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Deep Learning for Logo Classification

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Abstract

Logos are the brand ambassadors of any company or the organization which serves as the identity of it in many of the ways. Logos plays a distinct and significant role providing information about the documents of the particular organizations. Logos can be classified based on the size, texture, color, information, shapes and many other factors. In this work here, we mainly focus on classification of different types of logos in two stages of classification systems using Deep learning and KNN with Gabour and SIFT features respectively. The advantage of the proposed method is that the two stage classification yields better results and the accuracy with the classification of testing images is high.

Keywords: Logo Classification, Feature Extraction, Deep Learning, KNN, SIFT

1. Introduction

Logo is one of the vital information used to represent public merchandise or ideas of their organizations. In recent days, the logo plays a distinct and significant role to providing information about documents for particular organizations, whether it is government or business. It is the easiest and technical way to signify their ideas by using these graphic marks of logos. There are three types of logos they are like: few are includes only text called as 'text logos', few are includes only graphics called as 'graphic logos', and few are combination of both text as well as graphics which are known as 'mixed logos'. There are plenty of logos present in the world but each

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and every logo is unlike from each other and gives uniqueness. And logos are used to check the authenticity of an items or products. In early days many companies, offices and hospitals etc.., are maintained their information as documents in printed form which resulted in increase of size of the documents, parallel the number of problems were arises like takes a long time to searching a particular documents and it takes a large space to keep them. Generally documents or certificates contain a text, tables, diagrams, titles, seal, as well as logo and other elements. Among those, logo is a key visual feature to easily identify and classify the documents and decide to which company or hospitals belongs to. Using this approach have to saving time and avoid to reluctance from workload.

In Document Image Analysis and Recognition and the Pattern Recognition (DIARP), the concept of Logo classification is one of the very motivating topics by applying Deep Learning technique. Deep Learning is also called as 'Hierarchical Learning' because the classification takes a step by step process to removing the unnecessary process. Due to this it achieves classification accuracy at higher level than ever before. The large amount of considered data and substantial computing power is requisite by deep learning. It allows a various process of layers to learn demonstration of data. Deep Learning has a numerous hidden layers in context of neural network so that the term 'deep' is refers to it. The classification of logos by using deep learning technique makes it much easier.

2. Literature Survey

The logo detection and classification system has classified into four steps Logo detection, Segmentation, Feature extraction and Classification.

Hesson andAndroutsos (2008) has designed a system for classification of logo, the method is based on using co-occurrence histogram. The decomposition of Haar Wavelet has been used for the classification and indexing of logos. Arafat, Saleem, andHussain (2009) have proposed a novel scheme for classification of logos by applying various invariant techniques these techniques which were compared with Gradient Location Orientation Histogram (GLOH), invariant moments and Fourier Mellin transform. Among all FMT method provides a less computational time than other methods. Wang and Chen (2009) presented a novel technique based on boundary extension of the function rectangles to detect logos in the image of the document was presented. Initially the logos are detected has the benefit that is free on logo shape. After the logos are detected to decrease the false positive from pool of logos by using simple decision tree classifier, which

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will helps in provides maximum results on a huge size of documents in an existent world.

Hassanzadehand Pourghassem(2011) have described a system to improving detection of logos in an image of document. This novel method work is flows through in mainly three steps. Firstly, by using Horizontal dilation the separated parts of logos are merged in the form of horizontal direction. Secondly, the decision tree classifier is used for classifying logo and non-logo. At last by modifying operation the classifiers of decision tree are modified. Hassanzadehand Pourghassem (2011) have presented a framework for application of separated part of logos is proposed, which is based on spatial and structural features for the purpose of detection process by applying the bounding box. To merge the separated part of part of logos by using the morphological dilation operation and also increase the performance of detection rate. KNN is used to identifying the detected logos.

