A Study on precision farming techniques using IoT Precision Farming Techniques

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Abstract: The various Internet of Things (IoT) is a promising technology which provides effective and dependable results towards the modernization of several disciplines. IoT grounded results are being developed to automatically maintain and cover agrarian granges with minimum mortal involvement. The composition presents numerous aspects of technologies involved in the sphere of IoT in farming. It explains the major factors of IoT grounded smart farming. A rigorous discussion on network technologies used in IoT grounded husbandry has been presented, that involves network armature and layers, network topologies used, and protocols. likewise, the connection of IoT grounded farming systems with applicable technologies including pall computing, big data storehouse and analytics has also been presented. In addition, security issues in IoT husbandry have been stressed. A list of smartphones grounded and detector grounded operations developed for different aspects of ranch operation has also been presented. Incipiently, the regulations and programs made by several countries to regularize IoT grounded farming have been presented along with many available success stories. In the end, some open exploration issues and challenges in IoT agriculture field have been presented.

Index Terms:IoT, Smart farming, Precision Farming, applications, sensors, communication protocols, networks.

I. INTRODUCTION

This Ultramodern agrarian product relies on covering crop status by observing and measuring variables similar as soil condition, factory health, toxin and fungicide effect, irrigation, and crop yield. Managing all of these factors is a considerable challenge for crop directors. The rapid-fire improvement of precise monitoring of agrarian growth and its health assessment is important for sensible use of husbandry coffers and as well as in managing crop yields (Nigam etal, 2019). similar challenges can be addressed by enforcing remote sensing (RS) systems similar as hyperspectral imaging to produce precise biophysical index maps across the colorful cycles of crop development. RS is a fleetly expanding technology enforced in colorful agrarian operations. In particular, imaging spectroscopy in large nonstop narrow bands provides significant information for understanding the biophysical and biochemical parcels of agrarian shops [2]. It's also useful to identify the changes in colorful physical processes, which can be better linked using multispectral RS (Sahoo etal, 2015). Advanced ways of RS have been used for large scale crop force and yield prognostications (Mulla, 2013). RS operations are used in husbandry studies that are grounded on the commerce between electromagnetic radiation and soil or factory material on the Earth's face (Atzberger, 2013). RS combined with geographic information systems (GISs) and/ or global positioning systems (GPSs) are frequently used in PA. This allows growers and other husbandry directors to reduce inputs and maximize cost benefits using ultramodern technologies rather than traditional field approaches. currently, variable rate technology (VRT) is introduced to increase perfection husbandry practices. VRT is a vital element for PA and is getting more current for large land holders. In VRT, collections of field variable information and other input data are helpful in defining suitable amounts of chemical inputs needed for the fields. Hence the demand of perfection agrarian ways, precious products, fine RS information as well as VRT has grown extensively (Brisco etal., 1998).

II. IOT SMART FARMING NETORKS

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III. PRECISION FARMING

Precision Farming (PF) is the wisdom of perfecting crop yields and aiding operation opinions using high technology detector and analysis tools. PF is a new conception espoused throughout the world to increase product, reduce labor time, and insure the effective operation of diseases and irrigation processes. It uses a large quantum of data and information to ameliorate the use of agrarian coffers, yields, and the quality of crops (Mulla, 2013). PA is an advanced invention and optimized field position operation strategy used in husbandry that aims to ameliorate the productivity of coffers on husbandry fields. therefore PF is a new advanced system in which growers give optimized inputs similar as water and toxin to enhance productivity, quality, and yield (Gebbers and Adamchuk, 2010). It requires a huge quantum of information about the crop condition or crop health in the growing season at high spatial resolution. singly of the data source, the most pivotal ideal of PF is to give support to growers in managing their business. similar support comes by different ways, but the end result is generally a drop of the necessary coffers [4].

IoT based Precision farming consist of multiple monitoring and controlling applications such as climate monitoring, soil patterns monitoring, pest and crop disease monitoring, irrigation determine optimal time to plant and harvest and tracking or tracing [4].

