IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 1 Issue 10, December 2014.
www.ijiset.com
ISSN 2348 – 7968

An Overview of Content Based Image Categorization Using Support Vector Machine

Apeksha Chaudhari [1],Poof. K .S.Bhagat [2]

[1]P. G. Student, Department of E.C.E, J. T. M. College of Engineering, Faizpur, Jalgaon, India
[2] Assistant Professor, Department of E.C.E, J.T. M. College of Engineering, Faizpur, Jalgaon, India,

Abstract

Image categorization or classification is technique of finding out most prominent features of image to the query image and with the help of these features classifying image. Image classification is vital field of research in computer vision. Increasing rate of multimedia data, remote sensing and web photo gallery need a category of different image for the proper retrieval of user. Various researchers apply different approach for image classification such as segmentation , clustering and some machine learning approach for the classification of image. Content of image such as color, texture and shape and size plays an important role in semantic image classification. But the proper selection of feature are challenging task of classification, so various authors apply some machine learning approach for image classification such as decision tree, RBF network, Markova model and support vector machine. We propose a novel approach for content based image categorization using Support Vector Machine (SVM). Traditional classification approaches deal poorly on content based image classification tasks being one of the reasons of high dimensionality of the feature space. Using SVM we attempt to construct a mapping between the low level and the semantically level in order to determine which category an image belongs to.

Keywords

Image classification,Support Vector Machine, Feature extraction, Machine Learning

1. INTRODUCTION

Image information systems are becoming increasingly important with the advancements in broadband networks, high-powered workstations etc. Large collections of images are becoming available to the public, from photo collection to web pages, or even video databases. Since visual media requires large amounts of memory and computing power for processing and storage, there is a need to efficiently index and retrieve visual information from image database. Image categorization is an important step for efficiently handling large image databases and enables the implementation of efficient retrieval algorithm. Image classification targets to find a description that best describe the images in one class and distinguish these images from all the other classes [1]. Efficient indexing and retrieval of large number of color images, classification plays an important and challenging role. The main focus of this research work is devoted to finding suitable representation for images and classification generally requires comparison of images depending on the certain useful features .Image categorization is the process of grouping of similar types of image into a single unit i.e. called cluster of image. So the categorization is a very exciting task to find exact result. To improve the result of classification, extract the related feature of image, because of this we also get good accuracy [2].

SVM was first proposed by Vapnik and is gaining popularity in field of machine learning due to many attractive features and to show practical performance [3]. Its performance in classification of image is better than other data classification algorithm. It is mainly used in real world problem like voice recognition, tone recognition, text categories, image classification, object detection, handwritten ,digital recognition, and data classification [3].

2. IMAGE FEATURES

A number of image features based on color and texture attributes have been reported in literature. Although quantifying their discrimination ability to classification problem has not been so easy. Among the many possible features for classification purpose, extracted from an image, we limit our self to ones which are global and low level features. The simplest way to represent an image is to consider its bitmap representation.[4]

2.1 Color Feature

Color is one of the most important features in CBIR. It is most widely used for both human perception & computer vision [5]. In color feature extraction mainly image histogram value calculated. Image histogram is a graphical representation of an image. As we know image is a collection of pixels i.e. row and column, so the image histogram shows the proportion of pixels of each color within the image. Image histogram for each image is then stored in the database. At search time user can specify the desired proportion of each color .Image histogram shows how many times the particular colors occur in image. The main advantage of histogram is variation in scale, rotation &translation of image.

Currently RGB i.e. Red, Green, Blue color model is used in digital image because it is more convenient for displaying image in CRT. But it does not give good result in CBIR so we use HSV which is mostly used in CBIR system. In this color should be matched with human expectation. In this, Hue represents different colors, saturation represents percentage of white color and Value

ISSN 2348 – 7968

represents light intensity. Advantages of HSV are suitable with human perception [6].To calculate image histogram, image is converting into RGB to HSV space then each color pixel divided into levels this process called quantization. Here each level shows the number of time each color occurs in an image. In this paper, we use color histogram which in HSV color space as color feature. HSV color space attempts to describe perceptual color relationship more accurately than RGB space, while remaining computationally simple. The H, S, V stands for hue, saturation and value separately.