Rusinol, Andecy, Karatzas and Lladós (2011) have proposed to develop a method for dividing the document image. There are two methods are implemented which is based on bag of visual words and the other is use of sliding window technique. Saipullah, Ismail andSoo Y (2012) have presented a method for classification of Halal logos using a Fractionalize Principle Magnitude (FPM) extractor to evaluate the performance of feature extractor to considering both accuracy and time consumption parameters. At last Halal logo classification can be done by applying 5-fold across confirmation system to provide accurate results. Ali Bagheri andGao Q (2012) have described a method for developing a logo recognition application by applying multi class pairwise classification. The proposed system makes the speed of nearest neighbor classification algorithm and achieves better classification accuracy i.e LCO technique. Lei, Thing, Chen and Lim(2012) have described a technique which is mainly focus on classification of logos using both local edge based descriptor (DAISY) and spatial histogram. To recognize the location of logos with the help of spatial histogram and for the object detection by using saliency map. Support Vector Machine classifier is applied to classify the logos. Nejad and Faez (2012) have been presented a method by using pyramidal tree structure for segmenting the documents pages in horizontally and vertically. In this method they have to identify the particular position of logos with the help of pyramidal tree image. Then logos can be extracted through extension of boundary feature rectangle. For the purpose of feature extraction eliminating the skew angles and normalized the size of

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logos. Finally logos are recognized by using KNN classification.

Pourghassem (2012) has presented a technique for logo recognition and detection. Here Threshold based and Wavelet based algorithms are used to segmenting the document image. Two Multilayer perceptron classifier and K Nearest Neighbor classifier are used to divides the document image like text, picture, and logo region in a hierarchical structure. Alaei, Delalandre and Girard (2013) has described a scheme for finding of logos based on the piece-wise painting algorithm (PPA). Here the proposed work is flows through at coarse level. For the purpose of classification, the Nearest Neighbor classifier has been used. Le, Visani, De Tran and Ogier (2013) have proposed a technology is inspired on logo spotting and the logo recognition, the documents will be categorized. Firstly, extract the key points by both logos and test document image based on key point matching. SIFT features are extracted from key points matched logos. Then using spatial density based clustering method the segmentation has been performed. And an important step in this methodology is sort out the coordinated key points as a post processing by Homograph using RANSAC.Susmitha andPadmalatha (2014) have presented a novel method to detect logos on the basis of context dependent similarity kernel and then match with the reference logos. Fidelity term is used to measure the feature matching quality for matches the logos with the reference logos. Soma and Dhandra (2015) has proposed a new approach that is logos are detected and extracted from document image using boosting strategy. The logo recognition system contains three steps: Pre-processing, Feature extraction and Feature matching. After completed those process measure the similarity parameters of feature matched logos by using Euclidian distance. Finally the results are compared with Nearest Neighbor, K Nearest Neighbor and the Support Vector Machine classifiers. Dixit and Shirdhonkar (2015) have presented a method for automatic extraction of logos. In a future method logo can be extracted by using the method is morphological operation. Gray level and color information are supports for extraction of logos. Dixit and Shirdhonkar (2016) have developed an automatic method for detection and extraction of logos from the image document to calculate the thickness of black pixel in a logo by using SVD.

Oliveira, Frazão, Pimentel and Ribeiro (2016) has described technique an automatic graphic logo detection system. The proposed system involves convolutional neural network is allow for the detection of various graphic logos and this representation is trained with huge amount of dataset. Bianco, Buzzelli,

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Mazzini and Schettini (2017) presented a framework for deep learning logo recognition. Although it is not exactly placed, their study claims that the recognition pipeline comprises of the logo area proposal and the specifically trained Convolutional Neural Network (CNN) for logo categorization.

Velazquez, Gonfaus, Rodriguez, Roca, Ozawa andGonzàlez (2021) has presented a logo detection method in which they have enhanced Detection Transformation (DETR) which does the detection of the object as a set-prediction problem openly in an end-to-end fully differentiable pipeline without demanding priors. Since the DETR-FP technique only provides up to 30% relative improvement, there is still tremendous potential for improvement. Here in the review of literature we noticed that the methodologies followed for the document analysis and classification were restricted because of not all methods addressed the optimized level of feature fusion. Also the single stage of classification was limited with its classifier which resulted limitations of classifying logos across different groups.

