Significance and Classification of Miscellaneous Plants and Piper

Plants: A Survey

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Abstract

Plants are considered as an essential resource in ecosystem, as plants provides innumerable cherished resources like oxygen, they play an inimitable role in ecological balance. Since there are enormous variety of plant species across the world, it is imperative to classify these plants accordingly for attaining right benefits from the plants. Moreover, due to tremendous diversity of plants like piper plants, it is complicated to classify the plants according to the classes easily. Hence, different techniques are used for plant classification. However, plant classification using manual techniques are considered to be time consuming, prone to error and can be tedious process. Therefore, different AI approaches have been considered for plant classification as AI methods are faster, efficient, provides high level accuracy by effectively classifying the plants. Owing to these aspects, this paper focuses on compiling different AI techniques and emphasizes on reviewing all plant classification and piper plant classification using different AI techniques like ML and DL classifiers as piper plant classification helps with identifying and comprehending the diversity of piper plants as it provides innumerable benefits like medical, economical, culinary and other aspects the humans and environment. Various piper plants such as Piper Nigrum, Piper Betle and other such piper classes are reviewed in the study. In addition to classification, certain studies also deals with disease detection and assessing the quality of the piper plants. Moreover, applications of piper plants is reviewed in the present study for analyzing the utilization of piper plants across fields. Finally, the challenges are identified through the analysis of existing researchers and future recommendations are provided for overcoming the gaps that are intended to create promising work in this area.

Keywords- *Plant Classification, Piper Plants, Artificial Intelligence, Deep Learning, Applications*

1. Introduction

Plants play a huge role in the ecosystem providing countless valuable resources like oxygen and they play an irreplaceable role in ecological balance [1]. Different kind of plants are used for different purposes. Certain plants are utilized for food, certain types of plants are used for paper, shelter, fuel and so on. Usually, the parts of plants consist of six basic parts which includes roots, stems, fruits, seeds, leaves and flowers [2]. In which, Root, leaves and stem are considered as the three main parts of the plants. As there are huge variety of plant species across the world, it is important to classify these plants accordingly for obtaining the appropriate benefits from the plants. These identification and classification of plants helps the framers and plant experts [3] in so many different ways, further plant classification helps farmer informed about disease management, crop rotation which plays crucial role in proper cultivation and management. Hence, identifying the plants with similar characteristics helps farmers to expand the crops and discover different opportunities.

However, using plant classification using traditional techniques [3] are considered to be slow, time-taking process, tedious, daunting, difficulty in identifying the correct species due to the human intervention as humans are prone to error. Subjectivity also plays huge role in classification of plants as traditional approaches often depend on observations that are subjective by taxonomist [4]. This could lead to different difference in views and analyses of characteristics of plants. Further, conventional approaches of plant classification is considered to be time consuming as it require immense collection of data, preservation of plants [5] and studying the physical samples which are considered to be labor intensive. Moreover, due to the minimal morphological differences [6] exhibited by specific plants, classification of plants using traditional approaches are difficult. Therefore, it is revealed that, identification and classification of plants using traditional techniques are considered to be hard and challenging. However, in order to overcome these difficulties, AI techniques are used by the plant expert's, as AI methods are faster, efficient, provides high level accuracy by effectively classifying the plants [7]. AI algorithms possess the potential to process huge amount of plant related data like images, ecological and genetic data of plants [8]. This results in more quicker and more efficient classification of plants by saving more resources and time needed for classification of plants. As AI techniques are followed by pre-defined patterns and rules, it minimizes the potential

for human bias or error. Moreover, AI approaches aids in identifying rare or even endangered plant species and helps in monitoring the population of plants, thereby contributing to the plant ecosystem. Due to these factors, AI based approaches are used for effective plant classification.

ML (Machine Learning) based classifiers are used in the suggested study for classifying the leaf images to different plant species. Different process like dimensionality reduction, feature extraction and classification has been performed by the recommended study. ML technique like KNN (K Nearest Neighbor), NB (Naïve Bayes), DT (Decision Tree), Multi-SVM has been utilized for identification of type of plant using leaf images. The algorithm are evaluated by using Flavia dataset which consisted of 1600 leaf images and additional 625 self-collected images are used for evaluating the model [9]. Similarly, suggested study has utilized ML and DL based approaches for automatic detection of plants. Though there are lot of aspects like seeds, leaves flowers, berries which would contribute to the automatic detection of plant, leaf are considered to be the most significant and easily accessible part of the plants. Hence, leaf of the plants are used for plant classification. Classification has been utilized by Ada boosting and MLP (Multi-Layer Perceptron), KNN and DT. In which, Adaboost model has been considered for enhancing the precision rate of the system [10].

Plants are widely classified into various types and classes. Therefore, it is important to classify these plants accordingly. One such plant classes that needs to be classified appropriately is piper plants, as piper plants possess various advantages that would assist farmers for providing immeasurable benefits to the humans. Hence suggested study has focused on assessing the maturity level of piper classification. This study focused in determining the significant differences between the viewpoints of piper in providing the maturity level classification and maturity associated information. The model was employed using RF (Random Forest) algorithm.

