectively monitors the growth of the plant and communicates the details to the farmers [2].

A home garden is implemented using various sensors to monitor temperature and humidity and information are gathered through Raspberry Pi which is communicated to the gardener immediately [3]. Internet of Things is used to analyze the field of agriculture and describe the benefits of using IoT [4]. An IoT system is developed to measure the level of humidity and the information is communicated through communication module to improve the farming techniques [5]

The information that is gathered using the IoT devices are sent to the cloud and an alert message will be sent to the farmer if any abnormal activity takes place in the farm [6]. A cloud based module is used for monitoring, collecting data and sent using Zigbee technology to the ground station. The data is processed in the cloud to determine the status of the farm [7]. Soil condition is monitored and pest detection has been done using appropriate sensors for necessary action [8].

III. CORE CONCEPTS

Location Sensors

These sensors use a GPS system to determine the location of the IoT system and farm. Example: NJR NJG1157PCD-TE1 [19].

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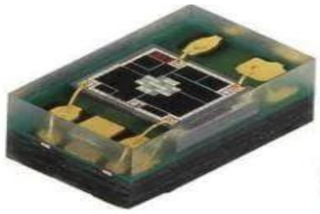

Fig 1: Location (GPS) sensor

Soil Moisture Sensor

This sensor is used to check the moisture content in the soil based on a threshold value. Example: Three-way Soil Tester.

Fig 2: Three way Soil Tester

Humidity Sensor

Humidity sensors are low-cost sensors which are used to measure the humidity level in air.

Fig 3: Humidity Sensor

Communication Technologies

There are various technologies that are used to transfer the gathered data from the sensors to the cloud. Bluetooth, Zig-bee, MQTT, RFID standards that are used for short range communications. LPWA, LoRa, Sigfox, NB-IoT are low power and long range communication standards [17].

3 Smarts that Help Farming

Smart Analysis & Planning:

Planting model is developed by gathering information about previous farming or farming done in a close by area and what are the conditions for effective growth of the plant.

Smart Sensing & Monitoring: Based on the planting model, the internet of things are used to monitor and track the soil moisture, lighting and temperature.

Smart Control:

Automatic control systems are used for watering, fertilizing and supplying pesticides.
All these solutions are combined together and analyzed through machine learning algorithms.

Weather Monitoring

The weather is continuously monitored using light and humidity sensors. The data collected from these nodes are used for weather prediction.

Types of Onions: There are several types of onions cultivated all around the world like Culinary Luxury, Yellow Onion, Sweet Onions, White Onions, Red Onions, Shallots and Green Onions. Among this red onions and sweet onions are famous in India.

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Fig 3: Types of Onions

Place	Season	Sowing Month	Harvest Month
Andhra Pradesh, Tamilnadu, Karnataka	Early Kharif	Feb-Apr	July-Sep
	Kharif	May-June	Oct-Nov
	Rabi	Sep-Oct	Mar-Apr

Table 1: Red Onion Cultivation Seasons

Types of Soil
The best suitable soil for onion cultivation is red and black loamy soil. Further other soil like clayey, sandy loam also helps onion crops to grow. The soil must be easily crumbled and heavy. The organic manure must be mixed with soil to make it rich.

Sowing Method
The soil has to be pulverized five to six times to remove clods if any. For one square meter of land 15gm of seeds are sowed in a depth of 2.5 to 3cm. The seeds are placed 30cm apart.

