International Journal of Multidisciplinary Research in Arts, Science & Commerce
(IJMRASC) ISSN Online: 2583-018X

Vol. 3(1), January 2023, pp. 47 - 56

A LITERATURE REVIEW ON SMART AGRICULTURE USING NEURAL NETWORK AND INTERNET OF THINGS

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ABSTRACT

The practice of cultivating the soil, raising crops, and raising animals for food is known as Agriculture. It plays an important role to support our daily life and financial system in most of the countries. It provided Food and additional raw resources, such as cotton, sugar, jute, and oil. Global Accuracy of Agriculture Market will be accelerating as 12.7% at Compound Annual Growth Rate between 2019 to 2026. Currently farmers are facing more challenges to produce enough crops to the expanded human population. Smart Agriculture is current farming making machinery based on the situations of spatial and sequential constraints in the field of crop development. Exposure to a global market for useful tools and intelligent systems that integrate advanced computing with electronic tools or control agricultural production is encouraged by "smart agriculture". The purpose of study is to find how Neural Network algorithms and Internet of Things can be applied on Agriculture process. This review paper also explores several use cases like drones, soil management, precision farming, livestock management and water management with automated irrigation.

KEYWORDS: *Smart Agriculture, Neural Network algorithms, Internet of Things*

INTRODUCTION

Agriculture is the backbone of the nation since it helps to provide food security for the entire population. Agriculture provides a living for almost 75% of people worldwide. The need to raise agricultural yields is a result of the population explosion, thus people must do more to elevate the standing of agriculture. Farmers are searching for effective strategies to boost crop yield while spending less money and making better use of their resources. This helps the farmers make better decisions and boost yields by enabling the new smart technology application in agriculture. Smart Agriculture is current farming making machinery based on the situations of spatial and sequential constraints in the field of crop development. Smart Agriculture explores several use cases like drones, soil management, precision farming, livestock management and water management with automated irrigation.

USE CASES OF SMART AGRICULTURE

- To raise the crop eminence, crop management is a vital activity. Nowadays, drones are essential to agricultural crop management tasks like crop monitoring, field scanning, and so forth. The temperature and water content of the crops are monitored in smart agriculture. Additionally, farmers can see their fields from any location in the world.
- Yield prediction is central branch of precision agriculture. It surrounds various activities such as yield survey, yield assessing, equal crop supply and demand, multidimensional study of crops, weather conditions, and economic states. The decision of what to cultivate and when to cultivate it is made easier for the farmers. It aids farmers in locating crop losses and preventing them in the future.
- Water management is necessary for a crop to grow properly. Monitoring the level of water is one of the important factors for crop growth. Agriculture's use of water affects the hydrological, climatological, and agronomic balance. Irrigation systems are used more efficiently, and forecasting the daily dew point temperature aids in identifying expected weather occurrences and calculating evapotranspiration and evaporation.
- Soil Management used to recognize the suitable crops and best type of fertilizer for the soil is an easy task. The pH, EC, and primary, micro, and macro nutrients in the soil affect the crop's quality. Specialists in agriculture uses a diverse natural resource, soil has intricate systems and nebulous mechanisms. Its temperature alone can provide information on how climate change is affecting the regional harvest.
- Weed Detection used to Detecting and removal of weeds are the main problem in Agriculture field. Weed eradication was traditionally carried out by hand. It takes a lot of era and wealth. Weed-eating robots are emerging technology will reduce the need of herbicides in many nations.
- Livestock management offers precise farming parameter assessment and prediction to maximize the economic effectiveness of livestock production systems, such as the cattle farming and egg production. For instance, 150 days before the day of slaughter, weight prediction systems can anticipate future weights, enabling farmers to adjust the diets and environmental factors.

