CHAPTER 2

LITERATURE SURVEY

2.1. INTRODUCTION

Last two decades have seen the arrival of new and deadly diseases which greatly affected the people across the globe. Because of these deadly new diseases, new research works have been carried out in the field of medical sciences to handle the deadly diseases through medicines. But recently, deaths and fatal health problems occur each year due to medication errors which may be due to prescribed, dispensing or administration of a drug. Illegal drugs and pills can be easily made and avoiding such illegal pill distribution is a challenging task. Thus, pill identification system has become an active research area in the field of medical sciences. Usually, illegal drugs are widely circulated in the international market, which is one of the major factors influencing criminal activities which lead to additional enforcement and tracking expense of law enforcement units. Identification of legal and illegal pills can help physicians and patients to have more confidence in the present healthcare system. Researchers have analyzed pill identification systems using several image mining techniques. This improved the accuracy of identifying legal and illegal medicines and can improve the quality of health care system. Various techniques are available in the literature for the assessment and estimation of formulation, quality, correctness, and stability of the solid drugs. This chapter focuses on the analysis of various existing techniques available for pill identification systems.
Figure 2.1: Latency Diagram of Existing Approaches
2.2. IMAGE MINING TECHNIQUES

Numerous research works have been carried on image mining. Developments in the area of image acquisition and storage technique have shown the way for incredible growth in extensively large and detailed image databases. The images which are available in these databases, if examined, can provide valuable information to the users. Image mining facilitates the extraction of hidden information, image data association or other patterns not clearly accumulated in the images. Image mining is an interdisciplinary effort that provides significant application in the domain of machine learning, image processing, image retrieval, data mining, database, computer vision, and artificial intelligence. Research problems in image mining, modern growth in image mining, predominantly, image mining frameworks, modern techniques and systems have to be explored and investigated (Hsu, et al. 2002).

Perner (2002) has discussed the image mining and its application to medical-image analysis. A tool and a technique for data mining in picture-archiving systems have been provided by this author. Knowledge-engineering methods are used to acquire a list of attributes for symbolic image descriptions. An expert describes images based on this list and accumulates descriptions in the database. Decision-tree induction is utilized to discover the expert knowledge, provided in the form of image descriptions in the database. This assembled decision tree provides efficient models of decision-making, which can be investigated to maintain image categorization by the expert. A tool for data mining and image processing is developed by this author and its application to image mining is revealed on the task of Hep-2 cell-image categorization. This tool and the technique are standard and can be utilized for other
image-mining tasks. This method has been implemented in lung-nodule analysis in X-ray images, lymph-node analysis in MRI and examination of breast MRI.

Content based tissue image mining has been proposed by Gholap et al. (2005). High throughput and huge information content are two significant features of any Tissue Microarray Analysis (TMA) system. Tissue image mining is resourceful and faster if the tissue images are indexed, stored and mined for content. A four-level system to exploit the knowledge of a pathologist with image examination, pattern identification, and artificial intelligence has been proposed in this approach. At Image Processing and Information Level, information such as disparity or color is utilized. At Object Level, pathological objects, comprising cell constituents, are recognized. At Semantic Level, arrangement and configuration of individual cells in sheets in a tissue image are examined. At the uppermost level, Knowledge Level, supposition of the expert is specified.

Sanjay et al (2007) has put forth an image mining technique using wavelet transform. It uses common pattern identical, pattern identification and data mining models with the intention that a real life scene/image can be associated with a particular category, assisting in different prediction and forecasting mechanisms. It is a three-step procedure, i.e. image gathering, learning and classification. Since the wavelet transform uses time, frequency association, it can be utilized for image mining as a substitute of Fourier transform. The wavelet transform is utilized to decompose an image into dissimilar frequency sub bands and a small frequency sub band is used for Principal Component Analysis (PCA). Classification assists in recognizing the category to which
an image relates to. They have constructed a prototype system for identification using the DWT + PCA system.

Sheela & Shanthi (2007) have described image mining approaches for categorization and segmentation of brain Magnetic Resonance Imaging (MRI) data. Image segmentation plays a vital role in several medical imaging applications by computerizing or assisting the description of anatomical arrangements and additional regions of interest. Automatic recognition of tumors in several medical images is encouraged by the requirement of better accuracy when handling with a human life. Also, computer assistance is demanded in medical institutions owing to the reality that it possibly will progress, the results of humans in such a domain where false negative cases must be at a very low rate. In their approach they have developed a system which uses image mining approaches to categorize the images either as normal or abnormal and then divide the tissues of the anomalous Brain MRI to recognize brain related diseases.

