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A SURVEY ON INTERNET OF AGRICULTURE

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Abstract: This paper presents ideas for a new generation of agricultural system models that could meet the needs of a growing community of farmers. In this era, especially in agriculture there is a need to improve the productivity of the farming through precision agriculture and boosting the crop plantation through techniques of plant breeding and genetic selection. But still both these techniques cannot be used together because of their farming methods. So we have proposed an idea of using analytics in great deal to solve this driven action. Precision agriculture makes use of a complete set of information technologies that rely on site-specific field information to vary production and management practices across the entire farm. Farmers have avoided potential precision agriculture technologies because of the time it takes to learn how to use them, the difficulty in managing the changes, and most importantly, a lack of obvious return on investment. Complexset of analytics, which is using data from the Internet of Agriculture, will shed new light on our understanding of what affects what, why, when and how and in the process reinvent the agricultural sector. This understanding will evolve with improvements in analytics and as associated scientific disciplines advance. Moreover, despite our tremendous data-collection capabilities, field and yield information is only valuable to farmers if it informs a management decision or agronomic practice. More sophisticated analytical tools that can synthesize all forms of data must be developed to enable the next step change in optimizing farming practices. We have also addressed the further advances in precision agriculture.

Keywords- Data Analytics, Precision techniques, Agriculture, Farming

I. Introduction

The Internet of Things (IoT) is a massive network system of interconnected computing devices, mechanical and digital machines, objects, animals or people that are identified with provided unique identifiers and the capability to transfer data over a network without human-to-human or human-to-computer intervention. The main objective of internet of things is establishment of communication between anything(any device), anyone, any services from any network, anywhere at any time.A IOT system usually has three components, Hardware, Middleware and Presentation

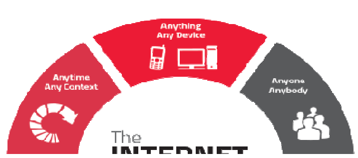
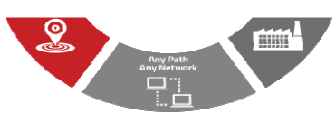


Figure 1 Objective of IOT



II. IoT Technologies

In this section, few IOT technologies are discussed which makeup the IOT elements.

2.1 Radio Frequency Identification (RFID)

RFID stands for Radio-Frequency Identification [9,10]. RFID is a embedded small electronic device that consist of a small chip and an antenna that enables wireless data communication. The chip is able to carry 2,000 bytes of data or less. It helps to identify anything automatically which is attached to it that acts an electronic barcode. A RFID system consists of two parts: a tag or label and a reader. RFID tags or labels have a transmitter and a receiver. The RFID component is composed of two components on the tags: a microchip to store and process information, and an antenna that receives and transmits signal. For each object the tag contains the specific serial number (object ID). The information encoded on the RFID tag is read by a interrogator or reader which acts as a two-way radio transmitter – receiver. The tag responds to the signal with the information stored in its memory by transmitting the read results to the computer program written for the corresponding RFID. There are two different types of RFID tags: battery powered and passive. A batter powered RFID tag is embedded with a small battery that powers the relay of information. A passive RFID tag will use the interrogator's radio wave energy to relay its stored information back to the interrogator.

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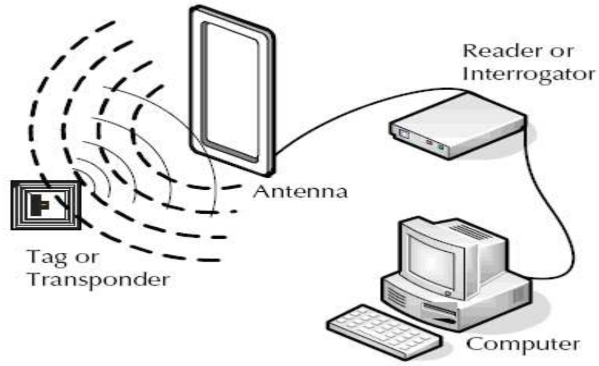


Figure 2 Working of RFID

2.2 **Wireless Sensor Networks (WSN)**

WSN [3,10] is the one of the most important elements in IoT environment. Sensor networks promising tools that have been emerged to monitor the physical world, that can able to sense, process and communicate. A sensor network is a network of interconnected tiny disposable low power devices called nodes. A wireless sensor node (or simply sensor node) consists of sensing, computing, communication, actuation, and power components. A WSN contains of tens to thousands of such nodes which communicate through wireless channels for information sharing.

