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Smart Agriculture and Plant Disease Prediction System- An overview

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ABSTRACT

Agriculture acts as the basic stamina of a country, contributing more than half of the sector of the economy throughout the world. The requirement for precision agriculture is important in determining the states of the crops to find the proper treatment for the plant. Like human beings and animals, plants do suffer from diseases that affect the complete plant, including leaf, stem, fruit, root, and flower and as a result, the plant may die or cause leaf drop, flowers, fruit drop, etc. For that purpose, the appropriate diagnosis is essential for the accurate identification and treatment of plant diseases.

The expert system can play an important role in stimulating agriculture's yield in India. The use of the knowledge-based system has widely increased during the last decade. IoT is an emerging paradigm that enables the communication between electronic devices and sensors through the internet which simplifies our lives concerning various domains such as environmental, industrial, agriculture, medical, transportation, etc. Several researchers have explained the IoT differently concerning individual interests and aspects. This paper presents a review of various plant diseases diagnosis methods and suggested a new idea for plant disease prediction.

Keywords: IoT, AI, Expert system, plant disease diagnosis, fuzzy logic

1. INTRODUCTION

Artificial Intelligence is a computer science domain involving the study and development of computer systems that demonstrate some form of intelligence. Automated systems are becoming gradually more common in all sectors. Fuzzy logic is a branch of artificial intelligence that handles imprecision, vagueness, and insufficient knowledge. Artificial Intelligence (AI) is now growing most in the domains that require specialized expertise without the assistance of commonsense knowledge.

Expert systems are utilized in day-to-day operations throughout almost all areas. During the last decade use of the knowledge-based system has extensively increased. It has been proved effectively that expert systems can solve problems in various sectors where human expertise is required. Few such sectors are chemistry, agriculture, biology, engineering, manufacturing, aerospace, military operations, finance, banking, medical, geology, and geophysics.

1.1 Internet of Things

Internet of Things (IoT) is gradually becoming an important facet of our life that can be sensed everywhere around us. In short, IoT is an innovation that puts together an extensive variety of smart systems, frameworks, and intelligent devices and sensors. It is really the future of communication that has transformed things (objects) of the real world into smart objects. The function of IoT is to unite every object of the world under one common setup; in such a manner that humans can control those objects and provide regular and timely updates on the status [2] [3].

IoT has a multidisciplinary vision to provide its advantage to several domains such as environmental, industrial, medical, agriculture, transportation, etc. [3]. The Internet of Things (IoT) mainly focuses on how to enable general objects to see, hear, and smell the physical world for themselves, and make them connected to share the observation, but that only connected is not enough, beyond that, general objects should have the capability to learn, think, and understand both physical and social worlds by themselves [4].

The use of IoT in agriculture is shown in the following figure 1. IoT can be defined as “things that are associated over the Internet.” This association helps in the transfer of information gathered from various devices to destined places over the Internet [2].

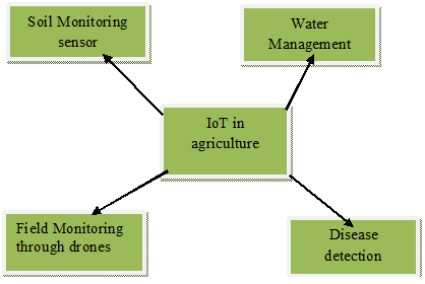

Figure-1 Use of IoT in agriculture

1.2 Expert System

A fuzzy expert system is a category of artificial intelligence that is composed of a set of membership functions and rules (fuzzy logic instead of Boolean logic) that are used to analyze the data. [5]. The Expert system over the years has been used in the various research area and have been very beneficial and useful with their result. The development of Artificial Intelligent (AI) technology systems can be a wide scope; for example, there are rule-based expert systems, frame-based expert systems, fuzzy logic, neural network, genetic algorithm, etc. The amazing achievement applications of AI has been reported in different disciplines including the field of medicals, militaries, chemistry, engineering, manufacturing, agriculture, management, smart cities, and others [7].

A fuzzy expert system comprises fuzzification, inference, knowledge base, and defuzzification subsystems and sets fuzzy logic to reason about data in the inference mechanism. An expert system is a collection of software developed for a particular area of domain aimed to suggest solutions to problems in the way human experts pertaining to that field would solve [6]. The components of the expert system are shown in figure 2.