Image mining approach using clustering and data compression techniques has been projected by Pattanaik et al (2008). Satellite images of clouds play a substantial role in forecasting weather conditions. Frequency of image acquirement ranges from one image per minute to another image per hour based on the climatic environment. These occurrences results in huge collection and creation of the image data warehouse. Permanent storage and transmission of images is a demanding task. In their approach, data mining, clustering method together with Vector Quantization (VQ) is implemented to cluster and compact static color image. Results are shown to demonstrate the findings both subjectively and visually.
Decision tree based image processing and image mining technique has been projected by Kun-Che et al (2009). In their approach, they have developed a common framework depending on the decision tree for mining and processing image data. Pixel-wised image characteristics are extracted and changed in a database-like table which permits a variety of data mining algorithms to make explorations on it. Each tuple of the changed table has a feature descriptor produced by a collection of characteristics in conjunction with the target level of a particular pixel. With the label feature, they adopted the decision tree induction in order to comprehend associations among features and the target label from image pixels, and to build up a model for pixel-wised image processing based on a specified training image data set. Both experimental and theoretical analyses are performed in their study. Their results confirm that the model can be extremely capable and effectual for image processing and image mining. It is estimated that by using this model, various existing data mining and image processing methods could be worked on together in different ways. Their model can also be used to generate new image processing techniques, enhance existing image processing methods, or act as a powerful image filter.

Victor & Peter (2010) have put forth a new minimum spanning tree based clustering algorithm for image mining. The minimum spanning tree clustering algorithm is proficient of detecting clusters with irregular boundaries. The authors have presented a minimum spanning tree depending on the clustering technique using weighted Euclidean distance for edges, which is a vital constituent in constructing the graph from the image. The technique constructs ‘k’ clusters with segments. This approach is very much capable of protecting detail in low variability image regions, while not considering detail in high variability regions which is the main advantage of
this approach. This approach has handled the problems of undesired clustering structure and redundant huge number of clusters.

Dubey (2010) has illustrated about an Image mining method which is dependent on the Color Histogram, and texture of that Image. Color Histogram and Texture are created and in accordance with this the resultant Image is found. They have examined the histogram-based search technique and color texture technique in two different color spaces, RGB and HSV. Histogram search distinguishes an image through its color distribution. It is revealed that images retrieved by using the global color histogram possibly will not be semantically related, although they share comparable color distribution in some results.

Rajendran & Madheswaran (2010) have proposed a method which deals with the detection of brain tumor in the CT scan brain images. The preprocessing technique applied on the images eliminates the inconsistent data from the CT scan brain images. Then feature extraction process is applied to extract the features from the brain images. A Novel Fuzzy Association Rule Mining (NFARM) is applied to the image transaction database which contains the features that are extracted from the CT scan brain images. A new test image has been tested with the mined (NFARM) rules. The proposed NFARM gives the diagnostic keywords to physicians for making a better diagnosis system. The experimental results of the proposed method to give better performance compared to the traditional Fuzzy Apriori algorithm.

The above image mining techniques consist of preprocessing, feature extraction, text, shape, color, feature extraction and other classification algorithms which are discussed below.
2.3. **ANALYSIS OF PREPROCESSING TECHNIQUES IN IMAGE MINING**

Image pre-processing techniques are used to improve the quality of an image before processing of an application. A small neighborhood of a pixel of an input image is used to get a new brightness value in the output image. These preprocessing techniques are also called as filtration and resolution enhancement. The medical image quality parameters are mainly noise and resolution. The main objective is to improve the image quality by denoising and resolution enhancement. Most of the imaging techniques are degraded by noise. In order to preserve the edges and contour information of the medical images, the efficient denoising and an improved enhancement technique is required.

The common characteristics of medical images are noisy, poor image contrast, non-homogeneity, weak boundaries and unrelated parts which affect the content of the medical images. These problems are rectified by pre-processing techniques.

Perona & Malik (1990) presented an anisotropic diffusion, which is the edge sensitive extension of the average filter. Anisotropic diffusion can be applied to the radar and medical ultrasound images. Spatially correlated multiplicative noise is present in such images.

Diffusion filtering combined with simple non-adaptive intensity thresholding is used by Yong et al (1996) to enhance the region of interest. The main drawback of this technique is the non-adaptive nature of the threshold value. Fuzzy
connectedness based intensity non uniformity correction has been implemented by Yong et al (1996). A sequential approach with fuzzy connectedness, atlas registration and bias field correction is used in this approach. The conclusions reveal that the proposed technique can be used only if the intensity variations between the images are of a limited range. Muller et al (2004) has analyzed noise, poor image contrast, Non-homogeneity, weak boundaries and special mark existing in medical images.

