ISSN (Online) 2582-9327

IJARSCMT

International Journal of Advanced Research in Science, Commerce, Management and Technology

Impact Factor: 5.781

Volume 2, Issue 6, June 2021

Agriculture Review on Deep Learning Applications Techniques

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Abstract: *Agriculture is one of the major industries in the world. With promising results and enormous capability, deep learning technology has attracted more and more attention to both theoretical research and applications for a variety of image processing and computer vision tasks. In this paper, the author investigate research contributions that apply deep learning techniques and ML to the agriculture domain. Different types of deep neural network architectures and ML techniques in agriculture are surveyed and the current state-of-the-art methods are summarized. The main objective of this paper is to find the various applications of Deep learning in agriculture such as for irrigation, weeding, Pattern recognition, crop disease identification etc.*

Keywords: artificial intelligence, precision livestock farming

I. INTRODUCTION

With the increase in the global population, there has also been a huge increase in the demand of food and agricultural products. To meet this increasing demand, an equivalent increase in the agricultural production is required, without comprising the quality of food products and also without affecting the natural environment. An important research area in this domain is Image acquisition and analysis. Using images of agricultural fields and parts of plants, important aspects of the field and plants can be explored. With the automatic image analysis of the field, the quality of soil can be examined and effective measures can be taken to make the soil fertilize and suitable for crops production[2]. Similarly, the diseases in plants can be detected and essential steps can be taken well in time to improve the quality of crops and reduce the health risks to humans from the diseased crops. Agricultural crops are prone to pests, which have threats of health problems to people [1] .

Emerging ICT technologies relevant to the understanding of agricultural ecosystems include remote sensing , the Internet of Things, cloud computing, and the analysis of big data. Remote sensing provides large-scale snapshots of the agricultural environment by means of satellites, planes and unmanned aerial vehicles (UAVs, i.e. drones).When applied to agriculture it has several advantages, being a well-known, non-destructive method of gathering information on earth features. Remote sensing data can be collected on very large geographic areas, including inaccessible areas. The IoT uses state-of - the-art sensor technology to measure various parameters in the field, while cloud computing is used to collect, store, pre-process and model huge amounts of data from different, heterogeneous sources. Eventually, big data processing is used in conjunction with cloud computing to analyze the data stored in the cloud on a large scale in real time. A large sub-set of the data collected by remote sensing, and the IoT contains images. Images can provide a complete picture of agricultural fields and a number of problems could be solved through image analysis. Therefore, image analysis is an important area of research in the agricultural domain and intelligent inspection techniques are used to identify / classify pictures, recognize abnormalities, etc., in different agricultural applications [13].

Machine learning combined with high-performance computing guarantees the ability to process large amounts of image data effectively. Early solutions to computer vision tasks depended on traditional machine learning methods, i.e., feature-based manual method. Common features include Deformable Part-Based Model (DPM),Histogram of Oriented Gradient (HOG)] and Scales-Invariant Feature Transformation (SIFT) ,Speeded Up Robust Features (SURF) and Haar-like features . They were usually combined with classifiers such as Support Vector Machine (SVM) to classify each image pixel. Although the traditional methods are easy to understand and many improvements have been done to them, most of the mare verified in low and medium density images and they usually need to be changed according to the specific situations . Moreover, most traditional methods either ignore the problems in dense scenes, namely, there is no discussion on dense scenes, or use simple heuristic methods based on shape and size, these methods are very in effective in natural environments with severe occlusion and large scale changes. Therefore, traditional machine learning methods are not appropriate for dense images. It has been demonstrated that in many applications, features extracted by deep learning are more effective than these hand-crafted feature. Moreover, deep learning solves various challenges in dense images. Deep Learning (DL) belongs to machine learning, based on representation learning of data, which realizes artificial intelligence by means of artificial neural networks with many hidden layers and massive training data. DL has been successful in computer vision , natural language processing, bioinformatics , automatic control , machine translation , automatic driving and other practical problems . The reason for the success of DL lies in its unique characteristics of network structure: deep neural network can acquire high-level features by learning local features from the bottom and then synthesizing these features at the top. DL uses multi-level abstraction to learn complex feature representations from raw data and generate components automatically. Different features at different levels can correspond to different tasks. Deep learning is a technology that uses deep network structure to learn features. Deep learning emphasizes the depth of the model structure, highlights the importance of feature learning and proposes various techniques to learn more and higher-level features better and faster. Strong learning ability enables them to implement various kinds of problems especially well and flexibly adapt to numerous highly complex problems. Monitoring and studying a large number of interesting objects in videos or images is an important task for the macro-world and micro-field, for instance, the research on crowding traffic and microscopic microorganisms. Usually, advances in one area are driven more by some combination of expertise, resources, and application requirements in other areas . Similarly, applications of DL in analyzing dense scenes spread to the agricultural sector after advances in medical diagnostics and population analysis. More and more scenes in agriculture produce a lot of high-density images, and they are becoming more and more attention. At present, agricultural tasks have been transformed into tasks of agro vision (computer vision in agriculture). There have been some reviews on the applications of DL in agriculture and some reviews pertinent to the use of DL in computer vision. They either gave a comprehensive overview of DL methods applied throughout the agricultural field or the latest research of DL technology in a certain agricultural field and also reviewed the application of DL methods in general computer vision tasks. However, none of them involved how DL works in dense agricultural scenes. The use of DL in fruit detection and yield estimation is summarized, including the problem of occluded fruit in imaging and the solutions. However, they were only concerned with the detectionand yield estimates while ignoring other agricultural tasks containing a large number of objects. Thus, the motivation for preparing this review stems from the need to summarize the applications of DL in agriculture with the increase of dense scenes and images[14].This paper investigates the applications and techniques of DL in agriculture. This paper aims to provide a reference to the DL methods for agricultural researchers. This paper can be helpful for researchers to retrieve the literatures related to the research problems quickly and accurately. This study is divided into five sections. Section 1 introduces the concept of deep learning in agriculture, Section 2 explains the methodology used in the present study of this article, Section 3 presents review of existing literature, Section 4 discusses Applications of Deep Learning in Agriculture in detail and Section 5 presents the conclusions of the work.

