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IOT Platform for Improving Indian Agriculture Systems

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Abstract :- The agriculture particularly in India, is not efficient and organized enough to address the growing demand for food, a direct result of the increasing human population. The major challenges in agriculture are production, storage, transportation improvement and deliver it to the end consumers with the best possible price and best quality. Currently all over India, it is found around 50% for the former production never reaches the end consumer due to the wastage and suboptimal prices. This paper provides the platform for incorporating Internet of Things (IOT) technologies in the agriculture sector, solution to reduce the season based crops, transport cost, predictability of prices on the past data analytics and the current market conditions, reduce the number of middle hops and agents between the farmer and the end consumer using IOT based solution.

Index Terms— Internet of things (IoT), Polyhouse, Leaf analysis, Smart agriculture, Agricultural automation, Cloud computing, Data collection.

I. INTRODUCTION

The Internet of Things (IoT) is a network of Internet enabled objects, together with web services that interact with these objects. Underlying the IoT are technologies such as RFID (Radio Frequency Identification), sensors, and smart phones. Through IoT, digitization of the physical world is being brought about on a massive scale. In the ideal IoT vision, each and every object is embedded with sensing, computing and networking capabilities. The common face of all these connected objects (be it a home appliance, a thermostat, a light or a wearable accessory) is that they collect data that is produced by or about people to offer value-added services [1].

In the agricultural sector, the development and deployment of IoT has been slow, especially in developing nations. The growing demand for food worldwide calls for efficient and effective farming strategies. Such strategies cannot be realized without the active involvement of IoT and cloud computing. A pressing need is thus felt for developing a human-centric IoT platform and cloud services, keeping in mind the fact that the literacy rates and education levels of farmers in developing nations are generally poor. A similar work targeting the Indian agricultural sector has been undertaken recently in which a bottom-up approach has been proposed [2]. IoT can be used to produce the best quality produce by controlling the factors which can be controlled by humans like the soil pH, soil moisture, temperature, humidity, rate of applications of nutrients. While harvesting, IoT can be used to monitor the temperature of the produce at cold storage as well as when it is moved in refer container from one place to another. Real time updates from the Retail store to know temperature at which the produce is kept and how many units are consumed thus helping in forecasting the near term logistics. Analytics over the past data can be used to guide the farmers as to which crop will give them optimal price at what time of year.

Supply is riddled with numbers of factors like unpredictable weather pattern (excess rain, drought, hail etc), amount of supply arriving at a given time at a given market, very short shelf life of perishables, unable to maintain temperature and quality control and so on. While on the Retail side majority of the consumers would like to buy whatever is available at the lowest price (due to excess supply) with the best quality thus depriving the farmers from getting the optimal rates which they should get for the produce. Sometimes it is also seen that there are some section of consumers which are not available in the current season. To get an optimal solution to the above problem there are number of areas which will have to be looked into like, growing the produce with minimal labor and resources, harvesting the produce at right time, access to the best market, time to reach the end consumer from the time the produce was harvested, optimization of distribution channels by various means thus reduction the transport cost, predictability of prices on the past data analytics and the current market conditions, reducing number of middle hops and agents between the farmer and the end consumer and so on. In the current scope we will only look into how IoT will provide us data to enable to provide solution to some the above problems.

II. TECHNOLOGY FOR THE IOT

The IoT is a technological revolution that represents the future of computing and communications, and its development depends on dynamic technical innovation in a number of important fields, from wireless sensors to nanotechnology. First, in order to connect everyday objects and devices to large databases and networks, and indeed to the network of networks the internet a simple, unobtrusive and cost effective system of item identification is crucial. Only then can data about things be collected and processed. Radio Frequency Identification (RFID) offers this functionality. Second, data collection will benefit from the ability to detect changes in the physical status of things, using sensor technologies. Embedded intelligence in the things themselves can further enhance the power of the network by devolving information processing capabilities to the edges of the network. Finally, advances in miniaturization and nanotechnology mean that smaller and smaller things will have the ability to interact and connect. A combination of all of these developments will create an IoT that connects the world's objects in both a sensory and an intelligent manner. Indeed, with the benefit of integrated information processing, industrial products and everyday objects will take on smart characteristics and capabilities. They may also take on electronic identities that can be queried remotely, or be equipped with sensors for detecting physical changes around them, even particles as small as dust might be tagged and networked. Such developments will be the merely static objects of today into newly dynamic things, embedding intelligence in our environment, and stimulating the creation of innovative products and entirely new services.

