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COMPARATIVE STUDY FOR MACHINE LEARNING TECHNIQUES TOWARDS IMAGE CLASSIFICATION

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ABSTRACT

The Intense change in the domain of computer applications because of availability and accessibility of huge amount data mined form from sensors and internet motivates researcher's study from simple data processing applications to Machine Learning. This research proves the fact that machine has an ability to learn itself and improve itself after necessary training. Image Analysis and implementing different methodologies for manual classification of images is more complex task for effective classification. This complexity led to a way where we need to go for automation for achieving high accuracy. The proposed paper aims at comparative examination of a variety of machine learning algorithm performance and accuracy towards image classification. In Proposed paper Logistic regression model,Naïve Bayes classifier model ,Support Vector model, Random Forest classifier algorithms used to test with UC Merced dataset, initiates with preprocessing and training followed by testing of data set. From this point investigation prompts towards best pick algorithm by observing the calculated accuracies among tested algorithms.

Keywords—Image Processing; Machine Learning, Logistic regression model; Naïve Bayes classifier model; Support Vector model; Random Forest classifier model;

I INTRODUCTION

Consistently, numerous images are generating which requires classification for the ease in organization and analysis at quicker pace. Even though image analysis and classification becomes tough task, it significantly needed to show resolutions in many applications based on images. Manual classification of images fails due to overwhelming time and accuracy. Researchers came to conclusion that complexity of the image Analytical evaluation increases with number of objects in the image. The process of wide range of implementing classifiers automated the process that reduces lot of human work with the aid of high accurate result.

The Machine Learning research came forward to adopt the capabilities of human to computers to learn by sensing and understand so that to take action based on previous and current positive and negative outcomes [1].Machine learning provides number of well formed algorithms for prediction and analysis that fall under three different categories (a) Supervised Classification that considers image as a labeled data points and a known group of pixels which requires more training (b) Unsupervised classification which uses no labeled data that can be considered when training needed on random data and when trained pixels not available. (c) Semi-supervised classification which takes advantage from both supervised and Unsupervised Techniques.[2]. These Machine learning techniques turns as a free service by real-time companies like Amazon, Microsoft and Google which runs on clouds as a "machine learning as a service" and "cloud machine learning" [3].

The Systematic study of the classification considers captured image data set which should process all together. Image classification involves segregation of images into different categories depends upon feature similarities and dissimilarities. This segregation may generate false results due to noisy, blurry and images with bad quality and clutter. The test object should compare with pre defined sample patterns available in data set to classify them into appropriate class[10,11,12,13,14].

To attain the desired results with accuracy in classification of image, various tasks to be performed in a structured manner step by step depicted in Figure 1.

Image Pre Processing: Task to be carried out for the benefit of models from the improved data which is attained by removing unwanted distortions. This step may include reading the image, resizing the image and augmentation includes gray scaling, reflection, histogram, Gaussian blurring, equalization rotation and translation. In this paper doubuchies wavelet transform is applied to devide the image into high level and low level frequencies. The high level frequencies are represents the approximation (smoothing components), Horizontal, vertical and Diagonal detail components are exracted.

Fig 1: Image Classification Flow.

Feature Extraction: This step make use of statistical methods to identify most interesting features and patterns that may confine to a particular class to differentiate the model from other classes or other models. This step refers to as model building or model training.

Feature Training

The extracted features are trained using various machine learning algorithms such as perceptron, svm, random forest, decision tree so on. The trained feature model is used to test the testing set of features for prediction of objects.

Classification of Object: This step refers to catalog detected objects into pre defined classes by using appropriate classification algorithm. Here comparison takes place between target patterns and mined patterns.

The Goal of this comparative study is to examining applications of machine learning analytically in the field of image processing. The proposed study organized in seven sections section 2 corresponds to related research done, section 3 Implementation, section 4 demonstrates data set description, and section 6 presents results and discussions. The last section concludes with future enhancement.

II RELATED RESEARCH

Random Forest Algorithm (RFA) is a supervised learning algorithm which consists of many decision trees. The algorithm creates decision trees on data samples and gets the prediction from each of them and finally selects the best solution by means of voting. The authors [4] developed an effective classification approach based on the Random Forest algorithm. Three fruits – apple, strawberry, and orange were analyzed and different features were extracted based on the fruit shape, color characteristics, and scale-invariant feature transform. A pre-processing stage using image processing was implemented to prepare the dataset to reduce their color index. Then, the fruit image features were extracted. Finally, the classification process is adopted using a random forest algorithm [4]