A histogram of an image is produced first by discretization of the colors in the image into a number of bins, and counting the number of image pixels in each bin. In our method, we quantize H, S, and V into 16, 4, and 4 bins, therefore we can get a 256 dimensional color feature vector. From the Fig.1, it demonstrates that although the images are classified in the same class by human, their color histograms are different obviously. It means that in the low-level space, they are not in the same class.[7]

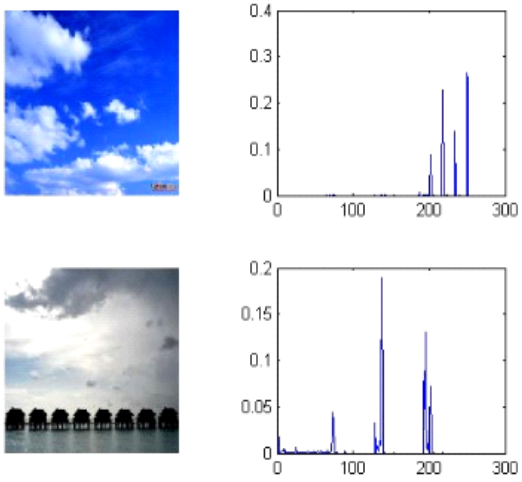

Fig.1 Color histogram of image

2.2. Texture

Texture refers to a structural collection of pixels of an image. Many features of image can be extracted by texture features. For texture feature extraction in 1973, Haraclick proposed Gray level co-occurrence matrix (GLCM). He proposed some parameters for texture extraction [10].

- Contrast (Moment of inertia): Image contrast can be a sharpness of image. Contrast is higher when image grooves are deep [6].
- Energy: It can be measure by gray distribution of image. Coarness of image depends on high energy level [6].
- Entropy: It is a quantity which is used to describe the amount of information of an image. If entropy level is low, then image having more black area. An image that is perfect having entropy zero [10].
- Correlation: It is used to calculate the degree of similarity of the elements of image [6].
-

2.3. Shape feature

It represents visual content of an image. We can easily recognize shape of an object, as every natural or manmade things have their own shape [6]. The database contains different varieties of shapes that are computed by many objects and at search time user can easily identify desired shape. There are two
types of shape features, Global Feature- aspect ratio, circularity and moment invariant, Local feature-Boundary segment . Shape feature queries apply for both example image and user drawn image [10].Shape feature can be divided into 2 categories [10]:

- Boundary based: Outer boundary of object is calculated.
- Region based: Entire region i.e. area covered by object.

3 FEATURE EXTRACTION

It is very important step for image classification in CBIR. In this, all the relevance or irrelevance features of image are extracted and on the basis of this classification of image performed. Basically feature extraction is a process of mapping image from image space to feature space. Feature space is a type of input space where similarity measures with the help of kernel function.

In digital image, basically there are many feature like color, shape, text, size and dimension etc. which are mainly used for feature extraction but extracting those feature which are more relevance to our work in difficult task. The output given by this step is in the form of vector [11] [12 [13].Basically image features can be divided into 2 parts-

1. Visual Features
2. Semantic Features

Feature which are extracted by human vision are called visual feature. They are further divided into-

1. General Features
2. Domain specific

General features are those which can be used for searching like color, shape, texture and feature which are used for particular domain and have knowledge about them [13].For example, we are searching for face of girl which belongs to human category, so here domain is human. Another one is we are searching for elephant which belong to animal category. These features are domain specific [11].

ISSN 2348 – 7968

Some features are semantic which are very difficult to extract. Semantic features are those which have same meaningful information about image. In this category mean value, RGB value, Histogram value, Standard deviation and entropy are belong. These features are not easy to find [11]. So to analyse the set of feature with the help of input data is called feature extraction

4. IMAGE CATEGORIZATION METHODS

Image classification is one of the important and complex processes in image processing. There are several image classification methods. The two main image classification methods are supervised classification and unsupervised classification.

