Plant Leaf Image Recognition using Multiple-grid Based Local Descriptor and Dimensionality Reduction Approach

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OUTLINE

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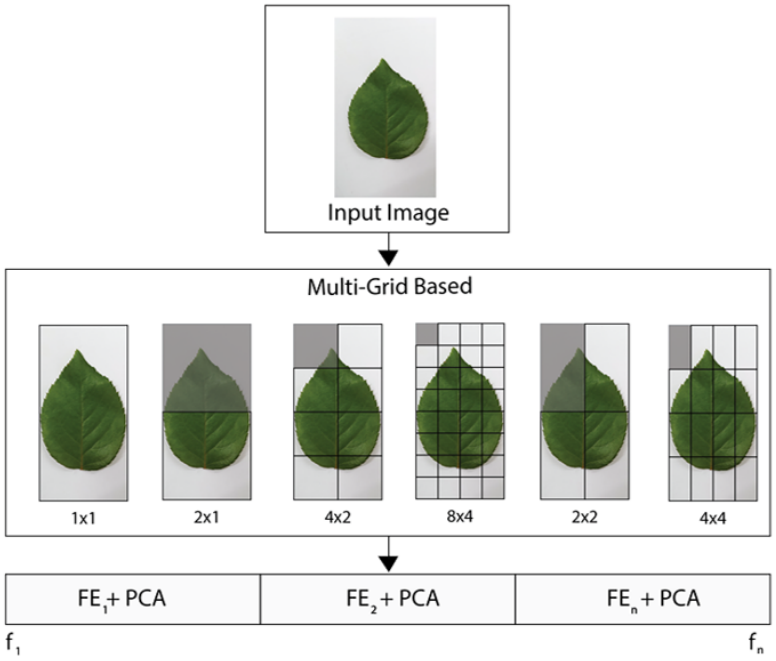
- PLANT LEAF DATASET
- EXPERIMENTAL RESULTS
- CONCLUSION

INTRODUCTION

Are those plants edible?

Identification provides an easy way for finding out without dangerous tasting.

CONTRIBUTIONS



The research focuses on the importance of plant leaf recognition by experiment with (Folio dataset) which collects 32 different species of plants.

The multiple grids divide plant leaves into sub-regions, then it brings the sub-region to calculate the special features using various feature extraction techniques that pull out the distinctive characteristics of the plant leaves. The methods are a histogram of oriented gradients (HOG), local binary pattern (LBP), and color histogram.

Finally, the feature will be fed to the dimensionality reduction method by using principal component analysis (PCA) in order to reduce the feature vector size of each method. The size reductions have direct effect on training time and increase the recognition efficiency as well.

In this paper, the feature vector was used in training and recognition by a support vector machine (SVM) and Multi-layer perceptron (MLP). This method obtained a very high recognition rate when compared to the deep learning method.

CONTRIBUTIONS

- Plant leaf recognition by experiment with Folio dataset.
- The multiple grids divide plant leaves into sub-regions and using various feature extraction.
- The methods are a histogram of oriented gradients (HOG), local binary pattern (LBP), and color histogram.
- Using principal component analysis (PCA) in order to reduce the feature vector size of each method
- The feature vector was used in training and recognition by a support vector machine (SVM) and Multi-layer perceptron (MLP).