A. CLIMATE CONDITIONS MONITORING

In husbandry it's the most important to cover rainfall conditions continuously so that unborn conditioning can be planed consequently. Weather stations are the most popular widgets in the field of husbandry which are used to cover different climate conditions. Weather parameters which are being covered include temperature, moisture, wind direction, and air pressure etc. Located across the field, rainfall stations collect the environmental data and shoot it to the pall garçon. Collected data is used for rainfall analysis to collude climate conditions, and give new perceptivity to take needed conduct to ameliorate agrarian productivity. US Food and Agriculture Organization (FAO) has been defined a rainfall related approach called Climate Smart Agriculture (CSA) which helps the stoner to transfigure husbandry system by relating climate conditions. A wireless detector network has been stationed by using IoT technology to cover rainfall changes by integrating the detectors and bias [1].

B. PEST AND CROP DISEASE MONITORING

Root causes of profit and product losses are crop conditions. Due to the smash of IoT agrarian system has been changed into digital system which helps the planter to make informed opinions. Vaticination of crop conditions at early stages helps the growers to induce further profit by saving crop from pest attacks. IoT cover crop in multiple ways by detecting different conditions and help crop from beast attacks. An IoT grounded monitoring system has been presented in to cover the wheat conditions, pest and weeds. Crop marauding is the biggest issue due to compression of cultivated land into different wildlife hangouts. In a monitoring and repelling system for the protection of crop against wild creatures attack has been presented. Discovery of crop complaint at early stages is veritably grueling in the field of husbandry. Because to descry crop or splint complaint a platoon of experts is called, which is precious and time taking process. Whereas, automatic discovery of conditions is veritably salutary, accurate and cheaper for planter as compared to homemade observation by experts. Image processing fashion also plays a vital part for the before discovery of factory complaint. A crop complaint discovery script has been tasted raw data via seeing bias is converted into usable format via remote garçon and also stored into database which is displayed through a stoner interface. After getting data multiple data mining models are applied for complaint (bacterial, fungal, viral) analysis [1].

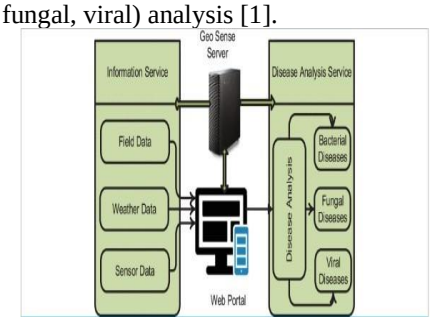


Figure 2: It is the Image processing technique also plays a vital role for the earlier detection of plant disease.

C. DETERMINE THE OPTIMAL TIME TO PLANT AND HARVEST

IoT increase functional effectiveness and enhance the crop productivity by determining the stylish possible time to gather and plant. IoT merge multiple being technologies like pall computing operations, end stoner operations, wireless detector networks((WSN's) and Radio frequency Identification (RFID) to determine the accurate time of weeding and sowing [1].

D. TRACKING AND TRACING

IoT provides instructional data to agrarian companies for better opinions making similar as planning, managing and connect with business mates intelligently by saving plutocrat and time. In growing terrain soil, air, water, diseases, and fungicides conditions are covered by RFID and Global Positioning System (GPS). GPS system is used to find the exact position of husbandry field and examiner colorful agrarian parameters by using wireless communication networks. In an armature has been develop which ever cover the soil condition and soil structure as per demand of crops culture. In this structure ZigBee is connected with other bias like content operation system (CMS), Global System for Mobile (GSM) and General Packet Radio Service (GPRS) by using Wireless detector networks to cover and realize real time data checking. GPS provides interface to interact with ARM (an intelligent monitoring system to achieve functions like SMS MMS) and gives an alarm to ranch director when an unwanted changes do and helps the growers to take corrective action. Although it's functional and conservation cost is high but it's extensively used in husbandry due to its exact position monitoring and tracking property [1].