The results of the model yielded in reasonable classification accuracy [11]. Apart from classification, certain studies focused on disease classification of Piper Betle leaves using Mask-RCNN model for identifying betle leaves attacked with disease [12]. Result of the model delivered in obtaining the disease accurately that affects the betel leaves. Owing to the aspects of different studies, present review paper focuses on compiling different AI techniques and emphasizes on reviewing all plant classification and piper plant classification which uses different AI techniques like ML and DL classifiers as piper plant classification helps with identifying and comprehending the diversity of piper plants as it provides innumerable benefits like medical, economical, culinary and other aspects the humans and environment. However, only few studies have worked upon piper plant classification which includes implementation of Deep CNN model for feature extraction and RF model for classification [13], Deep CNN and VGG-16 models were used for feature extraction and WUT-RF (Weight Updated Tuned- Random Forest) for classification by the recommended work [14], eventually, DBN (Deep Belief Network) was used in the model [15] for piper plant classification. Despite providing satisfactory outcome by the prevailing studies for piper plant classification, only limited works have been emphasized on piper plant classification. Thus, present paper focuses on highlighting AI models used for all plant classification and piper plant classification, as employment of AI techniques helps in increasing the accuracy of the model thereby making the model efficient for miscellaneous and piper plant classification. Hence, the objectives of the study focuses on,

- To review all plants and piper plant classification undertaken by the usage of ML and DL techniques for identifying and comprehending the diversity of plants.
- To discuss different applications of piper plants which includes medical applications of the plants.
- To tabulate and summarize different classification techniques employed for all plants (coriander, parsley, apple, grapes) and piper plant classification
- To encounter challenges faced by the existing works and deliberate on future recommendation of the model.

1.1 Paper organization

The paper is systematized in the subsequent way. Section 2. describes the survey methodology of the paper, overall progression of DL is fixated on section 3, Classification of different plants using DL classifiers is explicated in section 4, Implications of Piper plants is explained in section 5, Different AI based techniques for plant classification is dedicated on section 7, Applications is illustrated in section 7, comparative analysis is tabulated in section 8, critical analysis is depicted in section 9, challenges and future recommendation is focused on section 10 and conclusion is depicted in section 11.

2. Survey Methodology

Different techniques are used for fetching the appropriate content. Some of the method includes fetching of content, probing different DB (Databases) and scrutinizing the references with specific criteria. Therefore, survey

methodology is used for gathering the information appropriately the paper Figure.1. depicts the survey methodology of employed for the present paper.

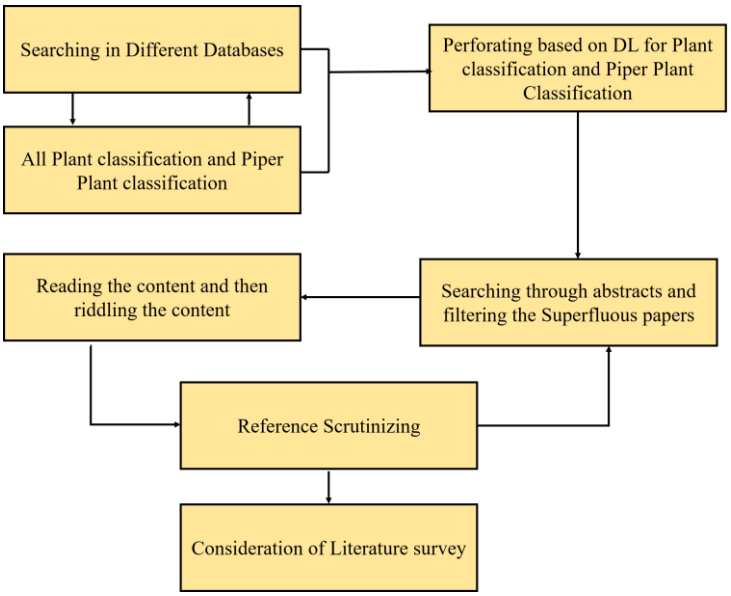

Figure.1. Survey Methodology

Probing Database

Searching content related to plant identification and classification using AI techniques in different DB. Along with miscellaneous plant classification, piper plant classification is also surfed. Key Terms used for searching the content includes "Deep learning for Plant classification", "AI approaches for classification of plants "Implications of piper plants", "DL for piper plant classification" and "Applications of piper plants".

Content Fetching

In the preliminary stage, studies were chosen based on the significance of label. Consequently, screening of abstract was done and while supposed to be appropriate, the general script is also pondered. Papers from IEEE, Springer, Wiley, Scopus, ProQuest, Web of Science, Science Direct, PubMed, Hindawi, MDPI, ACM, Taylor and Francis, are considered for fetching the content.

Reference Scrutinizing

The papers fetched for reviewing the studies are from 2016-2023. 46 papers are considered for reviewing the works of all plants and piper plant classification.

Inclusion criteria

- Articles associated to Plant classification and Piper Plant classification has been selected and reviewed.
- Papers from the year 2016- 2023 have been considered.

Exclusion criteria

The papers can be excluded if the articles, papers, or reviews if the records follow the below condition,

- Papers with irrelevant title, abstract are eliminated.
- Non-English papers are not considered.
- Papers with no distinct aim and methodology is omitted.
- Paper encompasses of the replica reports of the similar research study are not considered.

Though, the paper focuses on reviewing classification of all plants and piper plants, recent research papers have focused on other dimensions like maturity level classification, disease identification and seed quality of piper plants as well. Hence, these dimensions are also included in this paper.

3. Progression of Deep Learning

Different manual approaches are utilized for identification and classification of plants. This paper [16] presents an approach to classify the leaf shape and to identify plant species using venation detection. The suggested approach consists of five main steps to extract the leaf venation including canny edge detection, remove leaf boundary, extract curve, and produce hue normalization image and image fusion. Moreover, to localize the edge direction efficiently, the lines that extracted from pre-processing, are further divided into smaller segments. Thirty-two leaf images of Malaysian plants are analysed and evaluated with two different datasets, Flavia and Acer. The best accuracy is obtained by 99.3% and 91.06% for Flavia and Acer datasets respectively. Experimental results illustrated the effectiveness of the proposed approach for shape recognition with reasonable accuracy

Despite providing considerable accuracy, manual techniques are considered to be time consuming, prone to errors due to human intervention, tedious, challenging. Though there are various similarities between individuals of the similar species, the exact identification of plants is certainly not trivial and need more refined knowledge. Hence, experts who are associated to identification of plant species are need to be consulted, nevertheless they are considered to be expensive and inaccessible at times. Therefore, Different AI techniques should be used for classification of plants for classifying the plants effectively and precisely. Figure.2. depicts traditional methods and DL methods for plant identification.