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CONTRIBUTIONS

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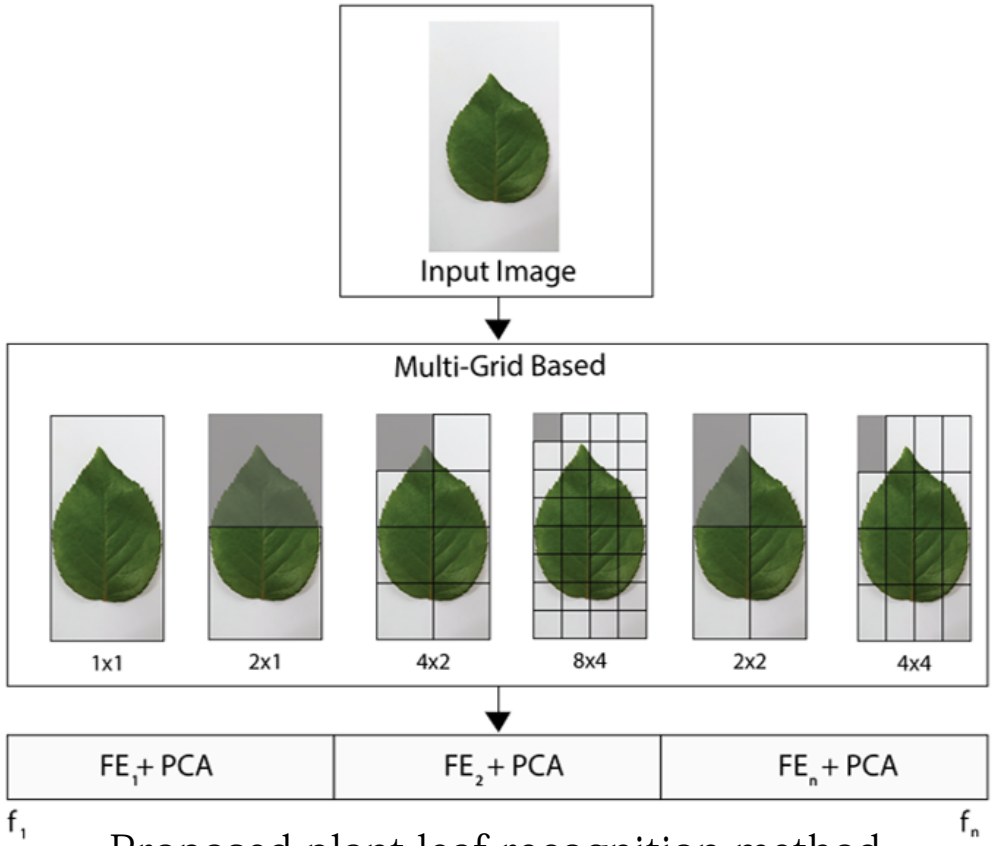
PROPOSED PLANT LEAF RECOGNITION METHOD

we use multiple grids and dimensionality reduction based these experiments, the Grids were determined at 6 different types,

including Grid size of 1x1, 2x1, 4x2, 8x4, 2x2, and 4x4.

After that, each sub-area was calculated to find the feature vector.



Proposed plant leaf recognition method

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PROPOSED PLANT LEAF RECOGNITION METHOD

Feature Extraction Techniques

1. Histogram of Oriented Gradients (HOG)
2. Local Binary Patterns (LBP)
3. Color Histogram

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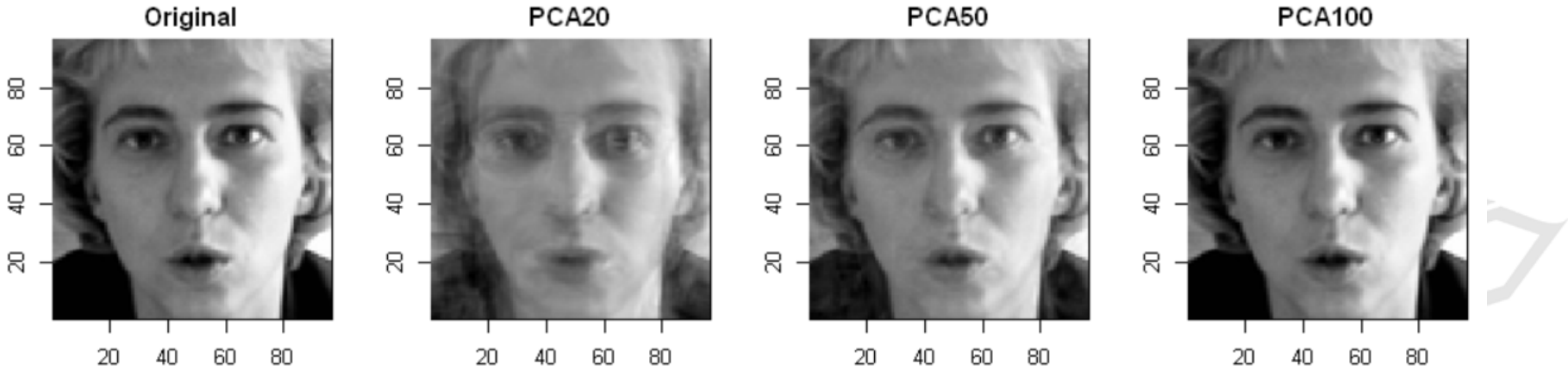
PROPOSED PLANT LEAF RECOGNITION METHOD

