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Applications of UAV in the agriculture field

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Abstract. As the world population is increasing day by day, the rise in food production becomes very crucial. Increasing prominence of technology in the agriculture sector is the X-factor to use unmanned aerial vehicles (UAVs) for the betterment of agricultural processes. In the agriculture sector, many aspects which are not under the control of human beings can also be monitored, managed by the use of technological devices like Unmanned aerial vehicles. Parallel, controlling the pollution in the environment is also important. Fertilizers and pesticides should be applied only in the appropriate amounts. Under amount leads to improper growth of the crop and over amount leads to the soil pollution which further results in water pollution. The usage of the unmanned aerial vehicles in the agriculture sector is a very beneficial thing in both aspects of crop growth and nature conservation. Advantages and application of the unmanned aerial vehicles are properly analyzed in the study.

Keywords: Unmanned aerial Vehicle (UAV), Feature Selection and Extraction, Classification, Aerial Spraying.

1. Introduction

Agriculture is the most promising and difficult area to work in since it is dependent on climate or weather, soil condition, irrigation water quality and quantity, and application rate. Scientists of the Food and Agriculture Organization of the United Nations (FAO) and the International Telecommunication Union (ITU) predicted that, by the year 2050, there has to be a steady increase in food production (70% per se) so as to meet the agricultural demands of the largely increasing population. One of the main problems that directly lower the quality of agricultural products is plant diseases. The primary responsibilities to enhance the quality of plant output for economic growth are the identification and categorization of plant lesions. The need for increased agricultural productivity is frequently reflected in a rise in the number of pesticides used during agriculture. Long-term exposure to these pesticides can result in a number of ailments in people, including cancer, issues with the respiratory system, and neurological abnormalities. Thus, aiming to improve spraying accuracy for pesticides and lessen the chance of human exposure to these compounds. The pursuit of sustainable agriculture has resulted in greater efficiency in the utilization of agricultural resources and inputs. In addition to promoting sustainable crop management, Precision Agriculture (PA) is one of the instruments used to assist farmers in making decisions that are increasingly precise and efficient. Precision agriculture can improve the efficacy of the products, lower costs with targeted applications according to need and the density of the issue or requirement, so that it may be able to change the

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application rates. Precision agriculture and remote sensing make it feasible to precisely assess agricultural issues, directing management in a way that greatly lowers costs. According to recent research, implementing cutting-edge agricultural production methods will allow for the rise in food production that is necessary. Computer technological advancements, along with the development of worldwide navigation and geoprocessing systems, are boosting opportunities for the use of unmanned aerial vehicles, or drones, in agriculture. More precisely, the Internet of Things (IoT) and, in particular, the rapid expansion of Unmanned Aerial Vehicles (UAVs) and Wireless Sensor Networks (WSNs) might result in important and cost-effective Precision Agriculture (PA) applications such as aerial crop monitoring and smart spraying chores. Irrigation, crop monitoring, soil and field studies, and bird control are the most common agricultural drone applications. Drone usage in agriculture has shown encouraging and useful outcomes. In a nutshell, drones take overhead pictures of the crop that are then subjected to image analysis. This allows for a distinct perspective on the plantation and the detection of issues that would have previously been more difficult to spot. Both satellite image acquisition and human crewed aircraft image acquisition are too expensive for the average farmer to afford. In contrast to the earlier situations, tiny UAVs or drones are seen as a more practical alternative and are equipped to provide photos of a high caliber. As a result, valuable findings about crop diseases, water stress, insect infestations, nutritional deficits, and other pertinent variables impacting crop yields can be drawn using them.

2. Literature Survey

Unmanned Aerial Vehicles (UAVs) not just make the human’s job easy but improve the results of a crop in the agricultural field. There are many operational parameters like flight speed, flight height, droplet size, weather conditions etc., which affects the spraying pattern on the target and the area where we intended to spray. Apparently, the studies have evolved from the objective of pest controlling to the objective of UAV operational parameters effect on weed deposition on target. After many experiments the optimal speed and height of the UAV has been found and it is also said that rotor UAV gives the best deposition results compared to other UAVs [1]. Further studies of the UAVs application in the agricultural field have given importance to the weather conditions as well. A model has been developed which first analyzes the weather conditions of the real time environment and starts to spray according to the weather inputs that have been analyzed which normalizes the effect of weather conditions on the UAV spray. The results shown by this experiment have also been constructive, efficient, stable which opened gates to many future works [2].Plants are vulnerable to different types of diseases. These diseases can cause severe damage to the target. In the past, many different parts of the world have been affected by famine as most of the crop production was damaged. It is difficult to detect the disease of the plant but it is very important to constantly examine the crop. To detect the disease of the plant, a model has been developed based on machine learning using python programming languages. This model is trained by the dataset and can be used in the real time environment with good accuracy and performance [3]. Research says that the demand for the food in future is very difficult to meet. UAVs solve almost all the challenges faced in the agricultural field thereby providing optimal solutions to the crop and environment as well. UAVs can be used for both monitoring and pest spraying. Both the hardware can be embedded into a single system using which decisions can be taken for the crop which can produce better results. This system can solve the general challenges in the agricultural field by using Information and Communications Technology (ICT) [4].