Cervinka et al (2005) has proposed a method using histogram of the intensity in CT images. The low contrast and blurring regions in CT images are enhanced by a Markov Random Field model.

Expectation Maximization Segmentation (EMS) software package is used by Greenspan et al (2006) for image pre-processing. The main advantage of this technique is that it is a fully automatic technique.

Morris et al (2006) has minimized the effects of inter-slice intensity variation with the weighted least square estimation method. The selection of weights for the least square method is the major disadvantage of this approach.

Peng et al (2008) has presented a preprocessing method including cutting out background area and normalization for CT brain images. In the proposed approach, an elliptical structure is constructed based on skull contour and then the incline imaging angles corrected.

Zhang et al (2008) has proposed a noise removal technique using wavelets and caveats. Hybrid approaches involving Variance Stabilizing Transform (VST) are also used in this work. But this technique is applicable for images with Poisson noise.
Tracking algorithm based de-noising technique is performed by Jaya et al (2009). The seed point for tracking is random in nature, the efficiency of this technique is low. A contrast agent accumulation model based contrast enhancement is implemented by Prastawa et al (2009). This improves only the contrast of the image and the unwanted tissues are not eliminated.

Hussein et al (2009) utilized the Median filtering open morphological operation and contrast enhancement to reduce noise and improve the image enhancement process. The contrast of each region is calculated with respect to its individual background. Background noise removing while preserving the edge information on suspicious areas can enhance a digital mammogram.

Ratan et al (2009) have used the wiener filtering methodologies for noise removal in abnormal MR brain images. Apart from noise removal, several other preprocessing steps are also reported in the literature. This includes image format conversion, image type conversion etc.

Dan Long et al (2012) has performed data preprocessing using Statistical Parametric Mapping (SPM8) probability maps. All the images resemble an isotropic resolution of 3 mm at the end of the normalization and segmentation process. Every image gets modulated to the original image that is target image. The target image gets selected as the good quality image. The modulated image gets smoothed by a 10-mm full width at half maximum (FWHM) Gaussian kernel.

Illan & Gorriz (2012) have presented a normalization technique for preprocessing SPECT images. Spatial normalization is one of the techniques similar to
image registration. Human brain may differ in size and shape and they can be viewed in
different views as sagittal, coronal and Hemispheric. The location of one subject’s
brain scan can be correlated to the same location of another subject’s brain scan which
is the main goal of spatial normalization. And also they have used Intensity
normalization.

Rajeshwari & Sharmila (2013) concentrated on average, median and wiener
filtering for image denoising and an interpolation based Discrete Wavelet Transform
(DWT) technique for resolution enhancement. The performance of these techniques is
evaluated using Peak Signal to Noise Ratio (PSNR). From the results, it reveals that the
efficient denoising and resolution enhancement technique is essential for image pre-
processing.

2.4. ANALYSIS OF TEXT AND SHAPE FEATURE EXTRACTION
TECHNIQUES

Ying Liu et al (2007) has presented a texture feature extraction algorithm
based on POCS theory for arbitrary-shaped regions. Mirroring padding and an object-
based initial padding technique providing smooth extrapolation is used to relieve the
spurious high frequency components as introduced by zero padding. Experimental
results prove the algorithm to be effective in describing arbitrary shaped regions for
image retrieval purposes.

Audithan et al (2009) has formulated an efficient and computationally fast
method to extract text regions from documents. They have proposed Haar discrete
wavelet transform to detect edges of candidate text regions. Non-text edges are
removed using a thresholding technique. They used a morphological dilation operator to connect the isolated candidate text edge and then a line feature vector graph is generated based on the edge map. This method exploited an improved canny edge detector to detect text pixels. The stroke information is extracted from the spatial distribution of edge pixels. Finally text regions are generated and filtered according to line features.

Grover et al (2009) has described an approach to detect text from documents in which text is embedded in complex colored document images. They proposed a simple edge based feature to perform this task. The image is converted to grayscale by forming a weighted sum of the R, G, and B components. Then edge detection is performed on the grayscale image by convolving the image with Sobel masks, separately for horizontal and vertical edges. Convolution is followed by elimination of non-maxima and thresholding of weak edges. Next, the edge image is divided into small non overlapping blocks of m x m pixels, where m depends on the image resolution. They performed block classification using pre-defined threshold which would differentiate the text from the image.