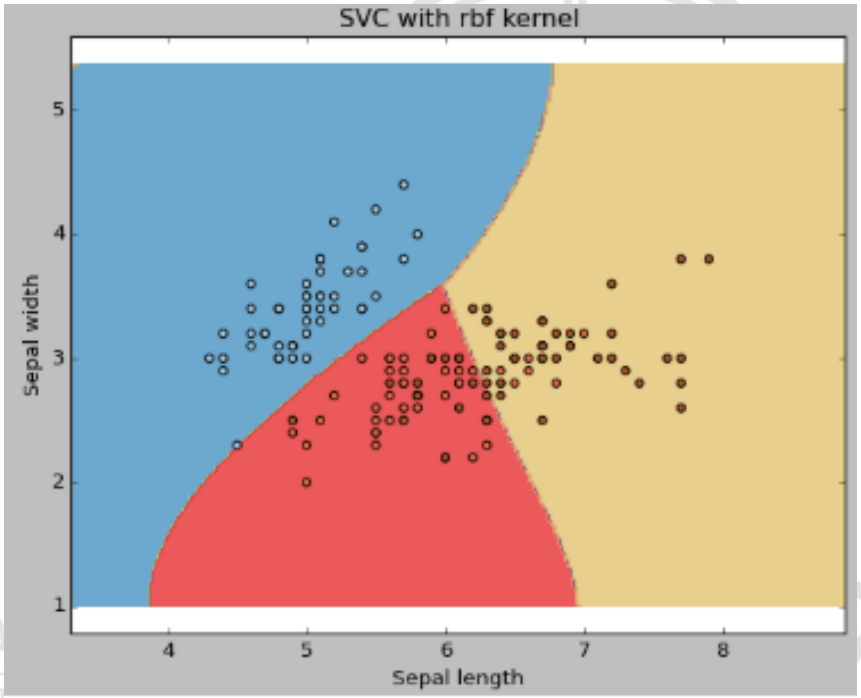
Dimensionality Reduction

- This research uses PCA in feature vector reduction.
- Feature vector from each technique has been reduced to only 80 Features.
- These techniques improved the accuracy rate as well.



PROPOSED PLANT LEAF RECOGNITION METHOD

- Support Vector Machine (SVM)
  - Radial basis function kernel (RBF Kernel)
  - The grid-search technique
  - The best C =100
  - The gamma = 0.1



