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LITERATURE SURVEY ON IOT BASED SMART AGRICULTURAL SYSTEM

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Abstract : Agriculture has remained the spine of human sustenance on earth. Since times unknown humans have learned and developed methods to produce food and other resources for their livelihood. Agriculture has seen large developments, especially in the last century. Scientific methods have accelerated the process of agriculture to a large extent. These developments have improved productivity by leaps and bounds. Though these developments come with a lot of benefits they also include several demerits that adversely affect the soil, humans and livestock. To retain and multiply the benefits contributed by these scientific development and to overcome the demerits and challenges faced in today's agricultural practices, this paper aims at discussing about methodologies that can be used to build an agricultural model that is much more simple and efficient. The model aims at automation using IoT that could lead to minimized labor efforts by almost refraining human intervention in agricultural practices. Machine learning algorithms can be used for weather and soil-based crop detection for better productivity. The downside caused due to the use of synthetic chemicals can be overcome using organic methods. A web portal to facilitate direct producer to consumer retail can be deployed to curb the exploitation on farmers by the elimination of middlemen. Hence the paper aims at developing an agricultural model based on IoT, machine learning, organic farming and a web portal for direct producer to consumer retail.

Key words: Internet of Things (IOT), Machine Learning, Automation, Technological Development, Organic Farming, Soil Infertility, Producer to Consumer retail, Deep Learning Neural Network, Convolutional Neural Network, Random Forest

I. INTRODUCTION

The evolution of the human race laid the very first stone of agriculture, since then agriculture has served as a fuel to human life on the planet. Though, agriculture is the source of human sustenance, it is always vulnerable to several external factors such as weather soil, water etc. Agricultural practices vary from region to region based on the environmental conditions of those respective regions. Agricultural methods have evolved with time, but since the beginning of the 20th century drastic developments have taken place in the field of agriculture. These developments have served both as boon and bane. These improvements in agricultural practices have served to reduce human labor and improve time efficiency. Large-scale agriculture has become effortless with the invention of scientific and technological agricultural practices. The development of synthetic fertilizers, pesticides and other chemicals for agricultural processes has resulted in better yield. Though these developments have benefited humans in the field of agriculture, they have imposed much serious effects on humans and livestock. From the above made observation of the development in agricultural methods, We notice that developments in the agricultural practices that deal with reduction of human labor have become a benefit , whereas the developments in the field of synthetic chemicals for agriculture have transpired to be unfavorable due to its ill-effects on soil, human life and livestock. With respect to these pros and cons of agricultural development and challenges, in this paper we have discussed about the methods that have had good and favorable development in the field of agriculture and improvements of these methods with modern day technologies such as Internet of things (IOT). The effects of synthetic chemicals used for agriculture are also taken into account and how to overcome these effects by sticking to primitive and cost-effective methods have also been discussed.

Technological advancements swapped ploughs with tractors, hand drawn wells with electric motors and many more. Science has played a major role in aiding labor efforts in agricultural field to a very large extent. With much more advanced technologies such as Internet of things (IOT), Machine Learning (ML) and Robotics, agricultural process can speed up and made more efficient using these advanced methods. In this paper, we deal with the use of Internet of things (IOT) and Machine Learning for building

a productive agricultural model. The Internet of things(IOT) is the most advanced innovation used for the process of automation. Since, Agriculture is a field that deals with several different equipment's based on the several criteria's, Internet of things (IOT) can benefit the process by coordinating with different agricultural equipment's, such as water pumps, sprinklers, growth, lights, etc. By analyzing the environmental conditions in a farm such as soil moisture, soil pH, light intensity, etc. IOT is the core of automation, and the agricultural sector can be made more gainful and large-scale production can be made much simpler and more prolific with the use of such ingenious technology. Machine learning can also be used in agriculture for several purposes such as favorable crop detection, growth and yield prediction, disease detection, etc.

