A Novel Approach To Smart Farming

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Abstract - *With the vast technological developments, urban areas are developing fast and natural resources around us are getting depleted. Natural resources in soil are vital for farmers to cultivate agriculture and provide us food. As the farmers lacks sufficient knowledge about the resources present in soil, they are facing lot of challenges in cultivating suitable crops and producing yield. Modern technological advancements such as Data Analytics and Internet of Things(IoT) enable us to predict the future of the given input before its actual implementation. By analyzing the recommended natural resources present in soil, we can predict the crops that are suitable to be cultivated in a given specific land. Our project is mainly concerned with overcoming the agricultural challenges by predicting the success or failure ratio of crops cultivation using various modern analytical techniques. This provides the farmer with smart agricultural practices and improves the yield.*

***Key Words*:** Data Analytics, IoT

1. INTRODUCTION

Agriculture is one of the most important occupations practiced in the world. It is the extended economic sector and plays an important role in the development of the country. About 65% of the land in the country is used for agriculture in order to suffice the needs of nearly a billion people. Thus, modernization of agriculture is very essential and thus will lead the farmers of our country towards more profit.

Agriculture in India includes a mix of traditional to modern farming techniques. In some regions in India, the traditional use of cattle to plow remains in use. Traditional farming techniques have some of the lowest per capita farmer incomes and Productivity. India is one such country which is largely dependent on the agricultural sector. Agriculture in India is not just livelihood but a way of life. The governmental organization is continually making efforts to develop this sector.

Though agriculture is being practiced for centuries, it remained underdeveloped for a pretty long time. We were unable to produce enough food for our people and foreign export. On contrary, we need to purchase food grains from other countries. This was because agriculture in India depended on the monsoon weather pattern. Suppose, there was enough rain, the crops fertilized properly when there wasn't enough rain the crops failed and most parts of the country were hit by famine. However, things changed with time. After independence, the government planned to bring about improvement in this agriculture. Dams were constructed, tube-wells and pump-sets were setups, fertilizers were made available and new techniques were employed.

With the use of technologically advanced equipment and good irrigation facilities and with specialized knowledge about the field things began improving. We started producing much more than we required and subsequently started exporting food grains and different agricultural products. Our agricultural sector is robust than that of many countries.

Fig 1.1 Traditional Farming in India vs. Modern Farming in Israel

The new strategy has two broad components the mechanical package and the biological package. The former refers to the use of tractors and other forms of machinery. The latter refers to the raising of yields through the use of improved plant varieties or the new varieties of rice developed at the International Rice Research Institute. Due to the dramatic effects on yields of some of those new varieties, the phenomenon is often referred to as the Green Revolution. These new varieties raise productivity if they are combined with sufficient and timely supply of water and additional usage of chemical fertilizers. The major impact of the biological package is to raise yields. The stress is on using improved plant varieties of combination with fertilizers and pesticides to raise yields of rice, wheat and more. Founding of the International Maize and Wheat Improvement marked the beginning of a truly international effort to develop high-yielding varieties of grains suits the tropical conditions found in most of the LDC's.