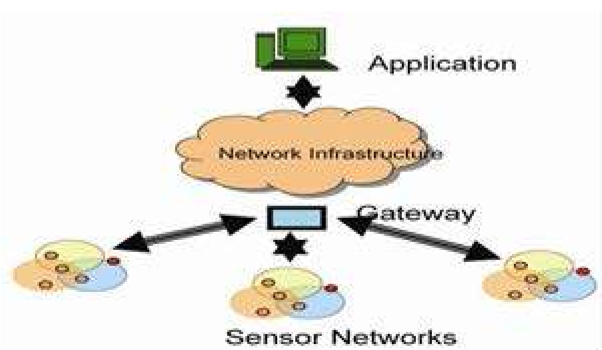


Figure 3 Architecture of WSN

2.3**Addressing schemes**

The ability to identify the things uniquely is most challenging issue for the success of IOT. The few most critical features for naming are: uniqueness, reliability, persistence and scalability. Each and every element that have already established the connection and those elements which are yet to establish the connection must be identified by their unique ID, location and functionalities. IPV4 naming support the identification of a group of cohabiting sensor devices geographically, but they do not identify individually. IPV6's internet mobility attributes may support to some extent in the identification of individual device. But still heterogeneous nature of wireless nodes, variable data types, concurrent operations and confluence of data from devices are the challenges. Data traffic, bottle neck at the interface between the gateway and wireless sensor devices, scalability of devices, reliability of data over the network are also should be considered during naming. Uniform Resource Name (URN) system is considered fundamental for the development of IoT that address the above issues. The duplicates of resources are created and those can be accessed through the URL.IPv6 also gives a very good option to access the resources uniquely and remotely[11].

III. **ITU Architecture**

According to the recommendations of the International Telecommunication Union (ITU), the network, Architecture Internet of Things consists of

(a) The Sensing Layer

(b) The Access Layer

(c) The Network Layer

(d) The Middleware Layer

(e) The Application Layers

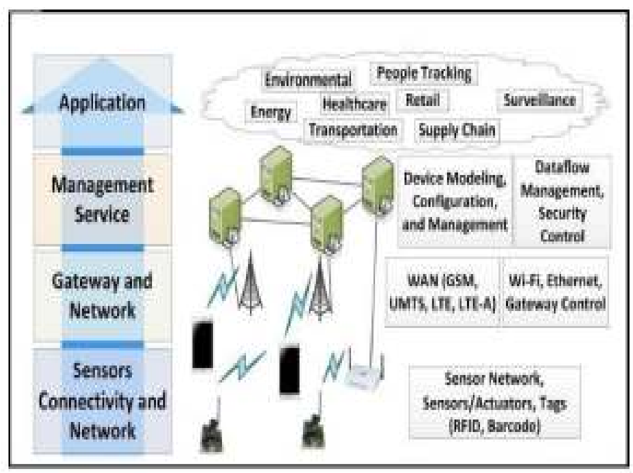


Figure 2 Layers of IOT Technology

3.1 Sensors connectivity and network:

Sensors are the front end of the IoT system. They are also termed as "Things" of the system. The main functionality of the sensors is to receive the data from the sensors or to transmit data to actuators. They are uniquely identified with unique IP address. The sensors are able to collect real time data and active in nature. They can be autonomous or user controlled.

3.2 Gateways:

Gateways routes the processed data and send it to proper locations for its (data) proper utilization.

Gateway helps in to and fro communication of the data. It provides network connectivity to the data. Network connectivity is essential for any IoT system to communicate. LAN, WAN, PAN etc are examples of network gateways.

3.3 Management Service:

Management service or Processors are the brain of the IoT system. Their main function is to manage, process the data collected by the sensor to extract the valuable information from the huge volume of raw data collected. It gives intelligence to the data. They provide securing the data – which performs encryption and decryption of data.Embedded hardware devices, microcontroller etc are the ones that process the data since the processors are attached to it.

3.4 Applications:

Applications forms an another end of the IoT system. Applications are necessary for utilization of the data collected. These cloud based applications which are responsible for rendering effective meaning to the data collected. Applications are controlled by users and are delivery point of particular services.Examples of applications are: home automation apps, security systems, industrial control hub etc

IV.Application areas for The Internet Of Things

4.1 Building & home automation:

Building automation or smart building[12] is described as building with technology of connected deviceswhich provide a convenient, comfort and secured environment for the occupants. A Intelligent home or building increases the quality of living. The research and implementation of building /Home automation is getting more popular because of the budding research area internet of things. Beyond this smart home reduces costs and conserve energy.

