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An Effectual Plant Leaf Disease Detection using Deep Learning Network with IoT Strategies

G Ramkumar[1*], Amirthalakshmi T.M[2], R. Thandaiah Prabu[3], A. Sabarivani[4]

[1] Department of Electronics and Communication Engineering, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University, Chennai, Tamil Nadu, India. **Email:** pgrvlsi@gmail.com
[2] Department of Electronics and Communication Engineering, Rajalakshmi Institute of Technology, Chennai, Tamilnadu, India. **Email:** amirthatm@gmail.com
[3] Department of Electronics and Communication Engineering, Jeppiaar Institute of Technology, Chennai, Tamilnadu, India. **Email:** thandaiah@gmail.com
[4] Department of Electronics and Instrumentation engineering, Sathyabama Institute of science and technology, Chennai, Tamilnadu, India. **Email:** sabarivanibme@gmail.com

Abstract: Now-a-days the agriculture and the crops management is the crucial need to take care with, as well as the image processing industry provides lots of beneficiary terms against crops protection and support precaution needs. In this paper, a new Deep Learning methodology is introduced with respect to Internet of Things (IoT) strategy to attain best prediction results with proper accuracy, which it termed as Leaf Disease Estimation using Deep Learning Principle (LDEDLP). This proposed approach of LDEDLP adapts all latest technologies such as Internet of Things to identify the disease effectively from the plants and provides the sufficient alert to respective user. The proposed approach of LDEDLP identify the affected portion and segment that by using image segmentation strategy and apply the classification logic to estimate the category of disease. The proposed approach of LDEDLP provides high accuracy ratio with proper prediction results, in which all this proportions are explained clearly over the resulting section of this paper.

Keywords: Leaf Disease Estimation, Deep Learning Principle, LDEDLP, IoT, Classification.

1. Introduction

Agriculture is the basic need of every country and the economic growth development of country is majorly depending on this field. Numerous people getting occupation and the agriculture are considered to be the oldest and convention job of many countries. Due to the rapid growth of commercial needs and modern civilizations, this generation people are not having interest to enter into the agricultural field. This is because of the loss faced by the farmers and their sufferings, in which the affections are literally known to the common people to get shiver to enter into the field of agriculture as well as its associated businesses. In order to reconcile the problem and assisting the farmers, this paper introduces a new methodology to support farmers and provides the early stage identification of leaf diseases and provides the appropriate alert to the farmers to make a necessary step to do precautions. The proposed methodology is named as Leaf Disease Estimation using Deep Learning Principle (LDEDLP), in which it adapts lots of latest technologies to perform this task much

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easier compared to the classical leaf disease identification strategies. The adopted technologies are Deep Machine Learning, Internet of Things (IoT) and Responsive Alert Mechanism, in which all these technologies and its purpose to this application will be explained in detail over the following summary. Due to the drastic growth of Internet of Things and its application development principles, there is a desire for making a systematic framework for agri-business, which will help the farmers to tackle some undesired circumstances ahead of time. This will assist the farmers properly with improving the nature of harvests and furthermore it will be helpful for their life style development as well [1][5].

