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Machine Learning Techniques with IoT in Agriculture

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ABSTRACT

Traditionally methods developed for agriculture focused on the specific functionality/ domain-dependent such as temperature, humidity pressure, etc and lacks of knowledge base for smart irrigation. In modern generation, the volume of information gathered by numerous sensors over a period, with a diverse series of applications nowadays, is acknowledged by means of Internet of things. Grounded by the properties of an application, the IoT strategies drive outcome in large volume and instantaneous streams of data. Implementing analytics for a large volume of data stream to find novel information, further predict understandings to produce precise and decisions to control a vigorous method that introduces IoT in a well-meaning model for industrial production besides a eminence of life refining technology. Machine learning (deep learning) eases the analytics and knowledge in the IoT domain, the major perspective is to use machine learning (deep learning) in IoT. Hence, in this paper we discuss a systematic review to determine different methods in agriculture practices.

Key words: IoT, WSN, crop prediction, deep learning.

1. INTRODUCTION

In early 1980s, a new terminology was introduced known as Ethernet which is most widely used local area networking (LAN) technology. Ethernet was used for connecting the nearby devices for short range communication [13]. Due to its limited mobility and short distance network of Ethernet, researchers have established a universal connection of computer with networked devices identified as Internet. Mean while from 1990, Internet had a ground breaking stimulus on commerce, and technology, with the intensification of nearby instant communication by different electronic devices such as email, instant messaging, World Wide Web, telephone calls, video calls and VoIP. The information can be directed to other devices through two communication network one is wired and other is wireless medium. The wireless technology has more advantages compared to wired which lacks in connectivity and long-distance communication.

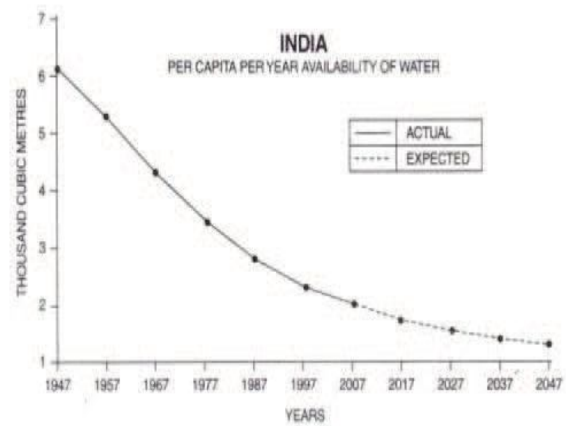

Figure 1: Availability of water [2]

Advancement in Wireless technology introduced a new concept, Wireless Sensor Network (WSN) technology, isknowingfor data collectionwith volume of information in the interested domain, transmitted through wireless link. WSN is utilized in varietyof areas such asmeasuring of lands, monitoring and controlling. Internet of Things (IoT) delivers a scientific space [32], in which plentiful "Things" as well as devices, for example, sensors and everyday tools, are boosted by more dispensation power and interacting competences. IoT, drive be acting as individual separate units or as a collaborating swarm of heterogeneous devices. It is quickly growing technology in terms of the precise information and communication media and the internet. IoT nowadays, has stretched to different areas, taken variety of forms and diverse number of applications.

In India, irrigation is one of the important and foremost sectors, that will be technologically extremely, prejudiced by the developments inthrust area of IoT. United Nation's (FAO) agriculture organization, forecasts that population of the world may reach up to 8 billion by 2025 and 9.6 billionby 2050 [31]. Essentially that can be related to anrise in growth of 70% in production of food items, must be achieved by 2050 worldwide. This upfront upsurge in people and intensify ingeminate for virtuous eminence goods has twisted the need for the modernization and escalation of different techniques in agriculture. Meanwhile, efficient utilization of aquatic and additional related resources is also obligatory in agriculture. Irrigation requirement depends on water, soil properties, temperature, humidity, etc. There are many major challenges in irrigation, the first and foremost is water, as per figure 1.1 [29], the availability of water is descending in further coming years. If rate of declination continues in coming years formerly, resulting in water scarcity for decades. Another major challenge is environment factor such as soil properties, temperature, humidity etc, that effects most for crop production.

The remaining paper is systematized in following order: Section 2 represents a systematic literature review of machine learning and IoT applied in agriculture. Section 3 presents proposed novel framework. Thus, this sectionexplains our research queries and practical tools with in details. Section 4 discuss the analyses of the objectives, conclusion and future plan of research.