RFID technology, which uses radio waves to identify items, is seen as one of the pivotal enablers of the IoT. Although it has sometimes been labeled as the next generation of bar codes, RFID systems offer much more in that they can track items in real-time to yield important information about their location and status. Early applications of RFID include automatic highway toll collection, supply-chain management (for large retailers), pharmaceuticals (for the prevention of counterfeiting) and e-health (for patient monitoring). RFID readers are now being embedded in mobile phones. Embedded intelligence in things themselves will distribute processing power to the edges of the network, offering greater possibilities for data processing and increasing the resilience of the network. This will also empower things and devices at the edges of the network to take independent decisions. "Smart things" are difficult to define, but imply a certain processing power and reaction to external stimuli. Advances in smart homes, smart vehicles and personal robotics are some of the leading areas. Research on wearable computing (including wearable mobility vehicles) is swiftly progressing. Scientists are using their imagination to develop new devices and appliances, such as intelligent ovens that can be controlled through phones or the internet, online refrigerators and networked blinds. The IoT will draw on the functionality offered by all of these technologies to realize the vision of a fully interactive and responsive network environment.

III. THE APPLICATION OF IOT TECHNOLOGY IN AGRICULTURE

Agriculture greenhouse production environment measurement and control system is an example of IOT technology application in agriculture. The critical temperature, humidity and soil signals are collected real-time in the agriculture production process, which is transmitted by wireless networks through Machine to Machine (M2M) support platform. It is to gain real-time data of agriculture production environment using Short Messaging Service (SMS), web, Wireless Application Protocol (WAP) pattern, so that the terminal can master the information to guide the production.

IV. THE SYSTEM STRUCTURE

Agriculture greenhouse production environment measurement and control system is made up of terminal link, business link and M2M support platform. Wire sensors can join with communication terminal directly, and then communicate with M2M support platform. Wireless sensors can communicate the M2M support platform through Radio Frequency. Operation management is charge of the service support platform, and the agriculture production monitoring system can get the greenhouse real time data which can send to the mobile terminal through SMS gateway. The structure of Agriculture greenhouse production environment measurement and control system is shown as Fig. 1.

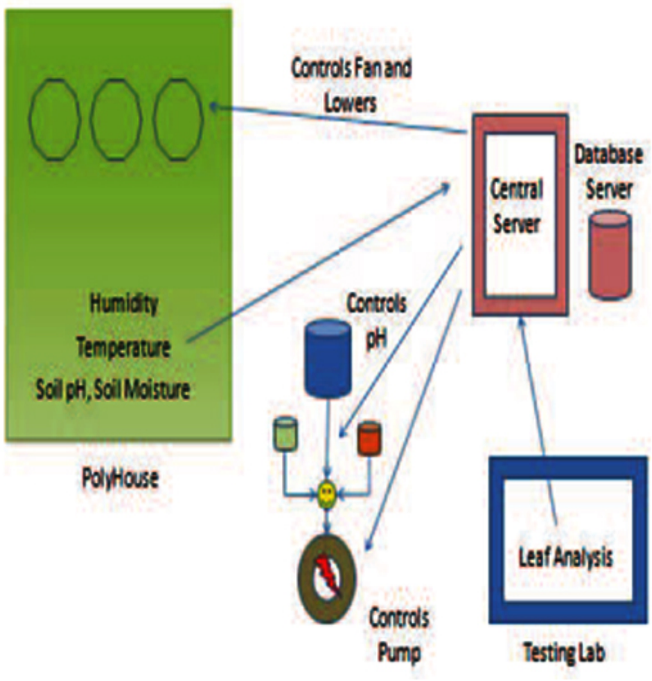

Fig.1. Structure for Agriculture - IoT

IV. SELECTION AND DESIGN OF HARDWARE

The terminal link is made up of wireless communication terminal and sensor collection. The sensor can get the greenhouse production real-time data, such as temperature signal and humidity signal. The value of these physical variables can change into a low-voltage electrical signal through the transmitter, and the transmission to the wireless communication terminal.

The temperature and humidity sensor can measure the greenhouse temperature and humidity, the normal value is shown as follow. Measurement range: -40 to 85 degrees, 0 to100% RH.