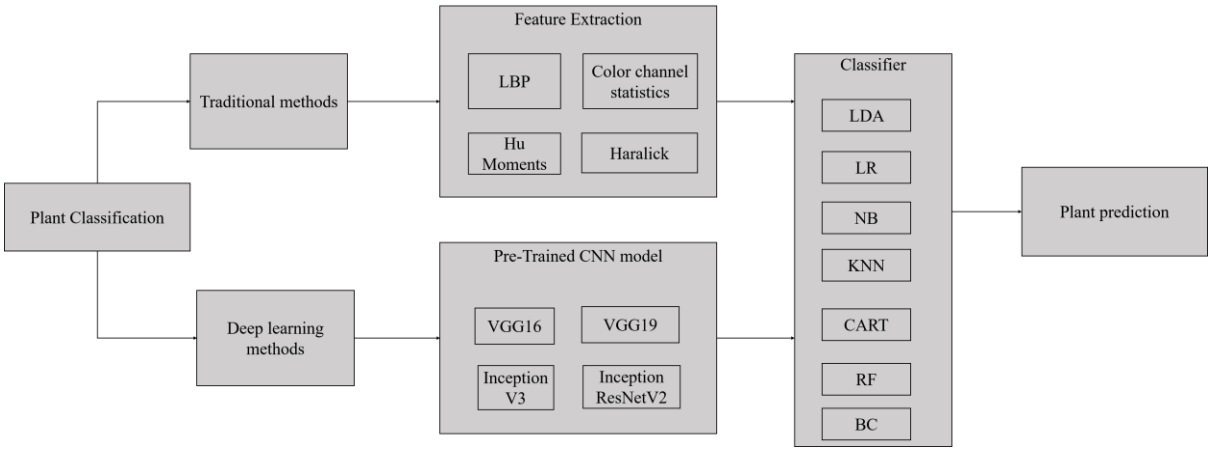

Figure.2. Traditional Methods and DL methods [17]

Figure.2 shows the traditional methods and DL methods used for feature extraction. Conventional model utilizes LBP, Hu Moments, Color Channel statistics and haralick, however, the pre-trained CNN model utilizes VGG16, VGG19, Inception ResNetV2 and InceptionV3 models. These DL based models deliver better accuracy and desired outcome than most existing techniques. Plant image classification was performed by implementing PI-CNN (Plant Image-CNN) model as it aided in reducing the number of training parameters and demonstrated in high accuracy on datasets with difference sizes in the suggested study [18]. Further, plant image augmentation has been carried out by utilizing PI-GAN model. 4 different types of datasets have been used in the paper namely PlantVillage, Fruits-360, PlantDoc and Plants for image classification. PI-GAN model extracted the features from two different plant images and combined together for generating a new plant image. This amalgamation of PI-CNN and PI-GAN helped in better classification of plant images like apple, banana, grape and peach. Though, the model delivered satisfactory accuracy, XAI (Explainable -AI) methods will be considered for increasing the accuracy of the model for image classification. Furthermore, classification errors could be minimized for sustaining the class information in the images which were augmented. Likewise, different DL based models deliver better accuracy and precise classification than employing conventional approaches.

4. Classification of Different Plants using DL

Plant species classification is considered to be critical for bio-diversity protection and for conservation. However, in most cases, classification using manual techniques are considered to be extremely hard and time consuming and even require experienced experts for precise classification of plants. The study has emphasized on assisting the non-expert and non-botanist for identifying the plants automatically without being prone to errors. Therefore, suggested study focused on employing DL techniques like DNN for effective classification of plants. Four different datasets have been used in the study such as Flavia, UCI leaf, Swedish leaf and PlantVillage. The experimental outcome of the study depicted that better classification accuracy was obtained for PlantVillage dataset and less accuracy was obtained for using UCI Leaf Dataset. As the existing study was dealing only dealing with plant classification, future work of the study focuses on disease detection and weed detection. Further, more public datasets could be used for the suggested model for performing precise classification of plants [19]. Similarly, the recommended study has focused on classification of plants which includes classifying the plants on

the basis of whether it is a poisonous leaf, herbal leaves or agricultural leaves from the given input image. In order to perform classification, recommended study has utilized KNN classifier by performing steps like acquisition of images, pre-processing, image segmentation, feature extraction and classification [20].

ANN technique has been used by the suggested study for automatic classification of plants based on the leaf features. It is due to that, CNN were found to be expensive and need an extensive dataset for training. Therefore, recommended study has focused on employing ANN model for proficient classification. The process involved in the study has been acquisition of sample images, then images are pre-processed for removing the noisy and unwanted data, then features were extracted, in the next step dimensionality has been reduced using PCA and finally classification was performed using ANN model. The dataset used in the existing study has been Flavia dataset, as the dataset has around 32 species with 1907 samples. Experimental outcome demonstrated that Accuracy of the model can be increased if fourier based features were incorporated as a part of future work [21]. Study utilized Beta Vulgaris and Daucus Carota image dataset for evaluating the different shape of the leaves and architecture complexity of the leaves. In order to proceed the process, recommended paper has utilized Deep convolutional auto encoders and Bayesian Gaussian process latent variable for obtaining better outcome [22]. CNN based classification technique has been used for identifying the leaves. In which, the approach encompasses shape and colour of the leaves of different plants. Around 375 images from 5 different classes were used for classification. Different leaves were classified successfully using CNN model which includes Rambutan, Mango, Cherry, papaya and Acaica. However, when the model was tested with a random environment, correct leaves were not identified properly due to the same color of environment which may interrupt the identification system. In addition, classification can be performed without high loss, which could be achieved other NN as a part of future work [23].

