International Journal of Recent Engineering Research and Development (IJRERD)
ISSN: 2455-8761
www.ijrerd.com || Volume 03 – Issue 04 || April 2018 || PP. 25-30

Farm Monitoring and Controlling Based On Precision Agriculture

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Abstract: The purpose of the research work is to design a smart farming also known as precision agriculture which allows farmers to maximize yields using minimal resources such as water, fertilizer, and seeds. In this proposed system, the smart farming will be link to smart sensing system and smart irrigator system with the help of wireless communication technology. Our system focuses on the measurement of physical parameters such as soil moisture content, nutrient content, and pH of the soil that plays a vital role in farming activities. A number of high ended sensing technologies are handling in precision agriculture which indulges various observed data that helps farmers to monitor and optimize crops. Wireless sensor networks are playing an important role with the advent of the Internet of things and the generalization of the use of web in the community of the farmers. The Internet of Things having a cloud which may represent the platforms allowscreating web services suitable for the objects integrated on the Internet. This paper presents WSN as the best way to solve the agricultural problems related to farming resources optimization, decision making support, and land monitoring. Monitoring is done with the help of wireless sensor networks and all the control process is done with the help of the microcontrollers.

Index Terms: Big Data, Smart Farming, IoT.

Introduction

The Internet of Things has opened up intensiveworthwhile ways for farmers and growers to cultivate the crops in soil and raise livestock with the use of cheap, easy-to-install sensors and an abundance of insightful data they offer. Prospering on this prolific build-up of the Internet of Things in agriculture, smart farming applications are gaining ground with the promise to deliver 24/7 visibility into soil and crop health, machinery usages, conditions of the storage places, behavior of animal and the energy consumption level.The farming and agricultural industry relies on innovative ideas and technological advancements to help increase yields and better allocate resources Today, a driving force behind increased agricultural production at a lower cost is the Internet of Things (IoT).A sensor is a tool which requires more energy to get information from one area to another. To achieve, IoT product creators often engineer applications to send much less data (or send data less frequently) to save on costs and power.The most IoT agriculture is typically outside or spread over a large area, need to consider a low power application. Otherwise, the service and upkeep of many distant sensors will be overwhelming for the end user.The data packets a sensor can send depends on the different factors such as end user application and local environment. And another important factor will be battery life .Once or twice a day is probably sufficient, which means the battery life will be far greater.Many farms have may contain water storage tanks, dung, Combustile, or livestock feed. Monitorthe water levels of these tanks more than once a day is probably unnecessary.Once the irrigation process starts, continual updates can ensure that the right amounts of water are being released which may leads to reduction of leakages. Some sensors—like moisture sensors—are embedded, and require microcontrollers to interface.Smart farming is a concept quickly catching on in the agricultural business. Offering high-precision crop control, useful data collection, and automated farming techniques, there are clearly many advantages a networked farm has to offer. To provide information about crop yield, rainfall, pest infection farmer need some technology, hence IoT sensors have a capacity to provide such kind of information to farmers. Soil nutrition information is invaluable to production and offer precise data which can be used to improve farming techniques over time.

The proposed system tries to produce a network based farming and agricultural activities so that the farmers can check on the requirements of the crops and accurately predict their growth.

Related Works:

The frameworks and platforms are still immature for agriculture. To resolve that the latest technology named IoT which is trend now and most applicable for agricultural sector.Duan Yan-e et al [12] proposed an IOT application that provides agricultural information and crop information to farmers on the basis of collected wireless sensor network data. This information is used to ensure that the rate of Fertilizer application and within the recommended limit.

Xiangyu HU et al.[13]developed an IoT application for remote monitoring and control of agricultural fields, which is based on the analysis of data collected by the wireless sensor network, which has enabled farmers to minimize the cost of hand And the efficient use of water resources.

Andreas Kamilaris et al. [14]have proposed an application called Agri-IoT allowing the analysis and the processing of data coming from a network of sensors (WSN) while exploiting the semantic aspects. This will make it possible to associate an easy publication of data on the semantic web.

An automated irrigation system was developed to optimize water use for agricultural crops. The system has a distributed wireless network of soil-moisture and temperature sensors placed in the root zone of the plants. In addition, a gateway unit handles sensor information, triggers actuators, and transmits data to a web application. An algorithm was developed with threshold values of temperature and soil moisture that was programmed into a microcontroller-based gateway to control water quantity [5].

The technological development in Wireless Sensor Networks made it possible to use in monitoring and control of greenhouse parameter in precision agriculture. [3] After the research in the agricultural field, researchers found that the yield of agriculture is decreasing day by day. However, use of technology in the field of agricultureplays important role in increasing the production as well as in reducing the extra man power efforts.