Technology has had its fair share of pitfalls that have had a serious threat to soil, human and livestock. Soil is the essential unit that supports life on earth. The soil is from where life originates. Soil is the lifeblood of agriculture without which agriculture cannot be accomplished. But in recent years, synthetic chemicals used for higher yield in agriculture have led to soil infertility issues that makes the soil unsuitable for production. These chemicals have not only affected the soil but also humans and livestock to a large extent. As these chemicals contain carcinogenic substances that cause cancer. To overcome these issues, organic methods can be implemented for a healthier way of production. Though organic farming is a safer way, it doesn't give the same yield as synthetic chemicals and also organic products come with a higher price tag in the market. These organic methods can still be used for safer agricultural practices. Organic products are progressing onto the market rapidly and the demand for organic products are on a twofold increase. Organic farming methods are the key to a much safer and healthier world. Organic farming can also be precisely used for better yield production and sustainability of the soil when planned and precisely carried out.

Over and above the merits and demerits provided by science in the field of agriculture. Agriculture, especially in the country like India, faces serious challenges such as drought, lack of mechanization, agricultural marketing, etc. One crucial challenge faced by farmers in India is the interference of broker or middleman in agricultural markets that has given a severe blow to the economical profits of the farmers. This issue was accelerated by several agricultural bills passed by the Indian government that multiplied the fear of the farmers as it led to the likelihood of interference of corporate companies that could cause severe blows to the economical profits of the farmers. This also laid bedrock to several riots and protests all over the country. So, this paper also discusses ways to overcome such issues by developing a platform for direct producer to consumer retail, where the economics figures are decided by the producers and the need for middleman or corporate companies can be eliminated. Thus, giving the farmers the complete benefit of their efforts.

With this being the case, this paper discusses the development of complete agricultural model that uses IOT as the core for agricultural automation, Deep Learning Neural network for plant disease detection, primitive organic methods for farming and a web portal for direct producer to consume retail. This paper aims at proposing an agricultural model that aims at laying foundation to the modern generation of farming in a much more simple, efficient and cost-effective manner.

II. MOTIVATION

- Since the beginning of the 20th century, scientific developments have changed the face of agriculture. Technological inventions like tractors and water pump motors have made agriculture much simpler by reducing labor efforts to a great extent. With the latest developments in the field of IOT, automation can aid agricultural processes by making it much more efficient .
- Artificial Intelligence and Machine Learning are replacing human intelligence. These technologies have advanced to several dimensions such as image, processing, computer vision, etc. These technologies can be made use of for several tasks such as plant leaves disease detection, weather-based crop detection, etc.
- With the increase in synthetic chemicals for agricultural purposes, the rise in cancer and other disease amongst human and livestock have had a large impact. To overcome these drawbacks, Organic farming is the key to safer and healthier agricultural practices.
- The last decade in India has seen a lot of exploitation of the farmer, by the middleman and it has also been observed numerous riots took place all over the country against the government bills passed under the agricultural schemes that could pave way for corporate companies to exploit farmers. Hence there is a large necessity for removal of the middleman or corporate companies that try to exploit the farmer. Hence the necessity for a platform that enables direct producer to consume retail is of utmost importance.

III. Problem Statement

To develop an agricultural model by implementing Internet of Things (IOT) as the root of automation to control all the equipment in a farm based on the farm conditions and use Machine learning for detecting plant disease in real time. To implement primitive organic methods to promote organic farming and build a web platform for direct producer to consumer retail.

IV. Objectives

- To automate farming using modern IoT technology like automatic irrigation using soil moisture detector, automated light intensity controller for higher yield, etc.
- Use machine learning to provide a platform for real time plant disease detection and soil and weather-based crop prediction system.
- To find organic solutions that can replace synthetic chemicals in agricultural practices.
- To build a web-based retail platform for direct producer to consumer retail.

V. Literature Review

[1] A.A. Raneesha Madhushanki, This paper discusses the increasing agricultural productivity using Internet of Things (IoT). IoT can be used to reduce human labor and increase productivity by collecting and analyzing sensor data from the fields. Water management was noted to be the highest subvertical of IoT followed by crop management followed by smart farming followed by livestock management and irrigation management at the same level. With respect to sensor data the most influential was environment temperature followed by environmental humidity followed by soil moisture and soil pH. Wi-Fi is considered the most frequently used for IoT in agriculture.

