Machine Learning Techniques Enhancing Digital Agriculture

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Abstract

In order to create new opportunities for data-intensive science in the multidisciplinary field of digital agriculture, machine learning has emerged with big data technologies and high-performance computers. Agriculturists and farmers are facing economic loss as a result of a variety of crop illnesses. Cultivators find it challenging to regularly monitor the crops when the cultivated area is enormous, in the thousands of acres. Machine learning is a helpful decision-making tool for choosing which crops to plant and what to do during the crop's growing season as well as for predicting crop yields. As machine learning is applied to sensor data, farm management systems are evolving into real-time artificial intelligence-enabled programmes that offer detailed recommendations and insights for farmer decision support and action. In this paper we have given detailed assessment of various machine learning applications in agriculture production systems.

Keywords: Machine Learning Technique, Remote Sensing data, Deep Learning, Crop yield prediction, Decision support system

1. Introduction

One of humanity's most basic requirements, food, is met by agriculture, which is a crucial component of the global economy. In the majority of nations, it is recognised as the main source of employment. Many nations, such as India, still practise traditional farming, and farmers are hesitant to adopt new technologies in their fields due to a lack of knowledge, high costs, or a lack of awareness of the benefits of these technologies [1]. The majority of times, plant illness is indicated by symptoms on the leaves. Therefore, it is necessary to develop an autonomous, precise, and less expensive Machine Vision System that can identify diseases from photos and suggest a suitable pesticide as a cure [2].

An ML model might be descriptive or predictive, depending on the objective of the research issue. To gain knowledge from the gathered data, descriptive models are employed. Future projections and historical analysis are both done using predictive models. ML research offers a number of issues while attempting to build a high-performance prediction model. Choosing the appropriate algorithms to address the issue at hand is essential, and the algorithms and supporting platforms must be to handle large amounts of data. In this study, only studies pertaining to agriculture are analysed in the applications of artificial intelligence and automation technologies. In this work, we provide a complete overview of the use of machine learning, neuralnetworks, and deep learning in agriculture [3-4].

2. Literature Review

Many agricultural assessments emphasize computer vision, machine learning, deep learning (DL), and artificial intelligence (AI). The process of attaining artificial intelligence is known as machine learning. Examples of deep learning include artificial, convolutional and recurrent neural networks. Artificial, convolutional and recurrent neural networks are part of the machine learning subfield known as deep learning. Figure 1 which will be utilised in section three in this literature review [3], shows the relationship between machine learning, neural network and deep learning.

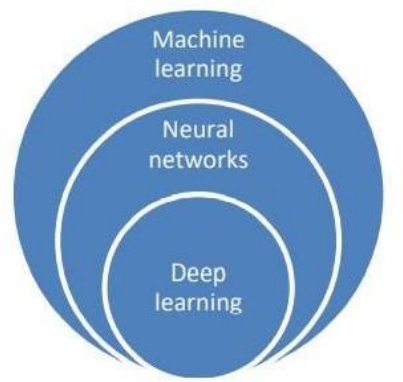

Figure 1. Relationship between Machine Learning, Neural Networks and Deep Learning

For decision-makers at all levels, including those in national and regional (like the EU) decision-making, crop yield forecasting is a significant difficulty. To help them choose what to produce and when to grow it, farmers can employ an accurate crop production forecast model. There are numerous methods for predicting crop productivity. This review article investigated the literature on agricultural yield prediction using machine learning in the field of agriculture production prediction. One of the exclusion criteria used in our analysis of the retrieved publications is whether the publication is a survey or standard review paper [5].

The articles were first grouped into four major categories: agricultural management, water management, animal management and soil management. There are various sub categories of machine learning applications in agriculture including yield prediction, disease diagnosis, weed identification, species recognition and crop quality. Animal welfare and livestock productivity were the two sub categories of ML applications in the livestock sector [5].The search engines used were Scopus, Science Direct, and PubMed. The works for which the articles have been selected have only ever been released as journal papers.

Despite being crucial for agricultural productivity, climate prediction is not discussed in this review since machine learning applications for climate prediction are a separate field. And last, this collection's entire content spans from 2004 to the present. Crop Management Yield Prediction In order to map and estimate yields, match crop supply and demand, and manage crops to maximise production, yield prediction is one of the most fundamental components of precision agriculture. The works of [6] provide examples of ML applications, including a non-destructive, efficient, and affordable method for counting coffee fruits on a branch. The method classifies coffee fruits into three groups: those that can be picked, those that cannot, and those whose maturation stage is disregarded. The method also determined the weight and rate of fruit maturity for coffee. The purpose of this effort was to advise crop growers on how to maximise financial gains and organise their agricultural operations.