In section III, we describe the proposed methodology which comprises of primary classification and secondary classification. Primary classification explains with the preprocessing, Gabor Feature extraction method and use of Deep learning for the classification. Secondary classification explains with the preprocessing; SIFT technique for feature extraction and KNN classifier for the classification. Section IV describes the results and the dataset used for the experimentation. The concluder remarks are noted in the section V.

3. Proposed Method

In this presented work, we have proposed two stage classification system called primary and secondary. Initially for both classifications, the given images are preprocessed using basic image processing operations like Noise removal and binarization. In Primary classification, we extracted the Gabor features and fed into Deep learning classifier for the purpose of classification of General classes of Logos. The primary classification results are fed into secondary classification to check the inner class of given logo. Here, the SIFT features and KNN classifier are used and it is illustrated in the following block diagram Figure 1.

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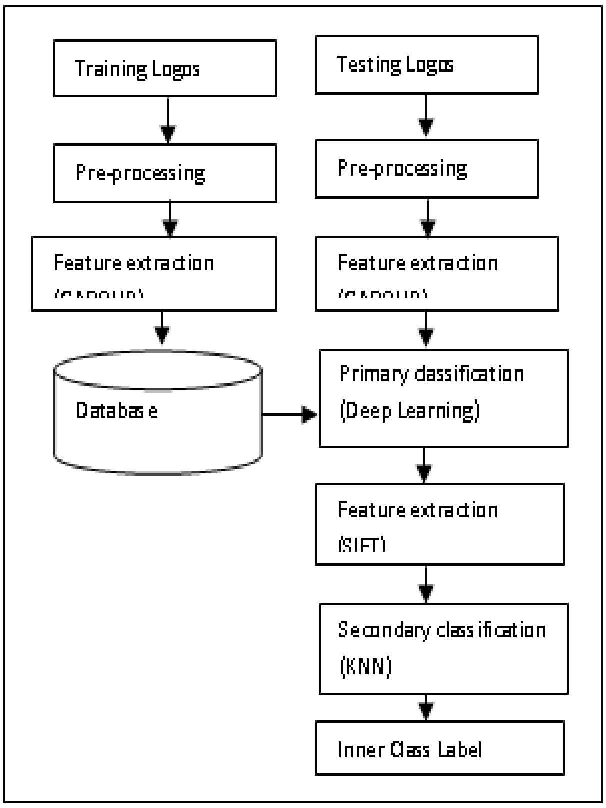

Figure 1 Overview of proposed method

3.1 Primary Classifications

Primary classification is the first stage of classification in the proposed system. Here we classify the given input images into its generic class. The considered generic classes for the experimentation are like Company Logos, College Logos, Cricket Association Logos, Hospital Logos, State Government Logos and Television Logos. Here we emphasize the art of feature extraction using Gabor features and these extracted features are fed into Deep Learning to classify the General classes of Logos.

a) Preprocessing

The data sets of different groups were considered and the noise removal process was carried out on all logo samples. Followed by the binarization were performed on the preprocessed logos and it was stored for feature extraction process.

b) Gabor Feature extraction method

The Gabor feature method is used for extracting the texture feature from the preprocessed logos. It's also called as a linear filter because it linearly analyzes the features. The Gabor feature estimates the particular frequency content in the logo in an exact direction. These filters are used in the form of wavelets that are openly linked to the Gabor filters. So, that number of openings and rotations can be designed. The wavelet consuming a more time, and which consists a Gabor filters with different rotations and scales are developed. And these filters are intimately related to the signal to make a Gabor space, in that primary visual cortex is directly related to this method.

c) Deep Learning

In Deep learning, increasing layer learns to transmit their input logo information into a more abstract and complex representation. Deep Learning (DL) technique

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is evolving as a promising branch of machine learning that demonstrates high-level abstractions which have multiple nonlinear transformations. Convolutional Neural Network (CNN) is one of the DL frameworks that have proven its capabilities in the field of image classification and the pattern recognition. In this section, the use of Convolutional Neural Network for blur type classification has been demonstrated .Currently, all the pattern recognition models in the domain of audio, visual or text are driven by the hand crafted feature sets, but in the case of image data it is not able to match the human capabilities of pattern recognition. To address this issue a good percentage of researchers working in pattern recognition field are exploring the might of Deep Learning and CNN in particular for image applications and his team are actively working on deep learning algorithms which automatically learns feature representation (from unlabeled data) thus saving from of time-consuming manual feature learning. CNN framework is developed and inspired by the human brain. Computation of the algorithm is based on massive artificial neural networks.