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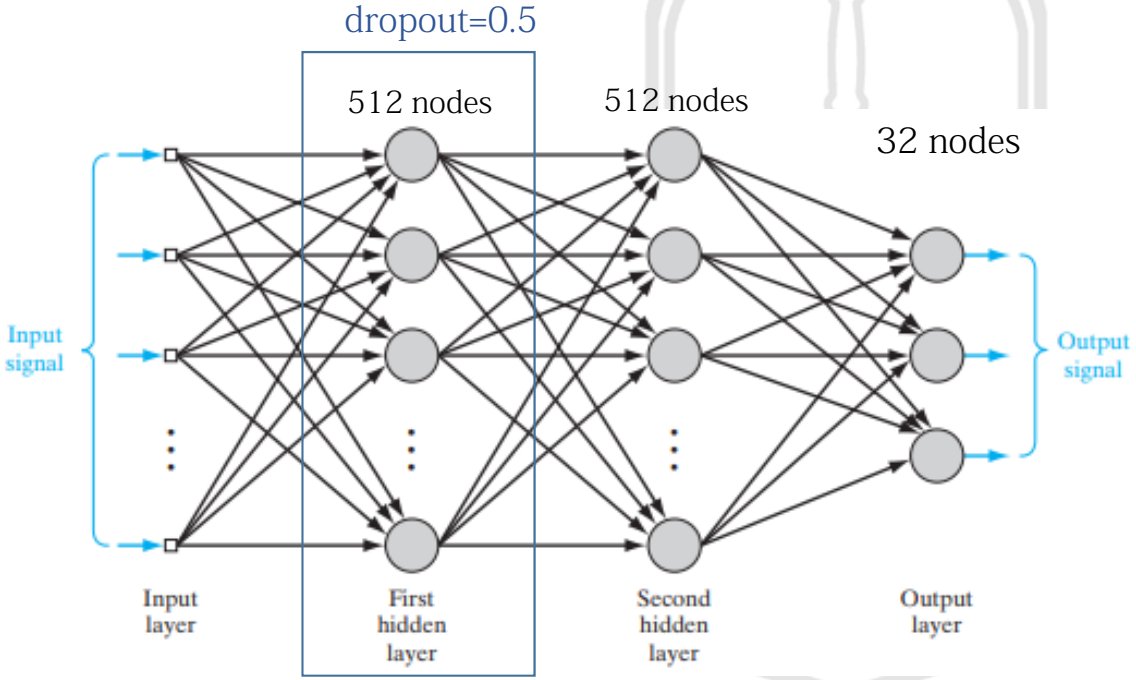
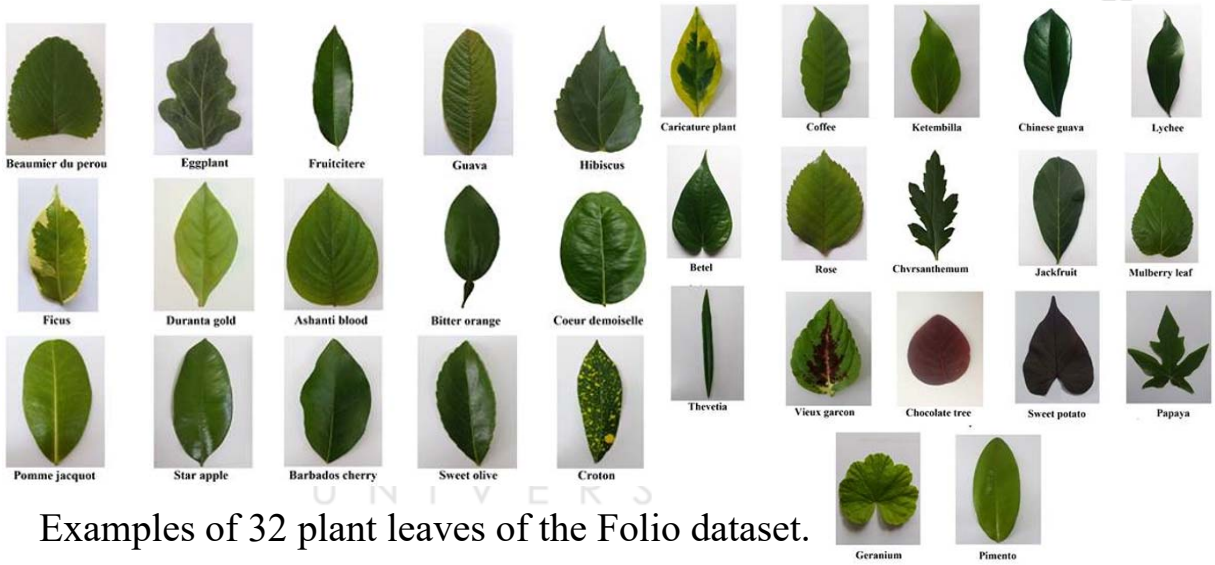
PROPOSED PLANT LEAF RECOGNITION METHOD

- Multi-layer Perceptron (MLP)
  - Size of each layer is 512 and 512 hidden units
  - The dropout rates of 0.5
  - Activation ='relu'
  - Learning rate = 0.001
  - Output 32 nodes



PLANT LEAF DATASET

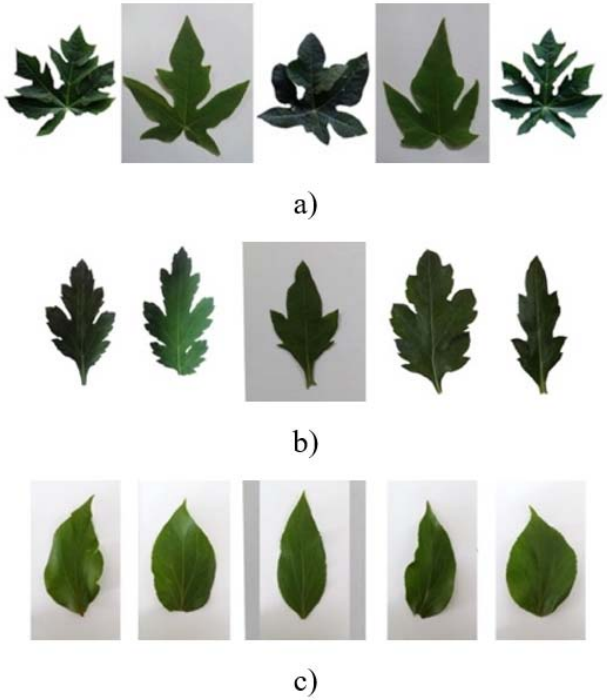
Folio Dataset
presented in 2015. The data represents 32 species of leaves plant images . All images were taken in the laboratory with a white background. All images were saved in the JPEG format.. The plants were in the University of Mauritius farm. The dataset contains 637 images



Examples of 32 plant leaves of the Folio dataset.

