A Review of Web Image Mining Tools, Techniques and Applications

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Abstract – The most appropriate source of finding data is the digital database. Digitization has happened in almost every sector and this has led to tremendous growth in easy access of huge data. The data does not have to be only in the form of texts. It can be in the forms of audio, videos and even images. People who have to make decisions on a daily basis are the ones who need to access the pre-existing databases for better information. The process of finding out relevant information from already existing images in the implicit and useful databases is called image mining. This method is being employed in almost every sector including agriculture, remote sensing, medical diagnosis, space research and others. The focus of this thesis will be on the applications of image mining and it will also study the existent material on this topic to understand the concept of image mining better.

Keywords- Web Image Mining; Mining Colour Images; Medical Diagnosis

I. INTRODUCTION

Storage technology and acquiring images have become easier today because of the big development in the technology that supplements these two functions. This is why extracting information and data that will be useful for people have also become easier. Image mining focuses on the underlying data or patterns and other image relationship which will not be visible to the layman at first look. [24] While some people claim that image mining is simply a subset of data mining, it is not true. Image mining is a disciplinary in itself and uses plenty of technological innovations like artificial intelligence, computer vision, image extraction, digital image processing, image learning and data mining as well.

There are issues in image mining and its applications which have been discussed by Wynne Hsu, Mong Li Lee and Ji Zhang [60]. They also focus on image mining framework and have developed certain guidelines for what the future of image mining holds.

The biggest challenge with image mining is working with a low-level resolution picture to bring about some of the biggest data that in lying beneath the picture. There are objects and relationships which can be revealed if the image mining is done properly on a low resolution picture. A proper framework for extracting information from a image has been developed by Ji Zhang, Wynne Hsu and Mong Li Lee [23]. They have given four stages for the same: Pixel Level, Object Level, Semantic Concept Level, and Pattern and Knowledge Level. The information is important and that can only be maintained if there are proper indexing schemes and retrieval techniques incorporated in the process. There are different of images that could produce information and data if processed properly. Ji Zhang, Wynne Hsu and Mong Li Lee [24] have developed different frameworks for understanding both the function-driven images and information-driven images as well. Moreover, they have even pointed out the unique functions of data mining that will be useful in the future.

Image mining is not just recovering data from images now, it is more than that. innovations are being carried out in the field of image mining to find out different patterns that will be useful to people. J. Fernandez, N. Miranda, R. Guerrero, F. Piccoli [17] have shown that the parallels between two images can be worked upon to bring about a simple data and this will also reduce other overhead costs of image mining. The first step is always to improve the resolution of the images. Then the images are processed properly for bringing out any kind of pattern or information through data mining.

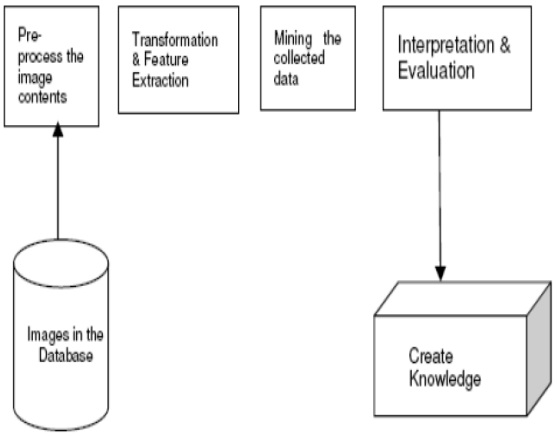

Figure1: Processes in Image Mining

The final result includes the patterns which are then used for different applications.

II. IMAGE MINING LANGUAGES, SYSTEMS AND TOOLS

Mining association rules for images is important to understand and Hassan H. Malik [19] has developed an effective way to facilitate learning this with the language called i-ARM. This language will make it easier to find out association in the images.

This scripting language makes finding association easy as it helps the developed in building a list of source image files which are based on number of terms, filters, confidence and other association parameters. Extracting association rules can be done with easily writable and comprehensible codes which can be developed by people who don't have any prior programming knowledge. The codes can be easily maintained as well. The language iARM can be easily customized according to the requirement of the back-end use. The rules can be developed accordingly using both signal and textual features. These extracted images are the one that show implicit information and relationships between the patterns present in the images. After the data has been extracted, they are further useful in classifying the images in proper order.