Nominal Accuracy: 0.3 degrees, 1.5% RH. Supply voltage: 3.5V to 24V DC, recommended 5V.

The temperature and humidity sensor are shown as Fig.2.

Fig.2. Temperature and Humidity Sensors

When the system working, the temperature sensor directly turns the temperature signal into a digital signal, and then is read out by Micro Control Unit (MCU). The humidity sensor can get the analog signal from the greenhouse air or the soil which the MCU can't read out, so Analog to Digital Convertors (ADC) are need to turn the analog signals into digital signals. MCU collects and process the temperature and humidity signal constantly in the whole work, and the temperature and humidity are displayed by the LCD screen. The power module provide energy to make the system work, also some other sensors can access to the MCU by RS-485 interface. The sensors work principle is shown as Fig.3.

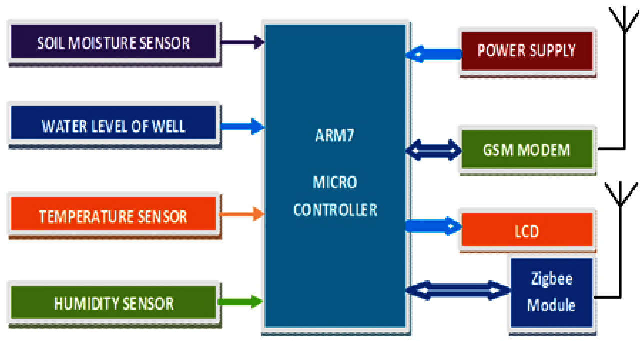

Fig.3. Sensors Working System

Wireless communication terminal is to capture the acquisition sensor signal transmitted through the wireless communication network to the standardized production of agricultural greenhouses monitoring business platform. The wireless terminal is charge of the communication between the remote control serial devices and central control system. Wireless communication terminal is a GSM modem that supports General Packet Radio Service (GPRS). GPRS is a packet switching technology for GSM networks. GPRS modems do not require a constant connection to the Internet as with a standard modem, because it uses the network only when there is data to be sent. GPRS offers faster data transmission and instant connections, subject to radio coverage. GPRS Modem fully enables desktop Internet applications over the mobile network. Other applications for GPRS Modems include file transfer and home automation. GPRS can be used in vehicle positioning applications to deliver several services like remote vehicle diagnostics and stolen vehicle tracking. The structure of wireless communication

V. SOFTWARE DESIGN

The system software includes site monitoring system data acquisition software, remote data acquisition receiver software, and web application software. The site monitoring system data acquisition are made up of user interface module, network communication module, data collection module, data processing module and system configuration module. Remote data acquisition receiver is made up of user interface module, network communication module, system configuration module, and database access module, which can communicate with the site monitoring system data acquisition software through the network communication module with TCP/IP protocol. The web application software include three parts of user authentication, data access, data query and download, which access the database through .Net, and the remote data acquisition can communicate with the database through .Net. The user terminals can get the real time monitoring data from the web page. In order to ensure a reliable long distance data transmission, the system collects the data through the wireless module access to Internet using wireless transmission technology. The data is connected to the specified network database server, and the software in the database server will receive the sending data through the socket. The data are verified its legitimacy and stored in the corresponding table in the database. Parts of a business for customers follow the guiding ideology of simple, clear, focused and designed to show mobile. It shows customers information in a page and the information include each greenhouse each detection point real-time data of air temperature and humidity, soil temperature, 24-hour, a week, or a month's curve and so on. Customers can set alarm value, and the data can be sent to the manager's cell phone via SMS when the data is more than alarm value. Customers are free to set the number of terminals and receive SMS alerts to mobile phone number. Service platform is also reserved for the mobile publicity window, can be integrated weather forecasting, agriculture information and advertising.

