7th International Conference on Research Developments in Applied Science, Engineering & Management
Mahratta Chamber of Commerce, Industries and Agriculture, Tilak Road, Pune (India)
15th -16th June 2019 www.conferenceworld.in ISBN : 978-93-87793-90-3

A Survey on Applications of Deep Learning in Agriculture

Prof. Chhaya Zala [1], Ms. Pruthvi Patel [2]

[1] *Department of Computer Engineeinrg ,GCET, India*
[2] *Department of Information Technology. Shantilal Shah Engineering College ,India*

ABSTRACT

One of the main sources of income in India for the farmers is agricultural. India's Economy is highly affected by agricultural production. Research work is at the peak in agriculture using deep learning and there are many applications which are being developed for this. Now a day's data generated in the agriculture field is available in huge size. To process a huge size of data deep learning models are very useful because of their high efficiency and accuracy. More numbers of hidden layers in deep learning can effectively handle huge sized and unstructured data. The domain of agricultural is the field of interest for many researchers. In this survey, we summarized some recent work that has been carried out in the domain of agriculture using deep learning.

Keywords — Agriculture, Deep learning, Neural Networks

1. INTRODUCTION

India's population is increasing day by day that increases the need for food which leads us to produce more and more agriculture products. The improvement in production and sustainability are now must in the agriculture industry. For precision agriculture task researchers are finding ways to incorporate new technologies and methods [1]. Farmers are using precision agriculture with information technology tools which helps them for making decisions in the supply of water, fertilizers, pesticides etc. in the fields [2]. These tools also assist farmers in the selection of seeds, crop production, disease, and pest detection and weed control.

There are many image processing techniques used by various researchers for improving the manual techniques to accurate and consistent decision making [3] but deep learning is providing more accuracy in the precision agriculture tasks. So, the usage of deep learning techniques is increased in recent years in each and every sector. Specifically, in the agriculture domain, there has been a rise in the use of deep learning technologies for different applications.

In this survey paper, we have carried out the survey of how deep learning technologies are being popular in different applications in the agriculture field. The paper is organized as follows: section 2

ISBN : 978-93-87793-90-3

introduction followed by section 3 which is about the literature reviews of applications in agriculture using deep learning; section 4 provides the summary of the related work; section 5 concludes the survey.

2. DEEP LEARNING

Being a subset of machine learning, deep learning adds more and more depth in model. Automatic feature extraction is the main advantage of deep learning technology. Deep learning models are capable of composing lower level features to form higher-level features. Deep learning can solve more complex and bigger problems precisely and fast.

Deep learning is capable of comprising of several different components like pooling layers, convolutions, fully connected layers, activation functions, etc. Unsupervised Pre-trained Networks, Convolution Neural Networks, Recurrent Neural Networks are examples of that. Hierarchical structure, large learning capacity, speed are some reasons why it is this much popular. The structure of deep learning models perform classification, prediction and many other tasks with high flexibilities that allow them to adopt a variety of complex problems [4]. Deep learning is widely used for raster-based data for image processing and video processing but there are many applications of deep learning which are using a variety of data like audio data, natural languages and many more. Weather data analysis is easy with deep learning [5] and population data analysis can also use deep learning models [6].

Manual feature learning of machine learning is no more there in deep learning. If we provide the data in the proper format to the deep learning model then model itself learn and selects the features to solve a problem. This helps in saving time because traditional approaches for classification task or prediction task need feature extraction before applying any classification algorithm which takes lots of time and sometimes the wrong choice of features can reduce the accuracy also. This kind of problems can be eliminated using deep learning auto feature extraction method. Deep learning models can learn and locate important features during the training process. This makes them to take a long amount of time during training but testing is very fast than any other traditional machine learning approaches [7]. Deep learning models are good when you have enough size of the dataset. When dataset size is small, deep learning model cannot increase the accuracy even it can drop down it in some applications.

3. LITERATURE REVIEWS

In this paper, we have summered many papers based on their applications in the agriculture domain using deep learning models. We have reviewed these papers based on the application areas, databases, techniques, architectures, and tools used for the research work.

1.1 APPLICATION AREA

Lots of research work has been going on in the areas like classification of crop types, weed identification, plan recognition, land cover classification, counting the fruits, crop quality in yield prediction, disease detection, etc. We analyzed some research papers which are published recently after 2015. This survey shows that deep learning applications in the agriculture domain are emerging.

The majority of papers deal with the image classification, which is the basic and widely used application of deep learning. [8] And [9] have used the deep learning model Convolution Neural Network for fruit detection and fruit counting respectively. Dayoub at.al in [10] has used deep learning model for estimating crop yield of corn. Soil moisture content prediction in the field is carried out in [11], while weather conditions prediction is mentioned in [12]. Mostly all papers are concentrated on the crops, while some are based on weed detection, land cover, research on soil, livestock agriculture and obstacle detection.