Sangkyum Kim, Xin Jin, Jiawei Han [51] has developed another method to chart the information in the images and this is the B2S method, also called Bag to Set. This one retains all the frequency related information and is not like the conventional histogram based log representation. This model has given birth to two distinct processes for classifying images. The first one focuses on the state-of-the-art classification of the algorithm SPM in computer vision. The other one is the *DisIClass* (Discriminative Frequent Pattern-Based Image Classification) which focuses on the image mining algorithms. The latter method was never used before because there are differences in data mining techniques. *DisIClass* uses the locality property of image data. Then it categorizes the data according to the sequential covering method. This method sets apart the discriminative feature and groups them together.

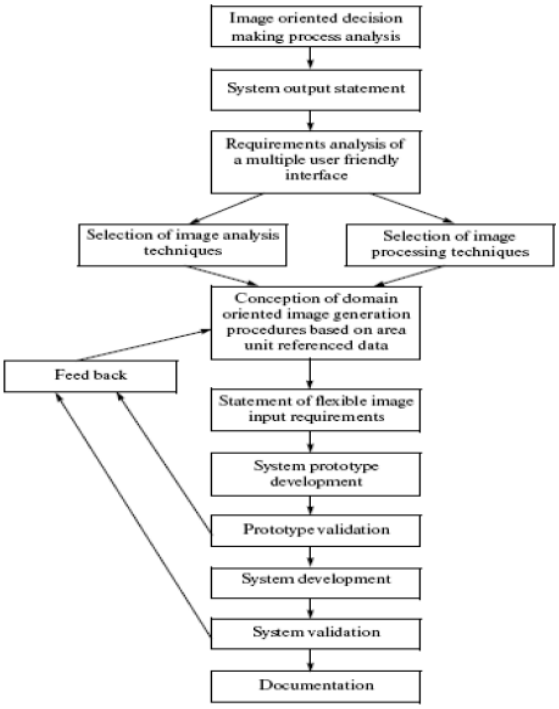

Figure 2: Image Mining oriented Geo-processing System (IMOGS)

Image based decisions can be taken in a better light with the integration of geoprocessing and image mining. This was proposed by R. Guadagnina, L. Santanab, E. Fernedaa, and H. Pradoa [18]. Image based decisions are taken in various domains including healthcare and others. IMOGS model has been shown in figure 2.

The visual content of the images also help in extracting relevant information and this is done through the meta search engine MetaSEEk (shown in figure 3) Ana B. Benitez, Mandis Beigi, and Shih-Fu Chang [1]. MetaSEEk is extremely helpful when the ranking has to be done for various image interfaces online. It ranks everything based on the user interface and their queries.

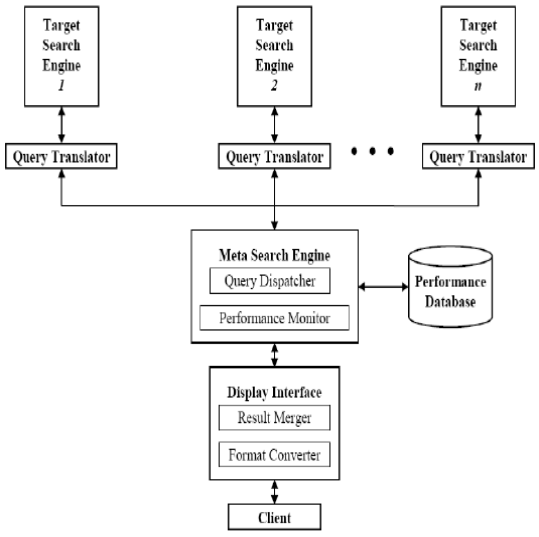

Figure 3: Basic components of a meta-search engine

III. WEB IMAGE MINING

Everyone who needs any kind of information goes to the World Wide Web today. This is the largest database of information on myriad topics. Digital images can be obtained of any scene around the world from the internet or the World Wide Web. However, classifying the various real world scenes into proper order is practically impossible right now because there are tons of information that need to be accessed on a daily basis. A solution has been proposed by Keiji Yanai [28] and it is currently under development. This involves using automatically generated images to catalogue the generic images rather than using hard images of the real world scenes.