Automatic plant classification has been considered as one of the common issues in computer vision [24]. Plant classification has become one of the challenging aspects due to the introduction of new species with a very similar pattern. Therefore, various efforts have been taken under consideration for automatic plant classification, in which leaf is considered to be more reliable source for plant classification as it displays similarity in morphological disparities like shapes, venation, textures and size. Hence recommended study has utilized CNN model as it provides better accuracy than the conventional techniques. However, the performance of the model could be further enhanced by employing CNN with SVM and KNN on 3 different datasets such as MalayaKew Dataset, Flavia and LeafSnap dataset. Study showcased that CNN+KNN model resulted in better classification than CNN+SVM model. Even Better outcome could be identified by using different algorithms for plant classification [25]. Correspondingly, the existing study has also utilized MK-D1, MK-D2, Flavia and LeafSnap Dataset for identification of plant species using plant leaf images. The performance of the study was carried out by using CNN model for better classification of images. As the recommended study focuses on employing the process on particular dataset, the future work of the research emphasizes on implementing the model in real time and drone captured images. Moreover, plant species can be identified by developing cloud based architecture, which can be implemented in future work [26].

Classification of leaves of different plants namely grape and apple has been carried out in the suggested study by implementing CNN model. The training set was comprised of 4000 images, in which, half of the images were trained as apple and other half of the images were trained as grapes. In next step, 1000 images were utilized for testing, in which 500 were tested for apple and 500 were tested for grape. The outcome of the model depicted that, utilization of CNN helped in classification and prediction of plant which delivered sustainable computing. However, the limitation of the study includes coverage of only 2 classes of plant species as this issue could be improved by covering wide-range of other plant species. Further, hybrid model like combination of CNN with other approaches can be implemented in the future for overcoming the issues associated to classification [27]. Mendeley, LeafSnap and images fetched from Google are used in the recommended study for plant classification. The process of the model functioned by employing CNN model which utilized Adam optimizer along with it. Experimental result predicted that, recommended CNN model provided better result than traditional CNN, ANN, and ANN [28]. Plant species identification from different images and videos can be daunting due to the huge diversity of plants in general. Therefore suggested paper has utilized both conventional and DL approaches for plant identification. Feature extraction has been carried out by using conventional approach and the features, which were extracted are classified by using other classifiers like KNN, RF, NB, LR, LDA. The model implemented Folio, Flavia and SwedishLeaf and Leaf12 dataset was used for plant classification [17]. Classification of disease, healthy and leaf burn of ladies finger plant leaf images is demonstrated in the suggested study. The model implemented for carrying out classification has been CNN model. The images for ladies finger plant leaf classification was collected from thandarai, velananthal. The dataset comprised of ladies fingers images, in which around 457 were images of healthy leaves, 509 were images of leaves with disease and 122 leaf images were images which are burnt. Though, the model helped with identifying the healthy, leaf burn and disease, multi classification model will be implemented for identifying different diseases in ladies finger plants [29]. Coriander

and Parsley were selected as the test subjects for the existing study as these leaves have analogous structures. A Total of 100 parsley and coriander leaf photos are collected for the research and the images were filtered by using kernels as the kernels possess a set size and aids in extracting the features from input photos for creating a feature map. The features which have been extracted were used for classifying plant leaves on the basis of its class types. The results obtained by the model aided in pushing to recognize plant diseases in future [30].

Apart from classification, disease detection also plays a huge role via optical observation of infected plant leaves for detecting different disease suffered by plants. Hence, the recommended paper has utilized EfficientNet DL method for plant leaf disease classification using PlantVillage dataset. PlantVillage dataset comprises of 38 classes and 54,305 images of total 14 different species in total, in which 12 are considered to be healthy and 26 were considered to be diseased. The experimental outcome detected that, apple was infected with apple rust, tomato and potato was infected with late blight, peach was infected with bacterial spot, grape was infected with black measles, cherry was infected with powdery mildew. Moreover, the model also detected healthy tomato and strawberry images. The future work of the suggested study emphasized on expanding the plant leaf disease dataset by maximizing plant diversity and the number of classes. This aids in increasing the precise prediction of the model in challenging environment [31]. Precise Detection of leaves disease in maize plants have been discussed in the suggested study, in which PlantVillage dataset has been used for validating the result. In order to perform detection of disease, AlexNet Model is used for rapid and precise detection of disease. The dataset encompassed of maize diseases such as rust based and leaf-spot diseases. Classification was performed by using CNN model. the future motive of the existing work projected on assisting the model as a practical tool for farmers in detecting the diseases and aids in protecting the maize crops [32].