Figure1: Use cases of smart agriculture

LITERATURE REVIEW

Senthil [1] et.al have suggested study has four modules for Smart farming process. Django framework is used to develop Web application software. Crop recommender.csv, soil.csv and scientific_names.csv datasets were obtained from Kaggle website in Crop Recommendation module. AdaBoost Classifier, Gradient Boosting Classifier, XGBoost Classifier, LGBM Classifier, Naïve bayes, Logistic Regression, SVM, Decision Tree Classifier, Bagging Classifier, Random Forest Classifier and KNN were used as Machine Learning algorithms. After hyperparameter tuning some algorithms accuracy was decreased but accuracy of Random Forest Classifier was increased as 95.4545%. Nitrogen, Phosphorous, Potassium content is obligatory for crop growth. V2 plant seedlings dataset obtained from Kaggle website in Weed identification module. Resnet152V2 pre-trained keras model is been used to classify the images. Resnet152V2 fine tuning model identified the name of the weed when the image is been uploaded by the user. Pests dataset obtained from Kaggle in pesticides recommendation module. Resnet152V2 pre-trained keras model is been used to classify the images. The accuracy obtained was 98%.Indian cost of cultivation survey data is used in crop cost estimation module. Cost is estimated by XGBoost regressor. For each model statistical measures such as r2 score, root mean squared error, mean squared error, and mean absolute error are estimated. The model with the highest r2score is chosen as the best model.

Prabira [2] et.al have suggested study on Smart paddy grassland supervising system using deep learning and Internet of Things. Smartphones, I.P. cameras, data storage and analysis modules (DSAM), and sensors are all included in the system. Two deep learning models Vgg16, Vgg16 plus SVM are prepared for image analysis. Agricultural pest and insect pests picture are used as dataset to identify paddy leaf diseases. The dataset comprises four kinds of paddy leaf diseases such as bacterial blight, blast, brown spot and tungro. In estimating the nitrogen status using healthy rice leaves. The

International Journal of Multidisciplinary Research in Arts, Science & Commerce
(IJMRASC) ISSN Online: 2583-018X

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four-level of Nitrogen (N) deficient leaf samples of the rice crop is publicly shared in http://dx.doi.org/10.17632/gzm5pxntyv.1. The dataset comprises four levels of nitrogen such as swap 1:1407, swap 2:1203, swap 3:1400 and swap 4:1380. All the data samples are resized to 300×300 pixels and also divided randomly into 80:20 fractions for training and validation. In addition, 100 each type of disease samples are kept for testing purposes. Model vgg16 achieved accuracy as79.86% and 84.88%. Model Vgg16 plus SVM achieved accuracy as 97.31% and 99.02% described in table1. Vgg16 plus SVM Model provide better performance than Model vgg16. Nearly every aspect that affects the productivity of paddy fields, including soil and rice plant conditions, may be monitored by the prototype.

Table 1: performance measures of deep learning models

Purpose	models	Accuracy	Sensitivity	Specificity	FPR	F1 Score	Training time
Leaf Disease Identification	Vgg16 plus SVM	0.97312	0.97312	0.99104	0.00895	0.9730	107.684
	Vgg16	0.79860	0.7937	0.9325	0.0675	0.7949	364.67
Nitrogen Status Estimation	Vgg16 plus SVM	0.9902	0.9902	0.9967	0.0326	0.9901	110.545
	Vgg16	0.8488	0.8531	0.9494	0.0506	0.8472	203.5467

Tuan [3] et.al have suggested study on Pest organization In Smart Agriculture Using Transfer Learning. The insect dataset obtained from Kaggle. Laybird, Mosquito, Grasshopper, Butterfly and Dragonfly are 5 types of insects. All images are resized as 224 x 224. This dimension was used in Deep Learning network like AlexNet, VGG16 etc. after hyper parameters for training Deep Learning model are set with the batch size 8 and total epochs 10. To provide more precise weight updates, the learning rate is fixed at 0.000744 and additionally reduced by 20% for each epoch during training. 8 various models of EfficientNet to evaluate their performance.

Table 2: performance of 8 EfficientNet models

Model	Precision	Recall	Acc	F-Measure
EfficientNet-B0	92.34	92.47	92.44	92.49
EfficientNet-B1	94.60	94.59	94.40	94.54
EfficientNet-B2	95.14	95.15	95.24	95.13

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EfficientNet-B3	95.49	95.66	95.52	95.54
EfficientNet-B4	95.31	95.77	95.52	95.46
EfficientNet-B5	94.91	95.00	94.96	94.91
EfficientNet-B6	95.35	95.45	95.23	95.35
EfficientNet-B7	94.19	94.33	94.12	94.21

Table 2 summaries the performance for each model. Experiments showed that EfficientNet-B3 achieves the best accuracy 95.52%.In future, this proposed method can be experimented on embedded systems for autonomous machines like drones or robots used in agriculture.

