International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2015): 6.391

Precision Agriculture: A Survey

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Abstract: ***Agriculture is the base of Indian economy. There is a need to provide better technological solutions to the farmers for the precision agriculture. Many methods and techniques are being developed in order to aid the agricultural activities. Precision Agriculture is one the most important fields with an increasing need of decision support systems. Precision agriculture includes different systems which provide the variety of services such as Information services, Traceability systems, Precision irrigation, monitoring, controlling and management of the agricultural field. This paper explores how precision agriculture services and related mobile apps have impacted the farmers in their farming activities.***

Keywords: Internet of Things; WSN; Mobile App; Agriculture; ZigBee; PIR

1. Introduction

In agriculture, the utilization of Wireless Sensor Networks (WSNs) is very efficiently used under the umbrella of precision farming. The development of agriculture industry starts with technologies farming machine like tractors, grain combine machine which needs to be economical and useful to the farmers. Day by day with growing Information and Communication Technologies (ICT), farmers can get benefits to extend their crop gain. Through sensor networks, agriculture field gets connected to the IoT that permits to form connections among agronomists and farmers crops irrespective of their location. With the assistance of this approach that provides time period data regarding the lands and crops, helps farmers build right
choices.

The new ideas within the upcoming technologies measure Wireless Sensor Network (WSN), internet of Things (IoT), and Precision Agriculture (PA) [1, 2]. The "Mote or sensor Node" is used as a collaboration and synergy of sensing, processing, communication and actuation. The massive strength of motes is that they form a network and co-operate according to numerous models and architectures, such networks are referred to as WSN. The Internet of Things is that technology, which connect real world things with each other which tend to make several embedded system together with fields like electronics Communication Technology and sensors through which the information will be transferred and received reliably [1].

The PA is no longer a new term in agriculture field. The initial development of PA was done in Minneapolis in 1992, and then it has become the research and implementation topic worldwide. Precision Agriculture is usually outlined as "Information and Technology based farm management system to identify, analyze and manage variability at various fields for optimum profit, property and protection of the land resource" [2]. In this mode of farming, new information technologies can be adopted to make better decisions about many aspects of crop production and maintenance. Precision agriculture increases efficiency. The aim is to manage and distribute inputs on a website at specific basis to improve long run cost and benefit. With increase in the input prices for production of the goods, the farmers are searching for better approaches to expand power and cut costs [4].

Researchers have proposed various models for agriculture sector with one or multiple technologies. Various functionalities will be given the assistance of multiple technologies. The basic functionality within the Precision farming is Precision Irrigation. This paper includes summary of existing Precision Irrigation systems also for explicit crops and area, for open agriculture and greenhouse system too. Data collection has been carried for environmental monitoring of the field with different sensors as per the systems requirement. Precision agriculture applications includes data collection, reporting, integrating GPS data into geographic information systems, Tractability systems such as animal tracking and identification, web cameras to view the field. The growing mobile technology and mobile enabled data services give a way to overcome existing asymmetry of information in all fields like agriculture, health care and education. There is an enormous gap between the supply and delivery of agriculture inputs and agriculture infrastructure which will form a bridge by the mobile technologies.

The android Apps that associate open supply development platform to create the terribly powerful applications to developers. This paper additionally mentions the android Apps built for Precision Agriculture in continuing section. There are several systems for development of Precision agriculture, from basic ones to a lot of technologically advanced ones. Precision Agriculture is classified according to requirements or need of the farmers.

2. Monitoring and Controlling Services

2.1 Existing Precision Irrigation

The basic functionality in the precision farming is Precision Irrigation. This paper includes a survey of existing Precision Irrigation systems. For the technique of automated irrigation various methods have been used such as irrigation scheduled depending on canopy temperature distribution of the plant [5], Irrigation systems based on water content of soil, measured with the help of dielectric moisture sensors to control actuators and to minimize the usage of water [6], also to optimize water usage and schedule irrigation of crops

using crop water stress index (CWSI) [7], estimation of the plant evapotranspiration (ET) [9], and irrigation by means of infrared thermometers [8]. Authors Joaquin Gutirrez, et al. [3] proposed Automated Irrigation System for agricultural crops. It contains a WSN network of soil-moisture and temperature sensors. With these sensor's moisture threshold values, algorithm was developed and programmed into a microcontroller-based gateway to control water to plants. This application also uses irrigation system with ZigBee technology and a GPRS module which transmits the data to an internet server through the mobile network. The monitoring of field is performed remotely with GUI interface through net access devices.

The work proposed in [10] contains different conditions required for the potato crop cultivation such as soil type, planting period, seed cutting and storage, harvesting methods and post-harvest. It includes node deployment, number of nodes and routing protocol. The WSN deployed is not generalized, however, it is suited specifically for potato crops in Egypt only. Authors AjiHanggoro et al. [11], proposed a method to remotely monitor and control the humidity of a green house. The water sprayer is turned ON to increase the humidity level, if the green house is found to be dry. On the contrary if it is too humid, the roof top is opened to lower the humidity. Such monitoring and controlling is done through Android Smartphone.

2.2 Crop Disease Detection by Image Processing

Image processing is widely used for different agricultural applications ranging from identification of the leaf of the plant to categorization of different diseases. With the emerging development in automated system for identifying and classifying different diseases of the contaminated plants is new research era in precision Agriculture. Identification of the diseases is the key to preventing the qualitative and quantitative loss of agricultural yields. Manual detection of the diseases is very difficult and not accurate to avoid this Image processing techniques.