Plant disease detection and prevention is a huge problem that is faced in the agricultural field. A survey is done by [5] which aim to find out which classification technique is best to use in a real time environment. This study mainly concentrates on citrus plants as they often get affected by a lesion which mainly includes Citrus canker. Images of the plants are taken and are pre-processed. The pre-processed images are segmented to extract features which are used for classification of the images. This study also aims to find out the best machine learning technique for clustering and classification of the images that are captured by UAVs [5]. Today's globe is characterized by constant change in both land usage and land cover. The proposed method presents a machine-learning pipeline that handles the entire difficult procedure in the following way as a proof-of-concept. Through the pipeline, the pertinent Sentinel-2 photos are obtained. Later, cloud masking is carried out, along with the linear interpolation of time frames that have merged features. After that, four dimensional arrays are made with all potential training data to serve as the foundation for the Light GBM estimator from the scikit-learn module. Finally, the databases for open land use and open land cover are updated with the categorized content. Overall accuracy (OA) for the experiment was a respectable 85.9% [6].It is important for scholars to examine precise precipitation prediction since rainfall has a significant impact on agriculture and daily travel. Because precipitation has nonlinear and dynamic properties, conventional methods like statistical models and numerical weather prediction (NWP) models cannot accurately forecast rainfall. This paper primarily offers basic information on ANNs and a number of algorithms that have been used in recent years to predict precipitation using neural networks. The paper also covers the topic of combining approaches and evaluating the outcomes. It has been demonstrated that neural networks may significantly increase prediction efficiency and accuracy [7].Land cover classification (LCC) is one of the key issues in earth observation, which has received a lot of attention in recent years. In order to uproot the time related properties of a series of SENTINEL 2A considerations, the present study used Long Short-Term Memory (LSTM), which has been experimentally proven effective compared to many other machine learning techniques like Support Vector Machine (SVM). In order to process the information provided by SENTINEL 2 and LANDSAT-⅞ satellites, an LSTM conceptual model has been presented. Also, different data classification plans are assessed while training and testing of the model using the space related data. By assessing the classification precisions of time related and space related models, impact of time related links between observations are investigated [8].As deep learning is ruling the data technology, it doesn’t fail to contribute its effectiveness in the agricultural field. Deep learning frameworks are developed with very useful features which include Theano, Tensor Flow, Keras etc. These frameworks are developed in different programming languages like Python, C++, R etc. Applications of deep learning in the agricultural field extends in every phase of the crop development [9].In most of the phases of crop development the images of the data entity are considered and the features from the images are extracted by the deep learning model which is sufficiently trained by the data set which are considered well before the usage of the model. Different phases of the crop include Crop planning, Plant phenotyping, Weed management, Pest management, Disease prediction, Crop yield estimation etc. In every phase of the crop development, the deep learning models like Long Short-Term Memory (LSTM), Convolutional Neural Network (CNN), and Recurrent Neural Network (RNN) etc. The performance of all the models are evaluated and compared with other techniques and concluded that deep learning is the best technique to use [9].

One of the basic attributes of the forest is its spatial dissemination. This helps people in many ways to analyze, interpret and use the forest resources. Spatial distribution of the forest can be detected and monitored using the process called Remote Sensing. This study extracted the real time information of the forest like aerial images, LiDAR, Single Sentinel-2 and time-series sentinel-2. Single sentinel-2 data should be fused and images should be segmented to extract the features [10]. From the information that is extracted data processing is done through different phases such as preprocessing, feature extraction and classification. For aerial images, time-series sentinel-2 and LiDAR data, firstly, the data should be cleaned through data preprocessing techniques. Then the features are extracted from the preprocessed information which then is classified into different classes developed models. The accuracy of the data model is assessed by classification results. Thus, spatial distribution of the forests can be analyzed which is very useful to determine other activities by humans [10].Another crucial aspect in the field of agriculture is crop classification. A model is proposed to find the spectral similarity and to classify the crops based on the features that are extracted. First, Geodesic Distance Spectral Similarity Method (GDSSM) is used to find the spectral similarity which gives the accuracy of 71.26%. Then Convolution Neural Network (CNN) is used to classify the data, which gives the accuracy of 67.29%. Finally, both the models are combined which gives rise to Geodesic Distance Spectral Similarity Method - Convolution Neural Network (GDSSM-CNN) model which then experimented produced the accuracy of 91.2% which is the highest of all the models on which the experimentation is performed. Thus, the feasibility of the farming in a particular crop is evaluated using the model that is proposed [11]. This model takes images as input. The accuracy gets better as the amount of input increases, but up to a certain threshold like 0.8-0.9. For any given threshold, GDSSM-CNN model gives the accuracy of excess to 89% which is highest of all models [12][13].