Architecture

CNN is layered with Convolutional layer and sub-sampling layer and finally their output is given as an input to fully connect the neural network.

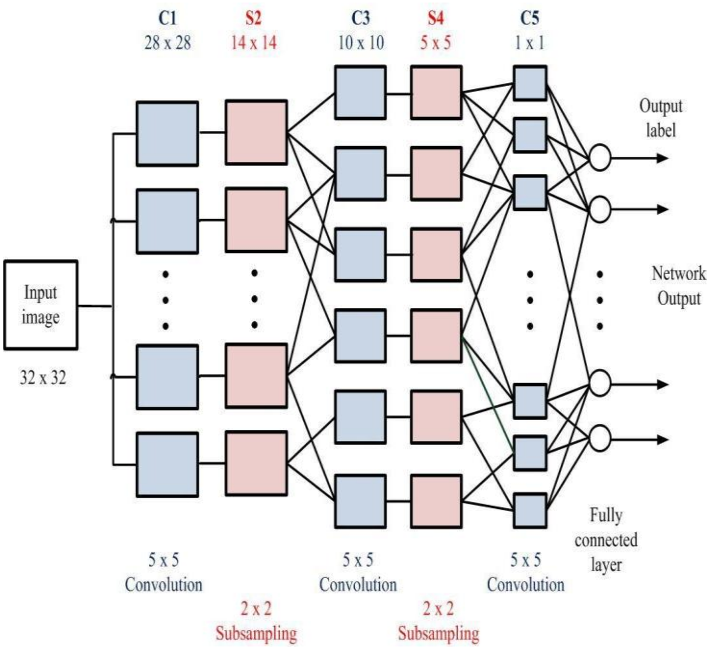

Figure 2: Architecture of CNN

The CNN architecture shown in Figure 2 accepts an input image of size 32x32pixels and there are totally six layers.

- First layer is Convolution layer C1 uses the 6 convolutional kernels of size 5x5. It generates six feature maps, each of which is 28x28 pixels.
- Second layer is Sub-sampling layer S2 uses receptive field of size 2x2. This layer produces feature maps of size 14x14pixels. Note that feature maps in a sub-sampling layer always has one-to-one connections to feature maps of the previous convolution layer. Hence the

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number of feature map do not change after the sub sampling layer.

- Third layer is Convolution layer C3 has sixteen convolutional kernels of size 5x5. It produces sixteen feature maps, each consisting of 10x10 pixels.
- Fourth layer is Sub-sampling layer S4 uses a receptive field of size 2x2 and produces 16 feature maps of size 5x5pixels.
- Fifth layer is Convolution layer C5 (Last Convolution Layer) uses the 120 kernels of size 5x5; Convolution layer C5 generates 120 scalar features as a result.
- Final layer is fully connected neural network with 120 input neurons and output having number of neurons depending on the desired number of output classes.

All the weights in the convolutional kernels in the convolutional layers are randomly initialized. During the course of training the filter weights get updated by back propagation method. After the training is over the CNN is expected to feed in the values to the fully connected neural network which is semantically richer than the raw images.