2. Related works

[1] RAHIM KHAN et al. proposed DSS can support farmers in their manual irrigation systems or automate irrigation actions. Water-deficient sections in both situations are recognized by using soil moisture and environmental data sensors. A simplified outlier detection algorithm is thus introduced and blended with the proposed DSS to fine-tune received data before processing. The working of the algorithm is O (1) for dynamic datasets generated by sensor nodes and O (n) for static datasets. Various subjects in technology-assisted irrigation management and their resolutions are also discussed. At present, different activities, particularly irrigation, in agriculture are performed with traditional procedures that are time to consume, labor-intensive, and wasteful. The main motivation is that crop quality and production rates will improve if the right resources are applied at the right time under suitable environmental conditions. Such mechanisms improve crop yield and conserve considerable resources, such as water, pesticide spray, and potassium. Different mechanisms are utilized to collect environmental parameters and soil features, such as moisture, salinity, pH, temperature, air humidity, and wind direction. Therefore, technology-assisted irrigation mechanisms, sensors, and actuators must be realized in real agriculture environments. These approaches provide water upon demand and control water wastage. They are helpful in controlling water resources but exert drastic effects on plant growth rate and yield. In this work, we developed a technology-assisted outlier detection and decision support system (DSS) to facilitate. Irrigation, particularly flooding. The proposed system is highly precise because it uses an embedded outlier detection module that thoroughly examines the correctness of the collected data and forwards the data to DSS for further processing. DSS analyzes different parameters to identify water-deficient sites and reports them to farmers or generates an alarm. This system possesses a user-friendly interaction environment that makes it easy to use.

[2] Junyong Liu, et al. say that this paper pro- poses an idea to combine smart agriculture and clean energy consumption, use surplus clean energy to supply agriculture production, and utilize smart agriculture to support power system with clean energy penetration. A comprehensive review has been conducted to first depict the road map of coupling an agriculture clean energy system, analyze their sensibilities and advantages. The recent technologies and bottlenecks are summarized and evaluated for the development of a combined system consisting of smart agriculture production and clean energy consumption. Several case studies are introduced to explore the mutual benefits of agriculture-clean energy systems in both the energy and food industries. In order to solve the issues in both agricultural production and clean energy consumption, a road-map is proposed to integrate smart agriculture into clean energy penetrated power systems, as shown in Fig. 2. The top part is the power system, where the clean energy generation is either injected into transmission levels, or integrated into the local distribution and micro-grid systems. The bottom part is the agricultural system, with electrical-related control factors such as lighting, temperature, watering and heating. Agricultural information technology (AIT) has been broadly applied to smart agriculture and has become one of the necessary tools for enhancing agricultural productivity and making full use of agricultural resources. A road map of integrating a clean energy power system into smart agriculture was proposed. However, the practical implementations still face certain bottlenecks, and must rely on several key technologies. They are: Multi-time Scale Coupling, Measurement and Monitoring System, Multi- system Correlation Coupling Mechanism, Establishment of a Clean Energy Consumption and Economic Evaluation System.

[3] Demonstrates that Francisco Yandun, et al. propose that this paper presents a survey of the

state-of-the-art in optical visible and near-visible spectrum sensors and techniques to estimate phenotyping variables from intensity, spectral and meter measurements. This article conjointly discusses the progress in processing strategies and also the current open challenges in agricultural tasks within which the event of innovative sensing methodologies is needed, such as pruning, plant food and chemical management, crop observance and automatic harvest. Three main applications will be recognized for agricultural phenotyping: Structural characterization: the estimation of parameters such as: cover volume, plant height, leaf space coverage, biomass, among others, ends up in take choices so as to reinforce the agricultural method. Plant/Fruit detection: successful results in automated activities such as pruning, harvesting, seeding, among others, depend on an accurate localization of the object of interests within the environment. To achieve this aim, several features and properties of plants and fruits have been used, namely: color, shape and temperature. Sensing methods for structural characterization rely mainly on color cameras, structured light cameras, 2D and 3D LiDAR sensors, time-of-flight cameras, stereoscopic vision or ultra-sonic sensors for volumetric and morphological measurements. The accuracy of the different approaches for morphological analysis, plant/fruit detection, and physiology measurement is in general above 80%. Pro- vided that environmental conditions can be isolated or made comparable; the accuracy of each sensing methodology is often associated to the characteristics of the plant, such as stem/branch complexity, foliar density and contrast between fruits, leaves and branches. Some challenges in PA which can benefit from the development of new sensing methodologies and the improvement of the process models include the measurement of the effectiveness of the phytosanitary spraying, the development of automated perception methods for pruning that are capable of handling the variability and complexity of the branch structure of shrubs and trees, and the improvement of crop monitoring techniques and inference models not only for yield estimation, but also to manage irrigation, soil and illumination conditions, growth rates, plant nutrient uptake and assimilation. Novel mechatronic systems, including ground and aerial robotic platforms, for high throughput phenotyping will require improvements in the speed of algorithms and their ability to cope robustly with plant and environmental variability.