The generic image classification mechanism has been described as knowledge acquisition from the huge database of the web [29]. There are three steps in the entire process of image classification. The first one is the gathering stage where the same images of a specific keyword are gathered together from the web using acquisition mechanism. The second stage is called the learning stage and in this stage the information or the important content is extracted from each image. This stage also helps in learning about the class in which it belongs. The third and the important stage is the classifying stage where the images are differentiated based on the specific keywords and the classes.

Measuring 'Visualness' is another important concept which was proposed by Keiji Yanai, Kobus Barnard [15]. The visual content of the images is as important as the information it holds and finding the visualness of the images based on their web positions will be helpful in annotating them.

In web image retrieval, different things can be used and one such important concept is the various modalities between the various images. Ruhan He Wei Zhan [49] has gone deep in his study of the modalities between two important concepts which are keywords and clusters using the multi-model association rule. Image classification in image mining has become an important and complicated topic. Many researchers have worked on this topic and are finding the problems in image classification with Rong Zhu, Min Yao and Yiming Liu [47] coming up with the problem as the distance between the training manifold and test manifold. In order to decrease this complexity in the feature dimensionality, they have come up with the non-linear reduction algorithm of the dimension.

Getting the required information from any image from the web is a difficult task as these images are usually not annotated. An effective method has been proposed by Zheng Chen, Liu Wenyin, Feng Zhang, Mingjing Li, Hongjiang Zhang [61] which uses image mining to bring out the required information. This system of image retrieval can also be known as the search image. The basic concept behind this approach is to bring about the required text information that is associated with every image. Then this information can be used to describe other low quality images on the web via the similarity assessment technique.

There are plenty of image mining techniques but the real challenge is to extract the semantically correct images from the internet. A solution has been proposed for this as well by Chunjie Zhang, Jing Liu, Hanqing Lu, Songde Ma [15]. This includes finding the relevant image with the help of Google Image Searcher. Then the output is then used for knowing more about the image, especially its spatial co-occurrence on the algorithm of the sensitive Markov stationary feature (C-MSF). The bags of word representation and the concept information are then properly integrated to get the proper spatial occurrence of the image on the web. The classification is done with the help of image mining.

E-commerce or e-business has become important in today's world. To have an online presence, every company needs to have an official website and the information is incomplete without proper images. Finding a single image from these image sources can be tough but there are two methods that help in it and these are the classification based retrieval or the colour based retrieval of the images. Since both the methods had some limitation, a better one was proposed by Seong-Yong Hong [53] which is the IIMS. It uses the web e-catalogue image retrieval system which employs user log and metadata. In this, there are various techniques which have been employed to get the user usage patterns like the texture and colour based image classification and also the indexing techniques like the bit vector index. Every user query is tracked and preferences are edited or added based on that to the user image database.

There is another method which collects and stores the images based on the humans who use it. Age estimation is done based on the answers to the queries and then the images are catalogued accordingly. Flickr, the image sharing website is used for the same [38]. For detecting the images of the faces, Active Shape Model is used. This model also eliminates any non-face images. Bio-inspired features are used which recognize the age of the face and then the algorithms tag the images accordingly on Flickr.

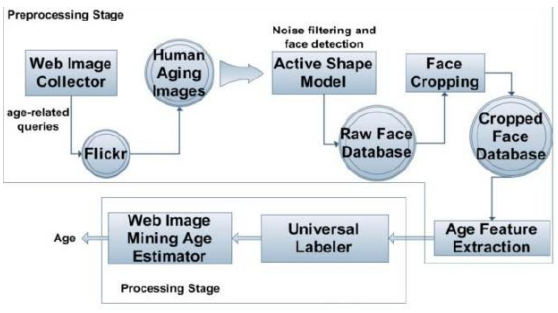

Figure 4: Web image mining using universal labeler algorithm for efficient and effective image labeling.

Another type of image retrieval system was found by Wichian Premchaiswadi, Anucha Tungkatsathan [58] which used joint query and relevant feedback to group images together and this is what is called as the On-line Content-Based Image Retrieval (CBIR). It used high-level and low-level image features to classify the images properly.