The ideology of disease identification over plants provides a huge support to farmers as well as agriculture field. A prior huge group of researchers are called by the farmers to classify the infections or any damage which happened to plants, even this training isn't known to each farmer, so that the researchers cost a lot and furthermore the time has come burning-through. While systematic identification of such diseases over plants is more advantageous than this long cycle of perceptions by the past researchers, as well as systematic procedure of the leaf disease recognition where the outcome comes out to simply checking the adjustment in plant leaves makes it less expensive and exact. Furthermore, consequently, Digital Image Processing innovation for early identification leaf infections which happened to plants and can mindful farmer at the beginning phase and save different plants from sicknesses. Plant leaf disease identification is a crucial task to image processing domain and that is a critical threat to the food related industry. Due to the hard nature of identifying several diseases over plants the growth of agriculture remains slow in development and the range of farming peoples are still low in level. To improve the life style and environments of farmers, a new methodology is designed on this paper with the integration multiple latest technologies. With the integration of Digital Image Processing with Internet of Things domain, the industry gets raised in next level [6][7]. The general leaf disease identification dataset is considered over this paper with 54 thousand and above plant leaf samples are presented into it, in which it can be classified into several classes for easy identification of diseases on testing phase. The training phase processing is designed innovatively to provide efficient classification principles to attain high accuracy. The training phase principles are Image Pre-Processing, Feature Extraction, Image Segmentation and Disease Classification. The same training phase concepts are applied as same as on the testing phase, but the only difference is that the training phase contains multi-image samples presented on the dataset but the testing phase considerations are only regarding the single presently captured leaf image, in which the testing image is processed accordingly with the training path considerations and provide the accurate predictions on result. The following summary illustrates more regarding the proposed approach dataset and the related descriptions in detail.

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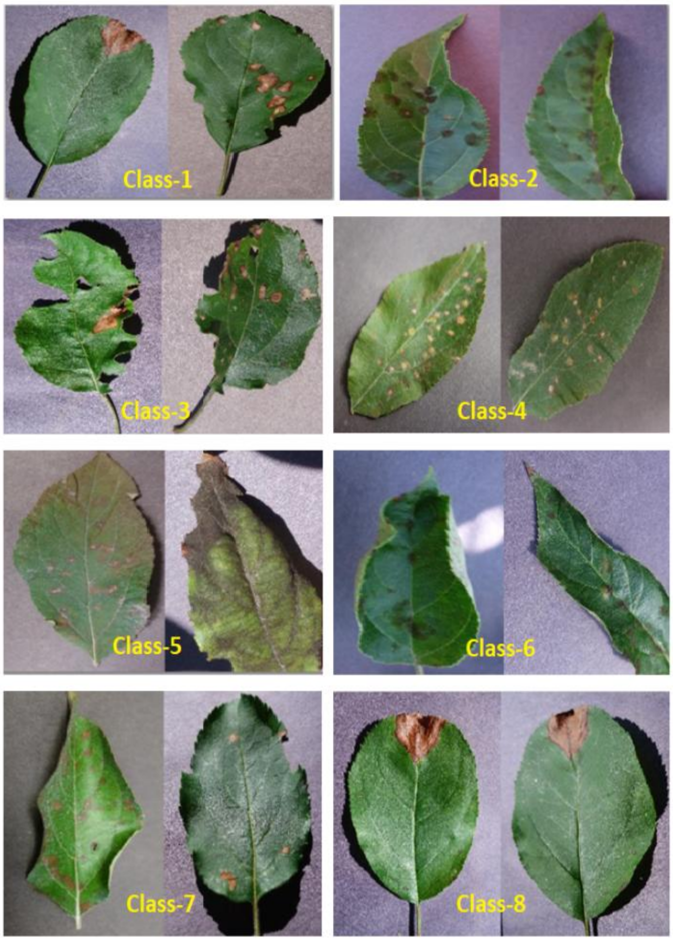

Figure 1. CNC turning centre

1.1. Dataset Summary

This proposed approach adopts general leaf disease dataset with the presence of more than 54,300 leaf images with the association of several classes and the respective labels binded to the classes [1]. Every class of label indicates the plant disease combination as well as that can easily be identifying the disease category with proper prediction principles. The following figure, Fig-1 illustrates the different views of affected leaf images with proper label indications accumulated from "Plant-Village" dataset. In this dataset, all the leaf images are properly segmented without any background surroundings as well as the clarity of leaf image is comparatively good with proper proportions of 256X256 pixel ranges. The leaf image disease segmentation process is systematic in terms of scripting and it provides good enough nature on associated dataset. The proposed approach associates a HSV operation during pre-processing for estimating the coloring range, brightness of the image and the saturation-key points of the leaf image. One of the means of that handling too permitted us to effortlessly fix color casting, which turned out to be very solid in a portion of the subsets of the dataset, accordingly eliminating another possible pre-disposition [8][9]. This arrangement of tests was intended to comprehend if the deep learning procedures really learn the idea of plant sicknesses or in the event that it is simply learning the intrinsic pre-dispositions in the dataset. The following figure, Fig-2 shows the various renditions of a similar leaf for an arbitrarily chosen set of leaves. The rest of this paper describe regarding Related Study over section 2, further section of Section 3 illustrates the proposed system methodologies in detail with