II. METHODOLOGY

In this study, the first step was citation databases analyse, it involved two steps:

- Collection of related works and,
- Detailed review and analysis of the works.

A survey is performed on various research papers on Applications of deep learning in agriculture. For this review paper, multiple sources have been used. Scopus has been used for searching various papers on the topic with the Boolean "Deep Learning and Agriculture. From Mendeley, the abstracts of the papers were studied and those which were found useful for this review, their full papers were downloaded from Scopus, Google Scholar, and Research Gate. The research paper from 2010-2021 selected for study. In the first step, a keyword-based search using all combinations of two groups of keywords of which the first group addresses deep learning and the second group refers to application of deep learning in farming.

III. LITERATURE REVIEW

In [16] proposed a Agri-IoT framework, a semantic framework for IoT based smart farming applications, which supports reasoning over various heterogeneous sensor data streams in real-time. Agri IoT can integrate multiple cross-domain data streams, providing a complete semantic processing pipeline, offering a common framework for smart farming applications. Agri-IoT supports large-scale data analytics and event detection, ensuring seamless interoperability among sensors, services, processes, operations, farmers and other relevant actors, including online information sources and linked open datasets and streams available on the Web.[17] did comprehensive review of research dedicated to applications of deep 9 learning for precision agriculture is presented along with real time applications, 10 tools and available datasets. The findings exhibit the high potential of applying deep 11 learning techniques for precision agriculture. In this paper the role of Smart farming for sustainable agriculture is discussed,a novel approach to fruit production prediction using deep neural networks to build a fast and reliable prediction system for agricultural production is presented. In this article, authors have considered different types of fruit production data (apples, bananas, citrus, pears, grapes, and total fruits), analysed this data, and predicted the future production of these fruits using deep neural networks. The data are taken from the National Bureau of Statistics of Pakistan and the production output of major fruits. Authors have implemented 3 different methods to predict the data for future fruit production. The first method is Levenberg-Marquardt optimization (LM), which was 65.6% accurate; the second method is called scale conjugate gradient back propagation (SCG), which had an accuracy of 70.2%, and the third method, is Bayesian regularization back propagation (BR), which was 76.3% accurate. Incorporates the performance analysis of clustering algorithms when applied to FAO Soya bean dataset. The algorithms are compared on the basis of various parameters, such as time taken for completion, number of iterations, and number of clusters formed and the complexity of the algorithms. Finally, based on the analysis, the paper determines the best befitting algorithm for the FAO Soya bean dataset. Comprehensive review of research dedicated to applications of machine learning in agricultural production systems is performed. The works analyzed were categorized in (a) crop management ; (b) livestock management; (c) water management; and (d) soil management. The survey shows that deep learning-based research has superior performance in terms of accuracy, which is beyond the standard machine learning techniques nowadays.