IV. MINING COLOUR IMAGES

Recognizing and grouping images based on colour is another part of image mining. A theory was proposed for the same by Aura Conci., Everest Mathias M. M. Castro [7]. The proposed theory used around 5 distance function of evaluation for images and also used 2 types of quantization. HSV-space segmentation technique was developed by D. Androutsos, K. N. Plataniotis and A. N. Venetsanopoulos [2]. This technique helped in recognizing the images that had prominent coloured areas.

Colour vectors are then used to build the right image indices according to the colour scheme each of them has.

A framework which used colour as the main feature and the Colour Moment and Block Truncation Coding (BTC) for recognizing the images and then classifying them was developed by Dr. Sanjay Silakari, Dr. Mahesh Motwani and Manish Maheshwari [50]. The image datasheet was prepared using this method and then the clusters were grouped together to get similar images together.

Another method was proposed which was the colour feature description method by Lukasz Kobylinski and Krzysztof Walczak [35]. The Binary Thresholded Histogram (BTH) was used in this to create a multiple image database.

Colour of the image and the texture are important in image mining and a process that involves both of these features was proposed by Rajshree S. Dubey [46]. The query image is the result of these two features. Two different colour spaces, RGB and HSV are used for the histograms. These histograms are prepared using colour distribution techniques in the entire graph.

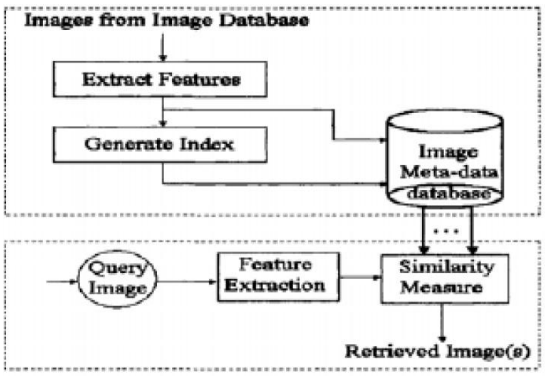

Figure 5: Content Based Image Retrieval (CBIR) System Architecture

2 dimensional colour images have association and this was found by presenting a data mining algorithm which was proposed by Carlos Ordonez and Edward Omiecinski [12]. The 4 main steps of this algorithm are feature extraction, object identification, auxiliary image creation and object mining. They are not based on any significant type of domain knowledge.

Segmentation problem was recognized by Vitorino Ramos, Fernando Muge [57] and they gave a genetic algorithm to figure out the small colour concentration areas of the images and then group them accordingly. This method also used k-means unsupervised for better precision and partition of the images.

In order to use the resources of users for identifying the images and getting the full information on them, Dr.V.Mohan and A.Kannan [39] have proposed a different colour image classification and retrieval method. The steps that are employed to find the right image clusters are Preprocessing, Colour image classification, Preclustering, Texture feature extraction, Similarity comparison and Neighboring target image selection.

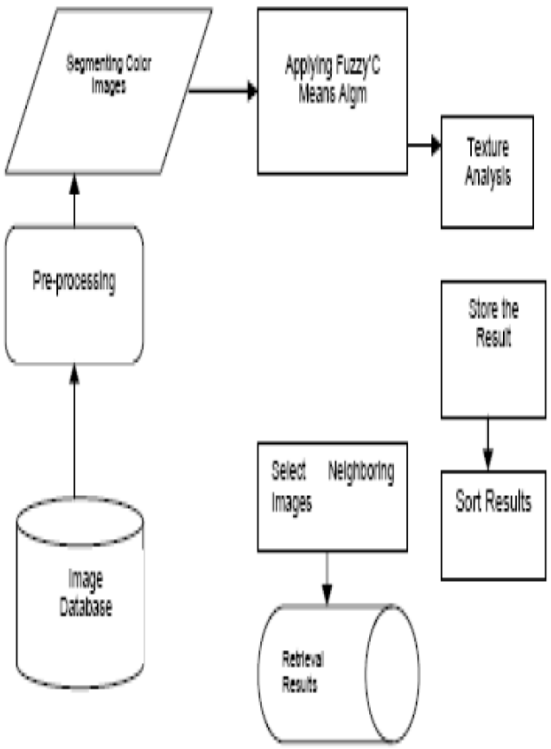

Figure 6: Block Diagram of Colour Image Classification and Retrieval System

V. IMAGE MINING FOR MEDICAL DIAGNOSIS

Magnetic resonance imaging (MRI) is an important procedure of medical sciences. However, another important procedure which is extremely important is the segmentation of Corpus Callosum in midsagittal sections. This part of the brain has