5. Implications of Piper Plants

Piper plants are considered to be important for various aspects due to its ability to provide versatile outcome in terms of medicinal aspects. The ability to provide various medicinal benefits for innumerable diseases like cancer, digestive disorder, respiratory problems, and heart diseases makes piper plants stand out from other plant species. Therefore, some of the major implications of piper plants includes,

- Medical implications
- Ecological implications
- Economic implications
- Culinary implications

Medical implications is considered as one of the strong aspects of piper plants due to its powerful medicinal properties. Most of the piper plants possess bioactive compounds that have been used in conventional medicinal practices for several years. These compounds depicted immense potential in treating different conditions like respiratory issues, digestive disorder, pain and other inflammation. Piper plants like Piper Nigrum and Piper Longum are used for medicinal purposes. Apart from medicinal purposes, piper plants are used for culinary purposes as well. In which, Piper Nigrum are commonly and most broadly used species across the world. Besides its medicinal and culinary properties, piper plants also play a huge role in ecological system, as they provide food sources and habitat for different organism. Similarly, piper plants also help in providing source of income to spice producers and farmers, also it contribute to the global spice trade, the demand for piper plants helps in impact the local and international economies. Some classes of piper plants along with common name are tabulated in table-1.

Table-1. Piper plants and its Common Name

Sl.No	Piper Classes
1	Piper Nigrum
2	Piper Longum
3	Piper Cubeba
4	Piper Betle
5	Piper Mullesa
6	Piper Auritum

Table-1 shows the Piper classes such as piper nigrum, piper Longum, piper cubeba, piper betle, piper mullesa and piper auritums.

6. Assortments of AI techniques for Piper Plant

Different AI techniques are used for identification and classification of piper plants and it has been reviewed in the subsequent section.

6.1 DL Techniques for Piper Plants

The primary objective of the existing study is to extract the features and for identification of Piper betle and Piper sarmentosum by employing SVM model. Different techniques have been used for plant identification, however, those techniques are measured to be time consuming and provide less efficient result for identifying the plants that are considered to be identical to each other, especially in terms of shapes. Hence, the recommended study focused on applying ML techniques. Piper betle and Piper sarmentosum are identical to each other since they belong to the same family 'Piperaceae'. Therefore, the process of classification is carried out by undergoing various stages. Initially, the images of Piper betle and Piper sarmentosum were utilized as data for extracting the features using different image processing techniques. Then, the feature extraction properties from the leaves namely axis, perimeter, area were estimated and extracted by utilizing MATBLAB. Finally, the process of classification has been performed by using SVM method with the features that are extracted previously for finding the best possible hyperplane which aids in identifying and classifying between the two types of plants. The accuracy obtained by using SVM for classification of Piper betle and Piper sarmentosum is up-to 80%. Therefore, from the model it could be analyzed that suggested SVM model benefits in classifying Piper betle and Piper sarmentosum, though species look identical [33].

Piper betle is considered to be one of the well-known species, which is incorporated as a medical plants due to various purposes. Piper Betle is primarily used for several purposes, which includes anti-septic, anti-inflammatory, sedative, itching relief, Anti-bacterial and for various other purposes. Red betel is also used for various purposes due to its medicinal as well as ornamental characteristics. The study utilized in the paper aids in classifying piper betle according to the color of the leaves, which includes red, green, black, blue and other colors. Suggested method encompasses of 5 different process, which includes image acquisition, ROI, Pre-processing, feature extraction and classification. Around 360 piper betle leaf images were utilized. Four different ML models such as KNN, NB, SVM and ANN are used for classification, in which SVM has delivered better outcome for classification of piper betle leaves [34]. Figure.3 depicts the process involved in the classification of piper betle leaves.

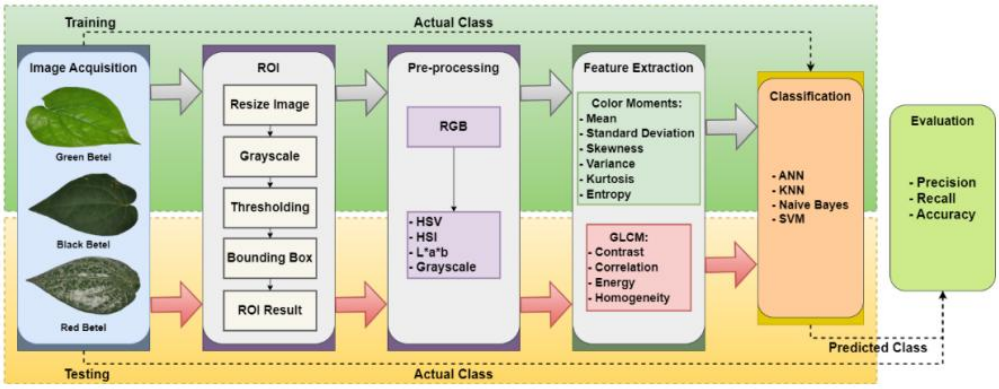

Figure.3. Process involved in classification of piper betle [34]

Similarly, Classification of piper seeds varieties are detected piper seed varieties. Around 1472 seed varieties are tested, the classification accuracy of the classification model was developed with full band using KNN, SVM and 1D-CNN model. The value obtained by KNN is 85%, SVM is 97.07% and 1D-CNN is 90.70%. Though, the value attained by 1D-CNN was not considerable highest, the ease of operation made the model more achievable for classification of piper seed variety [35].

Quality of seeds is considered to be one of the important factors for cultivation of piper. Therefore, picking the suitable seed cultivars is significant for breeding programs. However, the visual similarities and small sizes of the piper make it challenging to distinguishing between seed cultivars. Hence, AI approaches are used for providing high cultivar discrimination accuracy for rapid and precise outcome. Therefore, the study aided in classifying the piper seeds that belongs to different cultivars by employing CNN model. Two different approaches have been used for classification, in which training for piper seeds was done by ResNet18 and ResNet50. In the second approach, the features obtained from the pre-trained model was fused and feature selection was utilized for fusing the features together. Eventually, classification of piper seeds has been carried out by utilizing SVM with other kernel functions like Linear, cubic, quadratic and Gaussian [36]. Similarly, the quality of the piper seeds for separating high quality seeds from low quality seeds is stressed upon in the study. In order to achieve this, single

kernel germination tests were conducted for validating the predictive values of the identified features. Moreover, the model has utilized binary LR regression approach for predicting if a seed would germinate or not. The result obtained by the model has been considered to be promising and that focused on applying different seed selection approaches for improving the tedious tasks of choosing the high quality piper seeds [37].