1.2 DATASET USED

The database used to train the deep learning model can be real-time data or synthetic data produced by the authors. Papers [13], [14] have used the real databases, while [8] have used synthetic dataset. Some data sources are adapted from the well-known datasets publicly available datasets and others like [15], [16] and [17] have used databases created by the authors of the paper as per their needs.

Some of the research work needs small amount of data so their dataset's size will be small and that can produced by UAV [18], [19], [20] or it can be satellite-based remote sensing [21], [22], while others require a large amount of data if the problem is complex [13], [14], [17].

1.3 PREPROCESSING AND DATA AUGMENTATION

Data preprocessing is one of the important tasks for any kind of problem. Preprocessing is used to clean the data and convert it into the proper format. Many preprocessing techniques are available to make the data suitable for the model. In image classification kind of problems image resizing which consist of a method to reduce the size of a given image according to the need of a model. There are some popular image sizes like are 60*60, 128*128, 256*256 pixels. Background removal is also an important preprocessing step that gave the region of interest. Image segmentation can increase the size of dataset [19], [24], [25], it can be used to highlight region of interest to simplify learning process of the model [9], [13], [15], [26],[27]. Conversions of color, binary conversion, bounding box creation, etc. are also very useful. Histograms generation [17], [19], [23], Principal Component Analysis (PCA) filters [17], Wavelet transformations [10] are also useful to increase accuracy.

To make deep learning model general and to increase its performance data augmentation is important. Many researchers have used deep learning models on small data sets using data augmentation like in

ISBN : 978-93-87793-90-3

[15], [16], [28], [29], [30]. When a synthetic dataset is used for training and testing is carried out on real data [8], in that data augmentation can help to improve the accuracy. Because it helps the model to generalize in a better way and can perform really well on the real-world problems. Data augmentation includes transformations like rotation, scaling, mirroring [31], transposing [32], perspective transform [15] and PCA augmentation [16]. Rotations are performed in many application using deep learning models for training.

1.4 ARCHITECTURES AND FRAMEWORKS USED

Many research papers available with popular CNN architecture like VGG16, Inception, AlexNet. While using well-known CNN architectures, they have used the concept of transfer learning [4]. To increase the efficiency of the learning process transfer learning technique is used. It uses the already existing knowledge of some domain or task. It can be performed by fine-tuning the pre-trained model. In some of the work, it is not possible to train the model from scratch because the size of the dataset is very small or the network is more complex, in this case, if the initial weights are given from the pre-trained network efficiency can be increased. The transfer learning process uses the pre-trained CNN networks like VGG16, GoogleNet, AlexNet, DenseNet as mentioned and used in the [9], [13], [14], [16], [18], [32] papers. In the paper [30], linear regression is used, while [17] have used Large Margin Classifiers (LCM). All the research work which has used well-known CNN architectures had also used the deep learning frameworks like TensorFlow, deeplearning4j, Caffe, etc. Caffe is being the most useful framework. Caffe incorporates various CNN frameworks and data sources and it can be used easily by the users.

1.5 OTHER DETAILS

There many research papers available for classification problem in the agriculture domain using deep learning models. The number of classes can have a range from 2 [18], [20] up to 1000 [14]. In the paper [17], they have observed 91 classes of weeds found in agricultural fields, while [19] have taken 22 different crop plus soil classes. [8] and [30] have performed prediction on the fruit count so the output is the scalar value. Region of interest for detecting fruits in the image using multiple bounding boxes is carried out in [9] and [16]. Percentage of soil moisture content is predicted in the [11]. In table 1 some recent application of deep learning are mentioned .