application in both neurology and neurocognitive studies and helps in controlling the behaviour and emotions of the person involved. Thus, the significant part of the image mining process is segmentation of the Corpus Callosum as it helps in learning a lot about the human being. The statistical characteristics are focused on first and an image mining algorithm has been developed by Ashraf Elsayed, Frans Coenen1, Marta García-Fiñana and Vanessa Sluming [5]. The high intensity areas of the corpus callosum are then analysed graphically.

IRIS, Integrated Retinal Information System was developed by Wynne Hsu, Mong Li Lee, Kheng Guan Goh [59] for medical professionals. This method helps in scanning the eyes for any inconvenience which might be faced by diabetic patients.

Detection of tumours in the brain is another important part of the CT scan and the algorithm to help in this was developed by P. Rajendran, M. Madheswaran [45]. The pre-processing technique is the first part which helps in eliminating any type of inconsistent data from the scanned CT Images. Novel Fuzzy Association Rule Mining (NFARM) is the second step that contains all the required information from the CT scan and helps in giving proper diagnosis to the patient. The entire information of the brain scan is then analysed to arrive at a conclusion regarding the scanned images and the condition of the person's brain.

Detection of the tumours in the brains is a major part of the scanning. Since it is the question of a human life, it is necessary that the image mining algorithms which are being developed are accurate. L. Jeba Sheela, Dr. V.Shanthi [21] developed an algorithm that categorises the problematic areas of the brain as normal or abnormal. The abnormal areas are then further analysed to find any brain related disease.

To classify the tumours in the brain, a method was proposed by P. Rajendran, M.Madheswaran [44]. The five stages of this method are: pre-processing, feature extraction, association rule mining and hybrid classifier. The first stage is achieved by filtering the median. The canny edge detection technique is used next to get a clear image. Two image mining techniques are used here to get the proper images from the CT scan. The two methods are the decision tree method and the hybrid method.

The image mining technique has further been applied to breast mammography to get a clear view of any underlying cancerous tissues. The technique was developed by Aswini Kumar Mohanty, Saroj Kumar Lenka [6]. Here the hybrid approach is better used for feature selection of the images. It has been shown clearly in figure 7. The hybrid genetic algorithms reduce the features by 75% and give the image more clarity and precision.