4.1. *Supervised classification*

Supervised classification requires prior information before testing process and it must collected by analyst. In this analyst identifies representative training sites for each informational class and also here algorithm generates decision boundaries. Commonly used supervised classification approaches are parallelepiped, minimum distance to mean and maximum likelihood. The steps in supervised classification approach are:

- Training areas for each informational class are identified by analyst
- Signatures identifies(mean, variance, covariance, etc)
- All pixels are classified
- Map Informational Class[14]

4.2. Unsupervised classification

In unsupervised classification, prior information is not needed. It does not require human annotation, it is fully automated. This algorithm identifies clusters in data and also analyst labels clusters. The steps in unsupervised classification are

- Clustering data
- All pixels are classified based on clusters
- Spectral class map
- Clusters are labeled by analyst
- Map informational class[14]

5. SUPPORT VECTOR MACHINE (SVM): AN OVERVIEW

SVM was first proposed by Vapnik and it gives higher better performance in classification of image than other data classification algorithm. It is mainly used in real world problem like voice recognition, tone recognition, text categories, image classification, object detection, handwritten digital recognition, and data classification. Image classification is the process of collecting similar type of images in a single set. Manual browsing the database to search for identical images would be not practical because there is a large amount of database and it would be increased day by day. To improve the result of classification extract related features, because we also want good accuracy. Previous image retrieval system should consists some problems because users want to complete their search in a single step such as on web, time consuming problems and also some noise should be added to the resulting image. Previously working with neural networks for supervised and unsupervised learning. They show good results when used for such type of applications. Multilayer perception uses feed forward and recurrent networks. MLP shows multiple inputs and outputs for universal approximation of continuous nonlinear function.

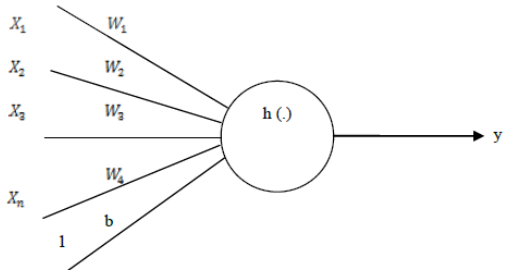

Fig.2 Simple Neural Network

Described some issues noticed:

• Local minima

• Finding how many neurons might be needed for a task ?

• If NN solution come together this may not give result in a unique solution

Now we give the data about X and Y axis and check how many hyper planes are there. For checking which solution is correct is a difficult task. To overcome this type of problem SVM should be used.

A. *Mathematically description of SVM (Support Vector Machine)*

There are several cases in this approach which are given below.

1).*Optimal separating hyper planes:*

A brief description of SVM algorithm is given as follows. Consider a given set of points in the form of training data which separate two classes of pattern based on given training set: S= {(x1, y1), (x2, y2), (x3, y3) ... (xi, yi)} Where xi is a p-dimension real vectors, yi= {-1, +1} and n is a number of sample. According to Vapnik's formula

$y\,i = < w \,.\, x > = b$……1

$=\sum w_i \,.\, x_i + b$

ISSN 2348 – 7968

Where w is a p-dim vector and b is constant or scalar. By adding a scalar value b it increases the margin between hyper planes and in the absence of b hyper planes is forced to pass through the origin. So in SVM we always use parallel hyper planes which maintain distance between them. Parallel hyper planes can be described by equation :

$w . x_i + b = 1$ for $y_i = 1$

$w. x_i + b = -1$ for $y_i = -1$

2) Linearly Separable:

we can select these hyper planes so that there are no points between them and then make an effort to maximize their distance. As we know in feature space there are number of hyper planes but choose the one for which the distance to the closest point is maximal is called optimal separating hyper planes . Since the distance to the closest point is 1. After subtracting the two distances we get the summed distance from separating hyper planes to the nearest points. Maximum Margin = M= 2/ w The quantity 2/w is called the margin and it is used for measure the generalization ability: the larger the margin, the better the find generalization error .