[4] explains us that Pooyan Abouzar et al. proposed an RSSI-based distributed Bayesian localization algorithm based on message passing to solve the approximate inference problem. The algorithm is designed for precision agriculture applications such as pest management and pH sensing in large farms where greater power performance besides communication and computational scalability are needed but location accuracy requirements are less critical. Information trouble which is a key constraint of popular non-Bayesian and Bayesian distributed techniques is shunned by a message passing schedule in which outgoing message by each node does not depend on the destination node, therefore is exceeded size. Fast meeting is achieved by 1) eliminating the setup phase linked with spanning tree construction which is frequent in belief propagation schemes, and 2) the parallel nature of the updates since no message needs to be exchanged among nodes during each update, which is called the coupled variable's phenomenon in non- Bayesian techniques and values for a significant amount of communication overhead. These features make the proposed algorithm highly compatible with realistic WSN deployments. The large size of the WSNs deployed in agricultural fields in addition to the nature of higher layer communication algorithms in terms of TDMA-based MAC and multi casting make most existing distributed localization algorithms ill-suited for use in such environments. Bayesian distributed techniques suffer from communication overhead required for setup phase in order to form loop-free graphs. On contrary, non Bayesian techniques are burdened with excessive communication expenses resulted from coupled variables, remarkable computational complexity needed to solve optimization problems at each iteration and generally suffer from slow convergence.

[5] Pratap Tokekar et al. defined the problem of designing sensing strategies for obtaining aerial images and soil samples with a UAV+UGV system to estimate the nitrogen level in a plot. Battery life of the UAV is limited, so the UAV and UGV can only sample a limited number of points. Precision agriculture can improve crop productivity and farm products through better management of farm inputs, leading to higher environmental quality. Measurement of soil

nitrogen levels across a farm and applying the right level of nitrogen at the right time and place, it is possible to reduce fertilizer usage by 25% without affecting corn yield. They studied the problem of maximizing the number of points visited by the UAV and UGV. Unlike traditional approaches, our algorithm takes into consideration the situation where the UAV can land on the UGV and thus be carried between points without expending energy. They also studied the problem of minimizing the time for sampling these points with a UGV. They presented a constant-factor approximation algorithm which sends a set of sampling locations and a tour of these locations, such that each point has a sampling location within its disk neighborhood. They have started building the complete system using a Clear path Husky A200 ground robot. To execute the algorithms presented in this paper, additional capabilities such as autonomous landing and soil sampling are necessary which part of their ongoing project is.

[6] Briefs us that Christopher Brewster et al. aim to guide industry stake- holders and researchers who have under- taken the task to build large-scale pilots in agriculture that are heavily based on IoT technologies. The IoT related difficulties and constraints for the agro-food sector are described together with the core objectives of IoT based LSPs. A system-of- systems architectural approach is proposed, with an emphasis on the interoperability aspects which are critical for the uptake of IoT technologies in the agro-food sector. The Agricultural Information Model approach is proposed to address semantic interoperability, and a farm-to-fork management information system solution ensuring data interoperability is outlined. There remain many challenges including the need for new business models, security and privacy, and data governance and ownership solutions, as they are critical for executing IoT based LSPs in agro-food. Finally, a detailed account is presented of the most appropriate IoT technologies and agro-food applications to be used, as well as the main key performance indicators to evaluate the performance of the proposed LSPs in a quantifiable manner. The execution of such LSPs will surely promote the usage of IoT in agriculture, thus optimizing various operations in the entire food supply chain resulting in reduced effort and cost for the producers, and higher food quality and safety, as well as extended food awareness for the consumer. Nonetheless, the main barrier that needs to be overcome before IoT is extensively exploited by the stakeholders across the food supply chain is the change of culture.