IV. APPLICATIONS OF DEEP LEARNING IN AGRICULTURE

This section describes the survey papers related with applications of deep learning in agriculture.

4.1 Plant Domain

With the development of agricultural modernization, the area of large-scale cultivation becomes increasing. DL has a wide range of applications in the planting of agriculture. There are several works on DL applying to crop disease classification or detection. The work by Ha et al. [42] proposed a highly accurate system to detect radish disease (Fusarium wilt). The radish was classified into diseased and healthy through the deep convolutional neural network (DCNN). Thework by Ma et al. [43] developed a DCNN to recognize cucumber four types of cucumber diseases. Compared to conventional methods (e.g., RF, SVM, and AlexNet), DCNN can detect better cucumber diseases with 93.41% of accuracy. Similar to the research [50] in [49], Lu et al. [51] in [49],[3] and [3] in [1] came up with CNNs to identify types of rice diseases with more than 95% of accuracy, which demonstrated the superiority of CNN based models in identifying rice diseases. The work by Liu et al. [52] in [49] presented a novel AlexNet-based model to detect four types of common apple leaf diseases. The approach demonstrated97.6% and improved the robustness of the CNN model in experiment. Considering the food security issues, Mohanty et al. [53]in [49] proposed to identify 26 types of diseases and14 crop species using the CNN model. The model demonstrated an excellent performance, which proved itself was feasible and robust for detection diseases. In their work[6], the authors have contributed towards the automatic recognition of plant diseases using image analysis. They have used GoogleNetBN and compared the results with VGG16 having 16layers and Inception V3 with 48 layers with accuracy 95.48%. In another work[4], S.Gayathri et al. proposed CNN LeNet model for recognition of four tea leaf diseases – blister blight, red scab, red leaf spot and leaf blight. In their work of 2020[5], the authors have used ResNet50 model to detect 5 strawberry diseases from "Taoyuan No. 1" and "Xiang-Shui" strawberry cultivars in Miaoli County, Taiwan [1].The work by Fuentes et al. [48] in [49] used DL three meta-architectures, faster region-based convolutional neural network (Faster R-CNN), region-based fully convolutional network (R-FCN), and single shot multibox detector (SDD). The work showed that the developed models can effectively detect nine types of diseases and pests in complex surrounding. Other works in recognition of plant diseases are [7] [1],[20] in [15], [47] and [3] in [1].

4.2 Animal Domain

As the concern on animals grows, DL technologies have been adopted in the animal domain for monitoring and improving animal breeding environment and the quality of meat products. The study on DL-based face recognition and behavior analysis of pigs and cows is very active in applied research. To develop an automatic recognition method of nursing interactions for animal farms by using DL techniques, it is showed that the fully convolutional network combining spatial and temporal information was able to detect nursing behaviors, which was tremendous progress in identifying nursing behaviors in pig farm. A Mask R-CNN architecture to settle cattle contour extraction and instance segmentation in a sophisticated feedlot surrounding is presented. DL techniques based on nose pattern characteristic to identify cattle to address the loss or exchange of animals and inaccurate insurance claim is used. Inspired by the work of face recognition, the work proposed a CNN-based model to recognize pigs. In order to predict sheep commercial value, an automatic system is built to recognize sheep types in a sheep environment and reached 95.8%accuracy. counting CNN to deal with the pig amounts and got 1.67MAE per image is proposed .Deep learning methods viz. CNN, RNN, LSTM can be used to provide accurate prediction and estimation of farming parameters to optimize the economic efficiency of livestock production systems, such as cattle and eggs production. A study on smart farming is key to developing sustainable agriculture is proposed[15].

4.3 Land Cover

Deep learning is also used in Land cover classification (LCC) is considered as a vital and challenging task in agriculture, and the key point is to recognize what class a typical piece of land is in. Deep learning methods such as CNN, GAN and RNN are able to be used for land cover classification of remote sensing image data. Deep learning applications in land use classification based on Sentinel-2 time series is explained. Agriculture Companies are leveraging computer vision and deep-learning algorithms to process data captured by drones and/or software-based technology to monitor crop and soil health [15]. Kussul et al. [56] presented a multi-level DL technique that classified crop types and land cover from Landsat-8 and Sentinel-1A RS satellite imagery with nineteen multi temporal scenes. Thework by Gaetano et al. [57] proposed a two-branch end-to-end model called MultiReso LCC. The model extracted characteristics of land covers and classified land covers by combing their attributes at the PAN resolution. The work by Scott et al. [58] train eda DCNNs model and used transfer learning and data augmentation to classify land covers for remote sensing imagery. The work by Xing et al. [59] used improved architectures, VGG16, ResNet-50, and AlexNet to validate land cover, and the results showed that the proposed method was effective with accuracy 83.80%. The work by Mahdianpari et al. [60]presented a survey of DL tools for classification of wetland classes and checked seven power of deep networks using multispectral remote sensing imagery[49].

