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A SURVEY ON SMART SENSORS IN PRECISION AGRICULTURE

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Abstract-- *Today's agriculture is being faced with variety of problems, due to the lack of available farmlands, limited supply of water for cropping, varying climate and increasing population. Farmers are being forced to increase productivity in order to satisfy the food need of growing population. This problem can be solved by introducing modern technologies in agriculture. Sensors are the most needed tools in precision agriculture. This article provides better understanding of noble services of the smart sensors in precision agriculture.*

Keywords-- *Precision Agriculture, Leaf Area Index, Weed mapping, Multispectral sensor, Remote sensor.*

I INTRODUCTION

Precision agriculture is nothing but doing the agricultural practices in a smart way. This method enables the farmers to increase the crop yields by reducing the quantity of resources needed such as water, fertilizers, seed and man power. The crops are monitored by the farmers accurately from the beginning, because of this, each need of crops are noticed and provided by the farmers. This accurate monitoring of crops is done by the implementation of smart sensors and mapping fields. This method provides way for the farmers to optimize the application of fertilizers, weed treatments and watering only when they are needed. Sensors are vital tools in modern agriculture management. This article reveals that the sensors are deployed to enhance productivity in agriculture and reduce both cost and impact on environment.

II TYPES OF AGRICULTURAL SENSORS

There are various sensing technologies which are implied in precision agriculture to provide data to monitor and optimize crop yields, some of them are,

- **a)** ***Optical Sensors:*** Light reflectance is used by the optical sensors in order to measure the varying properties of soil. Sensors can be fixed on the agriculture equipments, mainly on vehicles. These sensors are developed to know the level of moisture content, chemical content and fertility of soil. Photo detectors and Photo diodes form the basic building block for optical sensors.
- **b)** ***Electrochemical Sensors:*** These sensors give details about pH and nutrient contents of soil. Electrodes in these sensors work by detecting specific ions in the soil.
- **c)** ***Location Sensors:*** GPS maps the locations by knowing the latitude, longitude and altitude of the field.
- ***d)*** ***Dielectric Soil Moisture Sensors:*** It detects moisture level of the soil by measuring a dielectric constant implied in the sensor.
- ***e)*** ***Airflow Sensors:*** The total air permeability of the soil can be measured with the help of these airflow sensors, which can measure the soil permeability at various locations of the soil both statically and dynamically.
- ***f)*** ***Agricultural Weather Stations:*** They are free-standing units situated at different locations throughout the cultivating fields. These stations measure various data for precision agriculture such as airflow, seasonal rainfall, leaf moisture, speed of wind, humidity level, direction of wind, atmospheric pressure and solar radiation, etc.

III SENSOR OUTPUT APPLICATIONS

Sensing technologies provides data to the farmers to implement environmental impact free and optimized crop yield.

a) ***Variable Rate Fertilizer:***
This application tool provides various benefits such as high productivity and optimized usage of nutrients. The need of fertilizer is assessed according to the plant health. It is monitored by the GPS.

b) ***Weed Mapping:***
The weed occurrences can be found with the help of weed mappings. The GPS receiver with an aerial drone generates maps which show the weed occurrences. These weed maps can be combined with fertilizer maps yield maps and so on.

c) Variable Spraying:
These controllers turn the herbicide sprayers on and off. With the help of weed mappings the weed locations are identified and the needed volume of herbicide is estimated and applied in the field.

d) Salinity Mapping:
It is performed with the help of salinity meter across the fields affected by salinity.

IV SCALING SMART SENSORS TO SMART PHONES

Smartphone applications are now dealing with the concepts of Internet of Things (IoT), such as collection of field data and processing the gathered data concerning weeding, fertilizing, seeding and watering of crops. The data collection is done with the help of remote and handheld sensors which can be governed by the farmers. Some of the applications are,

a) Fertilizer Calculator:

Required nutrients are determined by leaf colour and soil sensors.

b) Soil Study:

The smart sensors capture images of soil at various locations of the cultivating field, with these images the sensors find the pH and chemical details of soil. These data helps the farmers to monitor and maintain the varying conditions of soil.

c) Water Study:
Photos captured by smart sensors will determine the leaf area index of the crops, which aids the farmers in assessing and fulfilling the water need of crops

SMART PHONE TOOLS

There are numerous smart phone tools such as camera, GPS, gyroscope, etc. which can be adapted to smart farming applications. These tools play a vital role in gathering data for the smart farming applications. Agricultural uses of existing smart phone tools are enormous.

