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Multi-Level Crop Management System using Internet of Things

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Abstract—***"Agriculture is the backbone of the livelihood security system of nearly 700 million people in the country and we need to build our food security on the foundation of home grown food"*** **- M.S. Swaminathan, Father of Green evolution. Over 50% of India's population is involved in Agriculture, but the contribution to the GDP is only 14%. The yield per acre is very low compared to other countries. Farming in India is still looked upon as a tradition and people are unwilling to look at it as a venture, as there is no guarantee of income. The Crop Management System is a step towards smart agriculture where income is guaranteed and people can look upon farming as a profit making venture. It helps in improving the agricultural produce through automated management of critical resources and also aids farmers in making decisions on cultivation. This is a cloud based solution to achieve "More yield per field" by optimally utilizing resources like water, fertilizers etc. The solution makes use of sensors to collect the critical plant parameters that act as inputs to the local automation system which in turn activates the actuators that control drip, fertigation, temperature and other critical parameters. The data is also loaded on to a central database which has data from other sources like weather stations, agriculture experts etc. This data is used for analytics by the central engine. The automation system also has a feature for manual intervention. This solution can be used as Device as a Service and can cater to the needs of greenhouses, open farms, gardens and cooperative societies. The solution helps in creating rural enterprises and entrepreneurs out of traditional farmers and also circumvents the need for skilled labour.**

Index Terms—**Internet of Things, Cloud Services, Sensors, Gateway.**

I. Introduction

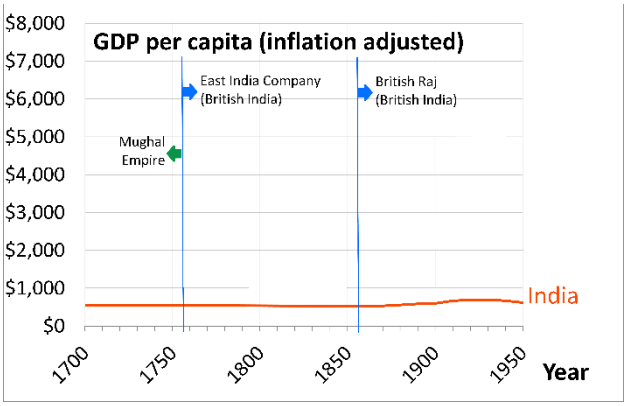
Agriculture is the oldest known occupation to man. Human Beings have been farming since time immemorial. Traditionally farming has been carried out by humans and by animals using certain basic tools. Farming later evolved and people started using machinery for agriculture to have greater yield and also reduce the workload. This later evolved to Automation.

This Automation system mainly focused on watering the crops when no one is on the field to save human effort. The system provides a timer-based watering system which waters the plant few times a day.

A. Evolution of Farming Techniques

The Automated crop management in mechanized agriculture farming is prone to errors. The system is inefficient as the plant may or may not need water at that particular moment. Also, the amount of water required by a plant during any particular period of the crop cycle is different. This may lead to the overwatering of the plant which in turn may cause the leaves to become brown. The automation system does not give the facility for real-time monitoring of crops. Any anomalies that occur cannot be detected.

The population in India involved in agriculture and other related activities is over 50%. But, their contribution to the GDP is just 14%. The yield per acre in India is very low compared to the other countries. The figure below shows that the per capita income obtained by farmers has been the same for over 300 years.



1.1 Agriculture per capita

The solution for increasing the Agriculture Produce and solving the problems because of the Automation is an IoT-based Crop Management System. This system is less prone to errors and can also be used almost anywhere.

II. IoT-Based Crop Management

Farmers consider themselves to be the best judge of their land and the crops. With experience gathered over several generations, they may be able to tell the needs of the plants. This may sometimes be inaccurate and could cause major problems if there are any anomalies.

The Crop knows what it wants. Hence, it is the best judge of the requirements. The Crop Management System is an IoT-based solution that will enable the crops to 'speak' by taking into account the major parameters required for crop growth.