ISBN : 978-93-87793-90-3

Table 1. Applications of Deep learning in Agriculture

SR. NO	AUTHORS	APPLICATION AREA	DATASET	NO. CLASSES	ARCHITECTURE	PERFORMANCE
1.	Chen, Yushi, et al. 8	Hyperspectral Data Classification	VIRIS and ROSIS hyperspectral datasets	16	EFM-CNN-SVM	98.69%
2.	Maryam Rahnemoonfar and Clay Sheppard 9	Fruit Counting	24000 images were generated for the training set, and 2400 for the test set	Fruit Count	Convolutional Neural Network with Inception Architecture TensorFlow [46] running on an NVidia 980Ti GPU	91% average test accuracy on real images and 93% on synthetic images
3.	Inkyu Sa , Zongyuan Ge, Feras Dayoub, Ben Upcroft, Tristan Perez and Chris McCool 10	fruit detection	ImageNet dataset	Two classes background anf fruit1	Region-based CNN (Faster R-C NN) Intel i7, 64-bit 2.90, quad-core CPUs, a GeForce GTX 980M 8 GPU (1536 CUDA cores)	0.83 F1 score
4.	Sharada P. Mohanty, David P. Hughesand Marcel Salathé 14	Image-Based Plant Disease Detection	54,306 images of diseased and healthy plant leaves	38	deep CNN with AlexNet and GoogLeNet	99.35%
5.	Angie K. Reyes , Juan C. Caicedo , and Jorge E. Camargo 15	Plan Recognition	Dataset of LifeCLEF 2015, which has 91,759 training and 21446 testing images	1,000	deep CNN Deep Learning library Caffe with NVIDIA Titan Z GPU (5,760 cores and 12 GB of RAM).	average precision of 0.486
6.	Srdjan Sladojevic, Marko Arsenovic, Andras Anderla, Dubravko Culibrk, and Darko Stefanovic	Image-Based Plant Disease Detection	30880 images for training and 2589 images	15	Deep CNN Caffe	96.3%.

ISBN : 978-93-87793-90-3

7.	Suchet Bargoti and James Underwood 16	Fruit Detection	2263 for training 482 for validation and 482 for testing	3	R-CNN	F1-score of > 0.9
8.	Wang Xinshao, Cai Cheng 17	Weed Seeds Classification	3980	91	PCA net	90.96%
9.	Julien Rebetez , Hector F. Satizábal, Matteo Mota, Dorothea Noll, Lucie Büchi, Marina Wendling, Bertrand Cannelle, Andres Perez-Uribe, Stephane Burgos 19	Crop Classification	Arial images from Swiss Confederation's Agroscope research cente	23	CNN and Histogram based model HistNN	F1 Scores for Hybrid model average is > 0.9
10.	Andres Milioto, Philipp Lottes, Cyrill Stachniss 20	Crop vs weed Classification	Two dataset with 867 and 1102 images	2	CNN	DB A - 97.3% DB B - 89.2%

Table 1 .Applications of Deep learning in Agriculture

4. CONCLUSION

This Survey shows how deep learning architectures are very useful in the felid of agriculture. By applying RNN, CNN, etc. farm management system can be converted to real artificial intelligence system to increase the agriculture production. It is expected that in future use of DL Algorithms will be more widespread to increase production level and to improve the quality of production.

REFERENCES

[1] Gebbers, Robin, and Viacheslav I. Adamchuk. "Precision agriculture and food security." *Science 327.5967 (2010): 828-831.*

[2] Aubert, Benoit A., Andreas Schroeder, and Jonathan Grimaudo. "IT as enabler of sustainable farming: An empirical analysis of farmers' adoption decision of precision agriculture technology." *Decision support systems 54.1 (2012): 510-520.*

[3] Saxena, Lalit, and Leisa Armstrong. "A survey of image processing techniques for agriculture." (2014).

[4] Pan, Sinno Jialin, and Qiang Yang. "A survey on transfer learning." *IEEE Transactions on knowledge and data engineering 22.10 (2010): 1345-1359.*

[5] Sehgal, Gunjan, et al. "Crop planning using stochastic visual optimization." *IEEE Visualization in Data Science (VDS). IEEE, 2017.*

[6] Demmers, Theo GM, et al. "Simultaneous monitoring and control of pig growth and ammonia emissions." The Ninth International Livestock Environment Symposium (ILES IX). *International Conference of Agricultural Engineering-CIGR-AgEng 2012: Agriculture and Engineering for a Healthier Life, Valencia, Spain, 8-12 July 2012. CIGR-EurAgEng, 2012.*

[7] Chen, Yushi, et al. "Deep learning-based classification of hyperspectral data." *IEEE Journal of Selected topics in applied earth observations and remote sensing 7.6 (2014): 2094-2107.*

[8] Rahnemoonfar, Maryam, and Clay Sheppard. "Deep count: fruit counting based on deep simulated learning." *Sensors17.4 (2017): 905.*

[9] Sa, Inkyu, et al. "Deepfruits: A fruit detection system using deep neural networks." *Sensors 16.8 (2016): 1222.*

[10] Kuwata, Kentaro, and Ryosuke Shibasaki. "Estimating crop yields with deep learning and remotely sensed data*." 2015 IEEE International Geoscience and Remote Sensing Symposium (IGARSS). IEEE, 2015.*

[11] Song, Xiaodong, et al. "Modeling spatio-temporal distribution of soil moisture by deep learning-based cellular automata model." *Journal of Arid Land 8.5 (2016): 734-748.*