3.2 Secondary Classifications

Secondary classification is the second stage of classification in the proposed system. Here we classify the subclasses of Logos which are inherited by the generic class. Here the subclasses for each of the generic class is defined which consists of the logos which belong to the same organization. Some of the subgroups vary like Philips, Amazon, Adidas, KIA belongs to Company Logos. MIT Mysore, RVCE, New Horizon belonging to College Logos. KSCA, GCA, RCA belongs to Cricket Association logos. Apollo, JSS, Fortis, KIMS into Hospital Logos. Government of Karnataka, Government of Uttar Pradesh, and Government of Tamil Nadu into state government logos and lastly the Television Logos sub grouped into Udaya, Suvarana, Public logos. Here we emphasize the art of feature extraction using SIFT method and these extracted features are fed with KNN for the secondary classification

d) Preprocessing

The data sets of different groups were considered and the noise removal process was carried out on all logo samples. Followed by the binarization were performed on the preprocessed logos and it was stored for the feature extraction process.

e) SIFT method

Filter key purposes of document are first removed by the bunch of reference pictures and deposited in the database. Object is

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identified at another image by separately equating each element from the new picture to this database and discovering candidate matching features based on Euclidean distance of its feature vectors. By the full arrangement of counterparts, subgroups of key focuses that cover up item and its area, scale, and direction in the new picture is distinguished with sift through great matches. Assurance of the predictable bunches is executed quickly by utilizing a productive hash table usage of the summed up Hough transform.

Group of 3 or more features agreeing on an object and its pose will then be subject to further thorough model testing and outliers will be discarded. Finally, given the exactness of fit and the number of potential fake matches, the chance that a certain arrangement of highlights reflects the nearness of an article is recorded. Object coordinates that pass through every one of such assessments could distinguish as right with high certainty.

The image is accepted and transformed into a "huge collection of local feature vectors" using the SIFT technique to visual feature extraction. All of these component vectors are resistant to scaling, rotation, and image analysis. These approaches share many features with the neuron responses in primate vision. To help extraction of such highlights, the SIFT calculation performs a 4 phase separating approaches:

- Scale Spacing Extrema Detection
- Localization of Key Point
- Assigning Orientation
- Key point Descriptor

f) KNN for Classification

The non-parametric K-Nearest Neighbors method is used for classification and regression. In either instance, the k closest training samples in the feature space are used as input. Usually, the closeness of points is determined by using distance algorithms such as the Euclidean distance formulation centered on data parameters. The algorithm categorizes a point based on the labels of the nearest neighboring K points, where K's value is specified.

The steps followed to perform K-nearest neighbors KNN algorithm are,

1) Examine the number of adjacent neighbor’s parameter K.

2) Find out the distance amongst all of the training samples and the query instance.

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3) Filter the distance and define adjacent neighbors based on the least distance to Kth.

4) Gather the closest neighbor's category.

5) Using modest majority of adjacent neighbors group as the application instance's predictive value.

4. Experimentation & Results

In this work, for the purpose of experimentation, we have created our own dataset consisting of six distinct datasets of general classes, such as company logos, college logos, cricket association logos, hospitals, state government logos, and television channel logos, as listed in Table 1 (which is displayed at Figure 3).For each general class we created subclasses under the labels of considered 6 different logo classes varies from 100 to 600 totally about 2000 logo images. These subclasses cover the different samples belonging to the same organization.

Table 1 Dataset

Group Name	Logo sample size
Company logos	127
College Logos	139
Cricket Association Logos	27
Hospital Logos	17
State Government Logos	28
Television Channels	131

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Figure 3 Samples of the Dataset

The experiment 1 shows the primary classification of logos using Deep Learning. The experimentation is conducted by varying the training percentage of dataset from 30, 50 and 70. Further the images are picked randomly from dataset maximum up to three times. Table II shows the Accuracy under varying training samples. In addition the Graphical Representation is shown in Figure 4. By analyzing the Table 2, we achieved maximum accuracy of 85.76%, 88.98%, 87.91% using Deep Learning.