2. LITERATURE REVIEW

2.1 IoT framework for automatic system in agriculture

Wireless network with sensors used for soil monitoring proposed in [1] uses Zigbee technology (CC2500) which is used through extremely warmth and cost effectiveness. It consists of 3 LED's which indicates transmission and reception with energy module. The frequency ranges from 2400MHz - 2483.5MHz.EWMA is used to signal events whenever the threshold value reaches as condition is met. The node moves into sleep/ wait state if the node has remaining time, which can save energy of the nodes. System in [27] uses RFID with FFD for wireless nodes and routes respectively, single chip control center, monitoring center with limited component compositions, accepted the Bluetooth network, wireless gateway, moisture content and control information transfer with the monitoring center. Individual acceptable devices collects information of temperature, humidity, soil moisture inevitably and collective limits of moistness with default analysis, determining what can and can't have irrigations. Each node is equipped with solar power, the solar power dynamically monitored at different time.As soon as the voltage goes below the specified level, the node notifies a low voltage alarm indication referred efficaciously, then the device goes hooked on sleep pattern until it gets fully charged.Andynamic, intelligent and irrigation system in [29] for the agricultural crops, focuses for controlling and monitoring the irrigation process inevitably using Microcontroller. The computerization portion is measured over python programming. The device entails of soil details using sensor which monitor the diverse ingredients of soil. A system in [30] provides information for farmer on the basis of automatically using WSN. The framework uninterruptedly gathers the parameters/ information of temperature of the area, humidity of area, and moisture circumstances of soil. In demand monitoring and controlling the irrigation practices an automated and smart irrigation framework is established and instigated. There is indispensable repetitive irrigation framework since it is unpretentious besides informal to mount. The device utilizes values as "On" and "Off" to control water supply. Python language is been used for controlling the systems framework. The system uses an algorithm for maintaining the verge values of soil moisture continuously. Framework provides on and off of irrigation framework for gathering data of moisture contents of different soils. The framework provides cost efficient moisture sensor that are coupled to wireless devices using gateway interface which directs intermittent information in timely way to server through protocols. Database coupled with database system continuously monitors the water table. The web-based interface provides information warehoused in records besides associates through specific values. Formerly it directs message to experts making aware of water requirement.

2.2 IoT framework for soil conditions

In [2] author has developed an agricultural management framework, the farmer will have assistance from an interface application in the procedure of graphical representation, to continuously analyze information in real time variances of the soil contents and on either side of a procedure notification by message will be communicated through an application when a perilous value is reached to evade water pressure. Data mining system in [17] that gathers/ collects information from various climate stations which predicts the moisture of the soil for the future days, all in real time for further study. The system was used with different algorithms of machine learning with an average accuracy of 68%. An effective soil moisture (SM) monitoring and retrieval method in [21] that emphases with soil feature extraction and VWC classification uses UWB radar. It compares two dissimilar artificial intelligence, adjustable network grounded fuzzy inference system (ANFIS) to derive soil parameters with 2 dissimilar Machine Learning algorithms, Random Forest and Artificial Neural Network (ANN). A novel framework is designed and developed by combining DBN (Deep Belief Network) to envisage the Soil Moisture Contents in [24] concluded a moistened corn field. The most widely used intelligent algorithms like NN, multi-layer network, were used for comparison. The hybrid models (MLP-MCA and DBN-MCA) were standardized and legalized on SMC data within 4 months, which stood inevitably experimented by a WSN. The Gaussian simulation was achieved in sequential form to evaluate the uncertainty of soil moisture estimations. An architecture using data mining for yield prediction in [25], framework containing a graceful module, which is in control for enchanting data from owners. The graceful module comprises of types of soil, soil pH value, pesticides contents, weather, water level, seed features. The selection module for features mostly responsible for subset selection of characteristic from crop particulars. The crop harvest forecast prototype helps in precise prediction of plant growth and plant diseases, as well as crop parameters and climate data which helps prediction of crop evolution can be used. Then precise assumed guidelines will be practical applied to the outcomes for categorizing crops.