E. SOIL PATTERNS

Soil monitoring has come one of the most demanding practices in husbandry field for both diligence and growers. In soil monitoring there are numerous environmental issues which affects on crop product. If these kinds of issues are linked data directly also the husbandry patterns and processes can be understand fluently. Soil patterns which are being covered consists of Soil moisture, humidity, fertilization and temperature. Soil moisture and humidity detectors are stationed to cover the humidity content in soil. An acceptable quantum of fertilization in the field also increase crop yield. Soil monitoring test report increase crop productivity and recommends an applicable fertilization results to planter. also, identification of polluted soil by using IoT technologies cover the field from over fertilization and crop loss [4].

F. IRRIGATION MONITORING SYSTEM

IoT ameliorate the current irrigation system in a further innovative way. A planter can optimize irrigation system in multiple ways by covering rainfall conditions and soil conditions. IoT technology examiner irrigation system in four ways like rainfall soothsaying data, control and examiner whole field from anywhere, Ethernet connection and WIFI. This ultramodern irrigation system facilitates the growers by installing multiple detectors, reducing growers yearly irrigation cost, and limit water coffers. In an intelligent irrigation operation system has been presented by using Machining literacy and open source technologies which smell different soil and rainfall parameters. An IoT grounded Low cost irrigation system has been designed in which uses HTTP and MQTT protocols to inform the stoner. Water quality is covered by detector bumps which are empowered with wireless communication. IoT

technology measure both physical and chemical constraints of ph, dissolved, temperature, conductivity and oxygen. Gathered data about water operation system is viewed on internet by using pall computing services. lately multiple IoT irrigation platforms have been developed to control the water consumption in the field. In a simple irrigation system has been developed by using WSN. In further advance system druggies can control the process of irrigation through cellular technologies. Likewise, system is proposed in which stoner transfer detectors data via cellular technologies to a database [1].

G. FARM MANAGEMENT SYSTEM

The relinquishment of smart husbandry is similarly adding the quantum of productivity by reducing the environmental impact but this smart husbandry fashion can be possible via Farm Management System (FMS). FMS is a crucial element for processing, planning, and decision making for the purpose of smart husbandry. An intertwined FMS allows the growers to cover the entire where whole data is collected via WSN, GSM modules and microcontroller. An identifier is used on the detectors and bias in all over the ranch which gives the proper knowledge of fertilization, rainfall data, automatic buffer zone range monitoring, and automatic detail record is generated according to per day conditioning of ranch. This whole information is stored in the computer in standard format and can be accessible via cell phone or internet for farther processing. To optimize the use of water coffers an automated irrigation and the monitoring system is used for piecemeal from irrigation system ranch is also defended from pest and beast intrusion[1].

H. AGRICULTURAL DRONES

Drones are defined as Unmanned Aerial Vehicles (UAVs) which are being employed in husbandry to ameliorate colorful practices of husbandry. These flying bias are controlled ever by remote control or autonomously programmed. Agrarian processes which are performed by drones are crop health assessment, scattering, screening, planting, gibing reports, dimension of nitrogen in wheat and analysis of soil conditions. Drones grease the growers via integration with Geographic Information Systems (Civilians) mapping, and crop health imaging. Drones are substantially stationed in large granges where issues related to bacteria fungus are delicate to handle and bear regular monitoring. In the area of husbandry fungicides and diseases are veritably important for crop yield. Agrarian drones are carrying out this job efficiently because of its high speed and effectiveness in the scattering operation. In addition they also stationed to cover timbers, beast and monoculture. An association Precision Hawk is using drones for precious data gathering through detectors for surveying mapping, and imaging of agrarian land. They perform in- flight monitoring, growers enters the detail about which field to survey and elect a ground resolution. An IoT grounded Farm operation information system approach has been developed to meet the bussiness objects. Agrarian drones are integrated with GPS bias cameras and detectors to cover crop health, like planting, crop spraying, webbing and analysis of soil. There are numerous other advantages of drone's application like crop health imaging, factory counting, quantum of nitrogen in wheat, factory height, drainage mapping, and weed pressure [1].