3)Linearly non-separable case:

When the data is not linearly separable we introduce a new variable called as slack variable denoted by ε_i. If We take variable $(\xi_1, \xi_2, \ldots\ldots\ldots \xi n)$ where>=0 such that Yi (w.xi+ b)>=1-ε_i, i=1 ……..N

4) Nonlinear support vector machines: In the non- linear case, we mapped the data into other space with the help of some nonlinear mapping function. This mapping function is called kernel function and space is called Euclidean distance.[15]

As described previously SVM classification is essentially a binary classification technique, but it can be adopted to multi class problems. A multi class SVM classifier can obtained by training several binary classifiers and combining their results. There are two widely used methods which are One- Against -One (1A1) and One-Against- All (1AA).[16]

The 1A1 approach involves constructing a machine for each pair of classes resulting in N(N-1)/2 machines where N is the class number of dataset. Each of these is the SVM trained to discriminate between two classes. Friedman[17] uses Maxwin method to classify a case.

The 1AA approach involves the division of an N class dataset into N Two class cases. To be classified class is a positive sample while the other are negative samples. Then used SVM classifier generates one class result.

In this paper we use the first method as our classifier. We construct N(N-1)/2 training results for each pair of classes. Also using voting scheme the winning class is the one which gets the most votes

6. CONTENT BASED IMAGE CLASSIFICATION USING COLOR FEATURE

S Agrawal *et al.* in Indian Institute of Technology Kanpur, India at 2011 worked on "Content Based Color Image Classification using SVM."They implement classification of image using SVM classifier in the color content of image using optimal hyper planes technique thorough SVM. In this paper, they use color image classification on features extracted from histograms of color components. The benefit of using color image histograms are better efficiency, and insensitivity to small changes in camera view-point i.e. translation and rotation [4].

W Yuan *et al.* in China in 2011 carried out work on "An effective method for color image retrieval based on texture." They proposed that an effective color image retrieval method based on texture, which uses the color occurrence matrix to extract the texture feature and measure the similarity of two color images. [18]

Yong *et al.* proposed the approaches that used to measure color feature. L1- metric and L2-relative metric are the similarity measures for the color histogram [19].

The methods proposed by *Yang et al.* extract the RGB color space and divide it into eight sub-regions. Each sub-region is represented by a color percentage, and if a color percentage of the sub- region is less than a threshold then it is merged by nearest region with same color agents. According to the quantity of each color component, the RGB color space is uniformly divided into 8 coarse partitions[20].

V Karpagam *et al.* (NOVEMBER 2013)carried out work on "Improved content-based classification and retrieval of images using SVM and proposed method in which the RGB image is converted to an indexed image with low level of color detail. All the 16,777,216 possible colors of the RGB space are not perceivable by the human eye. Therefore, the 24 bit color image is quantized to a 256-colour-indexed color image. The color map of only one image of the whole dataset is stored separately to decompose the remaining images of the dataset. A color approximation method is used to do the color mapping and the images will be almost in their original color[21]

N N Khalsa *et al.*proposed a image classification algorithm that use low-level image features such as Color map, edge map, energy level, Threshold ratio & nearest neighborhood classifier for classifying the image into synthetic and natural. In this, a binary classifier will be developed. Given an image, the classifier will extract and analyze some of the most relevant features and combine them in order to generate advance image classification system.[22]

ISSN 2348 – 7968

P Deole *et al.* proposed a content based image retrieval method which is used to retrieve query image from large image database using three features such as color, shape, texture etc. The main objective of this method is classification of image using K-nearest neighbors Algorithm (KNN).[23]