4.2 Smart cities

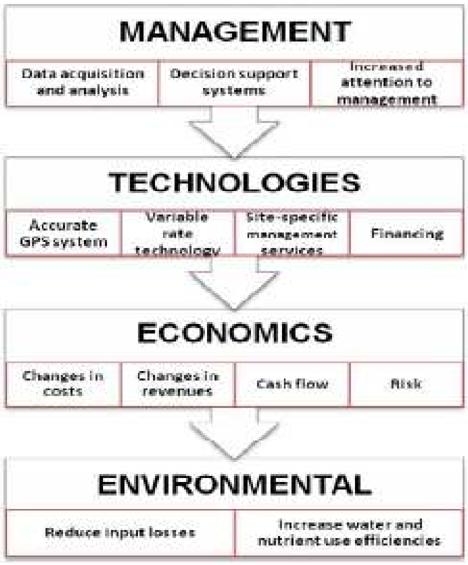
Smart City [13], aims at providing the most advanced technologies to communicate with value added services for quality administration of city that enchance the quality of l living.The number of IoT applications in many domains like such as home automation, industrial automation, medical aids, mobile healthcare, elderly assistance, intelligent energy management and smart grids, automotive, traffic management, and etc generate lot many data for the citizens in their place for their sophisticated living.

4.3Healthcare

There's an increased engagement and consciousness because of the advancement of healthcare technologies. In such a case, the demand for remote care is more encouraged than ever. However, the current healthcare ecosystems are not equipped with technologies that can improve patient care by updating them with real-time patient information and allowing them to take proactive measures for treatment. The IoT solution for the healthcare sector allows hospitals to get better care of quality while focusing on overall expenditure reduction.

4.4Precision agriculture

Precision agriculture [1,2]is the IOT enabled smart system for agriculture that transforms the agriculture industry and enables the farmers to contend with their challenges. Precision is also termed as precision age or precision farming. Innovated IOT applications can address the recent issues of farmers and therefore increase the quality, quantity, sustainability and cost effectiveness of crop production and raising the livestock. With precision technology farmers and the soil work better not tougher. Because of precision farming economical and environmental advantages can be visualized by reduction of use of water, fertilizer, herbicides and pesticides in addition to the reduction of farm equipments. Precision farming implies site-specific approach with in the field and adjusts the field management accordingly. The variations of can be traced to managementpractices, soil properties and/or environmental characteristics. Afarmer's mental information database about the field management over the years is trial and error. In recent situations such knowledge about the field conditions is difficult tomaintain because of the larger farm sizes. Precision agriculture automates and simplifiesthe datacollection and analysis of data. It allows taking decisions and implementing the decisions quickly.



4.4.1. Wireless Sensors in Precision Agriculture

The Wireless sensors in the precision agriculture applications not only increases the efficiency, productivity and profitability but also minimize the impacts on wildlife and the environment Soil base information are provided to the farmers to take decisions and adjust the strategies at any time. In figure 4, Wireless sensors in precision agriculture used to assist in

(1) Spatial data collection

(2) Variable-rate technology

(3) Supplying data to farmers.

Figure 4 Wireless sensor in precision agriculture

4.4.1.1 Spatial data collection:

Spatial data collection system has a data collection system, manager system, data acquisition system and control systems on farm equipments. This system is able to conduct local field survey to collect data on the availability of soil water, soil compaction, biomass yield, fertility of soil, leaf area index, temperature of leaf, chlorophyll content of leaf, plant water status, local climate data, diseases, yield of grain etc. The data is collected through WLAN by data collection vehicle and, the data is stored and transmitted by manager vehicle wirelessly [7].

4.4.1.2 Variable-rate technology

Variable rate technology helps to develop the automated fertilizer applicator in the field of crops. The system consists of aninput module and real-time sensor data acquisition, a decision module for calculating the optimal quantity and spread pattern for a fertilizer,and an output module to regulate the fertilizer application rate. Communications between the modules are established using a Bluetooth network [8].

4.4.1.3 Supplying data to farmers

It involves a web server which provides information on pest, diseaseinfestation and weather forecasts. Farmers can download the informationdirectly via Internet and use them for operation scheduling . Figure 5 shows the steps of precision agriculture.