Two different experiments were performed by Hua Zhang;, Wenzhong Shi, Kimfung Liu to evaluate the performance of the FTSVM (Fuzzy-Topology- Integrated support vector machine) method, in comparison with standard SVM, maximum likelihood classifier (MLC), and fuzzy-topology-integrated MLC. Experimental results indicate that the FTSVM method performs better than the standard SVM and other methods to improve the classification accuracy, hence providing an effective classification method for remotely sensed images. [5]

Rajendran, Periyasamy proposed hybrid approach of association rule mining and decision tree algorithm classifies the brain tumors cells in an efficient way. The anticipated algorithm has been found to be performing well compared with the existing classifiers. The accuracy of 95% and sensitivity of 97% were found in classification of brain tumors. The developed brain tumor classification system is expected to provide valuable diagnosis techniques for the physicians [6]

Craig Rodarmel and Jie Shan says that PCA approach is a useful preprocessing technique for hyper spectral image classification. They have used HYDICE and AVIRIS data sets for their classification research. The correct classification rate increases slowly in linearly when more PCA bands are involved in the classification process. The use of the most significant 5 (~10 percent) and 10 (~20 percent) bands can led to exact classification rates of about 70 percent and 80 percent or higher. Misclassifications caused by PCA-induced information loss mainly occur at feature class boarders in the image. They revealed CPU performance for PCA transformation will dominate the entire processing time if the most significant PCA bands are used. [7]

III IMPLEMENTATION

FEATURE EXTRACTION

Feature Extraction Refers to generality of amount of resources required to describe a larger set of data accurately. Computation algorithm .The number of variables turned as root cause in complex data analysis to raise major problems. The classification algorithm might over fits the training sample and generalizes poorly to new samples, when Analysis deals with a large number of variables where algorithm requires a huge amount of memory and computation power. For describing the data with sufficient accuracy feature extraction comes into picture as set of methods for constructing combination of variables to solve problems raised by over fitting variables. [10,11,12,13,14].

Feature extraction in this paper work around with two different techniques termed as

(a) Wavelet Transformation
(b) GLCM.

WAVELET TRANSFORMATION

Wavelet transformation is very familiar technique image processing technique by detecting the object. This will produce transformation values known as wavelet coefficient. Object classification or detection depends upon how this wavelet coefficient can be interpreted. Computation of coefficient distribution over selected parent of wavelet is familiar approach for feature extraction

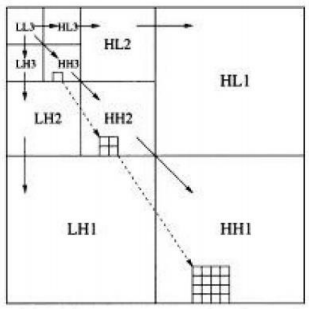

Fig 2: Joint spatial and frequency representation of a 2-D three scale DWT

GLCM (GREY LEVEL CO-OCCURRENCE MATRIX)

P. Mohanaiah and team says that GLCM (Grey Level Co-occurrence Matrix) is formulated to mine textual features. From overall text features mined necessary computation needs only four of second order features termed as angular second moment, correlation, inverse difference moment, and entropy [4] which provides high accuracy. These can be computed as follows

Angular Second Moment measures image homogeneity. If image has very good homogeneity (pixels of image are very similar) implies high angular second moment

$$ASM = \sum_{i=0}^{Ng-1} \sum_{j=0}^{Ng-1} p_{IJ}^{2}$$

Where i,j are the spatial coordinates of the function p(i, j) Ng is grey tone

Inverse difference moment known as local homogeneity. Uniformity in local grey level ,high in inverse difference moment

$$IDM = \frac{\sum_{i=0}^{Ng-1} \sum_{j=0}^{Ng-1} P_{ij}}{1 + (i-j)^2}$$

IDM weight value is the contrast weight

Entropy refers to computation of loss of information during the process of compression of image or measures the image information

$$ENTROPY = \sum_{i=0}^{Ng-1} \sum_{j=0}^{Ng-1} -P_{ij} * logP_{ij}$$

Correaltion used to estimate dependency between grey levels of neighboring pixels. Frequently used to measure deformation, displacement, strain and optical flow

$$CORRELATION = \sum_{i=0}^{Ng-1} \sum_{j=0}^{Ng-1} (i,j)P(i,j)) - \mu_x \mu_y$$

MACHINE LEARNING MODELS

DECISION TREE

Decision Tree (tree like structure which means root and leaf nodes are available) is a type of Supervised Machine Learning (that is you explain what the input is and what the equivalent output is in the training data) where the data is continuously split according to a certain parameter. The tree can be explained by two entities, namely decision nodes and leaves. The leaves are the decisions or the final outcomes. And the decision nodes are where the data is split.