O Chapelle *et al.* proposed a method using SVM for Histogram based image classification Which shows that SVM's can generalize well on difficult image classification problems where the only features are high dimensional histograms . It is shown that it is possible to push the classification performance obtained on image histograms to surprisingly high levels. This is achieved without any other knowledge about the task than the fact that the input is some sort of color histogram or discrete density.[24]

7.CONTENT BASED IMAGE CLASSIFICATION USING TEXTURE FEATURE

There are a lot of researches in the way of visual features extraction: for example texture has been considered as one of the most important features that refer to natural relationship between objects and theirs environment in an image [25][26]. Several authors have worked in finding descriptors and features for texture identification. Existing features and techniques for modeling textures include Bidirectional Texture Function(BTF), a sampled 6D data structure parameterized by position (x,y) as well as light (wi) and view (wo) direction: b(x, y; wi, wo). Essentially, BTFs are textures that vary with view and light direction and are acquired by taking photographs of a material under many view/light configurations.

Kautz *et al*. introduced a set of editing operators that enable the manipulation of view and light-dependent BTF effects. For effective editing, these operators can be restricted to work on subsets of the BTF, e.g., shadow areas, using selections. [27].

Zhao *et al*. have proposed a novel, theoretically and computationally simple approach in which dynamic textures are modeled using Local binary patterns(LBP) in three orthonormal planes within a volume. The texture features extracted in a small local neighborhood from three planes not only reflect the spatial-temporal features, but also are robust with respect to illumination changes. The key problem of dynamic texture recognition is how to combine motion features with appearance features. To address this, a recently proposed method is the volume LBP method (VLBP). But with the increase in the number of neighboring points, the number of patterns for basic VLBP will become very large. Due to this fast increase it is difficult to extend VLBP to have a large number of neighboring points, which limits its applicability [28].

Varma *et al*. investigated the classification from single images obtained under unknown view point and illumination[29]. Some invariant feature descriptors such as Zernike moments among these, Haralick features are the most widely used [30].

In his work, Haralick *et al.* proposed the use of Gray-tone Spatial-dependence matrices also called Gray-level co-occurrence matrices(GLCM) to extract texture features from an image. Since then, GLCMs became widely used for image texture features extraction in many types of applications [31]. The benchmark dataset called Brodatz database is considered [32].

Arnold *et al.* have proposed texture representation that includes Wavelet transform, Monrovian analysis, Geometrical method, Statistical method, and methods derived from them [33][34].

Manjunath *et al.* have shown that image retrieval using Gabor features outperforms that using pyramid-structured wavelet transform (PWT) features, Tree-structured wavelet transform(TWT) features and multi resolution simultaneous autoregressive model (MR-SAR) features [35].

Zhang *et al.* proposed energy distribution, mean, and standard deviation extracted from Gabor filtered image as texture features than the texture vector shifted circularly to be normalized so that the element by Dominate Direction1 to be the first element. In result all images that have a same texture by deferent orientation have a same feature vector; this method is more useful for images that main part of them has a regular surface [36].

William *et al.* proposed texture representation has been done by employing some steerable filters to achieve scale and rotation invariant texture representation [37]. Oriented filters are used in many vision and image processing tasks, such as texture analysis, edge detection, image data compression, motion analysis and image enhancement.

Guang-Hai Liu *et al*. used the spatial correlation of Textons to characterize the relationships between neighbouring pixels and extraction texture features energy, contrast, entropy and homogeneity. This procedure is powerful to detect texture features. [38] [39].

Xiao-Qing Shang *et al.* China in 2003 carried out work on "content based texture image classification." A new method for content based texture image classification is proposed using SVM of the image, which combines the characteristics of Brushlet and Wavelet transform.[40][41]

Yu Zeng *et al.* Wang Chinese Academy of Surveying and Mapping, Beijing , P.R. China in 2012 carried out research on "SVM-based Multi-textural Image Classification and Its Uncertainty Analysis."This paper presents a supervised image classification method which is multiple and multi-scale texture features and support vector machines (SVM). [42]

Tuceryan *et al.* [43] divided texture analysis methods into statistical, geometrical, model based and

ISSN 2348 – 7968

signal processing. This observation has motivated researchers to develop multiresolution texture models.

