

A Survey on Disease Detection of a potato Leaf Using CNN

M.s.Sindhuja Bangari
Department of Computer Science
and Engineering
New Horizon College of
Engineering
Bangalore, India
sindhuja.nhce@gmail.com

Dr. Rachana P
Department of Computer Science
and Engineering
New Horizon College of
Engineering
Bangalore, India
dr.rachanap@newhorizonindia.edu

Nihit Gupta
Department of Computer Science
and Engineering
New Horizon College of
Engineering
Bangalore, India
nihit67@gmail.com

Pappu Sah Sudi
Department of Computer Science
and Engineering
New Horizon College of
Engineering
Bangalore, India
pappusah98120@gmail.com

Kamlesh Kumar Baniya
Department of Computer Science
and Engineering
New Horizon College of
Engineering
Bangalore, India
Jaiswalprince1224@gmail.com

Abstract—India is an agricultural nation and crops yield rate is a serious concern over the nation. Lesser the production, higher the price of such crops and higher the hunger problem for those who can't even afford potato so in order to enhance the yield rate of crops and minimize the disease infection in plant deep learning model come up with a technology which will makes farmer work easier for some extent. They can rely on Deep neural Networks which is sub field of AI technology to detect the plant having disease and avoid doing it manually and give a proper treatment in the bud stage before it is too late. This paper reviews various papers and found out that Convolution Neural Networks (CNN) performs better in finding out the leaf disease also found that the CNN contribute the highest possible accuracy for disease detection.

Keywords: *Neural Networks (NN), Deep Learning (DL), Convolutional Neural Network (CNN), Potato leaf disease classification, leaves samples, Feature Extraction, Fungal and Bacterial Diseases.*

I. INTRODUCTION

Covid -19 effects all beings in the world. Humans understand that a good health only protect us from any kind of diseases or viruses. Such health concentrated industry is agriculture. Agriculture will play major role in all the countries. One such country is India. Majority of the people of the India is involved in agriculture. While farming, they grow a range of products, the most versatile of which is the potato, which accounts for 28.9% of India's total agricultural crop production [2]. As it is known, the potato is the king of vegetables and may be combined with virtually any other vegetable. White potatoes are also the most abundant and cost-effective source of potassium of any vegetable or fruit,

according to research. As the important is known to us of potato it is our responsibility to provide the people with the fresh and sufficient amount of potato. To get the potato production in huge amount the farming of potato plants should be proper. For the best yield disease infection in plant should be minimized for which farmer know to identify still doing it manually is little time taking task so it might can save time and be more confident to differentiate the disease and can give early treatment in bud stage. Nowadays it is seen that the farmers are not being aware of the disease caused in their crops at early stage. There is no proper technology to find the diseases at the early stage of crops. The use of AI technology everywhere now. It is also helpful agriculture industry with its recent advancement. AI has its sub field called Deep Neural Networks (DNN) [30]. Two concepts are required to detect the disease in leaves.

1. Object Recognition
2. Image Classification

This research focuses on detecting and recognizing the disease that has afflicted the plant [13]. Potatoes leaves are mostly affected by the fungal illness i.e. early blight and late blight [2]. The following figure [fig.1] shows the differences between healthy leaf and non-healthy leaf.



Fig1: Healthy leaf Vs Early Blight Vs. Late Blight

Deep Neural Network becomes popular by its profound technique to deal with the images.