3. IoT ECOSYSTEM

WSN(Wireless sensor Network)

Wireless Sensor Network is a collection of sensors for monitoring and recording the conditions of the environment. It also organizes the collected data at a central location. The sensors are used to monitor and to measure different farm variables example soil nutrients, weather data and factors that affect production. The sensors can be classified into location sensors, optical sensors, mechanical sensors, electrochemical sensors, and airflow sensors. These sensors are used to gather information, such as air temperature, soil temperature at various depths, rainfall, leaf wetness, chlorophyll, wind speed, dew point temperature, wind direction, relative humidity, solar radiation, and atmospheric pressure. The major components of a sensor node are a micro controller, transceiver, memory, power source, and one or more sensors.

Sensor nodes have a micro controller for monitoring, a radio transceiver for generating, wireless communicating devices and external energy source such as battery. A sensor node in a sensor network is able to process, collect sensor information, and communicate with other nodes in the network.

WSN is the most standard services employed in industrial and commercial applications, because of its technical development in a processor, communication, and low-power usage. The above sensor module consists of 4 sensors they are 1.pH sensor 2. Temperature sensor 3. Water level sensor 4. Light sensor(LDR).

One of the common ways of testing water quality measurements is by determining its pH level. pH is a measure determined by the amount of free hydrogen and hydroxyl ions in the water. The liquid that has more free hydrogen is given as acidic, and similar, water that has more free hydroxyl ions is alkaline. Calculating pH is in the series of 0 – 14: the system is logarithmic, so each reading describes a 10-fold variation in pH. For example, water with a pH of 4 is considerably more acid in nature than water with a pH of 5. With these measurements, a pH of 7 is given as neutral. For example, a typical rainfall has a pH of about 5.6, and a stream would have a pH in the range of 6 – 8.

Fig. 3.1 Sensor module

It is necessary to control the pH of the water as any changes in the level may harm the organisms that depend on it. Different organisms flourish in modifying ranges of pH and can be greatly affected by even a small shift. A switch in natural pH in the water level can be evidence of increased pollution or other environmental circumstances. This is because of the fact that pH can be altered by chemicals substances in the water. The solubility and physiological availability of the chemical components of water are defined by pH.

COMMUNICATION TECHNOLOGY

Communication technology plays a key role in the successful deployment of IoT systems. The existing communication technology can be classified based on standards, spectrum, and application scenarios. The communication standard can be grouped into a short-range communication standard and long-range communication standard. The communication spectrum can be grouped into a licensed and unlicensed spectrum. The IoT devices application scenarios can be based on sensors or back haul network, and deployment scenarios the short-range standards can cover distances within 100 m. The long-range communication standards can cover distances up to 10 s of kilometers.

Here communication establishes between the raspberry pi and the monitor. Raspberry Pi is in the field along with sensors and the data collected from the sensors are transferred to the laptop via a wireless network. The received data is stored in CSV format and this transfer of data is made possible through the server and client socket program.

DATA STORAGE AND PROCESSING TOOLS

In real time field data collection, a huge storage area is required, because based on the frequency of data collection it varies. Though the size of each data from sensors is in bits and bytes, the collection of data in the minimal intervals and use of multiple sensor nodes will eventually require huge data storage. A voluminous amount of data is required to train the machine and to make them predict the future results in advance.

An important thing to be noticed is a sensor does not always work perfectly as expected. Sometimes data collected from sensors may be garbage values so these values are needed to be removed. This process is technically called as data cleaning. Though data collection and storage is an important factor processing those data is the ultimate goal. Processing involves execution of programs which takes sensor data as input and gives out a graph or interpretable output format. In order to do this, a computing environment is required thus Raspberry pi is the best solution.