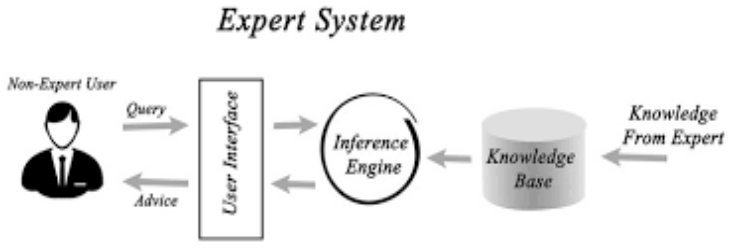

Figure-2 Components of expert system

It helps to distribute the expertise of a human. One expert system may contain knowledge from more than one human expert and hence we get the solutions more efficient. Fuzzy logic provides an effective means for conflict resolution of multiple criteria and a better assessment of options. New computing methods based on fuzzy logic can be used in the development of intelligent systems for decision making, identification, pattern recognition, optimization, and control [8].

The plant plays an important role in both human life and the environment. There are various plant diseases that occur and affect the normal growth of a plant. This paper presents the survey of IoT, and various technologies used in the agriculture field for plant disease diagnosis.

2. LITERATURE SURVEY

There are various methods developed for disease prediction and diagnosis related to plants. Some of them are highlighted in this paper.

Siddharth Singh Chouhan, et al. [1] proposed a novel method named Bacterial foraging optimization based Radial Basis Function Neural Network (BRBFNN) for the identification and classification of plant leaf diseases. They used Bacterial Foraging Optimization (BFO) for assigning optimal weight to Radial Basis Function Neural Network (RBFNN) which increases speed and accuracy of the network to identify and classify the infected regions on plat leaf by different diseases. They worked on fungal diseases like common rust, cedar apple rust, late blight, early blight, leaf spot. But this system has not yet been tested with different databases with dissimilar diseases like bacteria or viruses.

Philomine Roseline et al [9] presented a system for tackling the control and remedial measures for disease management for the staple food crop of Karnataka – Finger Millets popularly known as Ragi. They explained the process in the Integrated Disease Management (IDM) knowledge engineering process which consists of knowledge acquisition and knowledge representation. The process is divided into three stages: 1) To identify the symptoms that appear in various parts of the plants by asking questions about the appearance of the symptoms such as brown spots, black spots. 2) To identify the disease by using the inference engine rules with the symptoms. 3) To calculate the severity by fuzzy logic and recommend the remedial measures.

Raheela Shahzadi et al. [10] proposed an expert system based on the Internet of Things (IoT) that uses the input data collected in real-time. The proposed system provides a solution consisting of three main components the first component is the deployment of sensors in the field: soil sensors, humidity sensors, and temperature and leaf wetness sensors in the fields. Sensors collect the data and send it to sever, on the server side the expert system deployed, which processes the data and sends the recommendations to the farmers about crops. This ES provides the diagnosis of diseases, attack of weeds, and attack of pests, it provides the pesticide recommendation for weeds, diseases, and pests. Harvinder S. Saini et. al [12], presented a web-based fuzzy expert system SOYPEST (Soybean Pest Expert system) for integrated pest management (IPM). They explained the application of the fuzzy logic in uncertainty management during pest identification as well as for estimating pest activity levels. This system contains four phases. 1)Identification of insect-pest based on crop damage symptoms 2) Identification based on insect-pest morphology 3) Identification from the pest image 4) suggest control measures.

3. DIFFERENT METHODS OF PLANT DISEASE PREDICTION

Bhushan V. Patil et al. [11] developed a computational method that investigates to automatically identifies a diseased plant from leaf images of the cotton plant and IoT-based platform in collecting various sensor data for detecting climatic changes. The deep CNN model is developed to perform cotton plant disease detection using infected and healthy cotton leaf images by collecting images through the complete process used in training and validation for image preprocessing, augmentation, and fine-tuning.

Venkanna Udutalapally et al. [13] presented the novel concept of Internet-of-Agro-Things (IoAT) for automated plant disease prediction. This system consists of solar-enabled sensor nodes which help in continuous sensing. The analysis is performed on captured image trained Convolutional Neural Network (CNN) model. Wen-Liang Chen et al. [14] developed RiceTalk: Rice Blast Detection using IoT and AI. The RiceTalk utilizes non-image data generated by sensors that can be automatically trained and analyzed by the AI mechanism in real-time.

Pandiyan, Sanjeevi et al. [15] proposed Advanced Segmentate Dimension Extraction (ADSE) with HIoT procedural aspects. This IoT procedural aspect is identified as repetitive and persistent space in the leaf image. They suggested Signs based plant disease identification. Thippa Reddy Gadekallu et al. [16] proposed PCA-WOA based DNN model to classify the tomato plant disease dataset. Pravin Kumar et al. [17] introduced a technique named Particle Swarm Optimization (PSO) with Fuzzy c mean-based segmentation. They used Multiple Kernel Parallel Support Vector Machine Classifier (MK-PSVM). With this higher accuracy is achieved but it is highly time-consuming.