[2] Sonal Jain, discusses the use of Machine Learning algorithms such as Recurrent Neural Network for weather prediction. Random forest classification algorithms can be used to find the best crop based on the weather and soil condition to produce maximum yield. Machine Learning algorithms can be improved to give better accuracy and the result of this algorithm can help choose a crop for maximum production.

[3] Kiran R. Gavhale, plant disease has affected agricultural economy to a great extent. These diseases can be easily and effectively classified using Image Processing algorithms than through a naked eye. The paper discusses the merits, demerits and functionality of several different image processing methods such as region based, edge based, threshold based, feature based, clustering, Markov Random Field, texture feature classification, K-Nearest Neighbor, Radial basis function, Artificial Neural Network and Support Vector Machine.

[4] Esteban, Chemical pesticides, insecticides, fungicides, fertilizers have become the reason for several environmental pollution and health problems. To overcome this issue natural fertilizers and pesticides can be used that are usually generated from plant extract and animal waste. Some of the natural ingredients listed in the paper that can replace synthetic chemicals and crop residues, animal manure, bird manure, bovine manure, sheep manure, pig manure, urine, compost, vermicompost, biochar, plant essential oils, ginger, garlic, onion, nicotine, rue and nettle tea.

[5] S.Karthick, discusses the aspects of agricultural marketing in India. The paper discusses with the history of development of agricultural markets in India from the foundation of central Marketing Committee in1935. “Haats” were the firm of primary market for agricultural products followed by “Mandis” known to be as the secondary markets followed by the terminal markets that sold products to consumers or prepared for exports. The paper also describes the type of agricultural products traded, types of transactions and areas served.

VI. Proposed System

The agricultural model proposed is developed based on the following key elements:

i. Internet of Things (IoT) instrumentation in farms

The IoT framework in a field can be set up based on the master-slave architecture where the master is a coordinator, the hub and the slave are the workstations. A star topology can be constructed where several workstations communicate with the hub. Here the workstations are connected to sensor and camera modules and communicate the farm conditions read by the sensor to the hub.

The hub then communicates it through the network and service layer to the application layer. The hub controls all the controllers to control equipment such as water pumps and growth lights. WSN architecture is used to communicate between workstations, hub, and the user. The workstation comprises of sensors and the gateway node, the hub comprises of controllers and gateway node. Here we use ESP32 Wi-Fi module for communication.

ii. Analysis using Machine Learning

Machine Learning algorithms can be used to analyze the data collected from the field. Random Forest algorithm can be used to predict which crops are suitable to grow for the given soil parameter, location and sensor data. In the same manner Convolutional Neural Network (CNN) can be used to detect several leaf diseases by capturing real time data from the field using camera modules setup at the analysis of data in collaboration with automation process can provide much higher yield and prevent any damage.

iii. Producer to consumer online marketing

React.js can be utilized to build a web portal that can facilitate direct to producer to customer retail. Two portals can be built, one for the producer to upload details of the stock and the other for the customer to purchase these stocks. The web portal can also be built based on smart contracts for safer and secure online transactions through the portal.

iv. Graphical User Interface

A GUI is the simplest way to easily control the complete process at your fingertips. A mobile based and web-based GUI can be built for controlling the hub and the workstations at the field. Flask and Flask-RESTful can be used to implement the Machine Learning model into a GUI. The GUI can be used for the relative field data that can facilitate easy analysis of the data and control over the equipment in the field.