IV. PROPOSED SYSTEM

Methodology

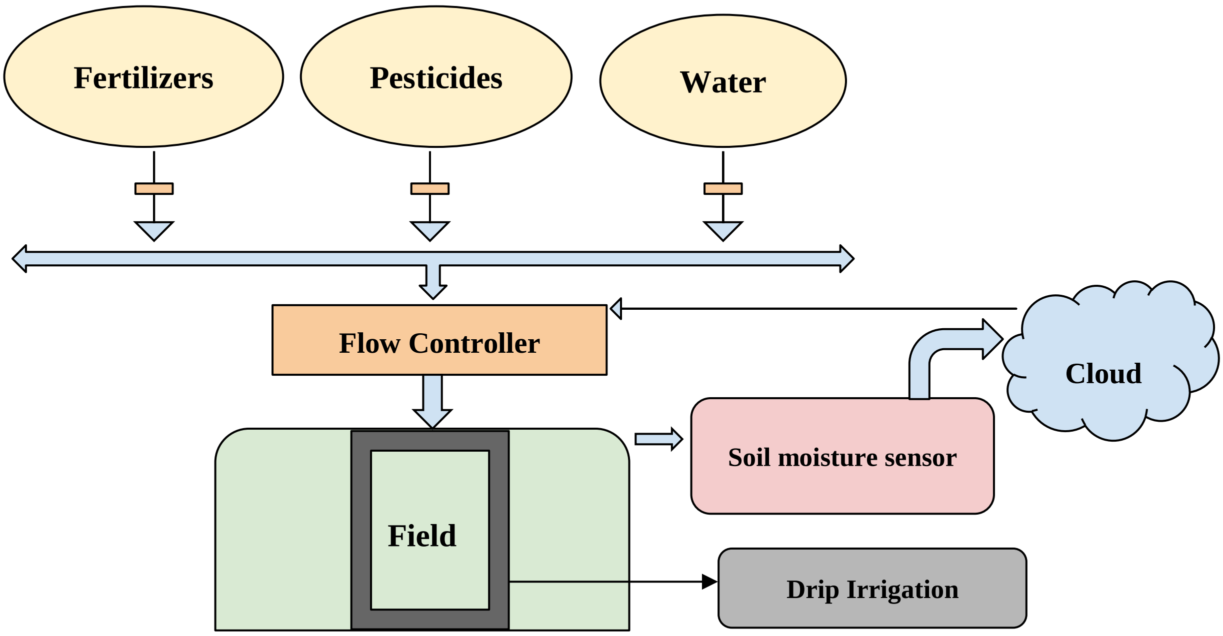

Fig 4: IoT System using Drip Irrigation

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The Internet of Things is used to monitor onion cultivation in the field. The major sensors that are used in the field are soil moisture sensor and location sensor. A relay is used to perform an action based on the sensor data. The sensor nodes are placed for every 25% of the land. The field is connected to a 4G network to transmit the data to the cloud for further analysis. The automatic irrigation system is implemented using a drip irrigation method where pesticides, fertilizers and water are supplied through the same.

Fertilizers that are rich in nitrate are used for onions during the time of sowing directly into the soil. The growing period of onion is usually 200 days from the time it is sowed. The system consists of three containers of Fertilizers rich in nitrate, pesticides and water. Based on the pH value collected from soil moisture sensor the motor is activated to pump water from the container to the field through the drip pipe.
Fertilizers are automatically pumped into the field when the seed is sown. The cultivation of onion requires nitrate rich soil.
Pesticides are used based on the season of the crop growth. Depending on the season pests the farmers are suggested with the respective pesticides to fill in the container. At an early stage, the pesticides are injected to the field through the drip pipe.

Communication Module
An application is developed to help the farmers to monitor the activities and plant growth. The data collected from the camera and the sensor is transferred to the cloud. The raw data are processed in the cloud analyzed and necessary actions are taken.

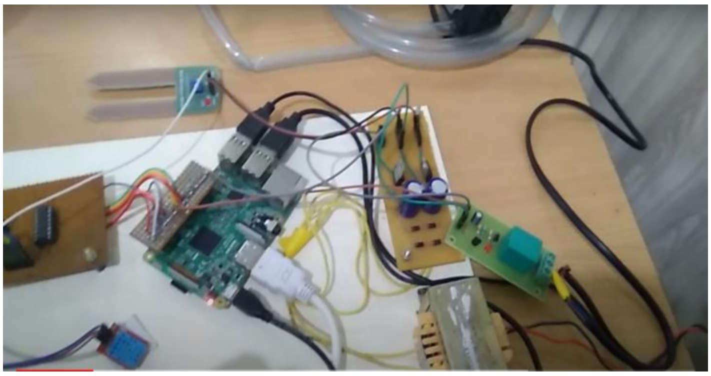

Fig 5: Implementation using Drip Irrigation

Smart Irrigation
The soil moisture sensor is placed in every 25% of the land and collects the moisture level in that part of the soil. This pH value in the soil is sent to the cloud on regular intervals. The soil moisture sensor senses the moisture level in the soil. For onion the pH value is to be 6.0 to 7.0. Ideally, up to 7.5 the crop can sustain. Since the pH value that is collected from the sensor node is every second the system uses cloud. When the pH value goes below the threshold value the actuator is enabled which in turn switch on the motor to pump water into the field.
For onions up to 5- 8 irrigations are necessary based on the soil moisture. The soil should contain good moisture levels for the crop to grow better. The irrigation must be stopped before 10 days of harvest.

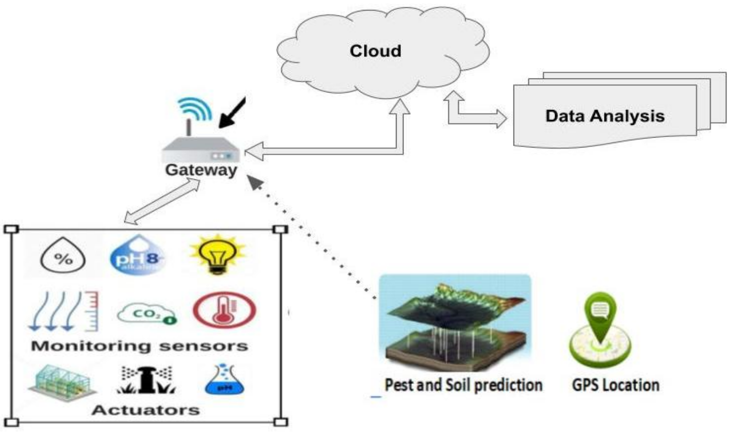

Fig 6. Flow diagram of IoT System

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Fertigation
Onion requires a soil rich in nitrate. Proper fertilization of the soil develops marketable onion bulbs. NPK is supplied in a 40:40:60 ratio during the beginning of the cultivation. The remaining fertigation is done in seven splits. The fertigation is done using drip irrigation so that manual intervention is not needed as well as the fertilizers reaching the ground directly. Amount of water usage is also reduced.
Pest
There are several pests that affect the onion crop during the growing season. Below is the table (Table 2) which shows the pests that affect the crop growth and the pesticides that can be used to prevent pests from damaging the crop and the onion.