Archana P. Kale et al. [18] proposed Internet of things (IoT) based Smart Farming decision support system with an Improved Genetic Algorithm. This system Improved classification accuracy though it uses only a less percentage of features. Dheeb Al Bashish et al. [19] provided an image-processing-based solution for automatic leaf diseases detection and classification. They performed this method on five diseases that affect the plants: Early scorch, Cottony mold, ashen mold, late scorch, tiny whiteness. During the trials, they analyzed that misclassification mainly occurred in four classes i.e., normal, cottony mold, late scorch, tiny whiteness.

A. Camargo et. al [20] developed a machine vision system for the identification of the visual symptoms of plant diseases from colored images. They performed this system on the Cotton plant and used SVM classifier. H. Al-Hiary et. al. [21] proposed an automatic disease plant detection and classification of leaf diseases which is based on K-means as a clustering procedure and ANNs as a classifier tool. The disease detected in this approach was found accurate in disease detection in a small computational method, but severity of the detected disease cannot be predicted.

The technique in [22] used image processing and measurements to detect severities of plant leaf diseases. Using this method, an accuracy of 96% is attained to detect the severities of plant leaf diseases.

4. NEED OF INVESTIGATION

Most of the conventional classifiers are implemented on smaller datasets based on hand-crafted features of images for the classification of data and are not suitable for datasets of huge size [16]. The technique in [22] used image processing and measurements to detect severities of plant leaf diseases. Using this method, an accuracy of 96% is attained to detect the severities of plant leaf diseases. However, the method proposed by authors [23] possessed the drawback of limiting users, who are not scientists or familiar with image processing.

5. PROPOSED OBJECTIVES

After reviewing the literature cited above it is identified that using an IoT environment we can provide real-time data which serves as basic information for processing. Also, it will save time and be useful for both expert and non-expert users. By using the expert system concept, it is possible to take decisions like human experts which help the user. With the concept of a hybrid algorithm, the performance can be improved. The proposed objectives are:

- To use IoT sensors to find parameters for disease prediction and apply fuzzy logic on the parameters identified by sensors.
- To develop an optimized expert system that provides enhanced performance for plant disease prediction with the highest accuracy.
- To increase performance by reducing human efforts with automation.

6. CONCLUSION

Agriculture in India has a very major history and one of the most important things in the agriculture industry is to transfer the latest updated information to farmers. From the survey, it was noted that various conventional methods are used for disease identification and management. The different techniques come up with IoT, fuzzy logic, and expert systems to help the farmers in disease management. Expert systems now are being used and proving a better option over traditional systems. So, in the proposed research we would develop an optimized fuzzy expert system that will guide farmers for disease detection and would be beneficial for agriculturists.

7. REFERENCES

[1] Siddharth Singh Chouhan, Ajay Kaul, Uday Pratap Singh and Sanjeev Jain, "Bacterial foraging optimization based Radial Basis Function Neural Network (BRBFNN) for identification and classification of plant leaf diseases: An automatic approach towards Plant Pathology", IEEE, February 2017.

[2] Abhishek Khanna, Sanmeet Kaur, "Internet of Things (IoT), Applications and Challenges: A Comprehensive Review", Springer Science+Business Media, LLC, part of Springer Nature 2020.

[3] Sachin Kumar, Prayag Tiwari, Mikhail Zymbler, "Internet of Things is a revolutionary approach for future technology enhancement: a review" Journal of Big data, Springer 2019.

[4] Qihui Wu, Guoru Ding, Yuhua Xu, Shuo Feng, Zhiyong Du, Jinlong Wang, Keping Long "Cognitive Internet of Things: A New Paradigm Beyond Connection", IEEE Internet Of Things Journal, Vol. 1, No. 2, April 2014.

[5] Maitri Patel, Paresh Virparia, Dharmendra Pate "Web based Fuzzy Expert System and Its Applications – a Survey" International Journal of Applied Information Systems (IJAIS) – ISSN : 2249-0868 Foundation of Computer Science FCS, New York, USA Volume 1– No.7, March 2012

[6] Harsimranjit Singh, Narinder Sharma " A Review of Fuzzy Based Expert System in Agriculture", International Journal of Engineering Sciences & Research Technology, ISSN: 2277-9655, July 2014

[7] C. F. Tan, L. S. Wahidin, S. N. Khalil, N. Tamaldin, J. Hu, G.W. M. Rauterberg, "THE APPLICATION OF EXPERT SYSTEM: A REVIEW OF RESEARCH AND APPLICATIONS", ARPN Journal of Engineering and Applied Sciences, ISSN 1819-660, VOL. 11, NO. 4, FEBRUARY 2016.