Leila [4] et.al have suggested study on Weeds and Crops Discrimination using Deep Convolutional Neural Networks. Crop/Weed Field Image Dataset is available through http://github.com/cwfid. Sugar Cane Orthomosaic dataset is available via http://www.lapix.ufsc.br/weedmapping-sugar-cane. Both Dataset was grouped as three categories such as soil or background, crops, and weeds. Both Dataset were evaluated by Deep Learning Models such as SegNet, FCN-32s, FCN-16s, FCN-8s, U-Net, and DeepLabV3+. The DeepLabV3+ reached an accuracy of 90.5% on precisely segmenting weeds compared to 85.8% of FCN-8s, 76.1% of FCN-16s, 66.7% of U-Net, 63.6% of FCN-32s, and 52% of SegNet. Finally the result shows that DeepLabV3+ has a superior performance on discovering weeds from the Crop/Weed Field Image Dataset. The U-Net reached an accuracy of 86.17% on precisely segmenting weeds compared to 85.89% of FCN-8s, 71.04% of FCN-16s, 80.16% of deeplab v3+, 80.16% of FCN-32s, and 64.5% of SegNet. Finally the result shows that U-Net has a superior performance on discovering weeds from the sugarcane dataset than other models. Table 3 shows accuracy and kappa value of Deep Learning Models.

Table 3: Accuracy and Kappa value of Deep Learning Models

Datasets	models	Accuracy	Kappa Index
Crop/Weed Field Image Dataset	SegNet	62.6	0.69
	FCN-32s	68.4	0.72
	FCN-16s	77.2	0.74
	FCN-8s	81.1	0.78
	U-Net	77.9	0.76

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	DeepLabV3+	84.3	0.82
Sugar Cane Orthomosaic dataset	SegNet	62.8	0.63
	FCN-32s	69.8	0.71
	FCN-16s	71.6	0.73
	FCN-8s	76.62	0.76
	U-Net	74	0.72
	DeepLabV3+	70.99	0.74

Sindhu [5] et.al have recommended study on Citrus Fruit Disease Classification using IOT with Cloud. Citrus fruit Diseases Image Gallery dataset contains various citrus diseases such as anthracnose, scab, black spot, melanose, greening, canker and leprosis. Improved Particle Swarm Optimization Convolutional Neural Network ((IPSO-CNN), Linear Discriminant Analysis (LDA), W-K-Nearest Neighbour Algorithm, Modified Support Vector Machine (M-SVM), Enhanced Bat Algorithm (EBT) and Decision Tree (DT) used to classify Citrus Fruit Disease. The least accurate result that the linear discriminant analysis (LDA) algorithm could achieve was 93.50%, which indicates that it performed poorly. The best value, 96.08% accuracy, is provided by IPSO-CNN. Table4 shows that accuracy and Area Under Curve of various classifiers. Finally the result shows that IPSO-CNN model is the most effective than other classifiers.

Table4: Accuracy and Area Under Curve value of classifiers

Classifiers	Accuracy	AUC
IPSO-CNN	96.08	0.98
M-SVM	95.80	0.98
W-KNN	93.80	0.97
EBT	94.50	0.98
DT	94.50	0.98
LDA	93.50	0.97

Kalaiselvi et.al [6] have recommended study Using IoT Framework and machine learning algorithms to predict the crop. Crop recommended dataset was obtained from Kaggle database. The dataset has seven special constraints like Nitrogen, potassium, phosphorous, pH, Rainfall, Temperature, and Humidity. Multilayer perceptron, JRip classifier and decision table classifiers are used to evaluate the Crop. The three classifiers are implemented through accuracy in first and second iterative model. In first iterative model, Percentage of accuracy lies on 98.2273% to 88.5909% For Multilayer perceptron, JRip classifier and decision table classifiers described in figure 2. In second iterative model, accuracy percentage is 98.22% for MLP and 96% for JRip after the normalization of data has

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not deviated from the result. The two iterated model characteristics unequivocally demonstrate that there has been no change in performance accuracy.