IV. IOT NETWORK ARCHITECTURE

The IoT architecture network is the main factor of IoT in farming field. IoT Agricultural network armature suggests an figure for the specification of an IoT agrarian network physical rudiments as well as their working principles, and ways. utmost of the IoT operations generally follow the four layers armature (Network Layer, Application layer, Physical and Mac Layer and Transport Layer) due to the fashionability, and interoperability of IP. After reviewing these four layers protocol we've also check two further approaches that are IPv6 and 6LoWPAN. This layer is the final position of abstraction which allows the development of multiple stoner operations. At this layer stationed communication protocols cover different agrarian parameters similar as rainfall information, soil humidity values, irrigation [1].

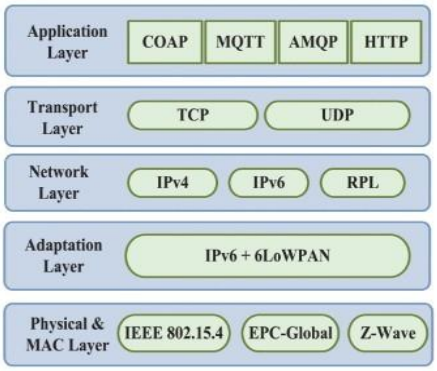


Figure 1: It shows the IoT network Architecture

A. APPLICATION LAYER

In the application layer due to the energy constraints and stringent computation involved by the IoT devices there are many lightweight protocols on application layer such as CoAP, MQTT, AMQP, and HTTP. These protocols can be increased or decreased according to the system requirement. CoAP protocol runs on UDP and works on the principle of the request or response architecture. AMQP protocol runs over the transition control protocol by following publish architecture asynchronously and use TSL/SSL for security assurance. MQTT is a bandwidth-efficient protocol which uses little battery power and designed for receiving and transmitting sensor information. Hypertext transfer protocol is a well known for the web messaging protocol which based on the request/response architecture. Runs over TCP and does not define any QoS, uses TSL/SSL for security purpose.

B. TRANSPORT LAYER

This layer is also called host to host transport layer, and is directly transferred from IP to IoT sphere. The main task of network layer is to collect and synopsize the agrarian information which is attained through detector layer. There are two protocols that are transmission control protocol (TCP) and stoner datagram protocol (UDP). TCP is a connection acquainted protocol which ensures the trust ability of delivered data. TCP data transmission speed is low as compare to UDP. UDP is a connection less protocol which

does not insure trust ability of data. Its data transmission speed is high as compared to TCP. Both of these protocols are used in different operations because their choices depend upon the conditions of operation [1].

C. NETWORK LAYER

This layer is a necessary technology for perfection husbandry and responsible to transmit agrarian information at operation layer. IP is the major choice with the being two performances that are IPv4 and IPv6. IPv4 came into actuality due to adding the large number of nontransferable bias. Whereas, invention of IPv6 was anticipated which gradationally establish on all networking bias. Routing protocol for Low Power and Lossy Networks (RPL) is considered as the main protocol while applying routing on 6LoWPAN. RPL correspond of distance vector routing protocol which uses Destination acquainted Directed Acyclic Graphs (DODAG) to specify routes. To support different overflows of business RPL modify itself according to network speed and admit routing criteria similar as status of the battery used in device, link quality, and advanced computational cost exchange [1].

D. ADAPTION LAYER

Adaption layer (AL) end is to insure the interoperability, and apply fragmentation, contraction and reassembly medium. Although AL attained numerous advances but still there is a complexity for IPv6 supporting because its direct use on IoT bias isn't considered reasonable. Generally clashes were seen with constraints which are associated with IoT bias. That's why, 6LoWPAN made a big trouble in order to drop the limitations of IPv6 and make it suitable for IoT bias. Detectors and bias use IPv6 and 6LoWPAN to transmit data over IEEE802.15.4 protocol in IoT agrarian network [1].

E. PHYSICAL LAYER AND MAC LAYER

This is the bottom most layer in husbandry network architecture which is responsible to smell and actuate different agrarian parameters. Within physical and MAC layer IEEE802.15.4 is one of the most popular standards which was designed for low cost, low consumption and low complexity. This standard was espoused by numerous protocols like Wireless HART, ZigBee and ISA100. IEEE802.15.4 substantially operates in ISM band of2.4 GHz. likewise, it also operates 915 MHz (in United Nations of American) 868 MHz (in European countries) and supports up to 250 kbps data rates. still literature shows some significant limitation of after approaches, which are regarding to mobility and network conformation. EPC-Global (designed for RFID technologies) and Z- surge (particularly designed for domotics) have also been used as volition of IEEE802.15.4 to exchange information directly from internet protocol (IP) [1].

