Applications of Information and Communication Technology in Agricultural Domain

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***Abstract*— Information and communication technology is a mean of effective communication. ICT is growing in every field like agriculture, medical, education etc. Agriculture is a backbone of Indian economy. It is necessary to check whether farmers get the required information whenever they required and what is the role of ICT in providing information to the farmers. Today's era is a full of challenges in agriculture domain due to various reasons such as climate change, global warming, and other issues. Application of modern ICT is used in agriculture domain to reduce cost and improve productivity. It has been found that application of wireless technology is useful in monitoring and controlling of agriculture field. This paper focus on application of ICT in agricultural domain such as environmental monitoring, water management and pest management. mKRISH platform developed by TCS is consider for case study.**

Keywords—Wireless Sensor Networks; Sensors; environment monitoring; water management; pest management, mKRISHI

I. INTRODUCTION

ICT refers to information and communication technology which helps to communicate information with the users. Agriculture is the most important sector in Indian economy. ICT has been developed in every sector including agriculture. It is an application of technology used to increase productivity in different sectors. The government of different countries has invested money to implement ICT in agriculture. Indian government also took the number of projects to implement ICT in agriculture. The objective of such projects is to communicate the information effectively to the end users i.e. Farmers. This paper focus on some agricultural domain to study the effectiveness of ICT in agriculture.

Wireless communication is important mediums of transmission of data or information to other devices in intra and or inter networks. A wireless sensor node is a small computing processor. These nodes are dully connected with a transceiver and both analog and digital interfaces. Various agricultural parameters related sensors such as temperature, humidity, pressure, sound, motion etc. are used and can be measured as physical value data can be stored which are then used for agricultural field controlling and monitoring. These sensor nodes automatically organize themselves into ad-hoc network. A Wireless Sensor Networks (WSN) is composed of several sensor nodes that have the capacity of sensing and gathering data. The WSN system requires a centralized control unit with user interface. WSN have raised considerable interest in the computing and communication systems by farmers and researcher's community. WSNs allow for real-time processing at a minimal considerable investment and easy to deploy, expand, maintain and resilient to the failure of individual measurement points [1] The system shown in Fig 1, comprises a self-administering WSN capable with sensing gathering, and sending data to the base station. It is a model used for monitoring and controlling different activities conducted in agriculture form [5].

Internet of things plays vital role in associating with WSN. The IoT is the internetworking of physical devices embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data [2].

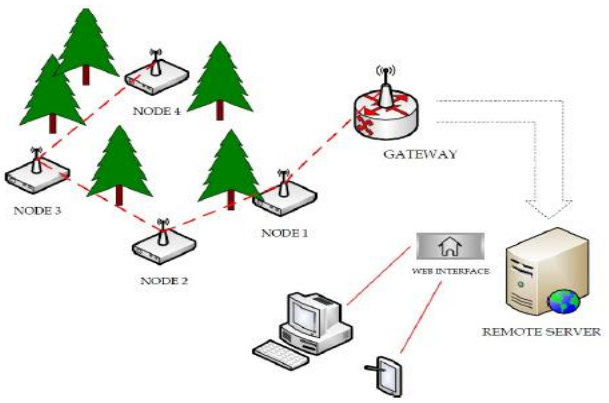

Fig1. WSN System

Precision Agriculture is precise in both the size of the crop field area and delivery amounts of water, fertilizer, pesticides etc. This technology can isolate a single plant for monitoring in the tens or hundreds of square feet. Precision Agriculture requires a unique software model for each geographical area, the intrinsic soil type and the crop or

plants. For example, each location will receive its own optimum amount of water, fertilizer and pesticide. It's generally recommended that data collection be done on an hourly basis. Frequent data collection doesn't provide additional useful information for the software model and becomes a burden to the WSN in terms of power consumption and data transmission. Less frequent monitoring may be acceptable for certain slow growth crops and areas that have very stable, uniform climate conditions. The data collection, monitoring and materials application to the crops allows for higher yields and lower cost, with less impact to the environment. Each area receives only what is required for its space, and at the appropriate time and duration. A general Agricultural application can be employed for: Large crop area monitoring, Forest/Vegetation monitoring, Forest fire prevention, Biomass studies, Tracking Animals, Crop Yield Improvement [2].