Nagabhushan et al (2009) has proposed a novel approach to extract the text in complex background color document images. The proposed method used canny edge detector to detect edges. When a dilation operation is performed on edge image, it creates holes in most of the connected components that corresponds to character strings. Connected components without hole(s) are eliminated. Other non-text components are eliminated by computing and analyzing the standard deviation of each connected component. An unsupervised local thresholding has been devised to perform
foreground segmentation in detecting text regions. Finally the noisy text regions are identified and reprocessed to further enhance the quality of retrieved foreground.

Thai et al (2010) has described an approach for effective text extraction from graphical document images. The algorithm used Morphological Component Analysis (MCA) algorithm, an advancement of sparse representation framework with two appropriately chosen discriminate over complete dictionaries. Two discriminating dictionaries are based on undecimated wavelet transform and curvelet transform. This method overcomes the problem of touching between text and graphics and also insensitive to different font styles, sizes, and orientations.

A robust and efficient algorithm for automatic text extraction from colored book and journal cover sheets has been proposed by Zarvi et al (2011) based on wavelet transform. A dynamic threshold is used to detect edges from detail wavelet coefficient. Further effective edges are obtained by blurring approximate coefficients with alternative heuristic thresholding. Region of Interest (ROI) technique has been applied and finally text is extracted. They evaluated the performance of their algorithm on 80 pictures collected from internet.

Zaheeruddin et al (2012) has proposed a mean based region growing segmentation (MRGS) which automatically find the seed pixel and optimal threshold value and thus makes the segmentation process very fast and accurate. Furthermore, experimental results are compared with the findings of expert radiologist and marker controlled watershed segmentation approach. A set of 3 mammogram images is used to demonstrate the effectiveness of the segmentation methods. Numerical validation of the results is also provided.
Verma & Mahajan, (2012) have used canny and Sobel edge detection algorithm for extracting the shape features for the images. After extracting the shape feature, the classified images are indexed and labeled for making easy for applying retrieval algorithm in order to retrieve the relevant images from the database. In their work, retrieval of the images from the huge image database as required by the user can be got perfectly using the Canny edge detection technique.

Srinagesh et al (2013) has proposed a new Modified Shape Descriptor (MSD) feature extraction technique which is used as descriptive feature to discriminate Objects in an image database. In Object recognition after initial Pre-processing, feature extraction is the next crucial step which determines the efficiency of the technique or method. A test image is taken from the database, which is then divided into 8x8 Blocks each shape, structure is detected using edge detection technique with Threshold method to generate the shape feature vector. Then, texton-based texture, color features are extracted using the existing Multi-texton Histogram (MTH) method. To form the final discriminating feature vector for that image in total, three features are extracted namely shape, texture and color for that particular image to form a discriminating feature vector which this then stored in a feature library. When a query image is given Euclidean distance between the query image and the test images feature values available in the feature library are computed. Based on the similarity characteristics top-k images are retrieved.

2.5. COLOR FEATURE EXTRACTION BASED TECHNIQUES

Ivan Lee, et al (1996) have presented an analysis of the CBIR system with human controlled and machine controlled relevance feedback, over different
network topologies including centralized, clustered, and distributed content search. In their experiment for the interactive relevance feedback using RBF, they observe a higher retrieval precision by introducing semi-supervision to the non-linear Gaussian-shaped RBF relevance feedback.

Zhao & Grosky (2002) view that bridging the semantic gap between the low-level features and the high-level semantics is within the interface between the user and the system. Other research direction is towards improving aspects of CBIR systems by finding the latent correlation between low-level visual features and high-level semantics and integrating them into a unified vector space model.

Nikolaoua & Papamarkos (2002) proposed a new image retrieval technique that can be used for retrieving color images. The proposed technique is based on a fractal scanning procedure, which extracts 1-D signatures for each one of the image color components. These signatures contain not only color information, but also shape and textural image information. Using Fourier descriptors and discrete transform, powerful features are extracted from the signatures that permit the efficient retrieval of color images. The system is suitable for retrieving query images even in distortion causes such as deformations, noise, color, cosine reduction and smoothing.