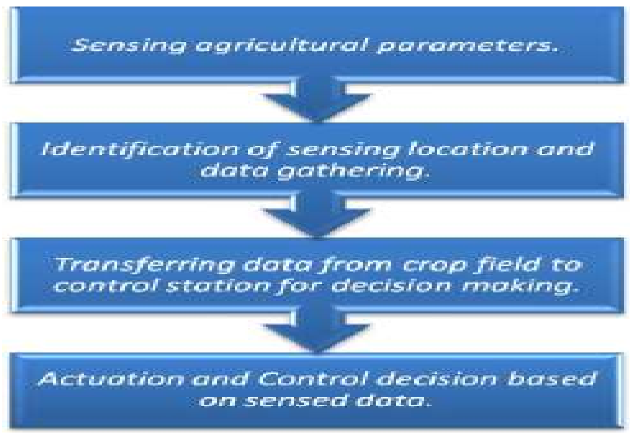


Figure 5 Steps of precision agriculture

4.4.2. Technology used in precision agriculture:

4.4.2.1 GPS/GNSS

Global Positioning System (GPS) receivers calculate the geo positions from signals broadcasted by GPS satellites.The satellite provides real time continuous information while in motion.This allows mapping the soil and crop measurements. GPS receivers, are either carried to the field or mounted on the implements that provide the information of the specific location which the farmer take it as sample and treat those areas. GPS applications in precision farming also enable the farmers in soil samplecollection, chemical applications control, and harvest yield monitor.To be useful in agriculture, new Global Navigation Satellite Systems (GNSS) receiver technology is introduced today to have accurate information.

4.4.2.2 Yield monitoring and mapping

Ayield monitor provides useful information and thus enhanceson-farm research. The data accumulated by the yield for a specific field enable the research on comparisons of hybrid, varieties or treatments. When it is linked with a GPS receiver, yield monitors provide data which is necessary foryield maps. Yield measurements are necessary for efficient decision making.yield monitor includes various sensors and other components that also includes data storage device,user interface and task computer that controls the , interaction and integration.Thesensors measure the mass or the volume of grain flow (grain flowsensors), separator speed, ground speed, grain. Figure 6 shows the yield monitor.

Figure 6 Yield monitor

4.4.2.3Grid soil sampling and variable-rate fertilizer (VRT)application

Taking samples from portions of farm not more than 20 acres is known as soil sampling procedure which is recommended. Soil samples from random spaces are combined and tested in the laboratory. Crop advisors make recommendations based on the sampling test.Grid soil sampling is similar to the soil sampling but intensity of sampling is increased.Thegrid soil sampling is a mapof nutrient needs, called an application map.Interpretationof crop nutrient needs is analyzed for each grid soil sample in the laboratory. According to the nutrients needs fertilizer application map is plotted with the entire set of soil samples.Variable-rate fertilizer spreader works in according to the application map loaded in the computer.

4.4.2.3 Remote sensing

Hand-held devices that are mounted on the aircraft or satellite act as data sensors. Data collection from distance is called remote sensing. Remote sensing provide evaluation of crop health.Plant stress related to moisture, nutrients, compaction, cropdiseases and other plant health concerns are often detected by overhead images. Electronic cameras can also capture infraredimages that relates to the healthy plant tissue. Remote sensing allow the farmers to make management decisions regarding season variability that affects the crop yield.

4.4.2.4 Crop scouting

In-season observations of crop conditions may include:Weed patches (weed type and intensity),Insect or fungal infestation (species and intensity), Crop tissue nutrient status, Flooded and eroded areas are some of the observations of crop conditions.GPS receiver is used to locate the location for treatment. Yield map variations can be explained with these observations.

4.4.2.5 Geographic information systems (GIS)

The main functionality of GIS is to store information such as yields, sensor data, soil survey maps, soil nutrients levels and crop scouting reports.GIS contains computer hardware and software that make use of feature attributes and geographical data to produce maps. The result can be displayed by adding a visual perspective for interpreting.In addition to data storage and display, the GIS also enables to manage the farming scenarios.

V. RelatedResearch

In the studies related to wireless sensor network, researchers measured soil related parameters such as temperature and humidity. Sensors were placed below the soil which communicates with relay nodes by the use of effective communication protocol providing very low duty cycle and hence increasing the life time of soil monitoring system. The system was developed using microcontroller, universal asynchronous receiver transmitter (UART) interface and sensors while the transmission was done by hourly sampling and buffering the data, transmit it and then checking the status messages. The drawbacks of the system were its cost and deployment of sensor under the soil which causes attenuation of radio frequency (RF) signals[14].

The newer scenario of decreasing water tables, drying up of rivers and tanks, unpredictable environment present an urgent need of proper utilization of water. To cope up with this use of temperature and moisture sensor at suitable locations for monitoring of crops is implemented [15].