In the early 70's Haralick *et al.* [44] proposed coocurrence matrix representation of texture feature. This approach explored gray level spatial dependent of texture.

Tamura *et al.* [45] explored texture representation from different angle and proposed a computational approximation on six visual properties like coarseness, contrast, directionality, line likeness, regularity and roughness. The QBIC system and MARs system further improved Tamura's texture representation.

In the early90's, the wavelet transform was introduced for texture representation. Smith and Chang [46, 47]used the statistics such as mean and variance features are extracted from wavelet sub bands as texture representation.

Gross *et al.* [48] used Wavelet Transform together with KL expansion and kohenon maps to perform texture analysis.

Thygagarajan *et al.* [49] combined wavelet transform with coocurrence matrix to take the advantages of statistics based and transform based texture analysis.

Ma evaluated texture image annotation by using various wavelet texture representation including orthogonal and bi-orthogonal wavelet transform, tree structured wavelet transform and Gabor wavelet transform[35].

The texture spectrum was initially used as a texture filtering approach (He and Wang, 1991). The importance of the texture spectrum method is determined by the extraction of local texture information for each pixel and of the characterization of textural aspect of a digital image in the form of a spectrum. Also, Ojala et al. [50] proposed the uniformed local binary patterns (LBP)approach to extracting rotation and histogram equalization invariant features, which was extended by Huang, Li and Wang by computing the derivative-based local binary patterns and applied it to the application of face alignment.

8. CONCLUSION

The purpose of this survey is to provide an overview of content based image categorization. Most of the systems use color and texture feature.content based image classification methods have been used extensively in many areas to improve performance of the system and achieve better results. In this experiment we use combination of different features to train SVM to achieve good performance.

9. REFERENCES

[1] J.Zhang , W.Hsu and M.Lee ," An Information driven Framework for Image Mining","In Proc. Of 12th International Conference on Database and Expert Systems Applications , Munich , Germany , 2001.

[2] J Umamaheswari and Dr.G.Radhamani, "Quadratic Program Optimization using Support Vector Machine for CT Brain Image Classification", IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 4, No 1, July 2012.

[3] D K. Srivastava and L Bhambhu, "Data Classification Using Support Vector Machine", Journal of Theoretical and Applied Information Technology, 2005 - 2009 JATIT.

[4] S Agrawal ,N K Verma , PrateekTamrakar and PradipSircar , "Content Based Color Image Classification using SVM "20 11 Eighth International Conference on Information Technology: New Generations

[5] SHI Dongcheng, XU Lan, HAN Ungyan, "Image retrieval using both color and texture features", The Journal Of China UniversitiesOf Posts and Telecommunications, October 2007.

[6] GuoyongDuan, Jing Yang, Yilong Yang, "Content-Based Image Retrieval Research", International Conference on Physics Scienceand Technology. 2011.

[7] BingxinXu, Qian Yin, GuangjunLv "Using SVM to Organize the Image Database"2009 International Conference on Computational Intelligence and Security.

[8]WAN Hua-Lin and Morsed U.Chowdhury,"Image Semantic Classification by Using SVM",Journal of Software,vol.14,No.11,pp.1891-1899,2003.

[9] He Dong-Chen and Wang Li,"TextureUnit,TextureSpectrum,and Texture Analysis",IEEE Transactions on Geoscience and Remote Sensing,vol.28,issue 4,pp.509-512,1990.

[10] NidhiSingh,Kanchan Singh, Ashok K. Sinha, "A Novel Approach for Content Based Image Retrieval", Procedia Technology 4, C3IT-2012.

[11] Sandeep Kumar, Zeeshan Khan, Anuragjain, "A Review of Content Based Image Classification using Machine Learning Approach", International Journal of Advanced Computer Research (ISSN (print): 2249-7277 ISSN (online): 2277-7970) Volume-2 Number-3 Issue-5 September-2012.