VI. FARMING AND TRANSPORTATION PROCESSES

In order to control the farming condition it is advisable to do farming u under controlled environment by using polyhouses. It helps in control of various factors affecting the produce. The initial investment is high but this can be easily recovered by the better yield produced over a given area. Polyhouses help in keeping out bugs and infection. Robotics arms on wheels with camera do the harvesting during the harvest period. Image recognition based on open CV is used to find the ripe produce by detecting the color and the shape of the produce. Sensor detects when the picking basket is full of produce thus helping the robots to stop picking the produce. With help of the various beacons and RFID tags in the polyhouse and the information from the serve, robot prints correct barcode which helps in detecting the polyhouse, aisle and the date and time when the produce was picked. Once the basket is labeled the robot moves to the conveyor belt and places the basket on the belt and picks up the next empty basket from the empty basket rack to continue the picking process from location it had last stopped. Beacons and the RFID tags help the robot to find the exact location. At the end of the conveyor belt the basket is loaded and transported to the grading unit.

In the grading unit basket filled with produce are unloaded and emptied on the conveyor belt where manual quality checks are done to remove unripe and damaged produce. The packaging unit packages the produce either by weight or by quantity depending on the produce. Central server correlates the basket label and the packing marks and numbers thus keeping track of the aisle in which this produce was grown and when it was harvested and when it was packed. Depending on the orders the packaged items are packed in larger packages and labeled with shipping address and sent to the correct bays for loading. Surplus produce is sent to the bay, which take the produce to the cold storage. SCM system plays a major role here to decide which packages and pallets are clubbed in which refer vehicle along with the route plan for the refer vehicle.

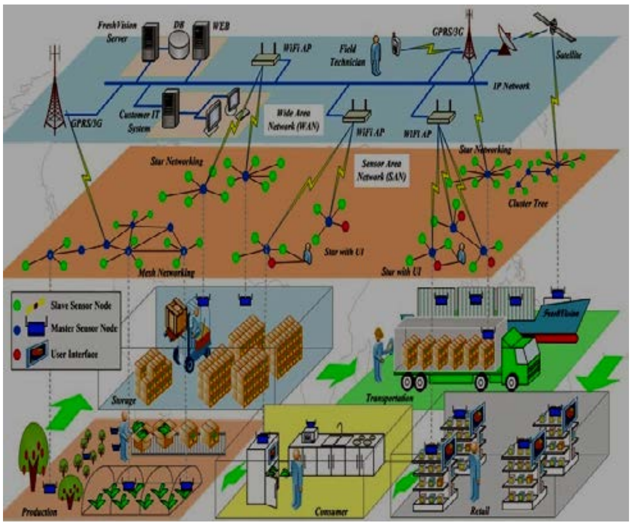

Fig.4. Farming and Transportation Representation

The refer vehicles are fitted with sensors which capture the temperature inside refer along with speed and location of the vehicle. If the temperature of the refer falls due to any reason the driver is notified by the central server to the corrective action and f failure cannot be fixed then the driver is guided by the operator in the central location to the nearest cold storage location or destination where the goods can be offered. This is critical because each refer truck can handled around 10 to 15 tons of produce. Generally a given refer truck will cater multiple stores. When the goods are unload at given store the RFID readers in the truck will detect tags in the pallets and will inform the server. The server will deduce the pallets unloaded the pallets unloaded and record the time and pallet unloaded. Once the produce reaches the store it will be loaded in the shelf and the RFID reader will detect the tags of the produce loaded on the shelf. Periodically it will detect the number of produce available on the shelf and update the central server. There are cases when the produce package cannot have RFID tags. In such cases integrating is required with store inventory management system to detect the low stock of the produce in the store. This information helps the central server to guide the SCM to create order for the given store based on the amount of produce present in the store. The daily consumption of a given store is sent to the analytic server which helps to predict the future quantity which might be required by the store on the given day.

VII. Conclusion

The text has studied on the IoT technology application in agriculture, and selected mobile wireless communication technology to achieve greenhouse-site monitoring. Remote monitoring system with internet and wireless communications combined is proposed. At the same time, taking into account the system management, information management system is designed. The collected data by the system provided for agricultural research and management facilities. Research shows the greenhouse monitor system based on IoT technology has certain precision of monitor and control. According to the need surrounding monitor, this system has realized the automatic control on the environmental temperature, humidity factors. And the system has offered a good growth condition, it is easy to operate, the interface is friendly, offering the real time environmental factors in the greenhouse. It can revise environmental control parameters; this system realizes the operation online, also have these characteristics: run reliably, high performance, improve easily.

It also provides the solution to reduce the transport cost, predictability of prices on the past data analytics and the current market conditions reduce number of middle hops and agents between the farmer and the end consumer using IoT based solution.

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