Table 2 Experimental Results for Primary Classification

	Training Percentage	Random set1	Random set2	Random set3
Primary	30	69.5	70.11	71.89

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Classification	**50**	**78.49**	**80.35**	**79.56**
	70	**85.76**	**88.98**	**87.91**

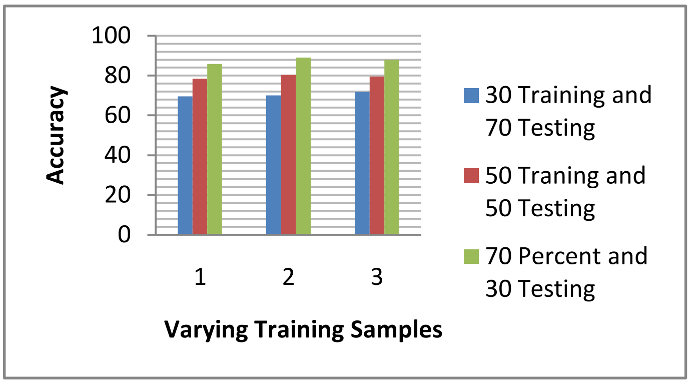

Figure 4Shows the Primary classification's accuracy for various training samples

The experiment 2 shows the secondary classification of logos using KNN. The experimentation is done by changing the training proportion of dataset from 30, 50 and 70. Further the images are picked randomly from dataset maximum up to three times. Here K=1 will be choose for all the experimentation. In the Table 3, it shows the inner classification of logos and the accuracy for company logos, college logos, Cricket logos, Hospital logos, state government logos and Television logos. Respectively the Graphical representation is presented in Figure 5 to Figure7. By analyzation of the tables, the maximum accuracies achieved are 80%, 77.13%, 79.18%, 79.49%, 80.00% and 80.00% for company logos, college logos, cricket logos, Hospital logos, state government and television logos respectively. The results show the superiority of our proposed method.

Table 3 Experimental Results for Company logos, College Logos, Cricket Association Logos, Hospital Logos, State Government Logos, and Television Channels

	Training Percentage	Random set1	Random set2	Random set3
Company Logos	**30**	**61.51**	**65.16**	**70.46**
	50	**67.35**	**71.27**	**69.23**

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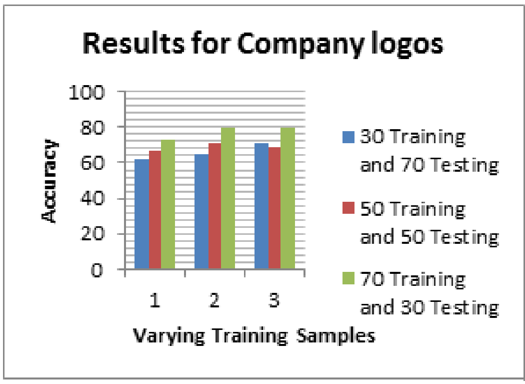
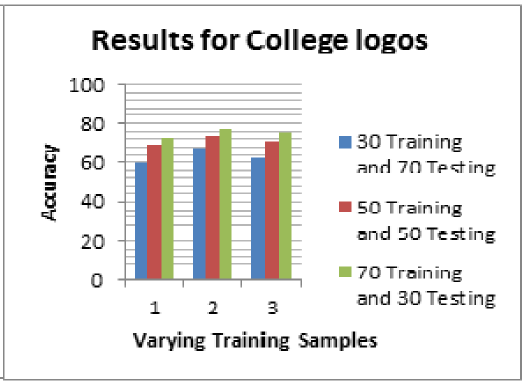
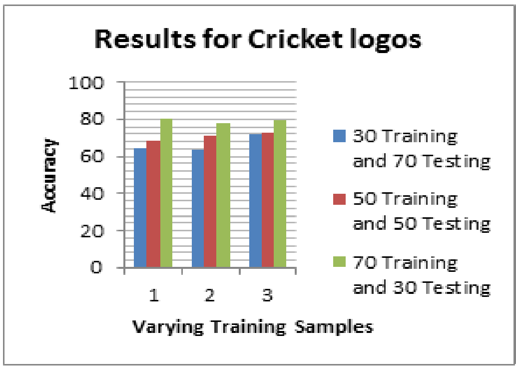
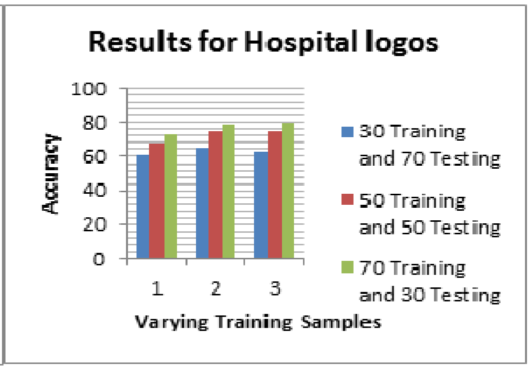
	70	73.19	79.89	80.0
College Logos	30	60.12	67.8	62.54
	50	68.78	73.5	70.65
	70	72.53	77.13	75.30
Cricket Logos	30	64.22	63.34	71.54
	50	68.21	70.89	72.98
	70	80.0	77.64	79.18
Hospital Logos	30	60.87	64.56	63.15
	50	67.6	74.43	75.32
	70	73.01	78.76	79.49
Government Logos	30	60.41	63.34	62.13
	50	67.9	75.65	76.47
	70	78.48	77.93	80.0
Television Channel Logos	30	64.15	61.18	68.27
	50	66.57	77.39	73.78
	70	79.42	77.60	80.0