a) ***Camera:*** It is employed for calculating the LAI (Leaf Area Index) and also in measuring the organic content of soil. It captures pictures of plant health, chlorophyll measurement of leaf and ripeness level.
b) ***Microphone:*** It is employed in providing maintenance of machinery.
c) Gyroscope: Gyroscope sensors are better known as Angular rate sensors. It detects the rollover of the equipment used in smart farming.
d) ***Accelerometer:*** It determines both LAI (Leaf Area Index) and also employed as an alarm for equipment rollover.
e) ***GPS:*** It provides crop mapping location, predicts solar radiation, and also alerts disease or pest location.

V APPLICATIONS OF SMART SENSORS

1. FARM FIELD SCANNING SENSOR
2. pH LEVEL MONITORING SENSOR
3. SENSOR IN DETECTING A CLIMATE
4. SENSOR IN DETECTING HEALTH ISSUES OF COWS
5. CONCEALED SENSOR IN A GRAIN
6. SOIL CHARACTERISTICS MEASURING SENSOR

1. FARM FIELD SCANNING SENSOR

Sun can said to be an scanning machine as it scans all the living and non living creatures in the world , likewise an sensor is capable of scanning an farm field from the sky ,which assess the farmers to check the condition of the farm field.

To make the crop management more effective, it is necessary to analyze the farm field thoroughly in order to improve the performance of yielding. For this, a miniature multispectral sensor is used known as PARROT SEQUOIA.

PARROT SEQUOIA, is a mini MULTISPECTRAL SENSOR, have an ability of detecting " invisible matter" those are hard to be notified by an farmer. The sensor is capable of taking calibrated images in the infrared and thus gathering the information of the farm field and on the crop growth.

Sequoia is a system of pocket sized package .It consists of a two components namely a GPS sun sensor and a 16 Megapixel camera. The GPS sun sensor or luminosity sensor records the light condition and it also provides an area for a SD card for storage capabilities. These components are multispectral, which are not perceptible by a sense. Sequoia takes pictures from crops in both visible and invisible spectrum. This armature allows it to compare the sun activity with the crop status of the field and so by doing this a farmer could be able to identify the low nutrient area.

FEATURES:

- It consists of four distinct spectral bands namely Red (bandwidth 660nm-40nm), Red –edge(bandwidth 735nm-10nm),Green(bandwidth 500nm-40nm) and near infrared(bandwidth 790nm-40nm).
- It consists of 64GB built in memory.
- Sequoia is embedded with GPS and IMU.

MERITS

- Identify the low nutrient area.
- By detecting the nutrient deficiency, refining the fertilization.
- Preventing and detecting the biotic stress.
- Identifies the hydric stress risks.
- By processing and utilizing agronomic indexes estimating crop yield.

ABOUT PARROT

Parrot was founded in 1994, which developed and marketed advanced wireless technology product for the customers. Paris is the headquarters of the parrot and currently there are more than 900 employees worldwide. It generates majority sales overseas.

2. pH LEVEL MONITORING SENSOR

To improve the agriculture it is mandatory to know about the anatomy of the soil, where REMOTE SENSOR is used to monitor the pH level of the soil.

This sensor is very useful in monitoring the acidity of the soil and also the soil drainage capacity by which the amount of water required level is known. This technique is useful for irrigation purposes.

3. SENSOR IN DETECTING A CLIMATE

Climate plays a major role in the agriculture, based on which a project is developed in Kenya and the name of the project is KILOMA SALAMA.

Approximately 75% of the population in Kenya depends on farming. The common disasters like drought, floods, landslides affects the farming in Kenya. The project is all about the "safe agriculture" an insurance project designed for the farmers in Kenya, so they can insure their farm input if any floods, excess rain or drought occurs. It is like a proactive measure taken for such kind of problems, for this reason this project have been implemented.

A weather station is connected with the farming field, so that during the drought or flooding period farmers have easier access of insurance for their harvest.

4. SENSOR IN DETECTING THE HEALTH ISSUES OF COWS

The status of the cow can be controlled by this smart agriculture technique and one of the toughest jobs in the primary sector is to manage the milk farm. The farmers should make sure that good quality of milk is produced from moonless late to the night.

But now, with the help of INTERNET OF THINGS (IoT) based HEALTHY COW solution is introduced by SCR DIARY.