4.4 Other Domains

The development of smart agriculture inevitably requires automated machines. To operate it safely without supervision, it should have the function of detecting and avoiding obstacles. The work by Christiansen et al. [61] detected unusual surrounding areas or unknown target types with distant and occlusion targets using Deep Anomaly, which combined DL algorithms. Compared to Faster R-CNN and most CNN models, Deep Anomaly had better performance and accuracy and requires less computation and fewer parameters for image processing, which was suitable for real-time systems. In contrast to[61],the work by Steen et al. [62] can detect an obstacle with high accuracy in the field of row crops and grass mowing. However, it cannot recognize people and other distant objects. The work by Khan et al. [63]used popular DL networks to estimate vegetation index from RGB images. They used a modified AlexNet deep CNN and Caffe as the base framework for implementation. The work by Kaneda et al. [64] presented a novel prediction system for plant water stress to reproduce tomato cultivation. The work by Song et al.[65] combined DBN and MCA to predict soil moisture in the Zhangye oasis, Northwest China. The workby Wang et al. [66] presented used CNN, ResNet, and modified architecture ResNeXt to examine lousy blueberries. The work by Mandeep et al. [67] employed H2O model to estimate evapotranspiration in Northern India and got a better performance than four learning methods, including DL, generalized linear model (GLM), random forest (RF),and gradient boosting machine (GBM) [49].A research on Deep Learning For Remote Sensing Image Classification For Agriculture Applications is proposed [15].

V. CONCLUSION

In this paper, the author has surveyed the development of deep neural-based work efforts in the agriculture domain. Analysed the works on the applications of deep learning and the technical details of their implementation. Each work was compared with existing techniques for performance. It has been found that deep learning has much better results than other image processing techniques. Moreover, with the advances in computer hardware, deep learning will receive more attention and broader applications in future research. Neural networks are in a real sense one of the best solutions to a few agriculture problems. Undeniably, the implementation of ANN to precision agriculture plays a crucial role in potential assessment of the idea of precision farming as a viable way of fulfilling the food demands of the planet. Nonetheless, in order to ensure viability of future food demands, farmers welfare and economic growth, more work on the impacts of ANN on agricultural problems has to be carried out.

REFERENCES

[1] Pooja Arora and Amit Jain, The role of deep learning in agriculture: Areview, AIP Conference Proceedings 2555, 050032 (2022

[2] N. Kussul, M. Lavreniuk, S. Skakun, and A. Shelestov, "Deep Learning Classification of Land Cover andCrop Types Using Remote SensingData," IEEE Geosci. Remote Sens. Lett., vol. 14, no. 5, pp. 778–782, 2017,doi: 10.1109/LGRS.2017.2681128.

[3] F. Jiang, Y. Lu, Y. Chen, D. Cai, and G. Li, "Image recognition of four rice leaf diseases based on deeplearning and support vector machine,"Comput. Electron. Agric., vol. 179, no. August, p. 105824, 2020, doi:10.1016/j.compag.2020.105824.

[4] S. Gayathri, D. C. J. W. Wise, P. B. Shamini, and N. Muthukumaran, "Image Analysis and Detection of TeaLeaf Disease using Deep Learning,"Proc. Int. Conf. Electron. Sustain. Commun. Syst. ICESC 2020, no. Icesc,pp. 398–403, 2020, doi: 10.1109/ICESC48915.2020.9155850.

[5] J.-R. Xiao, P.-C. Chung, H.-Y. Wu, Q.-H. Phan, J.-L. A. Yeh, and M. T.-K. Hou, "Detection of strawberrydiseases using a convolutional neuralnetwork," Plants, vol. 10, no. 1, pp. 1–14, 2021, doi:10.3390/plants10010031.

[6] S. H. Lee, H. Goëau, P. Bonnet, and A. Joly, "New perspectives on plant disease characterization based ondeep learning," Comput. Electron.Agric., vol. 170, 2020, doi: 10.1016/j.compag.2020.105220.