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proper algorithm flow and the Section 4 illustrates the Result and Discussion portion of the paper and the final section, Section 5 illustrates the concept of Conclusion and Future Scope of the proposed paper. These all will be explained in detail over the further section summaries.

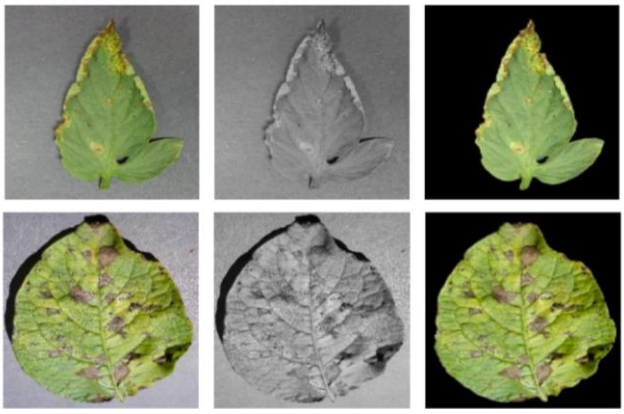

Figure.2 Two sets of affected leaf image samples from Plant-Village Dataset, which is used in several norms (i) Colored-Leaf, (ii) Grayscale Conversion and (iii) Segmented Leaf

2. Related Study

In the year of 2020, the authors PushkaraSharma'et al., proposed a paper related to plant leaf disease classification and processing using machine learning approaches [2]. In this paper [2], the authors described such as agriculture and its related activities are the major fund sources and it raise the Indian economy in a better way. The authors presented like in India on or average 65% people belonging to agricultural field. This paper [2] considers the growth and disease prevention activities of a crop, in winter season many crops are getting affected due to mist as well as the climate conditions damage the crops severely. This kind of diseases is identified by using machine learning strategies. The machine learning strategies are usually practionary approach and the performance of such approach is really good compare to the traditional classification approaches. This kind of Artificial Intelligence based approaches allows the user to monitor the crop and its related details closely without any flaws as well as the proposed approach of machine learning strategy identifies the infection of leaf before its getting spread to all over the plant or nearby plants. The proposed approach of this paper [2] assures the time efficiency with proper accuracy standards as well as the authors guaranteed that this kind of machine learning approaches improves the productivity and saves agriculture. The authors follow several stages of image processing over the paper from first to last such as: pre-processing, segmenting the leaf and affected portion of the leaf and classifying the category of affection. The major advantage found on this paper [3] is its time complexity management as well as the prediction accuracy range, in which it crosses 98%. As well as the disease detection and category identifications are the major highlights need to concentrate on and the proposed approach accuracy level is achieved by means of KNN algorithm. The further scope of this paper can be improvised by means of adding the deep learning techniques to the proposed approach accuracy. The major advantage identified from this paper [4] is the adaptation of Deep Learning strategies over the proposed approach in order to identify the crop disease via leaves of the plant. However, the limitation is like the approach is suitable for tomato based disease predictions, in order to enhance the work

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further, the same strategy is applied over the proposed work and make it suitable for all crops with proper accuracy levels.