V. PRECISION FARMING SENSORS

Smart Husbandry, also known as perfection husbandry, allows growers to maximize yields using minimum coffers similar as water, toxin, and seeds. By planting detectors and mapping fields, growers can begin to understand their crops at a micro scale, conserve coffers, and reduce impacts on the terrain. Smart husbandry has roots going back to the 1980s when Global Positioning System (GPS) capability came accessible for mercenary use. Once growers were suitable to directly collude their crop fields, they could cover and apply toxin and weed treatments only to areas that needed it. During the 1990s, early perfection husbandry druggies espoused crop yield monitoring to induce toxin and pH correction recommendations. As further variables could be measured and entered into a crop model, more accurate recommendations for toxin operation, watering, and indeed peak yield harvesting, could be made [4].

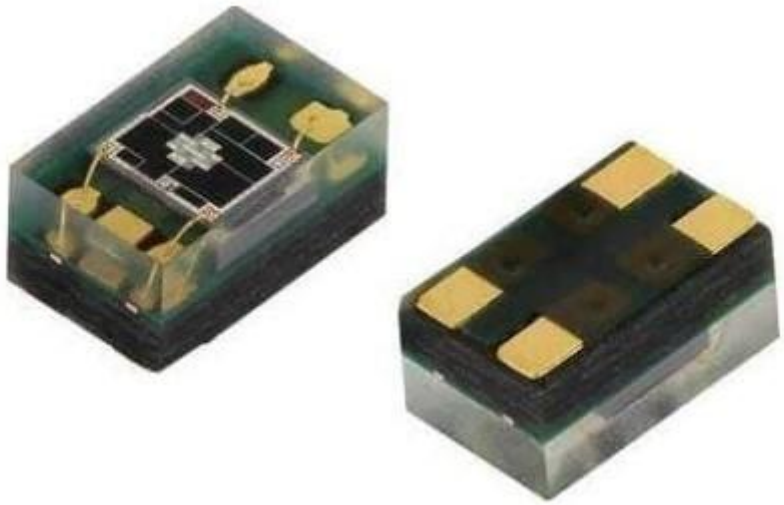
A. LOCATION SENSORS

Detectors use signals from GPS satellites to determine latitude, longitude, and altitude to within bases. Three satellites minimum are needed to triangulate a position. Precise positioning is the foundation of perfection husbandry. GPS integrated circuits like the NJR NJG1157PCD- TE1 are a good illustration of position detectors [3].

B. OPTICAL SENSORS

Optic Detectors use light to measure soil parcels. The detectors measure different frequentness of light reflectance in nearinfrared,mid-infrared, and concentrated light diapasons [3]. Detectors can be placed on vehicles or upstanding platforms similar as drones or indeed satellites. Soil reflectance and factory color data are just two variables from optic detectors that can be added up and reused. optic detectors have been developed to determine complexion, organic matter, and humidity content of the soil. Vishay, for illustration, offers hundreds of photodetectors and photodiodes, a introductory structure block for optic detectors [3].

Figure 3: Shows the optical sensor



C. ELECTROCHEMICAL SENSORS

Electrochemical Detectors give crucial information needed in perfection husbandry pH and soil nutrient situations. Detector electrodes work by detecting specific ions in the soil. presently, detectors mounted to especially designed "sleds" help gather, process, and chart soil chemical data [3].

D. MECHANICAL SENSORS

Mechanical Detectors measure soil contraction or "mechanical resistance". The detectors use a inquiry that penetrates the soil and records resistive forces through use of cargo cells or strain needles. AN analogous form of this technology is used on large tractors to prognosticate pulling conditions for ground engaging outfit. Tensiometers, like Honeywell FSG15N1A, descry the force used by the roots in water immersion and are veritably useful for irrigation interventions [3].

Figure 2: Honeywell Force Sensor

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