2.3 Crop, soil and Climate monitoring for crop section

There are many available systems which provide the functionality of the crop selection depending on the data monitored by WSN of different related sensors. D.D. Chaudhary et al. [12] proposed a novel technique to monitor and control various parameters of green house with the utilization of PSOC, the programmable System on Chip Technology as a part of Wireless Sensor Networks (WSN). With the help of environmental sensors, such as Temperature sensor, humidity sensor, CO_2 sensor, the farmer can easily record the desired crop's environment conditions By using this information, wireless sensor network data crop selection can be done properly. Such monitored data is sent to a central Decision Support System (DSS) for taking the crop selection decision.

3. Traceability Systems

In this section GPS – enabled system, animal tracking and Identification applications have been discussed.

3.1 Global Positioning System

Nowadays, the technologies used in precision agriculture are Global Positioning System (GPS), RS- Remote Sensing and GIS. With the help of these, one can monitor, the composition of soil and its distribution, fertilizer, seed, and distribution of crops production, for reducing the operational costs, to raise the yield and benefit economy. Also, it reduces the environment pollution that is caused due to agricultural chemicals [13]. GPS is very beneficial in farming, due to following reasons:

- Cost effective technology for farmers.
- High precision which reduces the use of pesticides and fertilizers.

Authors in [14] propose the use of Global Positioning System that supports vehicle guidance for agricultural applications. This system supports human guide with the help of GIS for mapping display using GIS.

The GPS receiver placed on vehicle top provides direction, and the driver covers that field in an optimal path. The navigation system uses adaptive Kalman filtering. This filter considers the a priori knowledge of the planned track and the behavior of an agricultural vehicle. It tests alternate hypotheses for predicting the path. Authors in [15] , propose method that provide solutions to the integrated systems used for data collection, positioning problems, accuracies therein.

The data collection was done from four test fields in Alberta with the help of DGPS along with crop yield monitors and electromagnetic ground conductivity meters that measure salinity. A Geographic Information System analyzes and combines various layers of information. Locations 1 m vertically and 50 cm horizontally are obtained in DGPS mode with the help of carrier phase smoothing code approach. The DGPS positions create a guide which demonstrates that fields are not homogeneous in harvest yields when they have been dealt with without contemplations for variability of soil, and geology or field history.

3.2 Animal Tracking and identification

The RFID is proving to be a boon to agricultural applications. It is being used in animal identification and tracking, from many years. The embedding of sensors in tags, allows to monitor the cold chain of food products.

3.3 Security Surveillance system

Security is one of the important issues for farmers. It is also important to detect and secure valuable items in the farm. The main objective for the surveillance is to secure the farm in absence of the farmer. For that detection of theft and animal interference in the farm should be avoided, and this can be done by security and surveillance system. For this, different technologies such as PIR sensor, CCTV and alert system are used which not only provide the security but also provides alert message too.

To achieve these goals, different technology and apps are designed and developed which provide necessary

information about farm and security. The following section describes some of the apps that are helpful in the Precision Agriculture.

4. Mobile apps

With the growing technology in the electronics field like smart phone, it is very easy to share or get any information from anywhere. Android apps nowadays provide efficient functionality to be grown with technology. In the field like precision agriculture farmers can get more benefits from the apps which are developed for the agriculture monitoring and information exchange. Apps that are used for agriculture monitoring are of different types which gives information like weather information, market rate and availability etc. Following are some apps used for monitoring and data information exchange purpose.

1) Mkisan application:
   This android app is designed and developed by CDAC Pune. This app gives assistances to farmers. [21].
2) Shetkari masik android app
   "Shetkari Masik" is very popular monthly magazine in the Agriculture sector since 1965. It is published by Department of Agriculture, Maharashtra. After the registration, the user can upload all the information on the portal without use of internet also [20].
3) Farm-o-Pedia
   This app has been developed by CDAC, Mumbai [22]. The application is provided with multiple language support. This Android application is designed for farmers or anyone related to agriculture in rural Gujarat. Available in English and Gujarati languages. The functions of the app are:
   Monitoring suitable crops according to soil and season, Obtaining crop-wise information, monitor weather and managing cattle in the herd etc.
4) Markets near me
   This mobile app is used to get the market price of crops in the markets in the area of 50 km of user location. It captures the location of mobile user and displays the crop's market price of markets nearer to the user.

4.1 Digital Mandi India

This app provides the Information of commodities in Mandi, such as price, availability of the goods from different places [23]. It enables farmers, traders and all users to have information on the updated Mandi price from any place. The features of this app are:

Watch various commodity categories, Know prices in different states, reach the selected commodity's mandi price, Know mandi price of a commodity, Synchronous data from the Indian government portal Agmarknet.nic.in etc.

5. Conclusion

Now-a-days Precision farming with information and geographical positioning is an essential tool to maintain and record all the specific information about the farm, weed patches, crop details, soil statistics and previous yield's data etc. This study provides an exploration into various precision agriculture technologies and Automation in the field of irrigation system which is useful for farmers that provide every possible and cost effective solution for improving precision agricultural production. The web and the Android versatile application allow the administration through portable media transmission gadgets, for example, a PDA, smart phone. In light of its vitality self-governance and low value, this portable application can possibly incorporate distinctive functionalities associated with the farm. So with the development in the technology and smart phone application precision agriculture provides effective and smart solution to the farmers to grow with improving precision agriculture.

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