II. RELATED WORK

The below table will give the detailed work that has happened on disease detection in a potato

Literature Survey

AUTHOR	TITLE	SUMMARY
Sumit Kumar, Veerendra Chaudhary , Ms. SupriyaKh aitan Chandra	Plant Disease Detection Using CNN [2021]	In this project a particular deep learning model has been developed which is depend on special architectural convolution network to detect plant diseases through images of different leaves [1].
Divyansh Tiwari , Mritunjay Ashish, NitishGan gwar, Abhishek Sharma, Suhanshu Patel, Dr. Suyash Bhardwaj	Potato Leaf Diseases Detection Using Deep Learning [2020]	This project have developed an automated system to diagnose and identify diseases in the potato leaves like early blight, late blight and healthy by achieving classification accuracy of almost 98% over the different test dataset. <u>Merits:</u> By the help of this technique farmers can easily detect diseases in their early stage and will be able to enhance their crop productions [2].
Sanjay K Hoysala, Santosh K S, Srihari D R, SuhithShe kar Chandra, Ajay Prakash B V	Recognition and Classification of Leaf Disease in Potato Plants [2019]	It help in identifying the disease caused in potato leaves, here we need to give potato plant leaves as input to the model. <u>Merits:</u> The model in this project proposed is efficient, fast and accurate and also it has a high prediction rate [3].
Pitchai R1, Sharath Kumar G2, Ashutosh Varma D3, MadhuBa bu CH4	Potato Plant Disease Detection Using Convolution Neural Network [2020]	It is capable of detecting disease in plants it also provide remedy for the same disease. We need to have proper knowledge of the disease and the cure to improve the plant's health and productions. <u>Merits:</u> Here by using python implementation of the framework is done and accuracy is 80% [4].
Soma Ghosh, RenuRam eshan and Dileep A.	An Empirical Study on Machine Learning	In this work, RGB image is used for exploring several ways to build an effective classifier for potato leaf disease. Based on this study

D.	Models for Potato Leaf Disease Classification using RGB Images [2021]	observations, they suggest to create a large input dataset. It is carrying out complete analysis of features which are learnt by the models to prove their hypothesis that features represent the overall organisation of an image rather than leaf and disease region alone [9] .
Mr. GirishAth anikar , Ms. PritiBadar	Potato Leaf Diseases Detection and Classification System [2016]	Implementation is carried out using the MATLAB Image Processing and Bioinformatics Tool Box to develop a quick, automatic and accurate system for disease identification and classification for potato leaves. <u>Merits:</u> The system can be used for disease identification and classification over Potato Plant leaves which ultimately helps the agriculturists i.e. farmers [10].
A T Madhavi, MMYuges h ,Srinidhi K ,C S SVijayasu ndar	Detection of leaf disease using convolutional neural network [2020]	In this system, Dense Net is used to find and classify various leaf diseases in only three plants i.e. tomato, potato and bell pepper. The identification is done for the dataset obtained from plant village, all data is collected through mobile camera and live detection. <u>Merits:</u> In the future, this system or study objective is to improve the rate of accuracy of the model, minimize the computation for small machines like mobiles and develop a mobile app so that it will be more user-friendly and can be used instantly [5].
S Jeyalaksh mi, R Radha	An effective approach to feature extraction for classification of plant diseases using machine learning [2020]	In this research work can be augmented by different classifiers like Decision Trees and Neural Networks can be modelled and the results obtained can be compared with the proposed method [6].