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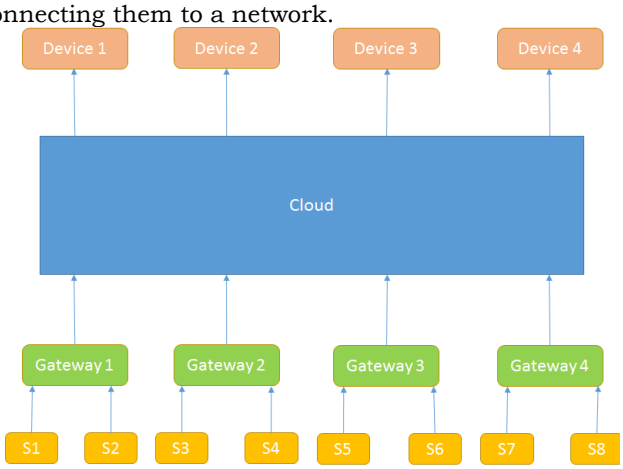
Temperature, Humidity, Soil Moisture and Light Intensity are the 4 important parameters for crop growth. These parameters are monitored by the use of sensors which are then Internet enabled and the feedback is then actuated to the plants.

A. Hardware System

Internet of Things is a Network of Objects. Devices, buildings, stores, etc. are Internet enabled by embedding them with sensors, software and connecting them to a network.



2.1 IoT Building Blocks

IoT consists of 4 main parts: Sensors, Gateway, Cloud and Front-end. The sensors in IoT are generally not on TCP/IP. Since the networks are different, they require a Gateway to connect them to the Internet. The Gateway gets the data from the sensors through the Wireless Sensor Network.

This Data from the Sensors is then transmitted to the Cloud using the TCP/IP protocol. The data on the Cloud is then analyzed for the anomalies and steps are taken to ensure the correct outcome at the Gateway side. The Gateway is also connected to Actuators which perform tasks based on the data returned from the Cloud.

The data from the Sensors is also sent to the End-user at the front-end GUI through the Cloud.

The hardware in this case involves 4 sensors: Temperature, Humidity, Light and Soil Moisture. These are some of the most important parameters of plant growth.

The temperature affects the growth and productivity of the crop depending on the crop's season, based on the 2 crop seasons of India. The rate of photosynthesis of a crop rises with increasing temperature. This is true upto a certain limit. After the upper temperature limit of the crop is reached, the rate of food used by respiration may become more than the rate of food used for photosynthesis. The high temperature may also prohibit food germination. The database in the Cloud gives information about the limiting temperature of each crop. This data is sent to the Gateway which is connected to the Fan and Pad arrangement. Based on the Atmospheric Temperature, the Fan is turned on and the crop can perform photosynthesis without worrying about the high temperature.

Humidity plays an important role in plant growth. Plants inhale through pores called stomata which open under certain conditions. While plants breathe in carbon dioxide, some of the moisture in the plant might escape. If the air is dry, the plant transpires moisture rapidly as compared to wet air. The leaves might lose moisture faster than the rate at which the roots absorb water. This may not leave enough moisture for photosynthesis. In order to prevent this, the plant may close its pores, due to which they may not be able to inhale carbon dioxide for photosynthesis. Without carbon dioxide, the leaves begin to die. It also interferes with the cooling process of the plant as the heat stays trapped in the plant. Generally the humidity required by most plants is around 50% plus or minus 10%. The humidity sensor checks the atmospheric humidity and sends the data to the Cloud. The Cloud compares it to the limiting parameters and gives the necessary details to the Gateway. If the humidity is less than required, the humidifier starts and if the climate is dry, the Gateway starts the dehumidifier.

Soil system is fundamental to the growth of plants. Moisture of soil is important for the growth of plants. A soil that can hold lot of water may come in handy during dry seasons and thus produce good yield. Soil is also important for the chemical process. The nutrients required by the plants are generally absorbed from the soil in a water soluble form. The retention capacity of the soil needs to be known so as not to over water the soil as well as the crop. Over watering might lead to the soil losing some of its important nutrients. It will also cause plants to become yellow or brown as they cannot absorb too much water. The soil moisture is sent to the Cloud via Gateway. Here, the limiting parameters are checked and sent back to the Gateway where the Dripper starts depending on the need of the plant. This solves a major issue as most farmers give a lot of water to the plant which in most cases have adverse effects on the crop and the quality of soil.