PLANT LEAF DATASET

Image differentiation of each species are shown



Some variety examples of plant leaves, a) papaya, b) chrysanthemum, and c) ketembilla leaf images of the Folio dataset.

PLANT LEAF DATASET

Some plant leaves still have similar shape

a) b)

Similarities shape between different plant leaves. a) The images of star apple and b) pomme jacquot leaves.

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PLANT LEAF DATASET

Dataset Pre-processing

- The process starts by converting all the images to black and white in order to find the plant leaves area (Region of interest: ROI) Crop to get ROI.
- Check the image of the leaf in the horizontal position and then rotate the image to vertical shape.
- the image resizes are resize to 400 pixels.

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EXPERIMENTAL RESULTS

In these experiments, we used 5-fold cross-validation to evaluate the results of the plant leaf recognition methods. We used a training set of 80% of 637 in total.

Plant leaf recognition results of the 15 different techniques on the Folio dataset

Multiple Grid Methods	Training Time (Sec)		Test Accuracy (%)	
	SVM	MLP	SVM	MLP
Color-Histogram	221.86	232.42	96.25±1.87	95.94±1.94
LBP	278.80	284.80	94.45±1.06	91.87±2.22
HOG	201.27	206.83	94.14±2.45	94.14±2.34
Color-Histogram-PCA	182.88	189.49	97.73±1.30	97.11±1.28
LBP-PCA	278.15	285.29	94.14±1.06	94.14±1.74
HOG-PCA	202.12	209.53	93.83±2.62	93.91±1.83
Color-Histogram-LBP	496.61	511.65	97.81±1.15	96.09±1.65
Color-Histogram-HOG	419.10	435.47	98.13±1.39	96.64±1.38
LBP-HOG	481.14	489.10	97.50±1.46	96.87±1.98
Color-Histogram-LBP-HOG	697.46	716.77	98.67±0.91	97.42±1.48
Color-Histogram-LBP-PCA	460.96	469.78	98.67±1.11	98.28±1.51
Color-Histogram-HOG-PCA	384.91	393.20	98.59±1.46	98.28±1.32
LBP-HOG-PCA	480.19	488.94	97.50±1.46	97.58±1.01
Color-Histogram-LBP-HOG-PCA	663.01	672.19	**99.06±0.89**	**98.75±0.92**
HOG-BOW	-	-	92.78±2.17	92.37±1.78

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HOG	94.14±2.45	94.14±2.34
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LBP-PCA	94.14±1.06	94.14±1.74
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LBP-HOG-PCA	97.50±1.46	97.58±1.01
Color-Histogram-LBP-HOG-PCA	**99.06±0.89**	**98.75±0.92**
HOG-BOW	92.78±2.17	92.37±1.78

EXPERIMENTAL RESULTS

Comparing results between proposed method and fine-tuned deep learning methods on the Folio dataset

Method	Test Accuracy (%)
AlexNet (Pawara P. and et al. 2017)	97.67±1.60
GoogleNet (Pawara P. and et al. 2017)	97.63±1.84
AlexNet (Pawara P. and et al. 2017) data augmentation (Contrast)	99.04±0.38
GoogleNet (Pawara P. and et al. 2017) data augmentation (Illumination)	**99.42±0.38**
Proposed Method (Color-Histogram-LBP-HOG-PCA)	99.06±0.89

CONCLUSION

Nevertheless,

- the data augmentation technique can increase the accuracy performance of the plant leaf recognition system.
- This technique added more than 4,000 illumination images to the training set. Subsequently,
- we used only 510 images to train the plant leaf recognition system

As a result, the accuracy result of our proposed method is slightly decreased than the fine-tuned deep CNNs with the combined data augmentation technique.

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CONCLUSION

- our proposed method, is much better than the histogram of oriented gradients combined with bag-of-words technique and fine-tuned deep CNN architectures which are AlexNet and GoogleNet architectures as well.
- We also have shown that the principal component analysis, which is the dimensionality reduction technique, increased the accuracy performance and decreased the number of the feature vector of the plant leaf recognition system.

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CONCLUSION

In future work, we would like to study the effect of parallel CNN architectures and use this architecture to train the plant leaf images.

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THANK YOU FOR YOUR ATTENTION

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