Gautam Trivedi , AnkurYaduvanshi , M.Hema	Identification of diseases in plants using deep learning [2019]	It focused how image from given dataset in field and past informational index utilized anticipate the example of plant diseases utilizing Convolutional Neural Network model [7].	Samer I. Mohamed	Potato Leaf Disease Diagnosis and Detection System Based on Convolution Neural Network [2020]	In this paper, The Convolutional Neural Network technology with a customized model architecture is used for diagnosis and detection of potato leaf disease. The main objective of the proposed system is to detect the plant diseases in early stage to decreases the plant's production losses [12].
R. Mounika, Dr. p. Shayamala Bharathi	Detection of plant leaf diseases using image processing [2020]	In this study, Technique for identification and order of leaf illness is executed. The division of the sick part is finished utilizing K-Means division. The deep learning algorithm may use in future for detection of different types of plant disease [8].	H.D.Gade , Dr. D.K.Kirange	Review of Plant Leaf Disease Detection Using Image Processing [2019]	In this paper, Image processing technique have been used in this paper for detection of potato leaf disease. Merits: Classifier are used for the accurate classification of the diseases which will help the farmers to reduce the pesticide usage and increase crop yields [16].
Dr. R. Dhaya	Flawless Identification of FusariumOxysporum in Tomato Plant Leaves by Machine Learning Algorithm [2020]	This research outlined our proposed methodologies, which include multiple steps for more precise findings. Because of the two-factor identification procedure, we were able to get more precise answers. Even when utilized with single-factor identification, whether image recognition methods or ML algorithms, a single factor identification method produced less accuracy. Our proposed classifier approach for identifying FO disease had a high prediction accuracy.[39]	Abulbasher	Survey on evolving deep learning neural network architectures [2019]	The review presents the deep learning neural network as an accurate way of categorizing and forecasting data that is unlabeled and unstructured using sorting and ordering in a feature hierarchy [40].
Taruna Sharma, Ruchi Mittal	Classification of Plant leaf diseases: A Deep Learning Method [2019]	This paper shows a study based on leaf disease detection and classification through deep learning techniques through Convolutional Neural Networks. Merits: In case of large number of data, this method gives accurate and fast results for leaf disease identification. It also has been found that the results obtained are better in case of deep convolutional neural networks [11].			

Table 1: Literature Survey

Comparison of model performance:

The below table 2 mentioned various algorithms that applied in detecting the potato disease and also noted the accuracy is each algorithm has provided.

S.No:	Algorithm	Ref No.	Accuracy
1	Ann	[17]	85-91%
2	NN	[38]	93%
3	BPNN	[10]	92%
4	Naive Bayes	[6]	88.67%
5	KNN	[6]	94.00%
6	SVM	[6]	96.83%
7	SSD &RCNN	[1]	94.60%
8	CNN	[3]	99.09%

Table 2: Comparison of model performance

The below figure fig 2. illustrating the Accuracy comparison between various algorithms. The below graph shows that CNN is having highest accuracy.

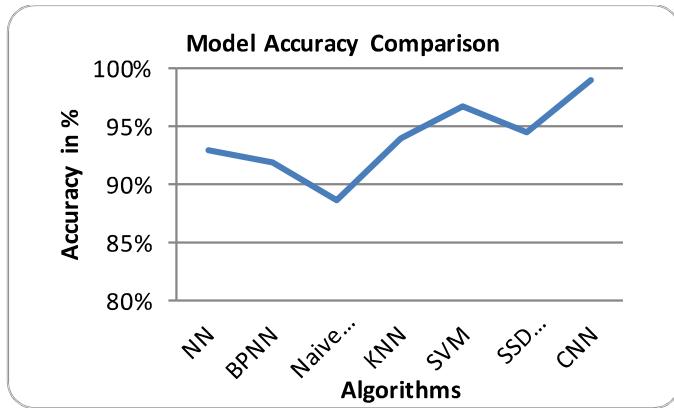


Fig 2. Model Comparison

III. PROPOSED METHODOLOGY

The convolutional neural network (CNN) is a deep learning neural network that belongs to the convolutional neural network family. CNNs are a significant advancement in image recognition technology. They are frequently employed in picture classification and are most commonly utilized to examine visual imagery.

Convolutional Neural Network: This is a particular kind of neural network that receives input in a two-dimensional shape. As image can be represented in the similar form, it becomes obvious to use such neural networks in the pre-processing of the image. Convolution is unique in that it generates certain features that can be detected in an image. It filters the input before generating a feature map that summarizes the presence of observed features. During training, these networks learn the filters in the context of a specific prediction issue. A single value is obtained by multiplying the filter with the input array once. When the filter is applied, the result is a two-dimensional vector known as the features. Once those are created then it is passed to the feature map through the non-linearity, such that the ReLU, for the outputs of the fully connected layer. [27]. The Fig. 3 shows the architecture of CNN

The architecture of a CNN is as follows

1. Convolution (conv) layer
2. ReLU (Rectified linear unit) layer
3. Pooling layer
4. Pair of fully-connected (FC) layers

Convolution(Conv) layer: The convolution layer is where the majority of calculation takes place. These layer performs convolution operations using a kernel based on image features, as well as attempting to extract picture features with ReLU and pooling layers.