SUPPORT VECTOR MACHINE

Support Vector Machine (SVM) is a supervised machine learning algorithm familiar for both classification and regression based challenges. In SVM we plot each data point in n-dimensional space (no of features) with the value of each feature being the value of a particular coordinates then, we perform classification by finding the hyper-plane that differentiates the two classes very well. The SVM classifier is a frontier which best segregates the two classes.

RANDOM FOREST

Random Forest is a well-established machine learning algorithm that belongs to the supervised learning technique. It can be used for both Classification and Regression problems in machine learning. Ensemble learning acts as base for random forest**,** which is a process of combining multiple classifiers to solve a complex problem and towards improve the performance of the model.

Random Forest classifier contains a number of decision trees on various subsets of the given dataset and takes the average to improve the predictive accuracy of that dataset**.** Instead of holding with one decision tree, the random forest takes the prediction from each tree and based on the majority selections of predictions, and it predicts the final output.

PERFORMANCE EVALUATION

Standard Performance Evaluation carried on machine learning classifiers implemented including Accuracy (ACC), Precision (P) , and Sensitivity (S) . Confusion Matrix explored as a base for these performance terminologies proposed by Sokolova and Lapalme in 2009.[5]. Computations of these performance evaluators depict below.

- ✓ **Accuracy (Acc)** refers to the overall Effectiveness of the classifier
- ✓ **Precision(P)** refers to class agreement of data labels with the classifier resulting positive labels
- ✓ **Sensitivity(S)** can be identified as the effectiveness of the classifier in identifying positive labels.
- ✓ **Specificity (S)** can be identified as the effectiveness of the classifier in identifying negative labels.

$$Accuracy(ACC) = \frac{TP + TN}{TP + FN + FP + TN}$$

$$Precision(P) = \frac{TP}{TP + FP}$$

$$Sensitivity(S) = \frac{TP}{TP + FN}$$

$$Specificity = \frac{TN}{TN + FP}$$

$$AUC = \frac{1}{2}\left(\frac{TP}{TP + FP} + \frac{TN}{TN + FP}\right)$$

IV DATASET DESCRIPTION

Remote sensing benchmark multispectral dataset UC Merced is considered for the experiment in the proposed work. The dataset is consisting of 21 classes of land use data for research purpose [14]. The images are sub sampled from USGS National Map urban area image collection. Each image consists of 256 x 256 pixels. The resolution of each pixel is 1 foot. The input image bands will be separated to apply the 2D Fast Discrete Curvelet Transform in Unequally Spaced Fast Fourier Transform (USFFT). Curvelet transform will decompose the image into three coefficients which are coarse, detail, and fine scale coefficients. The detail scale coefficients again consist of multiple orientations at each resolution [10,11,12,13,14].

VI RESULTS

Classifier	Accuracy	Precision	Recall	F1 score
PCA+Perceptron model	78.0	86.28	86.60	87.77
PCA+SVM(Poly kernel)	73.0	84.88	73.33	75.54
PCA+SVM(RBF Kernel)	92.0	92.71	92.33	92.35
PCA+SVM(linear Kernel)	93.0	92.93	92.66	92.70
PCA+RandomForest	86.0	87.35	86.0	85.89
PCA+DecisionTree	100	100	100	100

Table 1: Comparision of Various Machine Learning Models for Image Classification

Table 1 showing the results of model evaluation PCA with perceptron, PCA with polykernel, PCA with RBF Kernel, PCA with Linear Kernel, PCA with RF, PCA with Decision Tree

We Considered 32*3=96 features at initial stage and they were reduced to 10 by applying Dimensionality reduction using PCA methodology

From the Table of evaluated values our data set and features considered showing highest accuracy in Decision Tree.

Data set taken noted more than 85 % accuracy Except in case of PCA with SVM Poly kernel. According to results we believe our features strongly support classification technique for

effective classification.our data set inclined for Decision Tree classification with 100 % Accuracy images will be classified correctly