Some of the research attempts are done for betterment of farmers which provides the systems that use technologies helpful for increasing the agricultural yield. A remote sensing and control irrigation system using distributed wireless sensor network aiming for variable rate irrigation, real time in field sensing, controlling of a site specific precision linear move irrigation system to maximize the productivity with minimal use of water was developed by Y. Kim . The system described details about the design and instrumentation of variable rate irrigation, wireless sensor network and real time in field sensing and control by using appropriate software. The whole system was developed using five in field sensor stations which collects the data and send it to the base station using global positioning system (GPS) where necessary action was taken for controlling irrigation according to the database available with the system. The system provides a promising low cost wireless solution as well as remote controlling for precision irrigation.

System Architecture

For overcoming the problems of agriculture, the proposed work develops an initial framework based on IoT. The proposed solution consists of three main components the first component is the deployment of sensors such as soil sensors, humidity sensors and temperature and leaf wetness sensor in the fields. Sensors collect the data and send it to server, on the server side anotherexpert system is deployed. The system processes the data and sends the recommendations to the farmers about crops.

Deployment of Sensors

To collect the data about environment, humidity, soil moisture and leaf witness the sensors are deployed. Waspmote agricultures sensor board is used to collect the data. Because it is specially designed for handling agriculture activities. The sensor board consists of AT mega 1281 microprocessor and 2GB micro SD –card. Four different types of sensors, the soil sensor, humidity sensor, temperature sensor and leaf wetness sensors may contain in the board.With the help of three sensors include soil sensors, temperature sensors, humidity sensors and leaf wetness receptively for a precise and accurate measure of soil contents, environmental temperature, the humidity level in the environment and leaf wetness at the same time. The communication module XBee-802.15.4 is present in wasp-mote agriculture board. It can communicate with microcontroller at the rate of 38400 bps. The range of transmission is near about 500 meters. The gateway is the bridge between sensor nodes and server. It can communicate wirelessly with the sensor and through USB port with a computer. This can be tested under the controlled environmental conditions.Smart farming used Sensing technology which produces the reasonable data. Further the obtained data is processed and implemented to optimize crop yield while minimizing environmental effects. The main objective of this research is monitoring the yield which provides a crop weight yield by time, distance, or GPS location measured and recorded to within 30cm. Then Yield monitoring data is combined with the coordinates to create yield maps. To control granular, liquid and gaseous fertilizer material, optical surveys of plant health determined by coloration and perhaps Variable Rate Fertilizer application tools use yield maps. By using an on-board computer guided by real GPs location, Variable rate controllers can either be manually controlled or automatically controlled. A visual recognition system mounted to working equipment and which it improves the automation of smart farming technology. To control the pesticide spraying the variable Spraying controllers used to turn herbicide spray booms on and off, and customize the amount (and blend) of the spray applied. Afterwards, the weed locations are identified and mapped, the volume and mix of the spray can be determined. With the help of high-precision GPS, topography and boundaries can be recorded which are known as precision maps. Those maps are useful when interpreting yield maps and weed maps

System Hardware:

Tools Used: Software used for the Project is ARDUINO 1.8.2 and the hardware required for the project is listed below:

1. Arduino Uno
2. Analog Soil Moisture Sensor
3. DHT22 Digital Temperature and Humidity Sensor
4. MQ-135 Air Quality Gas Sensor Module
5. MQ-7 Gas Tester Carbon Monoxide Detecting Sensor Module 4P 180mA 5V DC
6. MQ2 Gas Sensor, Methane, Butane, LPG, Smoke Sensor
7. Ultrasonic sound sensor
8. LCD 16×2 Alphanumeric Display(JHD162A)
9. Jumper Wires Male to Male, male to female, female to female
10. GSM Modem Module for Arduino
11. Batteries
12. Motor
13. 1 kilo-ohm Resistances

The brief description of sensors is given below:

Agricultural Sensors

In precision agriculture, a number of sensing technologies are used which provide the data that helps farmers and growers to monitor and optimize crops, as well as adapt to changing environmental factors. Such sensing technologies are described below:

- **Location Sensors** use signals from GPS satellites to determine latitude, longitude, and altitude to within feet. Three satellites minimum are required to triangulate a position. Precise positioning is the cornerstone of precision agriculture. GPS integrated circuits like the NJRNJG1157PCD-TE1 are a good example of location sensors.
- **Optical Sensors** use light to measure soil properties. The sensors measure different frequencies of light reflectance in near-infrared, mid-infrared, and polarized light spectrums. Sensors can be placed on vehicles or aerial platforms such as drones or even satellites. Soil reflectance and plant color data are just two variables from optical sensors that can be aggregated and processed. Optical sensors have been developed to determine clay, organic matter, and moisture content of the soil. Vishay, for example, offers hundreds of photo detectors and photodiodes, a basic building block for optical sensors (**Figure 1**).

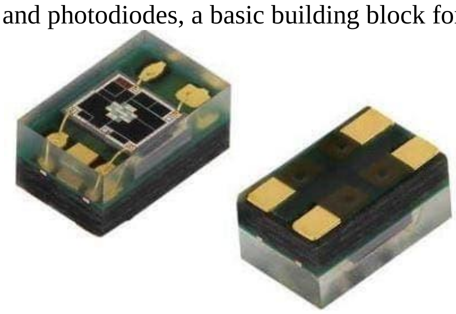

Figure 1: Vishay Photo IC Sensor

- **Electrochemical Sensors** provide key information required in precision agriculture: pH and soil nutrient levels. Sensor electrodes work by detecting specific ions in the soil. Currently, sensors mounted to specially designed “sleds” help gather, process, and map soil chemical data.