2.3 IoT framework for yield prediction

In [3] a agricultural production system GUI visualization software with IoT technology is used. The framework provides proper relationship scrutiny for the yield numerical information and information related to agriculture which provides enhanced skills of labors in farm, investigators, and government bodies to collect the information analyze the current circumstances and forecast future harvest. The system with IoT for environmental monitoring in [8] and provides an IoT framework using wireless technologies are implemented. The proposed framework for monitoring, the environmental aspects effecting the orchid leaves in green house and the progress of the orchid leaves can be restrained in real time in a synchronous fashion. In [10] a framework which comprises of monitoring and controller for environment management system, the web interface and system management for information storage as the global management system to implement a modest and stretchy monitoring remotely with control based for environment. The supportive characteristics are up line and downline monitoring as well as synchronous of information on framework, actuation, and downline management are provided. 2 field tests were directed to authenticate its functioning tests and functionalities such as, (a) monitoring of tropical horticulture cultivation, and (b) operations on monitoring and controlling the recent drip irrigation based control system for soil moisture contents. The basis has espoused in cloud constructed tropical horticulture supporting framework, purpose for long term environmental monitoring and controlling local facilities. Supplementary energy sources and power for aging like batteries shared with energy system or portable UPS, to inflate the functionality in addition with sustainability on long term environmental monitoring, might assist upgrading the performance and lessen the misplaced information.

A platform in [11] related to IoT for researchers in exactness or smartfarming and monitoring areas for ecologies. The system has multiple views, Individual opinions describing the solution from the viewpoint for architectural perspective of dissimilar shareholders, such as customers, researchers, developers, and project managers. Further discusses implementation and evaluation of various sensors nodes auxiliary IoT protocols interfacing with various analytical tools. Additionally, progress is planned by including IoT protocols and further intricate amalgamation of CoAP with different software development languages such as R and Python. In direction towards enlarging the resolution with completely information analytics capabilities, progress of detailed sensor data and detailed experimental resultsin terms of performance, scalability, and reliability are used. A new technique with less number of sensors in [15] to implement agricultural intelligent monitoring. Deployment algorithm on IoT platform for agricultural intelligently monitors farm values on an enhanced theory is proposed. It initial develops a framework for accurate device location detection. Model uses maximum key points and pre-described data for accuracy. A key point is selected with feature optimization technique, where the feature standards remain adjacent to the normal standards of apiece feature. The constraint of this system is, the system uses few sensor nodes. A system for environmental monitoring in [16] for visualizing temperature, humidity and CO2 using IoT, has been effectively applied and validated. Information is directed from one node to another node. The information retrieved at the destination device is collected and logged in anCSV file format in a particular CPU, through a Graphical User Interface (GUI), made in LabVIEW. An android software has been developed with specific features, through which information is transferred from LabVIEW to smartphones, for monitoring data from remote areas. A deep learning technique to predict crop harvest yield [20]. It extracts vital features for yield from input data. The system uses architectural framework based on Caffe, a tool or assessment model on deep learning and unravel the unruly of yield approximation in 2 ways using regression methods with Inner Layer.

2.4 IoT framework for environment variables

A cost-effective framework in [4] using environmental monitoring devices like Raspberry Pi system on chip. The framework premeditated by means of Python language and can be remotely accessed and controlled, through an Internet of Things platform. Information of the environment, features through sensors are collected and uploaded unswervingly to the internet, where it can be retrieved through cloud technology through internet. However there are some disadvantages of this system to calibrate the carbon monoxide sensor

Connecting many components the pin may damage device. An agricultural IoT system in [5], provides a framework through IoT based precession agricultural applications, which provisions cognitive concluded innumerable heterogeneous device values to be streamed in realtime. IoT system can be integrated through manifold cross area information streams, provided that a comprehensive processing pipeline, presenting a shared prototype for precise farming. The device in [6] essentially intelligently gathers information like temperature of the area, pressure accusation, area humidity, light strength and rain prediction values. The parameters can be regularly studied with several categories of devices in the typical model. The frameworkcan be utilisedto govern the temperature and humidity of particular area. The framework can also calculate the dew parameters with humidity. The framework can also monitor the fervor of light of particular area. Enabling the system to observe the pressure of the specific room/ area. We can also have the rain value. The main component of the prototype is the ESP8266 based Wi-fi module NodeMCU. 4 different variety of devices are interconnected to measure temperature and humidity, pressure sensor, rain drop module, and light dependent resistor. A threshold limit is set, if the value exceeds the threshold limit then a message, an email and a chirp post is transferred by notifying the owner of the device/ equipment to take essential actions. An IoT system in [9] for temperature, moisture and soil conditions are monitored using sensors designed for pH, temperature and moisture are successfully implanted and tested with minimal number of errors. The system has implemented on STM32 board with Bluetooth technique, being used for communication for a short distance. In future the can proposes to integrate 6LoWPAN for networking. This framework in [12] uses distant screening of temperature and acquire the possible prediction of whether temperature in consistent/ expanding/ diminishing manner. Additional, preferred positions are fixed, when temperature exceeds gritty threshold value an alert signal is accessible to the remote terminal. This can assist in prompting and alerting using interface. The pre arrangement encircling the Arduino sensor and cloud in [13] and formerly outspreading the effort for development of technique, which aimed at the broadcasting of information amongst them which can be of great use in monitoring the temperature and humidity. The system consists of IoT with numerous wireless technologies and gateway used with ATmega328 and OD-III as implanted OS.