II. TYPES OF SENSORS

A sensor is a device used in physical environment that detects and responds to inputs in the forms of analog values such as light, heat, motion, moisture, pressure, etc. The generated output is converted in meaningful to human-readable graphical or textual display for monitoring and controlling activities. Sensors are sophisticated devices that are frequently used to detect and respond to electrical or optical signals. The use of sensor in precision agriculture. Sensors have been used in precision agriculture to monitor and collect data of soil water availability, soil compaction, soil fertility, leaf temperature, leaf area index, plant water status, local climate data, insect-disease-weed infestation etc. These data can be collected by using different types of sensors. These sensors can be selected by different parameters depending on environmental conditions, communication range, accuracy and of course cost and brand in the market. WSN can be linked to external servers or services both with wires or wirelessly. The connection options could be using Ethernet connection, Wi-Fi, Bluetooth, or GSM-GPRS. [3]. Types of sensors used commonly in small area of agriculture field is given as:

- Temperature Sensor: The LM35 is an integrated circuit temperature sensor that can be used to measure temperature with an electrical output proportional to the temperature measured in °C.

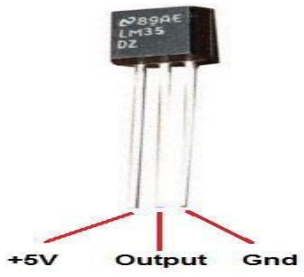

Fig 2. Temperature sensor

- Humidity Sensor: Humidity is an integrated circuit sensor that can be used to measure the presence of water in land. The HR202 humidity is a new kind of humidity-sensitive resistor made from organic macromolecule materials. The humidity sensor with its output proportional to the temperature in RH %. The operating temperature range is from 20-95%RH.

Fig 3. Humidity sensor

- Water Level Sensor: Water level floats sensor, also known as float balls, are spherical, cylindrical, belong or similarly shaped objects, made from either rigid or flexible material, that are buoyant in water and other liquids. They are non-electrical hardware frequently used as visual sight-indicators for surface demarcation and level measurement. They may also be incorporated into switch mechanisms or translucent fluid-tubes as a component in monitoring or controlling liquid level [7].

Fig 4. Water level sensor

III. APPLICATIONS OF WSN IN AGRICULTURE

The introduction of WSN nodes for farm monitoring has capability for supervising how parameters changes in real time environment. Application of WSN can be possible in every agriculture aspects, but important areas are environmental monitoring, water management and pest control as follows [4]:

A. Environmental Monitoring

Describes the processes and activities that need to take place to characterize and monitor the quality of the environment. The foundation of EM is the collection of data, which enables a better understanding of our natural surroundings to be gained by means of observation. Environmental Monitoring is not limited to the understanding of environments, but also includes monitoring for preservation reasons. The environmental parameters, such as temperature, humidity, water seepage of ground, etc. are the key factors of substations in electric networks. The manual inspection is still used in many substations in India.

EM plays a key-role to show the effects of human behavior on the environment and to disclose its limits. Typical applications, in addition to purely environmental

science purposes, include the protection of water supplies, radioactive waste treatment, air pollution monitoring, natural resource protection, weather forecasting and enumeration and monitoring of species. Environmental Monitoring strives to determine the status of a changing environment by analyzing a representative sample of the environment. As such, data acquisition forms a major part of EM. The data acquisition system in use must allow for the collection of representative samples, which includes concerns such as the intrusiveness of the measurement system itself, sampling accuracy or sample storage. In the last few years, the occurrences of natural Changes in atmosphere have been becoming the cause for the Fungus, Bacterial attacks on the agricultural. If such changes are not aware in time to us the precautions cannot be taken and there will be bad effect on the agricultural production. Thus, it is necessary to monitor parameters like Humidity, Soil moisture, water level of land [].

B. Water Management

The application of wireless sensor network for a water irrigation control monitoring is composed of many sensor nodes with a networking capability that can be deployed for an ad hoc and continuous monitoring purpose. The parameters involved in the water reservation control such as the water level and motor movement of the gate controlling the flow of water will be measured in the real time by the sensors that send the data to the base station or control/ monitoring room. Precision irrigation is an important practice in water- saving agriculture cropping system, which allows producers to maximize their productivity while saving water. While the accurate irrigation amount is difficult to obtain as the impact factor was too much.

Agriculture is the one which utilizes most of the fresh water, must be optimized in a best way to avoid the draining of natural resource. Many strategies are employed to save water such as drip; sprinkler irrigations. Irrigation is the application of water to the land soil. Automation in irrigation system generally consists of soil moisture sensor or water level sensor, a control system and irrigation system components. There are also several researches on soil moisture sensor-based irrigation system. Water level sensors have application in irrigation water distribution and delivery system.