- **Mechanical Sensors** measure soil compaction or "mechanical resistance." The sensors use a probe that penetrates the soil and records resistive forces through use of load cells or strain gauges. A similar form of this technology is used on large tractors to predict pulling requirements for ground engaging equipment. Tensiometers, like Honeywell FSG15N1A, detect the force used by the roots in water absorption and are very useful for irrigation interventions (**Figure 2**).

Figure 2: Honeywell Force Sensor

- **Dielectric Soil Moisture Sensors** assess moisture levels by measuring the dielectric constant (an electrical property that changes depending on the amount of moisture present) in the soil.
- **Airflow Sensors** measure soil air permeability. Measurements can be made at singular locations or dynamically while in motion. The desired output is the pressure required to push a predetermined amount of air into the ground at a prescribed depth. Various types of soil properties, including compaction, structure, soil type, and moisture level, produce unique identifying signatures.
- **Agricultural Weather Stations** are self-contained units that are placed at various locations throughout growing fields. These stations have a combination of sensors appropriate for the local crops and climate. Information such as air temperature, soil temperature at a various depths, rainfall, leaf wetness, chlorophyll, wind speed, dew point temperature, wind direction, relative humidity, solar radiation, and atmospheric pressure are measured and recorded at predetermined intervals. This data is compiled and sent wirelessly to a central data logger at programmed intervals. Their portability and decreasing prices make weather stations attractive for farms of all sizes.

Sensor Output Applied

Sensing technologies provide actionable data to be processed and implemented as need be to optimize crop yield while minimizing environmental effects. Here are a few of the ways that precision farming takes advantage of this data:

- **Yield Monitoring** systems are placed on crop harvesting vehicles such as combines and corn harvesters. They provide a crop weight yield by time, distance, or GPS location measured and recorded to within 30cm.
- **Yield Mapping** uses spatial coordinate data from GPS sensors mounted on harvesting equipment. Yield monitoring data is combined with the coordinates to create yield maps.
- **Variable Rate Fertilizer** application tools use yield maps and perhaps optical surveys of plant health determined by coloration to control granular, liquid, and gaseous fertilizer materials. Variable rate controllers can either be manually controlled or automatically controlled using an on-board computer guided by real GPS location.
- **Weed Mapping** currently uses operator interpretation and input to generate maps by quickly marking the location with a GPS receiver and datalogger. The weed occurrences can then be overlapped with yield maps, fertilizer maps, and spray maps. As visual recognition systems improve, the manual entry will soon be replaced by automated, visual systems mounted to working equipment.
- **Variable Spraying** controllers turn herbicide spray booms on and off, and customize the amount (and blend) of the spray applied. Once weed locations are identified and mapped, the volume and mix of the spray can be determined.
- **Topography and Boundaries** can be recorded using high-precision GPS, which allows for a very precise topographic representation to be made of any field. These precision maps are useful when interpreting yield maps and weed maps. Field boundaries, existing roads, and wetlands can be accurately located to aid in farm planning.

- **Salinity Mapping** is done with a salinity meter on a sled towed across fields affected by salinity. Salinity mapping interprets emergent issues as well as change in salinity over time.
- **Guidance Systems** can accurately position a moving vehicle within 30cm or less using GPS. Guidance systems replace conventional equipment for spraying or seeding. Autonomous vehicles are currently under development and will likely be put into use in the very near future.

Large-scale farming gained an early foothold in the practice of precision farming. Expensive sensors, infrastructure, and processing equipment could only be realistically put to work by agribusinesses with sufficient capital available to invest. Those that invested in precision farming saw handsome paybacks in terms of crop yields.

Features:

By collecting real time status of crop and in forming the information to farmer is the main objective it results better crop production. With the help of latest technology the following features are included:

- Notify the filed information to farmers via SMS
- Results the valuable information
- Detailed Data Analysis
- It is Cost Effective and also easy to implement

Experimentation and Results

Monitoring the level of water, soil moisture through the use of sensors, it is possible to achieve a more efficient system than the current existing. Our idea of “Smart farming”, mainly concentrates on Monitoring the water level, providing a smart technology for agriculture, avoiding human intervention, reducing human time and effort and which results in healthy environment.The system is designed to collect data and to deliver the data through wireless mesh network. The system also employs duty cycle technique to reduce power consumption and to maximize operational time. The Smart farm system was tested in an outdoor environment. In our system, the Smart farm sensors are connected to the internet to get the farm information.Experimental tests proves that project is a complete solution to field activities, irrigation problems, and storage problems using remote controlled robot, smart irrigation system and a smart warehouse management system respectively. Implementation of such a system in the field can definitely help to improve the yield of the crops and overall production.

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