ReLU layer: ReLU is an activation layer which based on given formula

$$\text{ReLU } f(x) = \max(0, x) \quad (1)$$

Following the completion of the convolution process, the ReLU operation will be computed, as it is responsible for the non-linearity

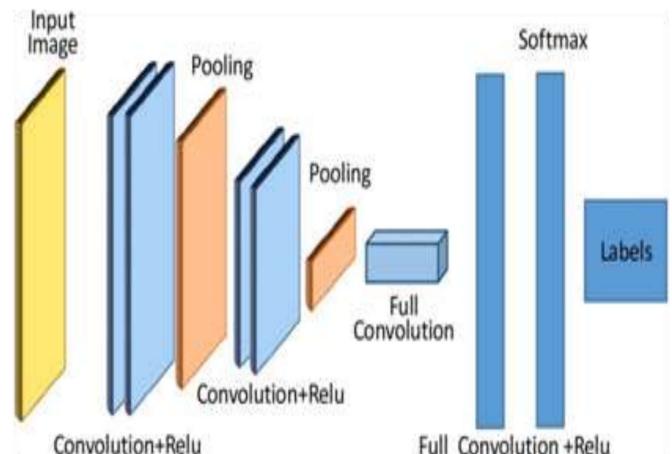


Fig. 3: CNN Architecture

The RELU layer converts all negative values to 0 and speeds up the training process. Pooling layer: It aids in lowering the spatial resolution of feature maps, as neurons in feature maps share their weight. Average pooling, maximum pooling, multiscale order less pooling, and stochastic pooling are the operations that the pooling layer computes. Flatten Layer: This layer reduces a two-dimensional dataset to a single feature vector.

Fully Connected Layer: This layer's neurons are entirely linked to those in prior layers. The fully connected layer accepts a feature vector as input and uses the softmax function to identify an input image. In this layer back propagation will be used to reduce the error value.

The below figure fig. 4 shows the CNN working mechanism in Plant leaf detection classification. It will take input image in the form 2D vector representation and apply the above discussed operation and finally classify the given image.

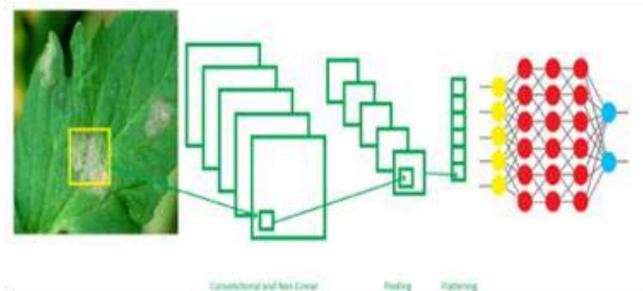


Fig: 4 Illustration of CNN in plant leaf detection (source adopted from [39])

The below figure demonstrate the various steps involved in image classification.