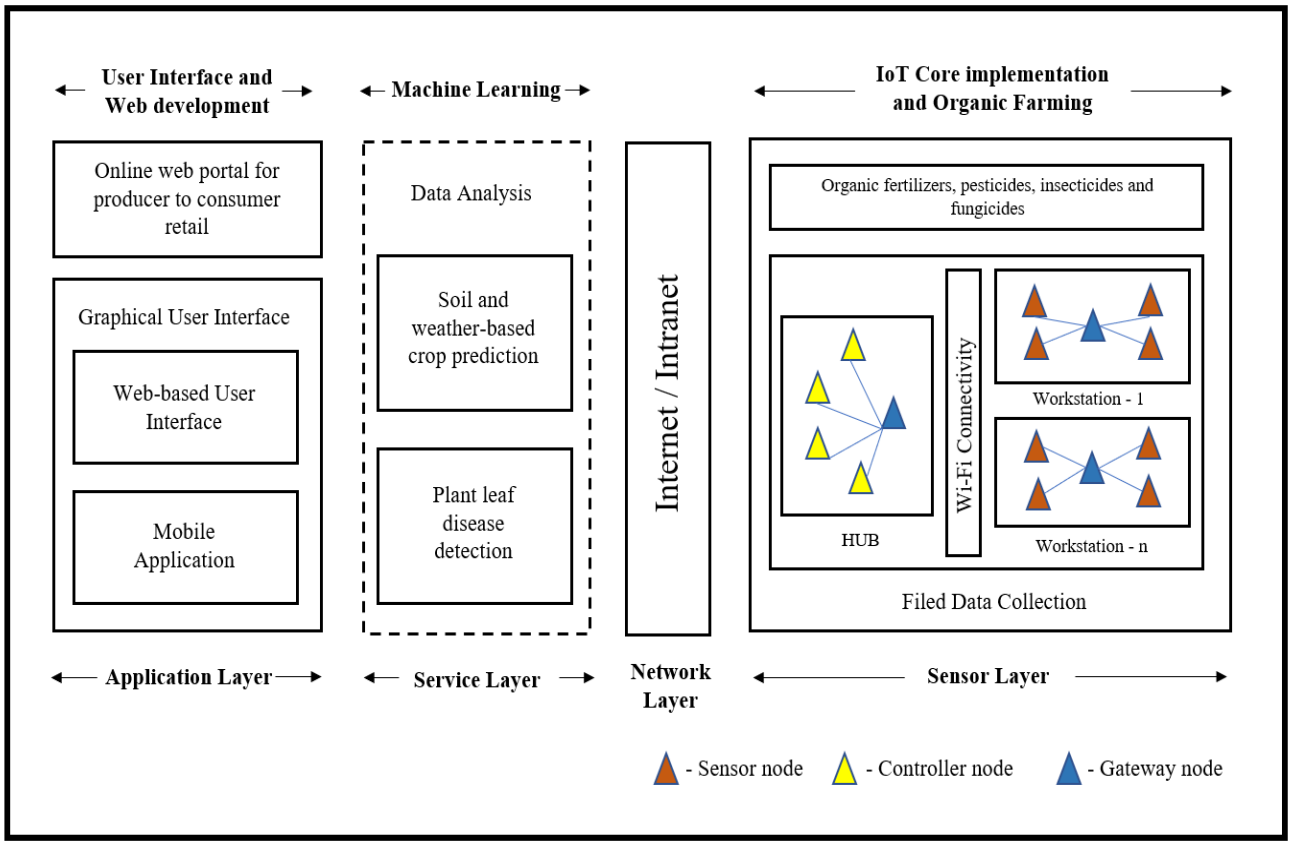

Fig. 1 – System Architecture of the Proposed Model

VII. Advantages of the Proposed System

The proposed agricultural model comes with the following benefits:

- Cost friendly in the long run.
- Reduced labor efforts.

- Zero waste farm
- Reduction in human and livestock diseases.
- Fertility of the soil is retained.
- To avert the exploitation of farmers by eliminating the middlemen.
- Real time data analysis for maximized yield.

VIII. Limitations and Challenges of the Proposed System

The proposed agricultural face the following limitations and challenges:

- High initial investment- Though the proposed agricultural model is cost efficient over a long period, the initial cost of setting up the model is considerably high.
- Periodic maintenance- The agricultural model consists of electronic equipment's that are placed in the farms and are prone to damage by water and other means. Hence timely maintenance of the equipment is of utmost importance for smooth functioning.
- Collection of raw materials for the organic farming- Though most of the natural materials used for organic farming are derived from plant and animal waste, the collection of these raw materials in large scale is difficult as it cannot be derived from a single source.
- Connectivity issues- In a country like India the Ethernet cables hardly reach the countryside where the agriculture is at its peak. Without such technical feasibilities connectivity to such smart farms are nearly impossible.

IX. Conclusion

In this paper we have discussed the ways and possibilities in which benefits of the scientific developments in agriculture can be derived by completely keeping away from the shortcomings present in today's agricultural sector. An agricultural model is proposed using methodologies such as IoT, machine learning, web development and organic farming.

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