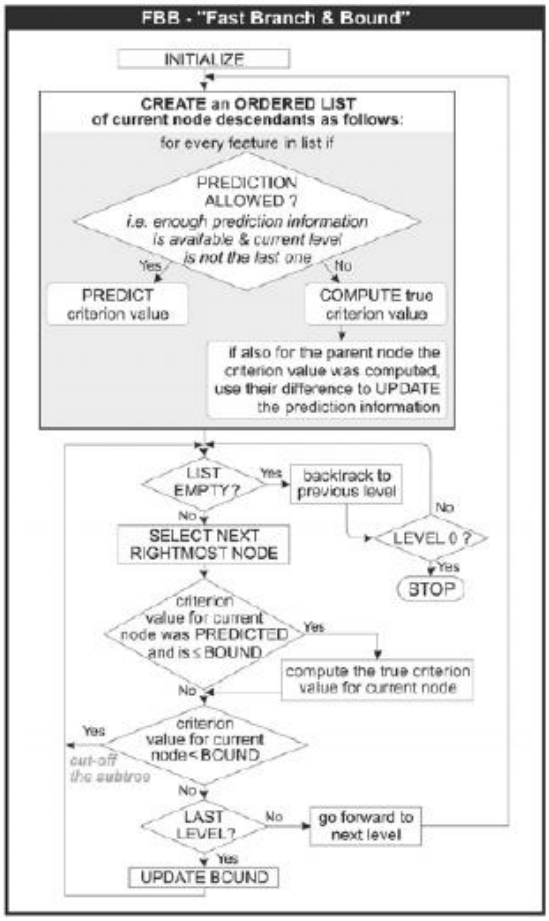

Figure 7: Fast Branch and Bound Algorithm

VI. IMAGE MINING IN VARIETY OF APPLICATIONS

Image Mining in Natural Scene Recognition: Aura Conci., Everest Mathias M. M. Castro [9] shows significant research on patch recognition for natural scene recognition. The relationships between the patches help in getting the required image precision. The example of this is a 'beach' scene which is characterized with sky and sand. The entire collection of images is showed through a spatial pyramid. The patch images are obtained from this spatial layout. Scene categorization is done with classifying these patch images. However, most of these methods do not go in the detail of the patch images and its relationships with each other. The spatial pyramid is used to create the discriminative patch combinations which help in categorizing the images. These patch combinations are then assigned to get the exact adjective and prepositions of the spatial layout. These adjectives and prepositions are then used to describe the images properly.

Image Mining in Remote Sensing: When it comes to application oriented studies, the one method of image mining that has gained recognition is the remote sensing image (RSI). Instead of using a single method, the researchers like Dr. C. Jothi Venkateswaran, S. Murugan, Dr. N. Radhakrishnan [26] have stated that the combinations of statistical,

parametrical and association rules will be more helpful in extracting information from the images.

T. H. Manjula Devi, H.S. Manjunatha Reddy, K. B. Raja, K. R Venugopal and L. M. Patnaik [36] proposed a Universal Steganalysis using Histogram, Discrete Fourier Transform and SVM (SHDFT). The cover image and the stego image have different characteristics.

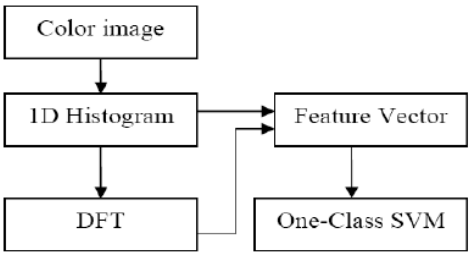

Figure 8: Block Diagram of SHDFT

Algorithm for SHDFT

- **Input**: The test image
- **Output**: SVM classifies the test image as cover or stego image.

1. Separation of the color planes, $c \in \{r, g, b\}$ of the color image.
2. Build Histogram (*1D*) for each color planes $c \in \{r, g, b\}$. Compute the 1st and 2nd moments i.e., mean and variance of the histogram coefficients. This yields *6D* statistics.
3. Build Discrete Fourier Transform for histogram of each color planes, $c \in \{r, g, b\}$. Compute the *1st, 2nd, 3rd and 4th* moments i.e., mean variance, skewness and kurtosis of the DFT coefficients. This yields *12D* statistics. Also compute the total energy for the DFT coefficients. This yields *3D* more statistics.
4. The *1st* order moment Mean of the difference of histogram and DFT is computed for each color channel. This yields *3D* statistics.
5. The feature vectors obtained from steps *2, 3* and *4* yields *24D* features.
6. The feature vectors obtained in steps 5 are used to train SVM to classify test image.

Figure 9: SHDFT Algorithm

Remote sensing is being used by government for various applications including the farming sector and for military imaging. In this images are categorized based on whether they are sensitive to light or not. This is one of the most effective and used method in the remote sensing world for any type of image mining. The algorithms that are in use have proved beneficial in finding the right type of images and classifying it properly. K Perumal and R Bhaskaran [41] have studied the different types of classifier for the purpose and drawn a comparative analogy which shows that the Mahalanobis classifier is the best for the task.

The most common type of imaging that is used for fruit grading is Nuclear Magnetic Resonance or Magnetic Resonance Imaging. The degradation of fruit can be avoided using this technique and it is preferred to the conventional methods. Image processing is the latest trend when it comes to fruit grading. They have investigated and added the k-means algorithms which have made the process of fruit grading more efficient.

VII. TECHNIQUES IN IMAGE MINING

An enhanced transformative approach has been developed by Dr. S.P.Victor, V.Narayani and S.Rajkumar [56] for image retrieval. Compilation of the representative prototypes are used in this image as the characterization of the final image. A vocabulary of N words is formed with the number of visual words in the entire compilation. Word histogram is created with these visual words and they are constructed and evaluated with these two steps: 1) Computation of local descriptors for a set of images 2) Cluster the previous descriptors by K-means. For image recognition, the best algorithm is the SIFT and this is why it is used in this evaluation and compilation as well.