3. Proposed system methodologies

The proposed methodology of this paper is designed based on the integration logic of several latest technologies along with Deep Learning principles as well as the Internet of Things (IoT) principles are added and these all will be described in detail one by one further. This paper introduced a new algorithm called Leaf Disease Estimation using Deep Learning Principle (LDEDLP), in which it integrates all the innovative technologies together to provide an efficient agricultural improvement system as well as improve the farmers' life in good manner. The proposed logic is useful to identify the leaf diseases on earlier stages and inform regarding that accordingly to the respective users without any delay. The concept of IoT enables the bridge between IoT smart agricultural device unit and the remote server end, so that the user can monitor the data accumulated from the agricultural land easily and report to the farmers immediately. The proposed approach of LDEDLP operates based on the following strategies to identify the disease presented over the plant leaf such as: Image Pre-Processing, Feature Description Extractor, Leaf Image Segmentation and Classification. All these details are illustrated in detail as below

3.1. Image Preprocessing

The image pre-processing stage is important to accumulate the image from the agriculture field and start processing according to the color conversion from RGB to BGR format. The converted image is further processed based on Hue Saturation Value (HSV Format), in which it provides the numerical data of the input image. These processing are made with the help of image pre-processing technique of the proposed approach Leaf Disease Estimation using Deep Learning Principle. The following algorithm, Algorithm-1 illustrates the overall logic of Digital Image Pre-Processing methodology in detail with proper Pseudocode and returns the final processed image for feature extraction process [10].

Algorithm-1: Image Pre-Processing

Input: Leaf Image for Processing.
Output: Return the processed image.

Step-1: Accumulate the input image from the system.
Step-2: Importing the required libraries to process the image further.
Step-3: Importing the required libraries to perform MinMax scalar logic to maximize the profit ratio of accuracy.
Step-3: Importing the required library to perform leaf image data generation.
Pseudocode:

```
from sklearn_preprocessing import Label_Encoder
from sklearn_preprocessing import Min_Max_Scaler
from preprocessing_image import Image_Data_Generator;
```

Step-4: Provide the proper testing and training paths for processing the images accordingly.
Pseudocode:

```
train_path= "/content/drive/.../dataset/train"
h5_train_data= '/content/drive/.../train_data.h5'
h5_train_labels       = '/content/drive/.../train_labels.h5'
```

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Step-5: Create a definition for the function called "rgb_bgr" with proper input parameter image.

Pseudocode:

```
        def_rgbbgr(imge):
    rgbimg= cv2.cvtColor(image, cv2.COLOR_BGR2RGB);
    return rgbimg;
```

Step-6: Create a definition for the function called "bgr_hsv" with proper input parameter image.

Pseudocode:

```
    def_bgrhsv(rgbimg):
    hsvimg= cv2.cvtColor(rgbimg, cv2.COLOR_RGB2HSV)
    return bgrhsv;
```

Step-7: Return the processed image.

Pseudocode:

```
  return hsv_img;
```

3.2. Feature Description Extractor

The feature extraction scheme provides details of the processed image features such as the lower green level ratio of the pre-processed image and the upper green level ratio presented into the leaf image. As well as the lower and upper brown color range specification ratio of the pre-processed leaf image. These ranges are properly estimated by means of the proposed approach Feature Descriptor model as well as the accumulated results is stored into the proper masking variables. The resultant masking variable contains the concatenation of the green mask and the brown mask objects. The bit wise conversion procedure is applied to obtain the final result of extracting leaf image features. The result of the feature descriptor portion will be useful for the further image segmentation process. The following algorithm, Algorithm-2 illustrates the process of Feature Extraction Scheme with proper Pseudocode samples.

Algorithm-2: Feature Extraction Scheme

Input: Pre-Processed Leaf Image from Algorithm-1.
Output: Return the processed image features.

Step-1: Creating the function named "img_segmentation" with proper input parameters.
Step-2: The two required input parameter definitions need to be mentioned properly.

Pseudocode:

```
  define img_segmentation(rgbimg, hsvimg):
```

Step-3: Creating an array structure for lower and upper green boundary ratio estimation.
Step-3: Create a variable for accumulating healthy values of green masking with respect to HSV values.