3. System Design

The system is designed using a back propagation neural network (BPNN) which is often used for classification of the images [14]. It usually has three or more layers among which one is the input layer, the other is the output layer and the third one is the hidden layer [15]. This neural network contains both the input and output layers which are connected to each other by a hidden layer(s). Each layer can have multiple nodes which are interconnected to the nodes of other layers. The strength of the connection is often referred to as weight. The input layer of the back propagation neural network is associated with the input features which are extracted from the leaf images that were captured by the unmanned aerial vehicles and the output layer is associated with the concerned diseases of the crop. Support Vector Machine (SVM) is used for supervised learning and disease classification.

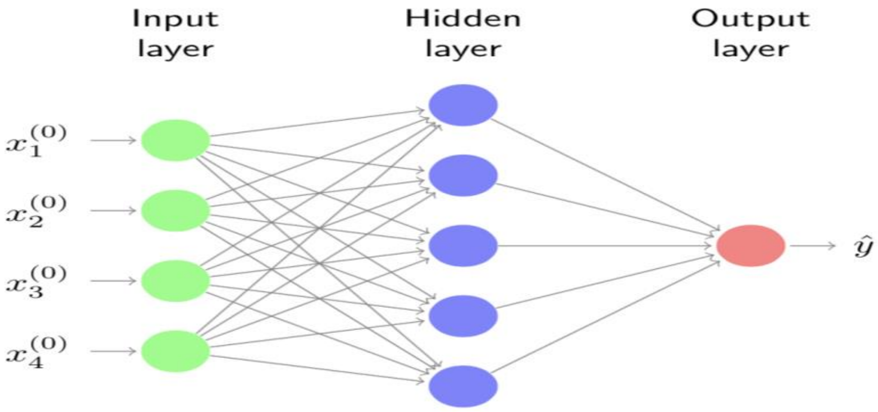

Figure 1. Back Propagation Neural Network.

4. Methodology

The images that are captured by the unmanned aerial vehicles are considered for image formation where the captured RGB images are standardized using different models. The HSI model is used for the image formation process. The formed images are then considered for image processing for efficient feature extraction. In this step the core information of the images is unaltered but the range of a few features are reduced which is known as localisation. The size of the image is also set according to the system that is designed. It is processed using the filters to eliminate useless regions of the leaf image. Choosing a good filtration technique makes the preprocessed images very suitable for feature extraction with great accuracy and speed. After acquiring preprocesses images, they need to be analyzed in order to extract the features of the images. The process of image analysis includes many methods like feature extraction, image segmentation, classification etc. Image segmentation is done to eliminate the useless region of the leaf images. A few regions of the boundaries are also removed which is known as boundary segmentation. This segmentation is done through different methods like thresholding, histogram and region growing. An image usually contains pixels, these pixels are labeled as 1 or 0 based on the check of the value compared to the threshold value. If the pixel value is higher than the threshold value then it is labeled as 1 or else if the value of the pixel is less than that id threshold value then the value that is labeled to the pixel is 0. Selecting the appropriate threshold value is also very important in the process of image thresholding. Thus, thresholding results in a black and which image where 0 labeled pixels are turned to white and only the pixels that are above a certain value (threshold) are turned to black. The other method through which the image segmentation is done is histogram method. In this method a histogram is drawn analyzing the intensity of the pixels in a particular region of the image. The x-axis points which have the peak of the histogram graph are considered as the authentic image and the fewer peak values are considered to the edges between the images pixels. Thus, the disease region and healthy region of the leaf image is found by analyzing the histogram drawn with pixel data of the image. Thus, the features are extracted from the images that are taken for the study. These are then fed into the back propagation neural network as the input in the associated input layers. The support vector machine thus processes the information according to the training data that is fed to it in the training phase of the learning. The features that are extracted from the images are first divided into training data and testing data. After the machine is trained by training data, it is tested with testing data that is present. The results are thus produced considering accuracy, speed as metrics to determine a good system.

5. Results and Discussion

Different samples of the wheat crop images are divided into training and testing data. This data is used for training and testing of the classifier. Here, the data from 13 different days within 1 to 8 days gap are considered for study and data is collected from the unnamed aerial vehicles (UAVs). Two types of images are collected i.e., RGB spectral images and multispectral images. Indices are used to diversify the collected images which shows the significance of the indices in evaluating a developed classifier system. Different indexes like NormR, NormG, NormB, NGRBDI, GLI, GR, ExG, VARI, ExR are considered for evaluation of the developed system. Two metrics i.e., mean and standard deviation of the images on their respective days are collected using different indices for both the type of images collected i.e., for RGB spectral images and multispectral images. Later then the results are compared and it is observed that multispectral images are found to be more specific in revealing changes in color phenotypes when compared to RGB images.