Raspberry Pi runs on the Linux operating system and the kit has dedicated memory card slot for storage purpose. This is like a mini computer which is capable of storing data received from the field and also processing that information with the help of python programs to obtain a processed output. Thus, the final output is provided to some visualizing tools.

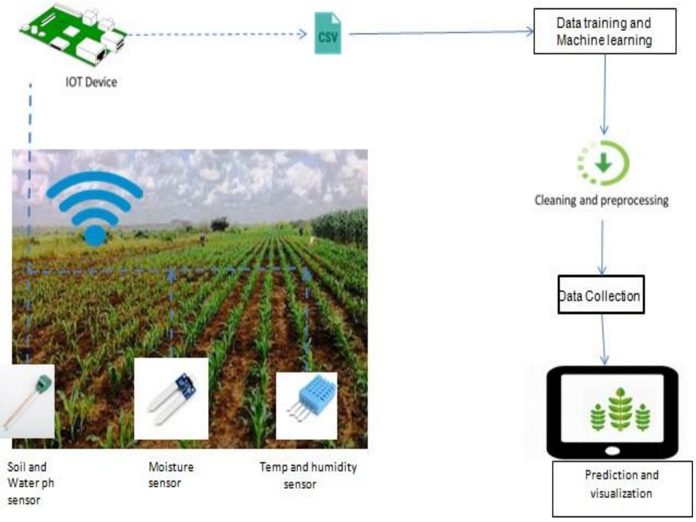
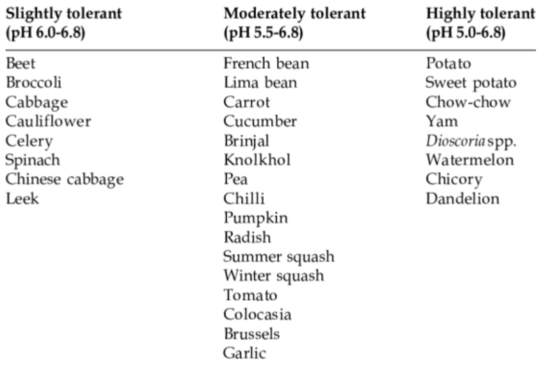


Fig. 3.2 An overview of implementation of Iot devices in agriculture

4. PROPOSED SYSTEM

In traditional farming techniques, farmers cultivate the crops based on their previous cultivation techniques certainly, their idea of farming works well, but they are not ready to cultivate new crops because they are ignorant of what are all the possible crops that can be grown in such soil conditions and the climatic conditions. Each crop has its own adaptations to conditions, in order to understand all these a farmer needs to learn from the agriculture department. To overcome all these issues usage of IoT devices such as water level, soil pH, temperature, humidity sensors were preferred. An example of soil ph range and its crop are given below.



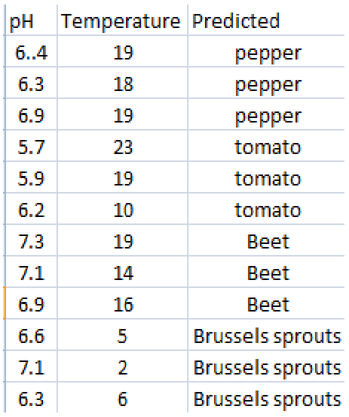
Slightly tolerant (pH 6.0-6.8)	Moderately tolerant (pH 5.5-6.8)	Highly tolerant (pH 5.0-6.8)
Beet	French bean	Potato
Broccoli	Lima bean	Sweet potato
Cabbage	Carrot	Chow-chow
Cauliflower	Cucumber	Yam
Celery	Brinjal	*Dioscoria* spp.
Spinach	Knolkhol	Watermelon
Chinese cabbage	Pea	Chicory
Leek	Chilli	Dandelion
	Pumpkin	
	Radish	
	Summer squash	
	Winter squash	
	Tomato	
	Colocasia	
	Brussels	
	Garlic	

Fig. 4.1. crops based on tolerance

Weather changes are always random and it would not be an effective approach to predict crop based on the single sensor reading. So a series of data collection is obtained from various sensors. It is to be noted that sensor data is not always correct; sometimes it may show irrelevant data also. To eliminate such difficulties data cleaning is required and these corrected sensors values are compared to the crops.