[8] Harpreet Singh, Madan M. Gupta, Thomas Meitzler, Zeng-Guang Hou, Kum Kum Garg, Ashu M. G. Solo, and Lotfi A. Zadeh, "Real-Life Applications of Fuzzy Logic", Hindawi Publishing Corporation Advances in Fuzzy Systems Volume 2013.

[9] Philomine Roseline, Clarence J M Tauro, N Ganesan, "Design and Development of Fuzzy Expert System for Integrated Disease Management in Finger Millets", International Journal of Computer Applications (0975 – 8887) Volume 56– No.1, October 2012.

[10] Raheela Shahzadi, Muhammad Tausif, Javed Ferzund, Muhammad Asif Suryani, "Internet of Things based Expert System for Smart Agriculture", IOT IRAN, Vol. 7, No. 9, 2016

[11] Bhushan V. Patil and Pravin S. Patil, "Computational Method for Cotton Plant Disease Detection of Crop Management Using Deep Learning and Internet of Things Platforms", Springer Nature Singapore Pte Ltd. 2021.

[12] Harvinder S. Saini, Raj kamal, A. N. Sharma, "Web based Fuzzy Expert system for Integrated pest management in Soyabean", International Journal of Information Technology, Vol. 8, No 1 August 2002.

[13] Udutalapally, Venkanna, Saraju P. Mohanty, Vishal Pallagani, and Vedant Khandelwal, "sCrop: A Internet-of-Agro-Things (IoAT) enabled solar powered smart device for automatic plant disease prediction", arXiv preprint arXiv:2005.06342, 2020.

[14] Chen, Wen-Liang, Yi-Bing Lin, Fung-Ling Ng, Chun-You Liu, and Yun-Wei Lin, "RiceTalk: Rice blast detection using internet of things and artificial intelligence technologies", IEEE Internet of Things Journal, vol. 7, no. 2, pp. 1001-1010, 2019.

[15] Pandiyan, Sanjeevi, M. Ashwin, R. Manikandan, Karthick Raghunath KM, and Anantha Raman GR, "Heterogeneous Internet of Things Organization Predictive Analysis Platform for Apple Leaf Diseases Recognition", Computer Communications, vol. 154, pp. 99-110, 2020.

[16] Gadekallu Thippa Reddy, Dharmendra Singh Rajput, M. Praveen Kumar Reddy, Kuruva Lakshmanna, Sweta Bhattacharya, Saurabh Singh, Alireza Jolfaei, and Mamoun Alazab, "A novel PCA–whale optimization-based deep neural network model for classification of tomato plant diseases using GPU", Journal of Real-Time Image Processing, pp. 1-14, 2020.

[17] SK, Pravin Kumar, M. G. Sumithra, and N. Saranya, "Particle Swarm Optimization (PSO) with fuzzy c means (PSO-FCM)–based segmentation and machine learning classifier for leaf diseases prediction", Concurrency and Computation: Practice and Experience, vol. 33, no. 3, pp.5312, 2021.

[18] Archana P. Kale, and Shefali P. Sonavane, "IoT based Smart Farming: Feature subset selection for optimized high-dimensional data using improved GA based approach for ELM", Computers and Electronics in Agriculture, vol. 161, pp. 225-232, 2019.

[19] Dheeb Al Bashish, Malik Braik, and Sulieman Bani-Ahmad, "A Framework for Detection and Classification of Plant Leaf and Stem Diseases", IEEE, 2010 International Conference on Signal and Image Processing, 2010.

[20] A. Camargoa, J.S. Smith, "Image pattern classification for the identification of disease-causing agents in plants", Elsevier, Computers and Electronics in Agriculture 66 (2009) 121–125.

[21] H. Al-Hiary, S. Bani-Ahmad, M. Reyalat, M. Braik and Z. ALRahamneh, "Fast and Accurate Detection and Classification of Plant Diseases", International Journal of Computer Applications (0975 – 8887) Volume 17– No.1, March 2011.

[22] Barbedo, Jayme Garcia Arnal, "An automatic method to detect and measure leaf disease symptoms using digital image processing", Plant Disease, vol. 98, no. 12, pp. 1709-1716, 2014.

[23] Sibiya, Malusi, and Mbuyu Sumbwanyambe, "Automatic Fuzzy Logic-Based Maize Common Rust Disease Severity Predictions with Thresholding and Deep Learning", Pathogens 10, no. 2, pp. 131, 2021.