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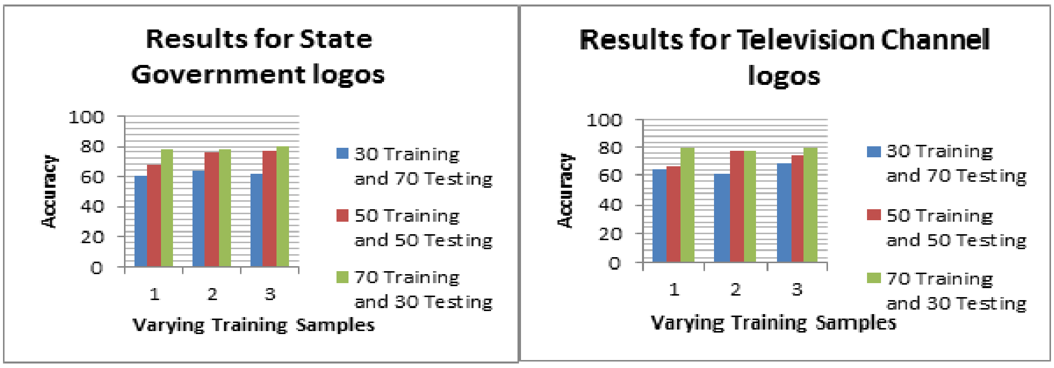
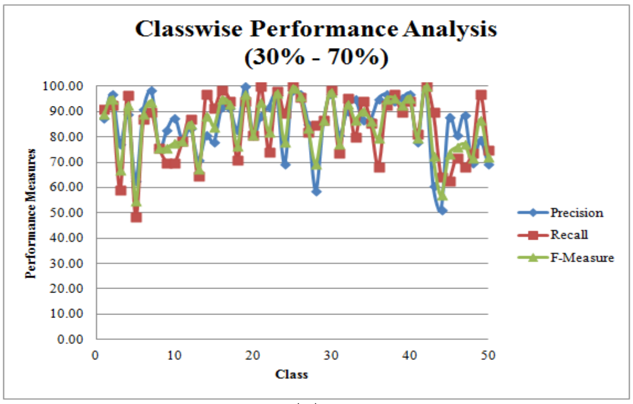
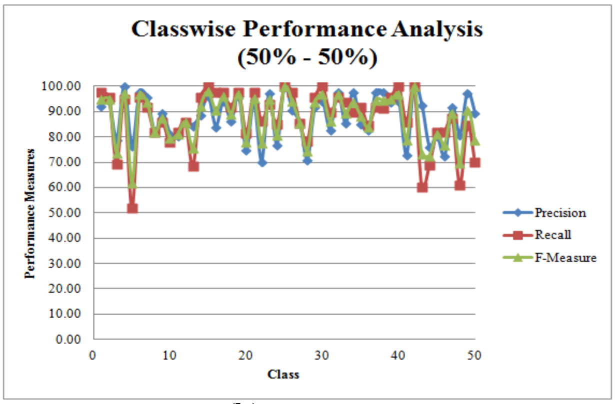