Image retrieval can be done using a highly evolved method as well which uses a lot of semantic features of these photos and a method for the same has been proposed by Peter Stanchev [42]. Fuzzy production rules are employed here as these help in extracting low level colour, features, texts and other graphics and converting them into high level semantic features which can be used for better image recognition and classification as well.

The bag-of-words (BOW) approach has been used as the best framework for object image mining. The image words are employed for the usage as they are encoded in the framework and then used as a patch for recognition of the images. Semantic topics are then used to recognize the different images with the help of the topics given. The setback of this framework is that it can have problems when a lot of vocabulary is used as there are mis-match words as well. The solution of this problem was proposed by Jen-Hao Hsiao, Chu-Song Chen and Ming-Syan Chen [22] which is the novel language bag of word method approach where the vocabulary of the entire collection of images won't be a hindrance.

Another method was proposed by A.Kannan, Dr. V. Mohan, Dr. N.Anbazhagan [27]. This method makes use of the cluster feature and exploits all the information which the image can give to the user. This uses the interaction of the features of the images with the users involved. The different techniques of this method have been shown in figure 10.

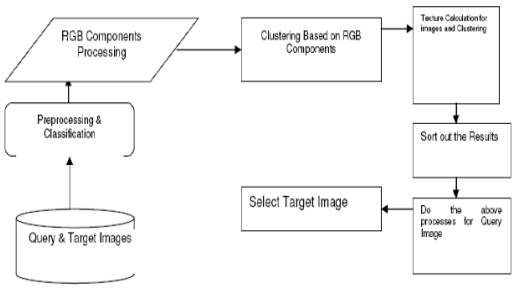

Figure 10: Block Diagram: Image Retrieval System

Canonical relations between the images is also of importance and the right method was proposed by Dipesh Dugar M , Dinesh Kumar Jain N , Raaja Sarabhoje Gopal , Haritha Ravi, Baskaran Alagappan [16]. They developed a proper learning framework for the same.

Spatial algorithm was proposed for image mining by Anthony J.T. Lee, Ruey-Wen Hong, Wei-Min Ko, Wen-Kwang Tsao, Hsiu-Hui Lin [3]. This image mining method was called the 9DLT-miner. Spatial association rules are mined in this one with the help of the 9DLT mining technique as every point has this type of spatial association rule. Then the images are stored respectively in the image database.

The tree method induction was formulated by Kun-Che Lu and Don-Lin Yang [34] for knowing the relation between the given attributes and the various labels on the images. A model was also constructed for mapping out the various data in the pixel-wised image database and mining technique. This data mining technique is highly effective for image mining and processing.

Euclidean distance is used for spatial algorithm in the right manner and the clustering is done properly for this image mining technique. This algorithm was proposed by S.P. Victor, S. John Peter [55].

Theory of Mercer Kernels are used by Dr. Ashok N. Srivastava [4] for proposing an image mining theory that gives automatic knowledge driven image mining technique.

Another theory or framework was developed using the concept lattice and cloud model theory which has been shown in figure 11. This theory was developed by Rupali Sawant [54]. The method of image mining with the help of image features are used here and they have been introduced in this chapter.

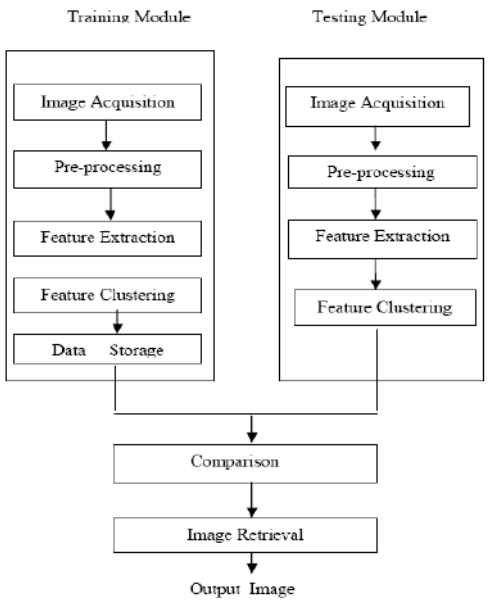

Figure 11: Framework of Image Mining System based on concept lattice and cloud model theory.

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