This system architecture suggests initial crop cultivation based on the above crops details. Subsequent crop cultivation are predicted using data which are collected during germination of the previously grown crop. These data are passed on to the machine learning algorithm which analyzes the pattern of environmental condition and changes in soil due to the crop grown in it. Initially, sensor module consists of a pH sensor, temperature sensor, water level sensor, and light sensor are placed in the agricultural land where farmer cultivates their crops. This sensor module requires a power supply to read data from the land and transfer it to the next module via the serial port. Three connectivity pins such as 5v, transmitter, ground pins were used to transmit the data, in the receiver end the same 5v pin and ground pins are common whereas the third pin is receiver pin. The next module is a Raspberry Pi Kit it collects data from the sensors through USB to TTL module this data is stored in the raspberry pi storage later this data is transferred to the client device using server and client socket program.

Data from the sensors are stored in string format and the string is trimmed in such a way sensor values alone are sent. In the client side, these data are collected and stored in a comma separated value (CSV) file. This file is further given to the program where it already learned from the training dataset, it includes all crops specifications with their respective pH values and optimal temperature ranges are defined. Issues with this data transfer are the received data is in an encoded format, there need decoded values in order to store data precisely.



pH	Temperature	Predicted
6..4	19	pepper
6.3	18	pepper
6.9	19	pepper
5.7	23	tomato
5.9	19	tomato
6.2	10	tomato
7.3	19	Beet
7.1	14	Beet
6.9	16	Beet
6.6	5	Brussels sprouts
7.1	2	Brussels sprouts
6.3	6	Brussels sprouts

Fig. 4.2. crop predicted table

This predicted crop result is loaded as an input to a Python developed web page that uses the functionalities of FLASK. Users can upload the data values whenever they want, whether it is on a daily basis or seasonal readings and can immediately view the output according to their compatibility. The page is also optimized to make the users understand the output more effectively and according to their regional language. Hence, this helps the farmers where they do not have to do much work and helps them in analyzing the crops that can be grown on their field. It also helps the farmer greatly in pre-visualizing the capabilities of profits that can be earned by safely growing the crop that is meant to be grown on their soil. Most of the farmers, even today follow the same traditional techniques and rely on specific type of crop growing to make their ends meet and to also enjoy some profits not knowing properly whether the crop product will grow on their soil or not, and therefore this system can be viewed as a safe and small scale alternative for helping the farmers predetermining the crops that they can grow.

வணக்கம்

CUCUMBER
வெள்ளரி
PH: 5.5
TEMPERATURE:21

Fig. 4.3. A view of the client webpage that can get input from the server program and display output

5. CONCLUSIONS

Our ultimate aim is to predict crop based on the soil pH values, water level, temperature, humidity, and light. For that, we deploy different types of sensors in the field with a controller for controlling the data collected from various sensors. In the next stage, these data are processed in the processing unit to make predictions. The data collected from the sensors are not flawless so data cleaning is required prior to applying any machine learning algorithms. These data collected from sensors are given to machine learning algorithm SVM(Support Vector Machine) to analyze the pattern in the field condition and the final result is passed on to a program which contains the necessary details about the crops, its soil pH ranges, its water requirements, temperature, humidity, and light. Initially, analyses are based on the static inputs as time goes these sensors collect data periodically and analyze the pattern and predicts the condition in the near future and suggests crops. Thus, it examines the best suitable crop which satisfies all the necessary condition mentioned in the program and suggests that crop.

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