Disease detection and yield prediction are the sub-categories with the most publications included in this review. One of the biggest problems in agriculture is the control of pests and diseases in open-air (arable farming) and greenhouse environments. The most popular approach of controlling pests and diseases is to evenly spray insecticides across the crop area. Despite being effective, this method comes at a high cost to the economy and the environment. Remains in agriculture products, consequences of ground water contamination, affects on local animals and eco-systems, and other things can have an impact on the environment. Agrochemical input is targeted in terms of time and place using ML, which is a component of precision agriculture management. In the literature [7], a method for identifying and distinguishing between healthy Silybum marianum plants and those that have contracted the smut fungus Microbotyum silybum during vegetative growth is provided. discovery of weeds Identifying and managing weeds is another important challenge in agriculture. Many farmers point to weeds as the biggest threat to agricultural productivity. Accurate weed identification is crucial for sustainable agriculture since weeds are challenging to recognise and tell apart from crops. Again, combining sensors and machine learning algorithms can produce effective weed discr imination and identification at a low cost with no adverse effects on the environment.

Machine learning weed detection could lead to the creation of weed eliminating tools and robots, reducing the demand for herbicides. In two studies, weed identification applications for machine learning in agriculture are discussed. The first study [8] provide a new method for identifying Silybum marianum, a difficult-to remove weed that results in severe crop loss, using counter propagation (CP), ANN and multispectral pictures obtained by unmanned aircraft systems (UAS).

3. Methodology

There are various methods defined in different researches for crop yielding and prediction. We taken three methods into consideration such as train machine learning model, purpose of Decision Support System and Query database.

3.1 For training the machine learning model numerous healthy and flawed crop photos are taken into account for each crop. Set the cutoff point for every crop. Train the model so that it will select the appropriate action for every type of crop. A collection of healthy crop photos, infected crop images, various illnesses of various crops, and pesticides for those diseases are all taken into consideration while building a trained model. various spatial. Many agricultural spacecraft, including NASA's TERRA satellite, RESAT-1, PSLV-C16, and PSLV-C36, have been used to collect high-resolution photos of the planet.

3.2 Decision Support System receives a reference image as input to diagnose a disease. To make the next decision, this system uses a trained model. A dataset is used by the trained model to generate accurate suggestions. Check to see if ageing is the cause if there is a significant shift in the Reference Image's threshold. If so, there is no need to inform the farmer. However, if the change is brought on by a disease, as shown by the malformations and colour changes in the leaves, edge detection and histogram analysis will be used to provide the right answer. The Decision Support System is depicted in Figure 2.

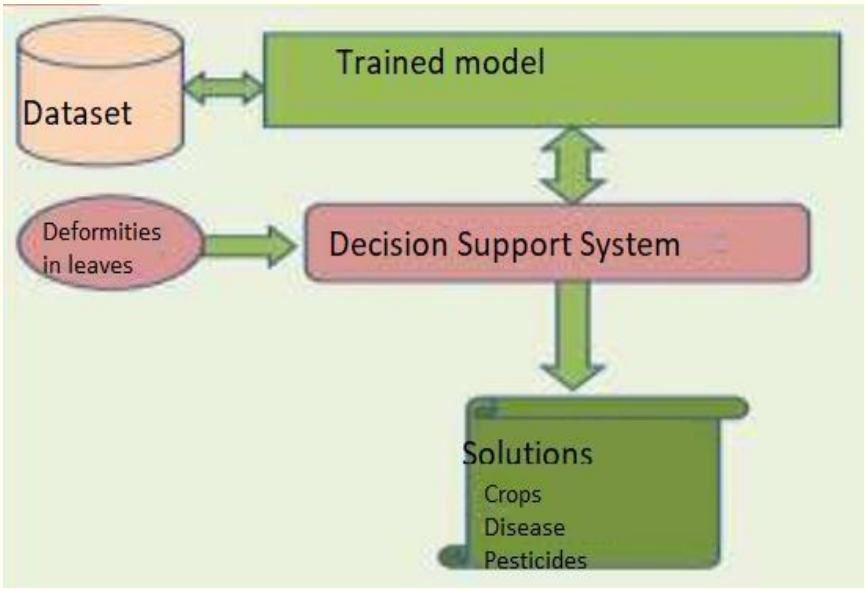

Figure. 2 Decision Support System

3.3 Research Query Database

The purpose of a query database is to get knowledge about the research that have been published in the field of ML and crop production prediction. Studies have been evaluated from a variety of angles to get understanding. The following four research questions (RQs) have been established to interpret the results.