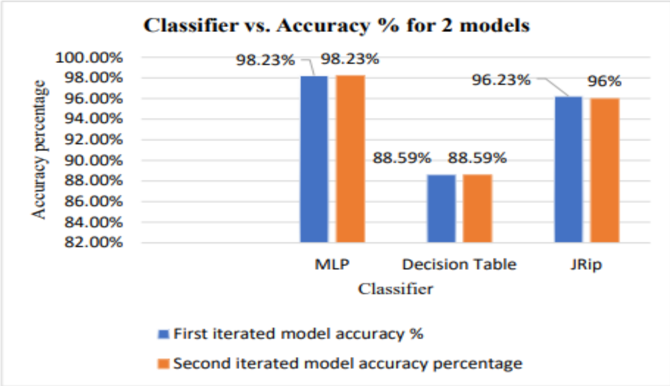

Figure2: accuracy of first and second iterative model

According to the description of report and data [7], 70% of the market was accounted to hardware components. Precision farming is expanding as a result of increased IoT usage in the agricultural industry. The most popular use in precise farming is yield monitoring since it helps farmers understand field variability and maximize yields. Applications for weather monitoring in precise farming are anticipated to expand at a faster CAGR during the projection period. In2018, the North American market accounted for 41.2% of the global market share for precision farming. Europe acquired a share of 36.9% of market for precision farming in 2018. Asia-Pacific market acquired a share of 17% of market for precision farming in 2018. Global Accuracy of Agriculture Market will be accelerating as 12.7% at Compound Annual Growth Rate between 2019 to 2026 described in figure 3.

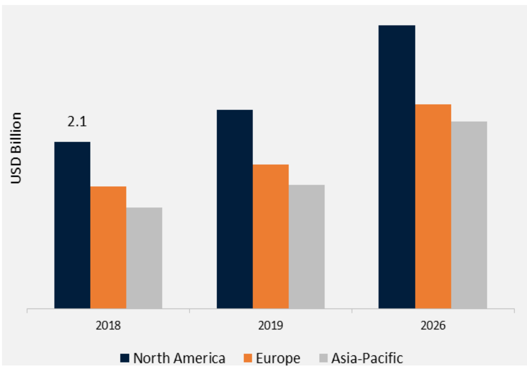

Figure 3: precision farming in 2018 to 2026

Kasara et.al [8] have conducted the study on IoT based Smart Agriculture using Machine Learning. By running a web server and providing storage for the datasets, Raspberry Pi assumes a crucial function in the system. Datasets containing values of temperature, humidity and soil moisture are loaded into the decision tree algorithm after applying decision tree algorithm on the sensed datasets, an output containing the decision to water the crop is made. This output containing decision is sent to the users or famers through an Electronic mail (E-mail) using Simple mail transfer protocol described in figure4. A need for water requirement email alert is issued to the farmer if the algorithm predicts a yes response. The farmer receives an email notifying that water is not needed if the algorithm anticipates a negative outcome.

Figure4: email alerts for water requirement

Sameer et.al [9] have conducted the study on Smart Agriculture using IoT and Machine Learning. The training dataset used for the training of crop prediction model contains features like nitrogen, potassium, phosphorus, temperature, humidity, pH, and rainfall whereas the fertilizer recommendation model contains features like phosphorus, potassium, pH ,nitrogen, and soil moisture.

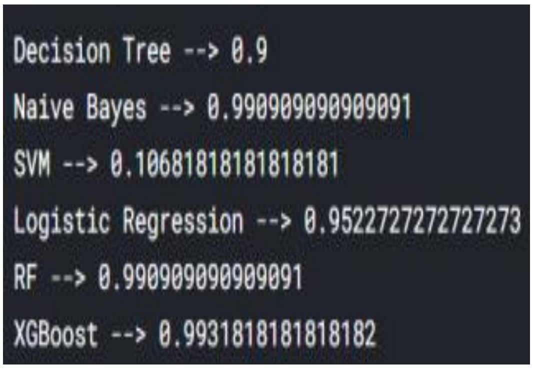

Figure 5: Machine learning model's accuracy

Various Machine learning algorithms were applied on the training dataset. Decision Tree, Naive Bayes, Support Vector Machine, Logistic Regression, Random Forest and XGBoost, and were compared based on the model's accuracy. XGBoost showed the 99.31% of highest accuracy and thus was used for the prediction model described in figure 5.

CONCLUSION

Agriculture is one of the major sectors for the economic development of India. The traditional agricultural sectors, which include farmers, seem to suffer from various problems like inadequate crop growth, and inadequate climatic conditions. These IoT and DL based recommendations will surely help the farmer understand more about the various factors, which help them in minimizing their costs, and make strategic decisions. This leads to a scalable and reliable solution, which will develop millions of people in India. This paper also talks about several use cases like drones, soil management, precision farming, livestock management and water management with automated irrigation.

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