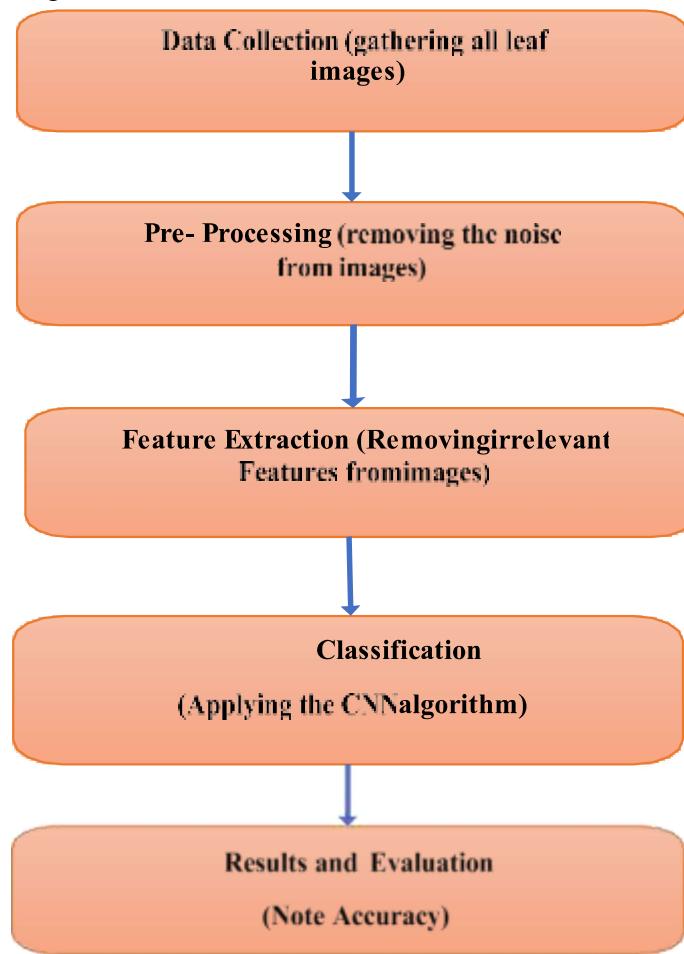


Fig. 5: Basic algorithm for Image Classification

Data Collection: This is the initial step for evaluation and implementation of any algorithm. For the high accuracy result, greater the number of data, higher the accuracy prediction. Initial step of proposed method is data collection. This dataset includes almost 2150 images including all the types of leaf pattern (Healthy leaf, early blight disease and late blight disease) [24] [31].

The Below Table 2. Describe the potato leaf disease detection dataset. It is having 3 class labels known as Early Blight, Late Blight and Healthy. Also this dataset categorizes disease based on its type and mention number of images the dataset holds.

Disease	Type of Disease	No. of Image
Early Blight	Fungal	1000
Late Blight	Fungal	1000
Healthy	No Disease	150

Table 3: Disease and its number of image

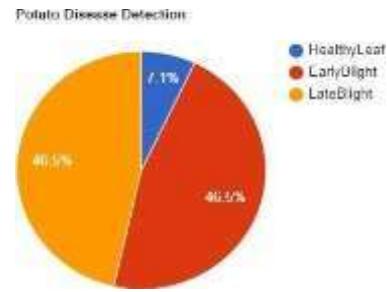


Fig. 6: - Number of images for each label

Pre-processing: - Preprocessing plays major role to get accurate results for any given dataset [33][34]. There can be various image with different pattern in it which can alter the result of classification so in this proposed method all the images are made to same size where only leaf of potato plant is focus apart from the leaf all other things are cropped just to focus the leaf.

Noise cancellation: - Before pushing the image to the further process, only the main features which is only needed for the classification process are kept and rest unnecessary features are removed from the image. Filtering of an image is done where image is made smoother and contrast is lowered in order to grab only important and relevant features.



Fig. 7: - Dataset (source adopted from [24])

In above figure fig 7. it can be clearly seen the exact image of the leaf, no other things are visible in the image otherthan leaf and all are of same size.

Feature Extraction: - After removing the noise from images, now feature extraction has to be done. Feature extraction used reduce the dimension without losing relevant information from a given image. It is also removes the redundant features.

Classification: - Here we can make use of any one deep neural network or classification algorithm such as ANN, CNN or SVM to classify an image to a certain target class label. CNN is one neural network used for image classification as it is giving highest accuracy results when compared to all the other algorithm.