Onion Maggots	Chloropyriphos 20EC	1ltr/ha
Army Worm	Carbofuron 3G Cypermethrin Permethrin	7.5kg/ha 0.04-0.11 lbs./ac 0.15-0.3 lbs./ac
Cut Worm	Dust carbaryl 5% or spray Dichlorovos 0.05%	Dichlorovos 5ml/ltr

Table 2: Pests and Pesticides for Onion Cultivation

V. RESULTS AND DISCUSSION

The IoT system is implemented in an acre of land. The land is divided into partitions. In each partition a soil moisture sensor is placed. A drip irrigation pipe is connected all around the partitions of the field. A humidity sensor is placed in the field to monitor the weather conditions based on which the irrigation system operates.

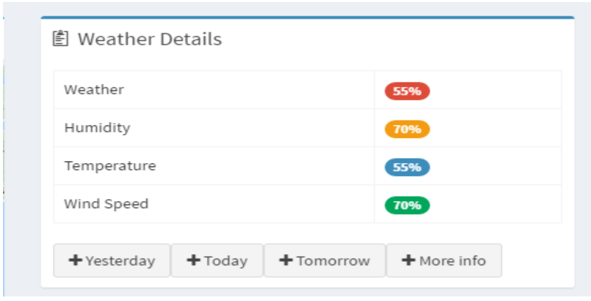

Fig 7: Weather monitoring details

The soil moisture sensor and temperature sensor measures the level of moisture and temperature level in the soil. The values are monitored continuously for any actions to be inculcated. The given graph Fig 7 & Fig 8 shows the variations of temperature and pH values.

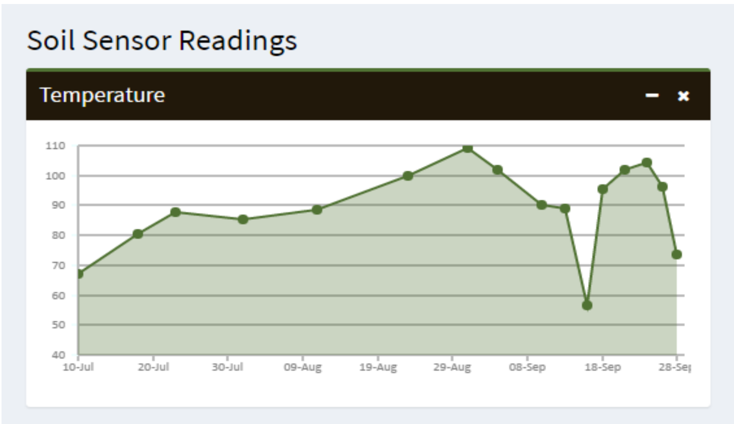

Fig 8: Temperature monitoring details

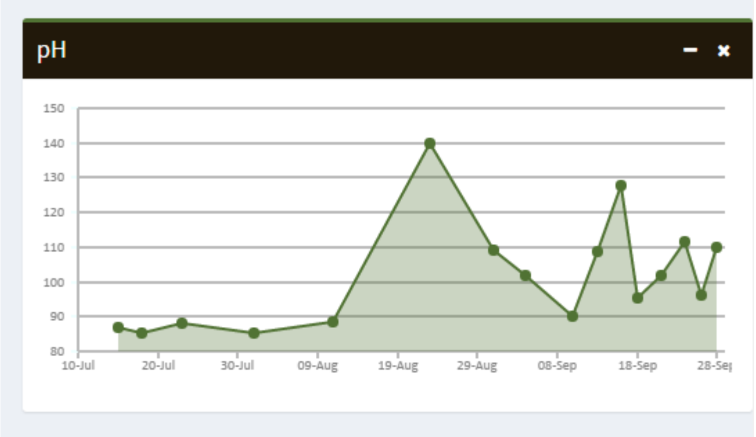

Fig 9: Soil monitoring details

V. CONCLUSION

The focus is mainly on providing a better quality crop and reducing the effort of farmers. Smart farming helps to reduce the costs and time. It helps to increase productivity and efficient schedules. It provides convenient operation from a smartphone with centralized data and high accuracy. This paper shows a model to implement a crop monitoring system until the onion is harvested. This can be extended by categorizing the harvested onions based on quality using image processing and machine learning techniques. The crop can also monitored using drones.

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