A monitoring system [14] consisting of sensors for gathering data like temperature, humidity and pressure. ESP8266 sensor,a low power, cost effective and thoroughly fused solution from Espressif. The ESP8266 used in this model, links to nodes in the cloud through its interface for temperature data displayed on cloud application in real-time and the management system generates alerts. Whenever the value reaches a high temperature an alert signal is issued. The only limitation of this system is it only concentrates on temperature not on humidity. Predicting air temperature with the help of deep learning method in [19, 20] which uses real time information from sensor some region. The system demonstrated here acts for air temperature as a functional part excepting its historical data, speed of wind, humidity, and pressure. Diverse supervised machine learning algorithms in [23] has been implemented one the decision tree learning, determining the outlinesof the facts set comprising adequate temperature and rainfall value attained all over the cropping period. 6 eminent crops for the past 12 years are analyzed and observed providing precise prediction of rainfall, temperature and yield data as tabular data using decision trees.

2.5 IoT framework for disease detection and growth of plant

A framework is developed for initial precise discovery of plant infections with the use of machine learning methods and further intimates the proper pesticides to guard the crop from those infections and decrease the man works. The prediction of pesticides, which aids growers to enhance the superiority of crop production and increasing the quality of grapes. The system, aids growers, by getting statistics and plan accordingly for utilizing fertilizers, pesticides, irrigation, etc. By precise identification of diseases and provided with accurate spraying of pesticides in addition with irrigation schedule, enhancement in the eminence and amount of grapes is attained along with reduction in extreme usage of pesticides. An architecture with deep learning method in [26, 22] to identify and categorize phonological steps of abundant kinds of plants which are purely grounded on visual information apprehended in timely manner, by cameras straddling on the ground at agro stations that have been implanted around all areas in the fields, with agriculture networking system for monitoring. AlexNet, a pre-proficient programmed neural network architecture is used to recognize and categorize phenological stages of plants. Testing of datasets collected through a government supported project and its performance if measured, for all the agro stations, placed throughout Turkey. A wireless controlled precise irrigation system in [18, 28] with three level architecture, for improvement of soil and plant with multiple sensors. The system can be remotely monitored and soil ratio can be sustained at fixedvalue for near extent, providing direct water supply to roots for improving water consumption efficiency.

3. RESEARCH METHODOLOGY

A methodical review is done for finding important evidences from the source that summaries the scientific literature. In systematic review comprehensive investigation, diverse ideas are scrutinized which are published in form of journal articles or conference papers by diverse investigators. Most important part is defining the inclusion criteria which ought to be cautiously selected by un folding premise. In this step, three famous databases were selected to discovery articles on research question. The exploration was done on google scholar, IEEE, springer publishers.

The summaries and titles of the documents are scrutinized based on relevancy and expertise of the subject in IoT with agriculture. Documents included are entirely inspected to excerpt and reviewed significantly, the required information with the aim of responding the main research queries. The criteria for inclusion of articles are researcher, type of article, year of publication, type of disease, type of publication, problem type, medical disciplines, objectives, research gaps, findings and results. After reviewing and summarizing the collected full-texts, 30 academic papers are selected, analyzed and interpreted.

4. RESULTS

The outcomes of investigation and conclusions are represented in this section. The final inclusion of papers includes 30 papersout of 86 articles. The included papers are repossessed from diverse scientific journals and conferences from 2009 to 2017. Amongst journal categoriesgrounded on the results, IEEE is at top rank, Springer in second rank and google scholar in third rank in this review. The foremost determination of investigation is to explore the practice of IoT methods in agricultural field and to predict the future of environment variables and yield of crop.

5. DISCUSSION AND CONCLUSION

This study was intended, for analyzing the effect of different machine learning techniques in agriculture. Previously few articles are published in IoT with machine learning. This research extended the knowledge about machine learning methods used with IoT in agriculture.

This investigation is achieved by analyzing the documents which influences the machine learning methods on yield prediction. In this respect, three databases are considered which includes Google Scholar, IEEE and Springer are considered to repossess the documents from 2009 to 2017. We can conclude that machine learning has proven results to predict the different features in agriculture and can be utilised for further research.

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