Pseudocode:

```
    lowergreen = img.array([25,0,20]);
    uppergreen = img.array([100,255,255]);
    healthymask = cv_in_Range(hsvimg, lowergreen, uppergreen);
```

Step-4: Creating an array structure for lower and upper brown boundary ratio estimation.

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Step-3: Create a variable for accumulating healthy values of brown masking with respect to HSV values.

Pseudocode:

```
lowerbrown = img.array([25,0,20]);
upperbrown = img.array([100,255,255]);
healthymask = cv_in_Range(hsvimg, lowerbrown, upperbrown);
```

Step-5: Creating a variable to store the diseased masking value ratio based on brown value occurrence on green masking portions.

Pseudocode:

```
diseaseMask=cv_in_Range(hsvimg, lowerbrown, upperbrown);
```

Step-6: Create a variable to store the diseased result with respect to green and brown masking ratios and send the final result to further classification procedure.

Pseudocode:

```
finalMask = healthyMask + diseaseMask;
finalResult=cv_bitwise(rgbimg+bgrimg, mask→finalMask);
```

Step-7: Return the final resultant features.

Pseudocode:

```
return final_result;
```

3.3. Classification and IOT Assistance

The proposed approach of LDEDLP classification principles are quite different from the traditional approaches, in which the training phase disease estimations are clearly maintained into the server end for processing further testing scenarios. In which, the testing results of feature extraction phase are gathered and cross-check the resulting scenario with already trained dataset samples. Once the testing result accuracy matches with the proposed classification accuracy, the resultant approach of LDEDLP produces the final classification accuracy with proper outcome proof. The resultant data will be pushed into the remote server by means of IoT assistance, in which it creates a bridge between processing machine and the server as well as accumulates the resultant data from local machine and push it to the remote server for further verification. The following algorithm, Algorithm-3 illustrates the classification scenario of the proposed approach.

Algorithm-3: Classification

Input: Extracted Features from Algorithm-2.
Output: Return the classified disease name with proper accuracy level.

Step-1: Create a classification principle object by analyzing the features of the input leaf image.
Step-2: Assume the validation procedure taken as 10X10 fold cross validation.
Step-3: Generating for loop to process all the images until the model images getting completed.
Step-4: Creating an object called kfold to read all the input values based on random seed procedure.
Step-5: Results of the cross validation folds are stored into the resultant variable called ‘cv_results’ with respect to training and testing image features.
Step-6: Append all the processed cv_results into the resultant variable called ‘results’.

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Pseudocode:

```
 for name, model in models {
kfold = KFold(n_splits=10, random_state=seed);
cv_results = cross_val_score(model, trainDataGlobal, trainLabelsGlobal, cv=kfold, scoring=scoring);
results.append(cv_results);
}
```

Step-7: Append the resulting label names into the proper name variable and print the resulting values and disease name to the user end.

Pseudocode:

```
 names.append(name);
          apply_LDEDLP(results);
msg→name, cv_results.mean(), cv_results.std();
print(msg);
return msg;
```

---

4. Results and Discussion

In this summary, the experimental outcome of the proposed approach Leaf Disease Estimation using Deep Learning Principle (LDEDLP) is to be discussed in clear manner with practical proofs. The entire process estimation clearly proves the performance ratio of the proposed system with clear leaf disease identification and prediction strategies with correct time estimations. The proposed system performance and accuracy measures are estimated in terms of overa;ll efficiency of disease identification and time required to process the entire process on real-time agricultural environment. The entire programming and analysis are composed by using python open-source supported tool platform and the resulting units are properly accumulated in fine manner. And the following graphical estimations prove the resulting summary of the proposed approach as well as the performance levels in detail. Additionally in the outcome, the proposed approach of LDEDLP proves the resulting accuracy level around 99%. The following figure, Fig.3 illustrates the leaf image pre-processing stages of the proposed approach.