- RQ1: Which machine learning techniques have been used to forecast crop productivity in the literature?
- RQ2: Which features have been utilised to estimate agricultural yield using machine learning in the literature?
- RQ3-Which evaluation metrics and evaluation strategies have been applied to agricultural yield prediction in the literature?
- RQ4: What difficulties exist in the field of machine learning crop yield prediction?

4. Results and Discussion

The use of deep learning and machine learning in agriculture has been thoroughly reviewed in this research. Advanced machine learning and deep learning models are applied in various phases of agriculture. Technology for deep learning is always evolving. This study shows that CNN is commonly utilised in agriculture and has outstanding results. Utilizing depth, additional structure, and hardware facility significantly improves the CNN's learning ability and reliability. Dataset creation, training and testing times, hardware support, deploying huge models on portable devices like PCBs or smart phones, and user awareness are still problems. A popular approach called "Transfer Learning" is widely used to get over the issues of a short dataset, the time required for training, and to improve the performance of the model. Farmers can increase their yields by utilising machine learning and Internet of Things (IoT) technology.

IoT is utilised to gather real-time farm metrics, and machine learning algorithms use the collected data to forecast or make recommendations to farmers for farming advancements. The survey found that in order to increase classification accuracy, Single-Shot Convolution Neural YOLO (You Only Look Once) must be used for detection and localisation. It is a cutting-edge, real-time object detection system. The most recent method for producing highly effective, more precise, and high-quality machine learning models in less time is automated machine learning (Auto ML). A tool called Auto ML automates every step of the machine learning process. The process of developing a machine learning model takes time and is iterative. Contrary to traditional ML model generation, which is time-taking, resource-intensive, and requires domain knowledge, auto ML may speed up the entire process to deliver a production-ready model in less time.

5. Conflict of Interest

There is no conflict of interest in this work.

6. Conclusion

We are keen to show how deep learning algorithms forecasts crop yields because neural networks are the most often use technique.

The advancement of artificial intelligence and machine learning over the past 20 years, there has led to a significant increase in the number of agricultural initiatives. Artificial intelligence is exemplified by techniques like deep learning, neural networks, and machine learning. This study looks at how these three axillary concepts have been developed and disseminated in research related to agriculture. The studies and graphs that are linked make it evident that the scientific community is specifically interested in these topics. The Web of Science citation database reveals a particularly notable change in the volume of published scientific publications on deep learning. In particular, the deep learning articles released in the first half of 2020 and the upcoming trends are appealing. It is clear that Tensor Flow dominates the field, yet most researchers choose Keras to make building neural networks easier. The most popular input method for neural networks is pictures, which are most often provided by cameras. Scientists frequently concentrate on wheat, corn, and grapes, and the most popular deep learning application is crop analysis. Convolutional neural networks have finally become widely used to solve difficulties in agriculture. We can draw the conclusion that "agriculture's future has already arrived." All we have to do is make use of the tools and information at hand. Edge detection and histogram matching are used to identify crop diseases at an early stage. The model that aids in making informed decisions about diseases was trained using machine learning techniques.

References

[1] Badage, A. Crop disease detection using machine learning: Indian agriculture. Int. Res. J. Eng. Technol.2018; 5(9): 866-869.

[2] Van Klompenburg T, Kassahun A, Catal C. Crop yield prediction using machine learning: A systematic literature review. Computers and Electronics in Agriculture. 2020; 177:105709.

[3] Dokic K, Blaskovic L, Mandusic D. From machine learning to deep learning in agriculture–the quantitative review of trends. In IOP Conference Series: Earth and Environmental Science; Dec, 2020. IOP Publishing ; 614 (1). p. 012138).

[4] Meshram V, Patil K, Meshram V, Hanchate D, Ramkteke SD. Machine learning in agriculture domain: A state-of-art survey. Artificial Intelligence in the Life Sciences.2021; 1:100010.

[5]. Liakos K G, Busato P, Moshou D, Pearson S, Bochtis D. Machine learning in agriculture: A review. Sensors.2018; 18(8):2674.

[6]. Ramos P J, Prieto FA, Montoya EC, Oliveros C E. Automatic fruit count on coffee branches using computer vision. Computers and Electronics in Agriculture.2017; 137:9-22.

[7]. Pantazi XE, Tamouridou AA, Alexandridis TK, Lagopodi AL, Kontouris G, Moshou D. Detection of Silybum marianum infection with Microbotryum silybum using VNIR field spectroscopy. Computers and Electronics in Agriculture.2017;137: 130-137.

[8]. Pantazi XE, Tamouridou AA, Alexandridis TK, Lagopodi AL, Kashefi J, Moshou D. Evaluation of hierarchical self-organising maps for weed mapping using UAS multispectral imagery. Computers and Electronics in Agriculture.2017; 139: 224-230.