[12] Le Hoang Thai, Tran Son Hai and Nguyen ThanhThuy, "Image Classification using Support VectorMachine and Artificial Neural Network", I.J. Information Technology and Computer Science, 5, 32-38, 2012.

[13] Xiang-Yang Wang , Bei-BeiZhang,Hong-YingYang, "Active SVM-based relevance feedback using multiple classifiers ensemble and features reweighting", Engineering Applications of Artificial Intelligence 26, 368–381, Elsevier Ltd, 2013.

[14]JipsaKurian, V.KarunakaranA Survey on Image Classification Methods International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)Volume 1, Issue 4, October 2012

ISSN 2348 – 7968

[15]SumitiBansalEr. RishamjotKaur,“A Review on Content Based Image Retrieval using SVM ”
International Journal of Advanced Research in Computer Science and Software Engineering Volume 4, Issue 7, July 2014 ISSN: 2277 128X
[16]] G Anthony, H Gregg, M Tshilidzi,(2007)”Image Classification UsingSVMs: One-against-One Vs One-against-All”,.[Online].Available:http://arxiv.org.
[17] Friedman J H,”Another Approach to Polychotomous Classification”, TechnicalReport, Standford University, Department of Statistics, pp.1895-1924, 1996
[18] Wang Xing Yuan, Chen ZhiFeng and Yunjiao Jiao. An effective method for colour image retrieval based on texture. Elsevier B.V. Publication, China ,2011.
[19] T. H. Y. Rui and S. Chang, “Image retrival : Past, present and future," Invited paper inInternational Symposium on Multimedia Information Processing, pp. 1-23, December1997.
[20] W. C. N. Yang and T.Li, “A fast mpeg-7 dominant color extraction with new similaritymeasure for image retrieval," Visual Communication and Image Recognition, vol. 19, pp.92-105, February 2008.
[21]V. Karpaga, R. Rangarajan “ Improved content-based classification and retrieval of images using support vector machine”CURRENT SCIENCE, VOL. 105, NO. 9, 10 NOVEMBER 2013]
[22]N.N. Khalsa, Parag. P. Gudadhe, Dr. V. T. Ingole,“Advance Image Classification System ”International Journal of Computer Science and Information Technologies, Vol. 5 (3) , 2014, 3210 – 3214
[23]MsPragati Ashok Deole,Prof. RushiLongadge,”Content Based Image Retrieval using ColorFeature Extraction with KNN Classification”, International Journal of Computer Science and Mobile Computing, Vol.3 Issue.5, May- 2014, pg. 1274-1280
[24] Olivier Chapelle, Patrick Haffner, and Vladimir N. Vapnik,” Support Vector Machines for Histogram-Based Image Classification”,IEEE TRANSACTIONS ON NEURAL NETWORKS, VOL. 10, NO. 5, SEPTEMBER 1999 1055
[25]Vishal S.Thakare , Nitin N. Patil and Jayshri S. Sonawane ,”Survey On Image Texture Classification Techniques” International Journal of Advancements in Technology http://ijict.org/ ISSN 0976-4860
[26] M.Rahimi and M.Moghadam, “A texture based image retrieval approach using elforganizing map pre-classification," IEEE International Symposium on Signal Processingand Information Technology (ISSPIT), pp. 415-420, December 2011.
[27] J. Kautz, S. Boulos and F. Durand, “Interactive editing and modeling of bidirectionaltexture functions," ACM Transactions on Graphics, vol. 26, p. 53, July 2007.
[28] G. Zhao and M. Pietikainen, “Local binary pattern descriptors for dynamic texturerecognition," In Proceedings of the 18th International Conference on Pattern Recognition,pp. 211-214, December 2006.
[29] M. Varma and A. Zisserman, “A statistical approach to texture classification from singleimages," International Journal of Computer Vision, vol. 62, pp. 61-81, April 2005.
[30] A. Khotanzad and Y. H. Hong, “Invariant image recognition by zernike moments," IEEETransactions on Pattern Analysis and Machine Intelligence, vol. 12, pp. 489-497, May1990.
[31] R. M. Haralick, K. Shanmugam, and I. Dinstein, “Textural features for imageclassification," IEEE Transactions on In Systems, Man and Cybernetics, vol. 3, pp. 610-621, December 1973.
[32] P. Brodatz, “Textures: A photographic album for artists and designers," DoverPublications, 1966.
[33] W. Arnold, M. Smeulders, M. Worring, S. Santini, A. Gupta, R. Jain, “Content-basedimage retrieval at the end of the early years," IEEE Transactions on Pattern Analysis andMachine Intelligence, vol. 22, pp.1349-1380, December 2000.
[34] J. Chen, “Perceptually-based texture and color features for image segmentation andretrieval," for the degree doctor of philosophy, Northwestern University, December 2003.
[35] B. Manjunathi and W. Ma, “Texture features for browsing and retrieval of image data,"IEEE Transactions On Pattern Aanlysis and Machine Intelligence, vol. 18, pp. 49-55,August 1996.
[36] A. W. D. Zhang and G. Lu, “Content-based image retrieval using gabor texture features,"IEEE Transactions, PAMI, pp. 13-15, August 2000.
[37] W. T. Freeman and E. H.Adelson, “The design and use of streerable filters," IEEETransactions On Pattern Aanlysis and Machine Intelligence, vol. 13, pp. 13-18, September1991.
[38] G. Liu and J. Yang, “Image retrieval based on the texton co-concurrence matrix," PatternRecognition, vol. 41, pp. 3521-3527, December 2008.
[39] L. Z. G. Liu and J. Yang, “Image retrieval based on multi-texton histogram," PatternRecognition, vol. 43, pp. 2380-2389, July 2010.
[40] AbhishekPandey, Prof. AnjnaJayantDeen, Dr. Rajeev Pandey,“Color and Shape Content Based Image Classification using RBF Network and PSO Technique: A Survey”
[41] Xiao-Qing Shang, Guo-Xiang Song, Biao Hou. Content based texture image classification. IEEE,Proceedings of the Second international conference on machine learning and cybernetics, Xian, november2003.
[42]Yu Zeng ,Jixian Zhang , J.L. Van Genderen , Guangliang Wang. SVM-based Multi-textural Image Classification and Its Uncertainty Analysis. Chinese Academy of Surveying and Mapping, Beijing ,P.R.China