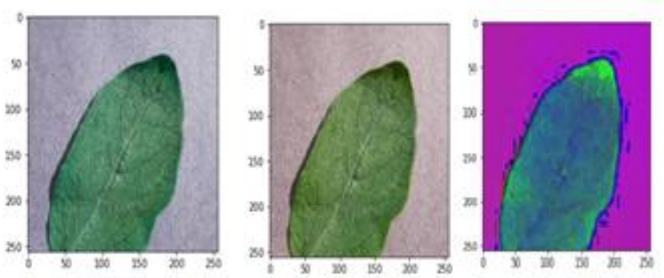

Figure.3 Pre-Processing Outcome

The following figure, Fig.4 illustrates the leaf image feature extraction resulting scenario of the proposed approach, in which it illustrates the green masking segmentation and brown masking sementation image natures and the outcome proof is displayed further. The general segmentation process splits the affected portion alone from the leaf image, but in this proposed LDEDLP based image segmentation scheme splitout the green masking area and

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the brown masking areas separately and concatenate the final resulting maksed images for classifcation procedures, in which it also leads a way to attain high accuracy results.

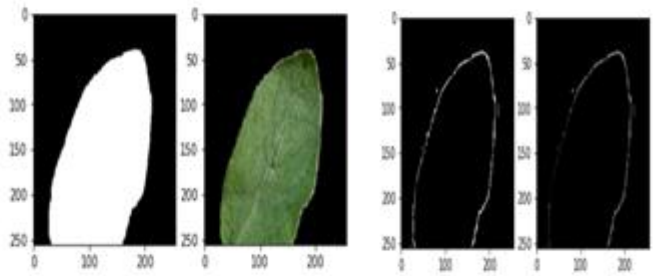
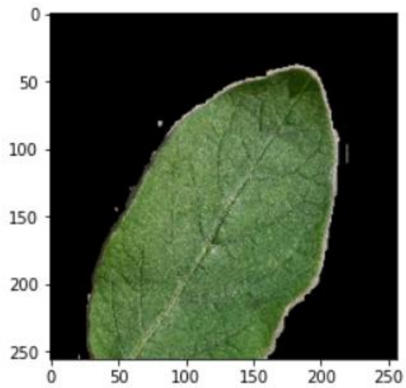


Figure.4 Feature Extraction and Segmentation Scenario (a) Green Masking Segmentation and (b) Brown Masking Segmentation

The following figure, Fig.5 illustrates the final leaf image classification strategic resulting scenario of the proposed approach, in which it illustrates the outcome accuracy as well as the resultant image view of the proposed approach




```
prediction_name = reverse_mapping[prediction]
prediction_name
```

```
'Potato-Late blight'
```

Figure.5 Classification Result View of LDEDLP

4. Conclusion and Future Scope

In this paper, an advanced deep learning algorithm called Leaf Disease Estimation using Deep Learning Principle (LDEDLP) based plant leaf disease detection strategy is implemented and attain the result successfully as well as analyzed all resulting scenarios properly with experimental proofs. This paper utilizes the advantages of two different concepts such as Internet of Things (IoT) and the Deep Learning Procedure, in which it combines those features in a unique manner to propose an integrated approach for feature extraction and classification process over the proposed approach. The proposed approach of LDEDLP and the Iot principles are used to propose a new classification logic and prove the efficiency of the leaf disease detection problem in clear manner as well as the resulting section clearly illustrates the process of feature extraction and classification process in figure 4 and figure 5. A deep learning approach is utilized on the proposed approach to

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train the machine in an efficient manner with multiples of leaf disease samples and the classification approach is applied in this paper for attaining better accuracy on disease prediction. For all the proposed results clearly demonstrate the efficiency of the proposed algorithm and in which it is more efficient and fine in working with around 99% accuracy levels. In further the work can be extended or revised by means of improving the timing efficiency over training process, in terms of using other two new algorithms such as Fuzzy based Deep Optimization Norms and the Logistic Image Classification Strategy to attain good accuracy levels.

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