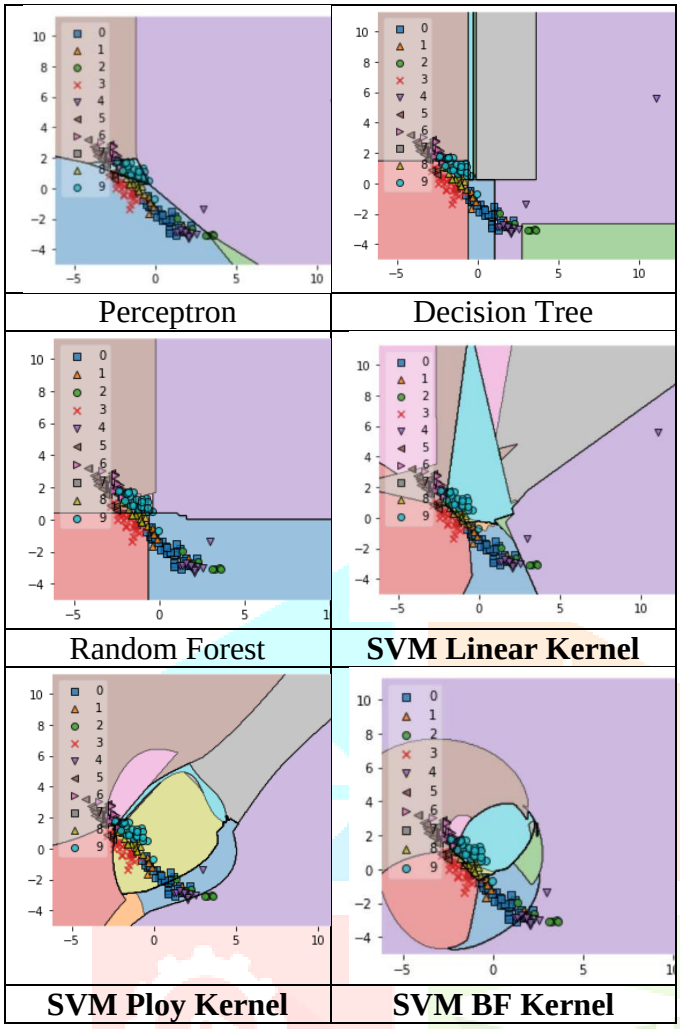

Fig 3: Classification Graphs

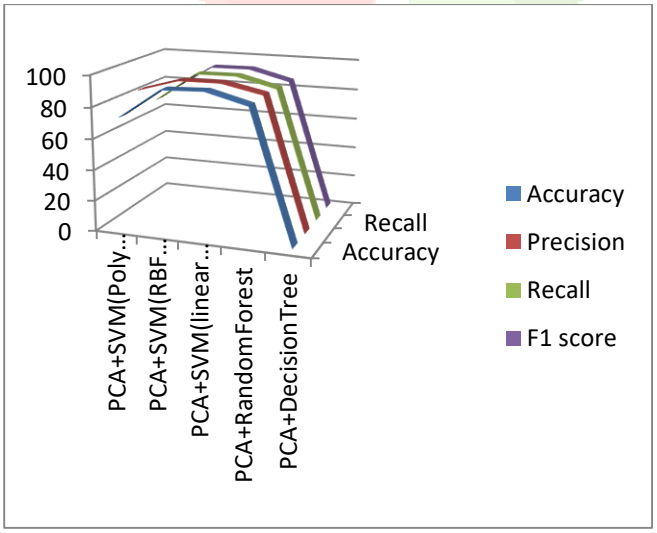

Fig 4: Test Model Graph

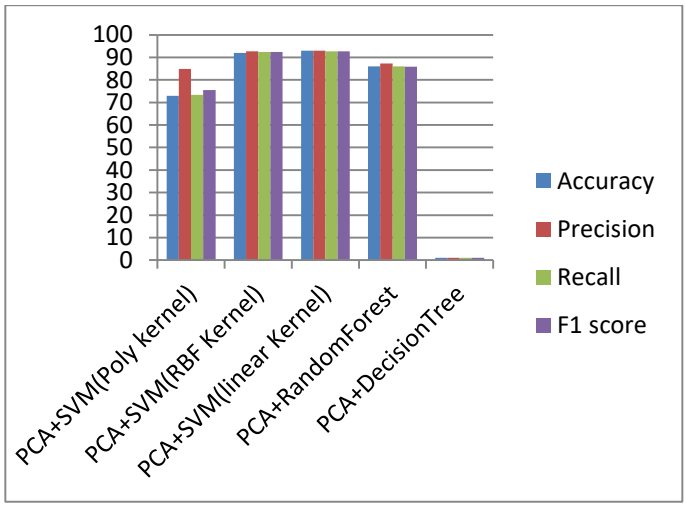

Fig 5: Test Model Graph in Bar

VII CONCLUSION

So far we compared significant number techniques on UC Merced dataset, PCA with perceptron, PCA with poly kernel, PCA with RBF Kernel, PCA with Linear Kernel, PCA with RF, PCA with Decision Tree . Among them Decision tree noted highest accuracy and remaining techniques noted more than 85% of Accuracy with respect to classification of images**.** So we concluded that features considered are good enough for classification and Decision tree classifies the images with 100% accuracy.

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