6. Conclusion and Future Work

This paper proposes unmanned aerial vehicles which constantly capture the images that make farming easy as only the decision making is left about what fertilizers or pesticides to use. These images are processed with different image preprocessing techniques which results in the clean, reduced and transformed data. Different diseases can be predicted by image processing techniques which take the preprocessed images as input. After the disease is diagnosed, proper fertilizers and pesticides can be used. According to the results, precautions can also be taken for better crop production in the future. Choosing a good image processing technique makes the results more accurate. Fertilizers and pesticides can be applied to the crop in the appropriate amounts as there are side effects of the over-applying of the fertilizers and pesticides to the crop. The future work of this study includes finding the best image processing technique which can be inferred from the experimental results of different image processing techniques.

References

[1] Prediction in metropolitan city. Computer Communications, 153, 353-366.
[2] Senthilkumar, K., & Easwaramoorthy, S. (2017, November). A Survey on Cyber Security awareness among college students in Tamil Nadu. In IOP Conference Series: Materials Science and Engineering (Vol. 263, No. 4, p. 042043). IOP Publishing.
[3] VE, S., & Cho, Y. (2020). A rule-based model for Seoul Bike sharing demand prediction using weather data. European Journal of Remote Sensing, 53(sup1), 166-183.
[4] Krishnamoorthy, N., Prasad, L. N., Kumar, C. P., Subedi, B., Abraha, H. B., & Sathishkumar, V. E. (2021). Rice leaf diseases prediction using deep neural networks with transfer learning. Environmental Research, 198, 111275.
[5] VE, S., Shin, C., & Cho, Y. (2021). Efficient energy consumption prediction model for a data

DOI: 10.54254/2755-2721/6/20230855

analytic-enabled industry building in a smart city. Building Research & Information, 49(1), 127-143.

[6] VE, S., Park, J., & Cho, Y. (2020). Seoul bike trip duration prediction using data mining techniques. IET Intelligent Transport Systems, 14(11), 1465-1474.

[7] Easwaramoorthy, S., Sophia, F., & Prathik, A. (2016, February). Biometric Authentication using finger nails. In 2016 international conference on emerging trends in engineering, technology and science (ICETETS) (pp. 1-6). IEEE.

[8] Easwaramoorthy, S., Thamburasa, S., Samy, G., Bhushan, S. B., & Aravind, K. (2016, April). Digital forensic evidence collection of cloud storage data for investigation. In 2016 International Conference on Recent Trends in Information Technology (ICRTIT) (pp. 1-6). IEEE.

[9] VE, S., & Cho, Y. (2020). Season wise bike sharing demand analysis using random forest algorithm. Computational Intelligence.

[10] Subedi, B., Sathishkumar, V. E., Maheshwari, V., Kumar, M. S., Jayagopal, P., & Allayear, S. M. (2022). Feature learning-based generative adversarial network data augmentation for class-based few-shot learning. Mathematical Problems in Engineering, 2022.

[11] Rajalaxmi, R. R., Narasimha Prasad, L. V., Janakiramaiah, B., Pavankumar, C. S., Neelima, N., & Sathishkumar, V. E. (2022). Optimizing Hyperparameters and Performance Analysis of LSTM Model in Detecting Fake News on Social media. Transactions on Asian and Low-Resource Language Information Processing.

[12] Shanthi, N., VE, S., Upendra Babu, K., Karthikeyan, P., Rajendran, S., & Allayear, S. M. (2022). Analysis on the Bus Arrival Time Prediction Model for Human-Centric Services Using Data Mining Techniques. Computational Intelligence & Neuroscience.

[13] Pavithra, E., Janakiramaiah, B., Narasimha Prasad, L. V., Deepa, D., Jayapandian, N., & Sathishkumar, V. E. (2022). Visiting Indian Hospitals Before, During and After COVID. International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems.

[14] Karrothu, A., Anilkumar, C., & Sathishkumar, V. E. (2022). An Escrow-Free and Authenticated Group Key Management in Internet of Things. In Smart Intelligent Computing and Applications, Volume 2 (pp. 505-512). Springer, Singapore.

[15] Chen, J., Shi, W., Wang, X., Pandian, S., & Sathishkumar, V. E. (2021). Workforce optimisation for improving customer experience in urban transportation using heuristic mathematical model. International Journal of Shipping and Transport Logistics, 13(5), 538-553.