Figure 5 Accuracy of different class logos

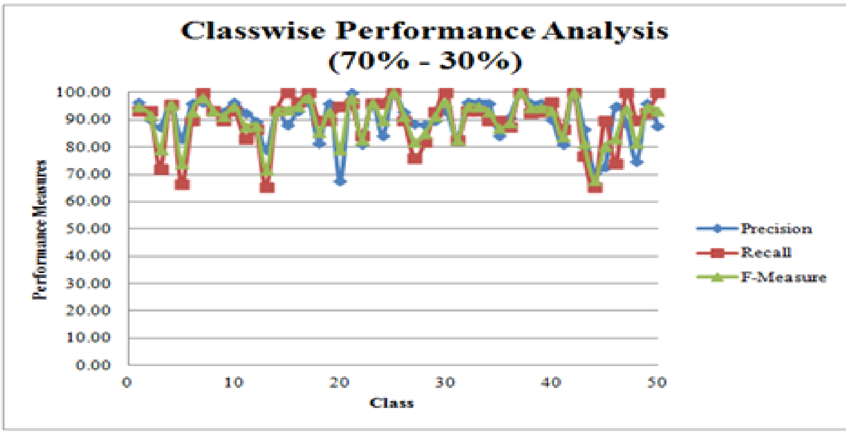
Further, we conducted experimentation on primary dataset and evaluated Precision, Recall and F-Measure. Table shows the Accuracy for different sets of training and testing and Graphical Representation of the tables is shown in Figure 6.



(a)



(b)



(c)

Figure 6 Class wise performance analyses in terms of precision, recall, and F-measure for (a) 30%-70%, (b) 50%-50%, and (c) 70%-30% train-test samples

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In addition, we also compare the results of Pre-Trained Models like VGG-16, VGG-19 and RESNET shown in Table 4.

Table 4 Comparison Results of VGG 16, VGG19 and Resnet

	Precision	Recall	Fl-score
VGG 16			
Company logos	0.71	0.69	0.7
College Logos	0.66	0.86	0.74
Cricket Association Logos	0.71	0.34	0.46
Hospital Logos	0.57	0.24	0.34
State Government Logos	0.56	0.59	0.58
Television Channels	0.62	0.45	0.52
VGG 19			
Company logos	0.88	0.85	0.87
College Logos	0.86	0.95	0.9
Cricket Association Logos	0.95	0.6	0.73
Hospital Logos	0.86	0.48	0.61
State Government Logos	0.83	0.81	0.82
Television Channels	0.75	0.77	0.76
RESNET			
Company logos	0.78	0.77	0.78
College Logos	0.82	0.86	0.84
Cricket Association Logos	0.79	0.54	0.64
Hospital Logos	0.74	0.33	0.45
State Government Logos	0.76	0.57	0.65
Television Channels	0.78	0.77	0.78

VGG19 is the best method for classifying logos on the Logo dataset based on accuracy and F1 scores. The first claim that pretrained models had significant cost and resource advantages over models created from scratch is still very much accurate.Our best model is our fine-tuned VGG19 model with transfer learning, image augmentation, and learning rate annealing, which gives us a model accuracy of 83% and F1-score of 82%, considering we trained our model from our image training dataset. The basic CNN model consumed resources, was expensive to compile, and required extensive hyper-parameter tuning to reach these results.

5. Conclusion

In this paper, we have proposed method for logo classification using two stage classifications. In primary classification, we used Gabor feature extraction and Deep Learning classifier. Further for secondary classification, we used SIFT feature extraction and KNN classifier. The experimentation is done with the own dataset. Here the primary classification is done to identify the generic class to which the given image belongs to. Then the secondary classification is done which will classify the testing image to a specific kind of sample in that generic class. Thus the proposed method is said to be effective in logo classification and results high compared to other existing methods.

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