Apart from classification of piper plants, recent studies have discussed a lot about disease identification of piper plants. However, in recent years, different diseases and other nutrients deficiency ruins various parts of plants like branches, berries, leaves and more. Therefore, it is imperative to identify these diseases before it destroy the entire plant. Plant experts and skilled farmers may possess the ability to identify the health issues of the plants by going through visual inspections, however, these approaches are not considered to be as effective as DL approaches. Therefore, DL based model has been used in the suggested study for classifying the diseases of piper nigrum and nutrients deficiency of the piper leaves. Hence, a CNN model has been customized for determining, how the training parameter affects the performance of the model in terms of prediction. Further, recommended C-CNN (Customized CNN) has been compared with the existing VGG-16 and InceptionV3. However, the experimental results proved that C-CNN model delivered better accuracy and effective disease classification than the other models. The suggested model are only based on leaf images with a single symptoms, therefore, the future work of the study deals with multiple symptoms [38].

The paper has focused on classifying different plants which includes Piper Nigrum, Piper Longrum and Piper betle and other plants by using different pre-trained models such as VGG-19, VGG-16 and CNN model, in which from the models, it was identified that VGG-16 model, delivered better accuracy for classification of the plants, whereas the CNN was considered to be next model, with better accuracy rate. However, from the experimental outcome, it was identified that, this existing models can assist finding indigenous medicinal plants that can provide various benefits to the people [39]. Likewise, study [40] emphasized on classification of herbal plants which includes piper betle along with other herbal plants. In order to accomplish the classification of plants, recommended study has utilized CNN-LSTM model for identifying the type of herbal plants correctly. Results of the model indicated that, accuracy of CNN-LSTM model has been enhanced when compared to the existing models for classification.

7. Applications of Piper Plants

Piper plants holds various medical and other beneficial properties. Therefore, this section reviews different applications of piper plants like piper cubeba, piper Nigrum, betel and other piper classes.

7.1 Piper Cubeba

Piper Cubeba, also known as cubeb is considered as a traditional herbal medicine which is used to treat various diseases such as respiratory disorder or other digestive problems. The plant are rich in essential oil and are found predominantly in fruits and it is easy to buy. Piper cubeba is considered as a native plant of Borneo and Java, where the appellation of the plant is considered as Java pepper. The plants holds various pharmalogical properties like anti-parasitic, insecticidal activities and antimicrobial activities. Some of the other applications of Piper Cubeba is the ability of the plant to heal the wounds by enhancing the supply of blood, synthesizing the collage and impeding the infection of the wounds. Figure.4. shows the leaves, flowers and berries of piper cubeba [41].

Figure.4. Piper cubeba a) Leaves b) Flowers C) berries [41]

7.2 Piper Nigrum

Piper Nigrum is considered as an Indian origin and it is grown on an estimation of 1,37,378 ha in India, with an evaluated yield production of sixty one thousand tons in 2019-20 [42]. Piper Nigrum is considered as one of the

most traded spices and some of the common spices used in different cuisines across the world. Piper Nigrum is produced from still-green of the plant. Moreover, the pepper sprit and the pepper oil of the Piper Nigrum are used as an Ayurvedic and other herbal treatments. Piper Nigrum are used for curing different illness like oral abscesses, constipation, toothaches, insomnia and sunburn. Medicinal properties of black paper has been depicted in Figure.5 [43].

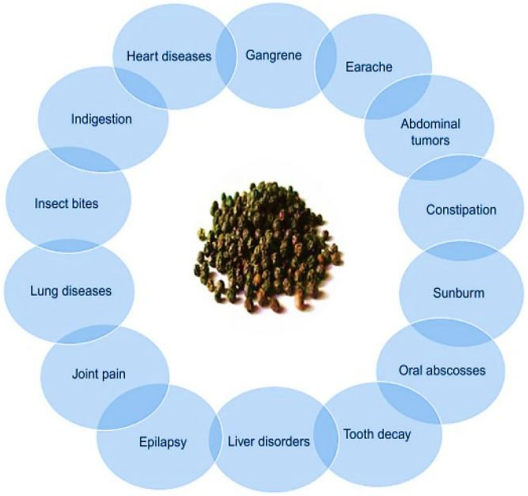

Figure.5 Medicinal properties of Piper Nigrum [43]

Figure.5 shows the therapeutic properties of Piper Nigrum, in which different disorders like indigestion, sun burn, abdominal tumors, heart disease, joint pain, insect bites and other problems can be solved by incorporating Piper Nigrum.

7.3 Piper Betle (Betel)

Piper Betle also known as betel leaves, comes under family piperaceae. Piper betle is considered as one of the popular medicinal plants in Asia and plant leaves of betel is used for treating various health conditions, as it is considered as highly abundant and inexpensive. Further, there are various commercial applications of utilizing betel leaves, which includes mouthwash, cosmetic products, dietary supplements, medicinal products and other products as well. Moreover, the future development of the medicinal products obtained from betel leaves could be helpful for curing dermatophyte infections, preventing oral diseases and even other diseases which are considered to harmful. Therefore, it can be examined that are various anti-fungal and anti- bacterial properties of betel leaves and the properties of betel leaves helps in various applications [44].