[12] Sehgal, Gunjan, et al. "Crop planning using stochastic visual optimization." *2017 IEEE Visualization in Data Science (VDS). IEEE, 2017.*

[13] Mohanty, Sharada P., David P. Hughes, and Marcel Salathé. "Using deep learning for image-based plant disease detection." *Frontiers in plant science 7 (2016): 1419.*

[14] Reyes, Angie K., Juan C. Caicedo, and Jorge E. Camargo. "Fine-tuning Deep Convolutional Networks for Plant Recognition." *CLEF (Working Notes) 1391 (2015).*

[15] Sladojevic, Srdjan, et al. "Deep neural networks based recognition of plant diseases by leaf image classification." *Computational intelligence and neuroscience 2016 (2016).*

[16] Stein, Madeleine, Suchet Bargoti, and James Underwood. "Image based mango fruit detection, localisation and yield estimation using multiple view geometry." *Sensors 16.11 (2016): 1915.*

[17] Xinshao, Wang, and Cai Cheng. "Weed seeds classification based on PCANet deep learning baseline*." 2015 Asia-Pacific Signal and Information Processing Association Annual Summit and Conference (APSIPA). IEEE, 2015.*

[18] Lu, Heng, et al. "Cultivated land information extraction in UAV imagery based on deep convolutional neural network and transfer learning." *Journal of Mountain Science 14.4 (2017): 731-741.*

[19] Rebetez, J., et al. "Augmenting a convolutional neural network with local histograms—a case study in crop classification from high-resolution UAV imagery." *European Symp. on Artificial Neural Networks, Computational Intelligence and Machine Learning. 2016.*

[20] Milioto, Andres, Philipp Lottes, and Cyrill Stachniss. "Real-time blob-wise sugar beets vs weeds classification for monitoring fields using convolutional neural networks." *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences 4 (2017): 41.*

[21] Kussul, Nataliia, et al. "Deep learning classification of land cover and crop types using remote sensing data." IEEE Geoscience and Remote Sensing Letters 14.5 (2017): 778-782.

[22] Minh, Dinh Ho Tong, et al. "Deep Recurrent Neural Networks for mapping winter vegetation quality coverage via multi-temporal SAR Sentinel-1." *arXiv preprint arXiv:1708.03694(2017).*

[23] Hall, David, et al. "Evaluation of features for leaf classification in challenging conditions." *2015 IEEE Winter Conference on Applications of Computer Vision. IEEE, 2015.*

[24] Ienco, Dino, et al. "Land cover classification via multi-temporal spatial data by recurrent neural networks." *arXiv preprint arXiv:1704.04055 (2017).*

[25] Yalcin, Hulya. "Plant phenology recognition using deep learning: Deep-Pheno." *2017 6th International Conference on Agro-Geoinformatics. IEEE, 2017.*

[26] Potena, Ciro, Daniele Nardi, and Alberto Pretto. "Fast and accurate crop and weed identification with summarized train sets for precision agriculture." *International Conference on Intelligent Autonomous Systems. Springer, Cham, 2016.*

[27] Grinblat, Guillermo L., et al. "Deep learning for plant identification using vein morphological patterns." *Computers and Electronics in Agriculture 127 (2016): 418-424.*

[28] Namin, Sarah Taghavi, et al. "Deep phenotyping: deep learning for temporal phenotype/genotype classification." *Plant methods 14.1 (2018): 66.*

[29] Mortensen, Anders Krogh, et al. "Semantic segmentation of mixed crops using deep convolutional neural network." *CIGR-AgEng Conference, 26-29 June 2016, Aarhus, Denmark. Abstracts and Full papers. Organising Committee, CIGR 2016, 2016.*

[30] Chen, Steven W., et al. "Counting apples and oranges with deep learning: A data-driven approach." *IEEE Robotics and Automation Letters 2.2 (2017): 781-788.*

[31] Dyrmann, Mads, Henrik Karstoft, and Henrik Skov Midtiby. "Plant species classification using deep convolutional neural network." *Biosystems Engineering 151 (2016): 72-80.*

[32] Sørensen, René A., et al. "Thistle detection using convolutional neural networks." *2017 EFITA WCCA CONGRESS. 2017.*

[33] Gohel Chhaya C., Mukesh M. Goswami, and Vishal K. Prajapati. "On-line handwritten Gujarati character Recognition using low level stroke." *2015 Third International Conference on Image Information Processing (ICIIP). IEEE, 2015.*

[34] Chhaya Zala and Pruthvi Patel, "Introduction To Big Data Analytics Using Cloud Computing ", *at International Journal of Research In Electronics And Computer Engineering, IJRECE, volume 6, issue 2 ,2018.*