Light is another important parameter in agriculture. Crops can grow properly within certain limiting parameters. An increase in the intensity of light leads to increase in photosynthesis and reduce the number of hours a plant needs to perform photosynthesis every day. Beyond a certain amount, the photosynthesis process stops and the plant starts to respire more. The LEDs on the plant can be placed in various Greenhouses or Hydroponic plant to solve this problem. This is done through checking the ideal amount of light required by the crop through the Cloud.

B. Multi-tier System

The key to enabling communication between all sensors, actuators and other "Things" in the ecosystem is standardization. Standardization, however, is easy to be claimed in a research environment, but difficult to be achieved in the real world. Reference architectures are of great help for standardization, as they define guidelines that can be used when planning the implementation of an IoT system.

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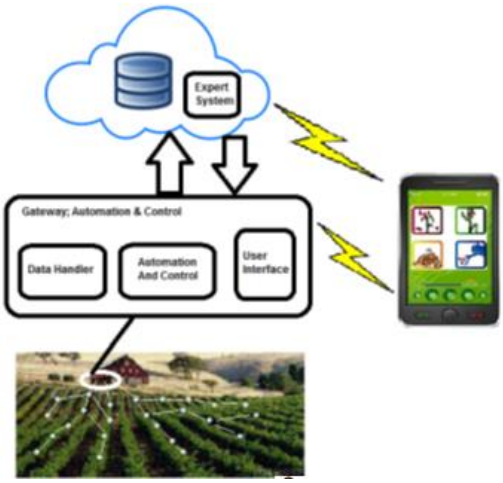
The architecture defined by us is in compliance with IOT – A, reference architecture for IOT systems. As shown below, the system will have 3 levels of control.



2.2 Multi-Tier Control System

1. Level 1 (local Control):

At the local level (For a field), the data from the sensors is collected at the crop control system (Gateway). The local intelligence is capable of making decisions on if an actuator, for example to start a pump, is to be enabled or not depending on the sensor data.

2. Level 2 (Cloud Service):

This will be managed by the central agency that has agriculture experts. The same data that is coming to local control is also forwarded to this cloud service after some filtration and processing. The cloud service is an advisory that can override the decision of the local control and send alerts to the end user (farmer). This system also acts as an interface to the end user. Standard architecture will seamlessly integrate this with other Internet standards that will help building user applications and other advisory applications easily using Internet standards.

3. Level 3 (Manual Control):

The decisions of the local control and the cloud service are intimated to the farmer (end user). The user can override the decision and may not activate the actuator as in the case where he may know that there is scarcity of water and it is required for other priority activities more than for irrigation purpose.

This helps the farmers save their resources as they know the availability of the said resources.

CONCLUSIONS

With this Multi-tier Architecture, the crop yield is sure increase. The estimated increase in crop yield with just the local control is at least 20%, while the estimated increase in yield using the Cloud-based expert system in as much as 50%. This helps the farmers have surplus at all times. The farmers not just get out of the traditional mold with this solution, but it also helps in inculcating an entrepreneurship spirit in them. This spirit being inculcated at rural level would definitely help the Digital India Initiative.

REFERENCES

[1] https://en.wikipedia.org/wiki/Agriculture_in_India.
[2] http://www.ext.colostate.edu/mg/Gardennotes/143.html.
[3] http://members.optusnet.com.au/bdobson/Why%20Humidity%20is%20Important%20to%20Plants.html.
[4] http://www.agriculturesnetwork.org/resources/learning/mod2-online/learning-block-1/1.3/1.3.1
[5] http://www.cropsreview.com/light-intensity.html.
[6] https://upload.wikimedia.org/wikipedia/commons/9/94/1700_AD_through_1950_AD_per_capita_GDP_of_United_Kingdom_and_India_during_the_Colonial_Era.png.
[7] http://mms.businesswire.com/media/20131118005374/en/392535/5/1118-2013-cloud_diagram.jpg.
[8] http://collections.infocollections.org/ukedu/en/d/Jg26p2e/2.2.2.html.