C. Pest Control:

Pest detection and control is at least as old as agriculture because there has always been a need to keep crops free from pests. Many techniques so far proposed for pest control in agriculture using wireless sensor network. Since agriculture is considered as one of the oldest occupational activity, pest management and control is then born. Farmers usually need to keep their crops free from harmful pests as possible for these creatures may damage their yields resulting to a poor harvest and poor food quality. So far, there are many feasible techniques proposed for pest control in agriculture using WSN. One of these techniques may include pest identification through physical characteristic detection. The system has a stored data regarding the physical attributes of pests, when such pest is detected, the system can easily know what type of pest it is and immediately suggest possible ways on how to manage the farm situation.

IV. MKRISHI

The mKRISHI platform, developed by Tata Consultancy Services in 2007, enables farmers to access best-practice information and agricultural experts through low-cost mobile phones using SMS. The connection between agricultural advisory services and risk mitigation is an important one, because information alone is often not sufficient to manage risk.

Through the advisory service, farmers might inquire how much fertilizer or pesticide to use, so they can optimize their use of these costly inputs. Similarly, farmers might inquire about when to harvest to avoid inclement weather. Farmers with cameras in their phones can submit photographs to supplement their messages. While responding to farmers' queries, experts can incorporate soil information by accessing the soil sensor nearest to the caller's location. Farmers can also request a voice- or SMS-based expert response.

mKRISHI disseminates a wide range of personalized information; the critical difference is that experts can respond to farmers' queries. To provide the early warning and news information, the system relies on a web-based mobile platform that ties into many information sources. Data are gathered from commodity exchanges, agricultural research Institutions or Agricultural University, banks, weather servers, local markets, and solar-powered weather and soil sensors distributed throughout the areas where the service is offered. This is shown in figure . [6].

To respond to farmers' queries, mKRISHI relies on an automated database of frequently asked questions. The database can handle most questions, which are usually generic, but more specific or sophisticated questions are forwarded to 10 experts with Internet access. These experts interact with a system that resembles email; they can see attached photos and soil sensor information with each message and their response is sent back to the farmer by SMS.

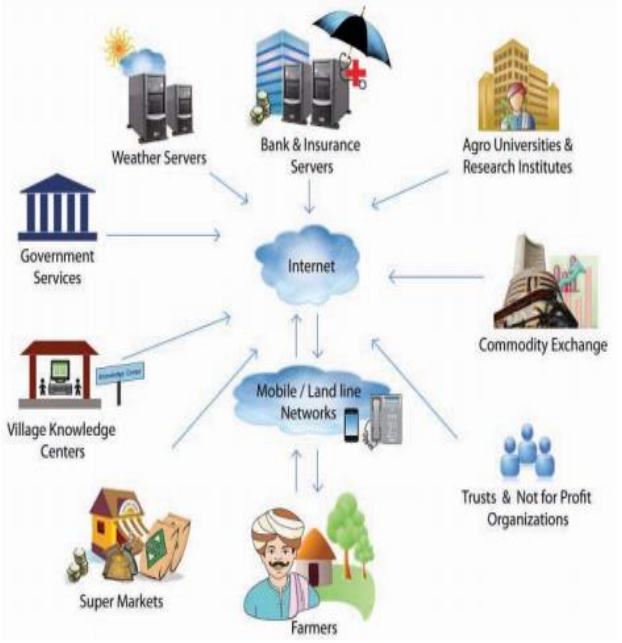

Fig 5. mKRISHI

The complexity of the platform and the numerous pieces that are tied together, from people to technologies to automatic sensors, imply a difficult and expensive challenge to sustainability. Another challenge is posed by the inability to collect the full marginal cost of the service from farmers.

V. CONCLUSION

The application of ICT has been started in almost all countries including India. The numbers of applications are available for different functions like agricultural marketing, supply chain management, agricultural information system, pest control and management etc. Wireless Sensor Network is an integrated part of today's ICT. A WSN is an emerging field with day by day increasing applications areas in agriculture. This paper has described the applications of a wireless sensor network for environment monitoring, water management and pest management. mKRISHI has been able to organize and personalize it through a large consortium of partners. It is concluded that ICT should work as a guide as well as friend of the farmers to give right advice to the farmers

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