Instead of monitoring livestock regularly, a collar with inbuilt microphones and movement sensor is kept which monitors the behaviour of the cows and their ruminating time.

If any decrease in the health issue of the cow an alert message will be sent to the farmer through the smart phone.

This information provides the farmers to reduce cow health issues and improves the quality and quantity of milk production.

5. CONCEALED SENSOR IN A GRAIN

After the harvesting process, maintaining and storing process of collected grain is very important in order to get a profitable yield.

Bean IOT a legume shaped grain like plastic devices of thumb size kept in the grain silos (a large storage area where grains are kept) is for monitoring the condition of the grain.

Bean IOT consists of Bluetooth, gyroscope, electronic compass and a humidity sensor, all these components together is very helpful in measuring temperature, moisture, altitude and movement of grains in the silos, so that if any problem arises a message is will be sent to the smart phone of farmer.

The life of the battery lasts for 14 months and they charge wirelessly.

It remains in inactive state in rest of its time.

6. SOIL CHARACTERISTICS MEASURING SENSORS:

1. **On-the-go sensors:**
   The sensor is attached to a farming vehicle which defines various characteristics of the field soil. GPS receiver is also attached to the farming vehicle. Data that are measured by the sensor are generated on a soil map, which provides information for application rates of chemicals for the enhancement of soil properties.

2. **Real-time sensors:**
   It is employed for variable-rate application, where fertilizers, pesticides are used based on soil's characteristics. These sensors are also attached to the farming vehicles, the real-time changes such as nitrogen content, weed presence are measured using this sensor.

ADVANTAGES OF SOIL MOISTURE MONITORING:

- It is very accurate, more accuracy in fine soils due to the presence of fine sized particles.
- It can read the soil volumetric water content directly with continuous measurement at same location.
- It is of low cost with no special maintenance.
- It has wide moisture reading range (0 to 200cb, or kPa)
- It is usable under several seasons with proper maintenance.

DISAVANTAGES OF SOIL MOISTURE MONITORING:

- It is a destructive method and requires more labouring.
- It is a time consuming process.
- The accuracy rate will be less in sandy soil due to the presence of large particles.
- It requires periodic service
- Each soil's need to be calibrated.
- It will perform slow if the soil's water content changes due to rainfall or irrigation.

VI GLOBAL IMPLICATIONS OF SMART SENSORS

A survey says, in this modern, developing world, at an average of 80 percent of the total food consumption is being satisfied by around 500 million small farms, this can be even more enhanced with the application of smart sensors in precision agriculture. Precision agriculture technology is being globally accepted and becoming widely accessible. These Smart sensors are handheld devices which can measure the nutrient content of the soil and water. Thus enables the farmers to accurately calculate the required amount of water and fertilizers. Precision agriculture will be in great demand for small field agriculture in future.

Problems in both small and large farm fields can be overcome by the application of smart sensors in precision agriculture, which helps farmers to provide the sufficient food needed. Smart sensors in smart farming includes benefits such as,

- It optimizes the use of nitrogen fertilizer which in turn reduces the amount of nitrous oxide released from soil.
- Soil health is managed and monitored which eliminates the nutrient depletion.
- It reduces the usage of fertilizers and pesticides by monitoring the needs mentioned in the fertilizer controller.
- It controls the compaction of soil by minimizing the traffic of the equipment.
- Water study, capability in smart sensor leads to efficient usage of water.
- Emission of carbon dioxide is reduced by lowering the usage of fuel and other energy consumptions.

VII CONCLUSION

Precision agriculture, it is the smart way of making agricultural practices in order to satisfy the growing demand for food throughout the world, this is possible with the implementation of modern technologies in precision agriculture. Smart sensors make precision agriculture even cheaper and easier in order to collect every agricultural detail and to apply those agricultural details to enhance crop productivity. Using the smart sensors, resources are used most efficiently in precision agriculture. Both large and small farms can be monitored, managed using tools built into smart phones, farming applications. Smaller-sized machineries are being developed to arrive at solutions for small farms. This smart technology also provides solution for global warming, pollution control and other environmental impacts.

Autonomous farm vehicles will be increased in future developments of precision agriculture. Unmanned Aerial and Unmanned Ground vehicles will be employed for acquisition and transmission of data. These vehicles not only monitor crops and soil conditions, but also monitor the status of farm equipments. Maximum yield with minimal usage of resources is possible by using smart sensors in precision agriculture.

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