7.4 Piper Longum

Piper Longum is commonly called as ‘pippali’. It primarily propagates as an herbaceous vine or perennial shrub. The fruits of the piper Longum is primarily used as a culinary spice and can be used for several medical purposes like cold, snakebite, cough, scorpion sting. Numerous bioactive-phytochemicals, which includes esters, alkaloids, and steroids are generally extracted from piper Longum plants. Likewise, essential oil extracted from the fruits and roots of betel leaves includes antioxidant, anti-snake agents, Anti-asthmatic and cardio-protective agents. Most of pharmacological properties were accredited to anti-inflammatory effects and anti-oxidants it is due the capability of betel leaves to modulate number of enzymes and signaling [45]. Table-2 shows the different applications of piper plants.

Table- 2.Applications of Piper Plants

Sl.No	Reference	Plant Type	Applications
1	[43]	Piper Nigrum	• Piper Nigrum are used for curing different illness like oral abscesses, constipation, toothaches, insomnia and sunburn. • Disorders like indigestion, sun burn, abdominal tumors, heart disease, joint pain, insect bites and other problems can be solved by incorporating Piper nigrum
2	[41]	Piper Cubeba	• The plants holds various pharmalogical properties like anti-parasitic, insecticidal activities and antimicrobial activities. Some of the other applications of Piper Cubeba is the ability of the plant to heal the

			wounds by enhancing the supply of blood, synthesizing the collage and impeding the infection of the wounds
3	[45]	Piper Longum	• The fruits of the piper longum is primarily used as a culinary spice and can be used for several medical purposes like cold, snakebite, cough, scorpion sting. • Numerous bioactive-phytochemicals, which includes esters, alkaloids, and steroids are generally extracted from piper longum plants

8. Comparative Analysis

Different DL methods are used for miscellaneous plant and piper plants classification. Table-3 depicts the objective and the results of the plant classification employed by different prevailing studies.

Table-3. Comparative Analysis of plant classification

Sl.No	References	Objective	Results
1	[19]	To assist the non-expert and non-botanist for identifying the plants automatically without being prone to errors.	➢ DL techniques like DNN for effective classification of plants. Four different datasets have been used in the study such as Flavia, UCI leaf, Swedish leaf and PlantVillage. The experimental outcome of the study depicted that better classification accuracy was obtained for PlantVillage dataset and less accuracy was obtained for using UCI Leaf Dataset
2	[20]	To classify plants on the basis of whether it is a poisonous leaf, herbal leaves or agricultural leaves from the given input image	➢ KNN classifier by performing steps like acquisition of images, pre-processing, image segmentation, feature extraction and classification. ➢ Better Results have been obtained by employing KNN model.
3	[23]	Identifying the leaves of plants for plant classification	➢ CNN based classification technique has been used for identifying the leaves. In which, the approach encompasses shape and colour of the leaves of different plants. Around 375 images from 5 different classes were used for classification. Different leaves were classified successfully using CNN model which includes Rambutan, Mango, Cherry, papaya and Acaica
4	[25]	Automatic plant classification using DL and ML methods	➢ CNN model as it provides better accuracy than the conventional techniques. However, the performance of the model could be further enhanced by employing CNN with SVM and KNN on 3 different datasets such as MalayaKew Dataset, Flavia and LeafSnap dataset. Study showcased that CNN+KNN model resulted in better classification than CNN+SVM model.
5	[33]	To identify Piper betle and Piper sarmentosum by employing SVM model	➢ Therefore, the process of classification is carried out by undergoing various stages. Initially, the images of Piper betle and Piper sarmentosum were utilized as data for extracting the features using different image processing techniques. ➢ The process of classification has been performed by using SVM method with the features that are extracted. ➢ The accuracy obtained by using SVM for classification of Piper betle and Piper sarmentosum is up-to 80%. ➢ Therefore, from the model it could be analyzed that suggested SVM model benefits in classifying

			Piper betle and Piper sarmentosum, though species look identical
6	[34]	To classify piper betle according to the color of the leaves	➢ Suggested method encompasses of 5 different process, which includes image acquisition, ROI, Pre-processing, feature extraction and classification. Around 360 piper betle leaf images were utilized. Four different ML models such as KNN, NB, SVM and ANN are used for classification, in which SVM has delivered better outcome for classification of piper betle leaves

From table-3, it can be observed that, different datasets and different models, which includes DL and ML are considered for plant classification. Most of the studies focused on assisting the non-botanist for identifying and classify the plants effectively and emphasizes on automatic detection of plant classification. Moreover, from the analysis, it can be detected that, CNN classifier has been used by different studies for plant classification. Even for piper plant classification different approaches have been considered for obtaining precise outcome.

9. Critical Analysis

Critical analysis is performed with regards to different factors utilized by several conventional methods for plant classification. Figure.6 depicts the usage of AI classifiers for plant classification, in which the figure demonstrates that CNN based algorithms have been utilized a lot in existing studies for classification of plants, Whereas, few studies were focused on ML based algorithms such as KNN and SVM for classification of plants and the rest of the studies focused on ANN and hybrid approaches.