IV. CONCLUSION

This paper reviewed several papers, which contributed their research to detect the disease in potato leaves using deep neural networks. The potato leaf disease categorized into two types one is Early blight and second is Late blight. This paper found that CNN to distinguish and classify diseases in the potato leaves like early blight, late blight and non-infected with a highest accuracy when compared with the other deep neural networks. This paper found that Artificial Neural Networks (ANN) [17] resulted with 85% accuracy, Support Vector Machines (SVM) [16] resulted with 88.89% and CNN [3] resulted with 99.07%. So, it is found that Convolution Neural Network gives the most possible accuracy and it is the recent technology in the field of Deep learning which came in practice to identify the image and differentiate the peculiar feature from the image.

REFERENCES

- [1] Sumit Kumar, Veerendra Chaudhary, Ms. Supriya Khatan Chandra "Plant Disease Detection Using CNN", Turkish Journal of Computer and Mathematics Education Vol.12 No.12 (2021), 2106-2112
- [2] Divyansh Tiwari, Mritunjay Ashish, Nitish Gangwar, Abhishek Sharma, Suhanshu Patel, Dr. Siyash Bhardwaj,"Potato Leaf Diseases Detection Using Deep Learning", [2020]
- [3] Sanjay K Hoysala, Santosh K S, Srihari D R, Suhith Shekar Chandra, Ajay Prakash B V," Recognition and Classification of Leaf Disease in Potato plants", [2019]
- [4] Pitchai R, Sharath Kumar G, Ashutosh Varma D, Madhu Babu CH," Potato Plant Disease Detection Using Convolution Neural Network ", [2020]
- [5] A T Madhavi, MM Yugesh, Srinidhi k, CS SVijayasundar, "Detection of leaf disease using convolutional neural network", [2020]
- [6] S Jeyalakshmi, R Radha, "An effective approach to feature extraction for classification of plant diseases using machine learning", [2020]
- [7] Gautam Trivedi , Ankur Yaduvanshi , M.Hema, " IDENTIFICATION OF DISEASES IN PLANTS USING DEEP LEARNING", [2019]
- [8] R. Mounika, Dr. p. Shayanala Bharathi, " DETECTION OF PLANT LEAF DISEASES USING IMAGE PROCESSING", [2020]
- [9] Soma Ghosh, Renu Rameshwar and Dileep A.D., " An Empirical Study on Machine Learning Models for Potato Leaf Disease Classification using RGB Images", [2021]
- [10] Mr. Girish Athanikar , Ms. Priti Badar, " Potato Leaf Diseases Detection and Classification System", [2016]
- [11] Taruna Sharma, Ruchi Mittal, " Classification of Plant leaf diseases: A Deep Learning Method", [2019]
- [12] Samer I. Mohamed, " Potato Leaf Disease Diagnosis and Detection System Based on Convolution Neural Network, [2020]
- [13] N.ananthi, K.kumaran, Madhushalini.v, Ganesh moorthi.s, Harish.p, " Detection and Identification of Potato Plant Leaf Diseases using Convolution Neural Networks", [2020]
- [14] Sk Mahmudul Hassan , Amab Kumar Maji , Michał Jasinski Zbigniew Leonowicz and Elżbieta Jasinski ; "Identification of Plant-Leaf Diseases Using CNN and Transfer-Learning Approach", [2021]
- [15] Mrs. Gaganpreet Kaur, Sarvejot Kaur, Amandeep Kaur, " Plant Disease Detection: a Review of Current Trends", [2018]
- [16] H D Gadade, Dr.D K Kirange, " Review of Plant Leaf Disease Detection Using Image Processing", [2019]
- [17] Mr. Viraj A. Gulhane, Dr. Ajay A. Gurjar, " Detection of Diseases on Cotton Leaves and Its Possible Diagnosis, [2011]
- [18] Ayushi Godiya, Dr Abhay kothari, " Study of Different Disease in Potato and their Detection Technique Using Leaf Image", [2020]