ISSN 2348 – 7968

.International Conference on industrial control and electronics engineering, 2012.
[43] .Tuceryan M, Jain A.K, "Texture Analysis handbook of Pattern Recognition and Computer Vision,1994.
[44] Haralick,R.M., Shanmuga, K. and Dinstein,I"Textural Features for Image Classification", IEEE
Transactions on Systems, Man and Cybernetics, vol. SMC3, .(1973), pp. 610-621.
[45`] H. Tamura, S. Mori and T. Yamawaki, Textures Corresponding to Visual Perception, IEEE Trans.
syst. Man Cybern, SMC- 8(6), 1978, pp, 460-473.
[46] J. R. Smith and S.-F. Chang, Visually searching the web for content, IEEE Multimedia Magazine
(3), 12–20, 1997. [Columbia U. CU/CTR Technical Report 459-96-25]
[47]. J. R. Smith and S. F. Chang, Transform features for texture classification and discrimination in large image databases, in Proc. IEEE Int. Conf. on Image Proc. 1994.
[48]Cross,G.R., Jain, A.K., Markov random field texture models, IEEE Trans. Pattern Anal. Machine Intell, PAMI-5(1), 1983, 25-39.
[49] K. S. Thyagarajan, T. Nguyen, and C. Persons, A maximum likelihood approach to texture
classification using wavelet transform, in Proc. IEEE Int. Conf. on Image Proc., 1994.
[50] B. Vijayalakshmi, V. SubbiahBharathi," A Novel Approach to Texture Classification using
Statistical Feature"