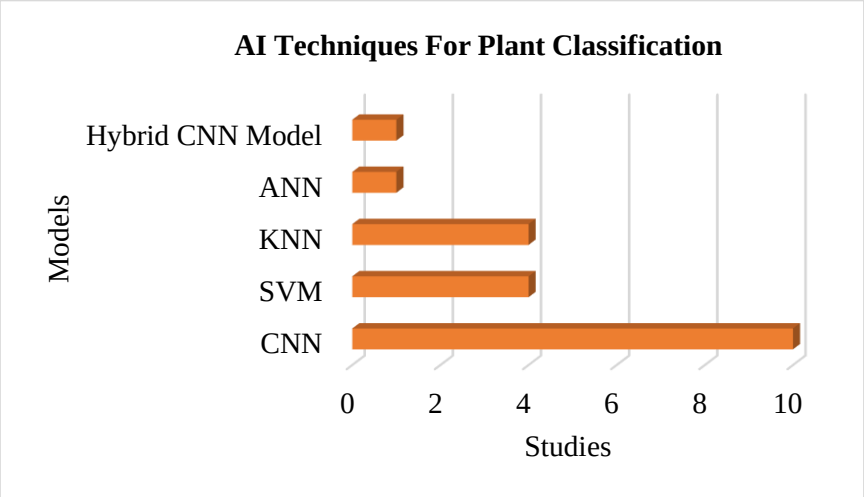

Figure.6. AI Techniques for Plant Classification

From the Figure.6, it can be identified that, 50% of the paper has focused on CNN model for plant classification, 20% of the papers have utilized SVM and KNN classifiers and remaining 5% of the papers has utilized ANN and hybrid CNN models for plant classification. Different piper classes used for piper plant classification has been utilized in the study. Figure.7 depicts the different type of piper classes used for piper plant classification in existing studies.

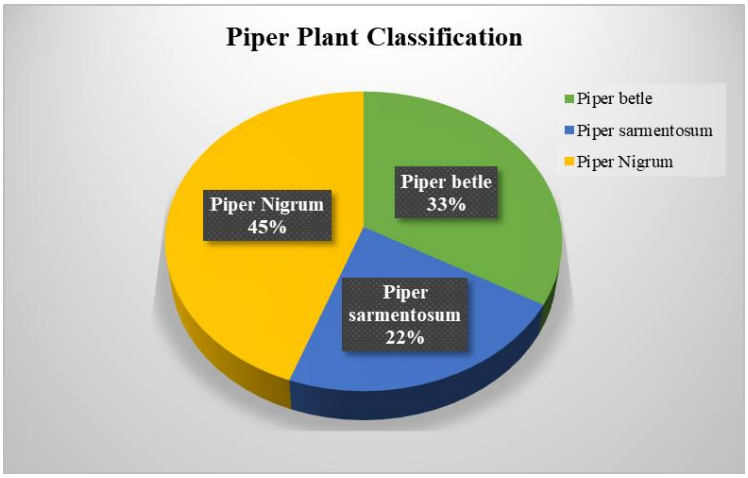

Figure.6. AI Techniques for Piper Plant Classification

Figure.7 depicts the usage of piper plants for classification, in which, figure demonstrates that 31% of the studies have utilized Piper Nigrum and Pepper bell classes used for classification of piper plants, then, 23% of the studies were focused on Piper betle class for piper plant classification and 15% of the studies were focused on Piper Sarmentosum for plant identification. From the critical analysis, it can be comprehend only limited piper classes have been discussed in the existing studies for piper plant classification.

10. Challenges and Future Recommendation

Various challenges faced by different studies are mentioned as follows,

- Classification can be performed without high loss, which could be achieved other NN as a part of future work [23].
- Forthcoming work of the research emphasizes on implementing the model in real time and drone captured images as the recommended study focuses on employing the process on particular dataset. Moreover, plant species can be identified by developing cloud based architecture, which can be implemented in future work [26].
- Future work of the model focusses on incorporating different types of piper since suggested model has used only limited varies of piper seeds [46].
- Despite providing better outcome, the model only focused six label class diseases of piper fruits and leaves, however, there are various other kind of diseases which not only affects fruits and leaves of piper but also root and stem of the piper plants, which could be considered as a part of future work. In future, hybrid ML algorithms can also be used for improving the performance of the model for piper classification [47].

From the existing studies, it can be analyzed that, various studies have focused on employing DL techniques for classification of plants, however, limited studies have explored piper plant classification. As piper plants contains various medicinal and significant properties, classification of piper plants will deliver better results. Further, different applications can be employed using piper plants in future, as Piper plants possess provides medicinal, economical, culinary and ecological implications. Therefore, in future, different dimensions needs to be focused on employing piper plant classification for identifying, comprehending the diversity of piper plants as it provides innumerable benefits to the humans.

11. Conclusion

Plants play a significant role in ecosystem, therefore, it is important to identify the plants correctly for obtaining the appropriate benefits from the plants. However, classification of plants using manual techniques are considered time-consuming, slow, and prone to errors due to human intervention. Therefore, different AI techniques like ML and DL classifiers are used for classification of plants. Moreover, the paper focused on reviewing piper plant classification, as piper plants possess various beneficial properties. However, from the papers that have been reviewed, it can be examined that very few studies have focused on piper plant classification using DL techniques. Apart from classification of piper plants, the paper has also focused on identifying quality of the piper seeds, maturity level of the piper plants, diseases affected by piper plants as most research works utilizes these aspects as well. Therefore, from the papers that have been reviewed, classification of piper plants can be focused on future as piper plant classification aids in identifying and comprehending the diversity of piper plants as it provides

innumerable benefits to the humans. The paper discussed about various applications of piper plants which predominantly includes medical applications of the piper and critical analysis of different studies demonstrated that CNN model is considered to be used widely for plant classification.

The classification of varied plants and piper plants help with countless factors, which primarily includes medicinal benefits provided by these plants. Through this review, it may start as an initiative point for researchers, researching about Piper plants for classification in more advanced ways and the advancement of the future research work, can assist farmers to monitor the crop health, detect the diseases affected by the plants and aids in optimizing framing practices and may also assist forestry for identifying the tree species and assist the biodiversity of the forest.

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