- [19] Hardikkumar S. Jayswal and Jitendra P. Chaudhari, "Plant Leaf Disease Detection and Classification using Conventional Machine Learning and Deep Learning", [2020]
- [20] Hardikkumar S. Jayswal and Jitendra P. Chaudhari, "Plant Leaf Disease Detection and Classification using Conventional Machine Learning and Deep Learning", [2020]
- [21] Krizhevsky, Alex, Ilya Sutskever, and Geoffrey E. Hinton. "Imagenet classification with deep convolutional neural networks." *Advances in neural information processing systems* 25 (2012): 1097-1105
- [22] Simonyan, Karen, and Andrew Zisserman. "Very deep convolutional networks for large-scale image recognition." *arXiv preprint arXiv:1409.1556* (2014).
- [23] He, Kaiming, et al. "Deep residual learning for image recognition." *Proceedings of the IEEE conference on computer vision and pattern recognition*. 2016
- [24] <http://kaggle.com/arjuntejaswi/plant-village>
- [25] Kang, X.; Song, B.; Sun, F. A Deep Similarity Metric Method Based on Incomplete Data for Traffic Anomaly Detection in IoT. *Appl. Sci.* 2019, 9, 135. <https://doi.org/10.3390/app9010135>
- [26] Manikanta Munnangi, Crop: Plant Disease Identification Using Mobile App
- [27] P. Patil, N. Yaligar and S. M. Meena, "Comparision of Performance of Classifiers - SVM, RF and ANN in Potato Blight Disease Detection Using Leaf Images," 2017 IEEE International Conference on Computational Intelligence and Computing Research (ICCC), 2017, pp. 1-5, doi: 10.1109/ICCC.2017.8524301.
- [28] Aditi Singh and Harjeet Kaur Potato Plant Leaves Disease Detection and Classification using Machine Learning Methodologies
- [29] Kang, Xu, Bin Song, and Fengyao Sun. "A deep similarity metric method based on incomplete data for traffic anomaly detection in IoT." *Applied Sciences* 9.1 (2019): 135
- [30] V. Veerasamy et al., "LSTM Recurrent Neural Network Classifier for High Impedance Fault Detection in Solar PV Integrated Power System," in *IEEE Access*, vol. 9, pp. 32672-32687, 2021, doi: 10.1109/ACCESS.2021.3060800.
- [31] N. Kumar, Y. S. Sneha, J. Mungara and S. G. Raghavendra Prasad, "A Survey on Data Mining Methods Available for Recommendation System," 2017 2nd International Conference on Computational Systems and Information Technology for Sustainable Solution (CSITSS), 2017, pp. 1-6, doi: 10.1109/CSITSS.2017.8447672.
- [32] ClaraKannani, A and P. V. Vinitha . "Ontologies in Semantic Web: A Comprehensive Analysis." (2019).
- [33] Kumar, Nirjanan & Sneha, Y & Mungara, Jitendranath & Prasad, S. (2017).
- [34] Convolution Neural Network for Image Processing— Using Keras Angel Das Aug 20 2020.
- [35] S. Biswas, B. Jagyasi, B.P. Singh and M. Lal, "Severity identification of Potato Late Blight disease from crop images captured under uncontrolled environment," 2014 IEEE Canada International Humanitarian Technology Conference - (IHTC), 2014, pp. 1-5, doi: 10.1109/IHTC.2014.7147519.
- [36] Neena Aloysius and M Geetha, "A Review on Deep Convolutional Neural Networks", International Conference on Communication and Signal Processing, April 6-8, 2017.
- [37] Dhaya, R. "Flawless Identification of Fusarium Oxysporum in Tomato Plant Leaves by Machine Learning Algorithm." *Journal of Innovative Image Processing (JIIP)* 2,no. 04 (2020): 194-201.
- [38] Bashar, Abul. "Survey on evolving deep learning neural network architectures." *Journal of Artificial Intelligence* 1, no. 02 (2019): 73-82.
- [39] <https://medium.com/bbm406f19/week-2-plant-disease-detection-9bdd819b870>