The cloud computing devices that can create a whole computing system from sensors to tools that observe data from agricultural field images and from human actors on the ground and accurately feed the data into the repositories along with the location as GPS coordinates[16].

This paper discusses about proposing a low cost and well-organized wireless sensor network technique to obtain the soil moisture and temperature from various location of farm and as per the need of crop controller to take the decision whether the irrigation is enabled or not[17].

In this paper, greenhouse is a building in which plants are grown in closed environment. It is used to maintain the optimal conditions of the environment, greenhouse management and data acquisition[18].

The smart agriculture market is expected to reach $18.45 Billion in 2022, at a CAGR of 13.8%. BI calculates approximately 75 million IoT devices will be shipped for agricultural uses in 2020, at a CAGR of 20%. IoT devices can be of great help in enhancing the production and yield in the agriculture sector since these devices can be used to monitor soil acidity level, temperature, and other variables. Moreover, smart agriculture will help in monitoring livestock productivity and health as well. IoT sensors are capable of providing farmers with information about crop yields, rainfall, pest infestation, and soil nutrition are invaluable to production and offer precise data which can be used to improve farming techniques over time. Internet of things, with its real-time, accurate and shared characteristics, will bring great changes to the agricultural supply chain and provide a critical technology for establishing a smooth flow of agricultural logistics[19].

It is the biggest issue of agriculture now days. In a conference in Lahore on "Climate smart Agriculture" experts from agriculture sectors found out that agriculture production will decrease 10-20% by 2050 because of climate change. Climate change affects directly all the factors related to agriculture. It directly impacts on quality and productivity of crops. Therefore a quick solution is required to address this issue .A recent report by Ericsson, in fact, claims that information and communication technologies (ICT) could help cut up to 63.5 Gt of GHG emissions by 2030[20].

Smartphone and IoT are complementary to each other. Therefore it has a huge role to play in smart agriculture. Now a days, because of cheaper smart phone available in market, farmers can easily have access to it. Moreover their computing power helps user to create a variety of practical applications. The android mobile application i.e android app helps to monitor and control the field from anywhere. The mobile application uses PHP script to fetch data from MySQL database[21].

Some functionalities of different type of sensors used for better farming.

- Soil moisture sensor helps to manage irrigation efficiently. This sensor with two probes is inserted into the soil. The probes are used to pass current through the soil. The moisture in soil has less resistance and hence passes more current through the soil whereas, the dry soil has high resistance and passes less current through the soil. The resistance value help detecting the soil moisture.

- The DHT11 is called as temperature and Humidity sensor. The total amount of water vapor in air is defined as a measure of humidity. When there is a change in temperature, relative humidity alsochanged. The temperature and humidity changes occur beforehand after irrigation. The amount of water droplets in air is increased after irrigation. This causes decrease in temperature which in turn increases the relative humidity of thesurroundings. The temperature and humidity reading are often notified to the user so that the user can be able to know the field conditions from anywhere.

- Light sensor helps to detect light intensity of the environment. Light being a major source for crops responsible for photosynthesis. Light Dependent Resistor(LDR) is used in which the resistivity decreases with increase in light intensity and vice versa. Measurement of resistors is done by voltage divider circuit due to light intensity variations. Light intensity increases voltage level. The analog reading is taken from the board. It can be used in green houses where artificial lighting is done using any of the incandescent lamps, fluorescent lamps instead of sunlight[22].

Agriculture is important segment of the Tamil Nadu. This paper discusses about the Association rule mining, Classification, clustering and regression. It also discussed the application of the data mining techniques in agriculture such as K-means, Fuzzy set, Decision tree, Bayesion classification, naïve bayes, K nearest neighbor, neural networks and support vector machine[23].

VI. Conclusion

In this paper we have analyzed the factors and the technologies which are used for the precision agriculture .As the agricultural system models needs a new generation to meet the needs of a growing farmer community, we have proposed the method of precision agriculture. Through this precision agriculture analysis, we firmly belief that an opportunity is provided to improve the productivity of the farming. The need of the data analytics was also greatly discussed to make future predictions' towards the farming outcome. Another objective of this proposal is also to overcome the lack of obvious return on investment. Till date the precision agriculture was avoided by the Farmers as they believe that it takes more time to implement but we have proposed how the difficultycan be managed. We have also discussed about the effects acquired through precision agriculture and this understanding will help the farming community to evolve field and yield information while taking the decisions.

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