Ryszard S. Chora’s (2007) contributes their work for the identification of the problems existing in CBIR and Biometrics systems describing image content and image feature extraction. They have described a possible approach to mapping image content onto low-level features. Their paper has investigated the use of a number of different colors, texture and shape features for image retrieval in CBIR and Biometrics systems.
Jaiswal & Kaul (2009) have concluded that content based image retrieval is not a replacement of, but rather a complementary component to text based image retrieval. Only the integration of the two can result in satisfactory retrieval performance. They reviewed the main components of a content based image retrieval system, including image feature representation, indexing, and system design, while highlighting the past and current technical achievement.

Peter Stanchev et al (2009) has explained that several visual descriptors exist for representing the physical content of images, for instance color histograms, textures, shapes, regions, etc. Depending on the specific characteristics of a data set, some features can be more effective than others when performing a similarity search. For instance, descriptors based on color representation might be more effective than with a data set containing mainly black and white images. Techniques based on statistical analysis of the data set and queries are useful.

Fatemeh Alamdar & Mohammad (2011) presented a color feature extraction method based on dynamic color distribution entropy of neighborhoods. Dynamic color distribution entropy of neighborhoods (D-CDEN) method measures the spatial relation of colors in an image and takes into account of the contents of the image by neighborhoods extraction of pixels for every color bin of the image color histogram. In this work a new dissimilarity measuring is presented to demonstrate image retrieval and these results are compared with I-CDE. Experiments are carried out using two databases of 1000 and 6384 images. These experiments show the acceptable efficiency of this approach.
Sandip S. Patil & Atul V. Dawson (2012) uses color feature extraction using clustering. The proposed technique preserves image color distribution and reduces the distortion that occurred during the feature extraction process using binary quaternion moment preserving (BQMP) technique. Experimental results show improvement over the prior binning technique.

Pattanaik & Bhalke (2012) proved that Content Based Image Retrieval overcome all the limitation of Text Based Image Retrieval by considering the contents or features of the image. A query image can be retrieved efficiently from a large database. A database consisting of different types of images has been implemented in the system. Different Features such as histogram, color mean, Color structure descriptor texture are taken into consideration for extracting similar images from the database. From the experimental result, it is seen that combined features can give better performance than single feature. So selection of feature is one of the important issues in the image retrieval. The system is said to be efficient if semantic gap is minimized.

Kiran Kumar Reddi (2013) has proposed a CBIR system that allows searching and retrieves images from the databases using the fuzzy c-means algorithm and K-means clustering. The system uses low level features like color, texture and shape. Feature extractions are done using the space transformations and median filtering and then color feature extractions are done using the fuzzy methods to represent color in a way that reduces this semantic gap. Fuzzy c-means clustering is first applied for grouping similar images and k-means clustering technique is then applied to retrieve a better favored image.
Devipriya & Angel Viji (2013) have presented a new method for automating colorization. The process is combined with several techniques of Digital Image Processing in order to improve the automation of the colorization process. This includes Gabor-based image segmentation which is combined with an improved fuzzy C-means clustering, extraction and storage of the Texture and Color Descriptors, and a texture-based color retrieval technique. The MKFCM is used for clustering. The proposed algorithm provides significant flexibility in selecting and combining different kernel functions. The system for colorization of gray scale images can be created including various features.

Nitin Jain & Salankar (2014) have presented a two feature color and texture extraction algorithm. Color histogram is mostly used to represent color, features but it cannot entirely characterize the image and is also rotation invariant about the view axis. This approach uses Gabor filter, which is a powerful texture extraction technique either in describing the global content of an image. Color histogram as a global color feature and histogram intersection as the color similarity metric combined with Gabor texture have proved to give good retrieval results than that of region based retrieval systems.

2.6. FEATURE MATCHING

Numerous point matching algorithms have been proposed and used in the fields of computer vision and pattern recognition. These range from relaxation-based methods, to cluster detection in transformation space by computing point-to-point correspondences, to hierarchical decomposition of transformation space coupled with the application of a robust similarity measure. Most of the techniques presented are computationally intensive, or take a long time to run in practice.
Normalized Cross Correlation and its modifications are classical area based methods (Pratt, 1991). The similarity measure is computed for window pairs from sensed image and the reference image and its maximum is searched. The window pair for which similarity measure is maximum area is set as the corresponding one. For sub-pixel accuracy interpolation of the Cross Correlation measure values is used. Although mutually translated images can be aligned with Cross Correlation based measures it can also be applied when a slight rotation and scaling is present. Generalized versions of Cross Correlation are there for geometrically more deformed image. In this method Cross Correlation is computed for each assumed geometric transformation of the window of sensed image. Thus, this method can handle more complex geometric transformations than only translation.

A method proposed by Huttenlocher et al (1993) uses a similarity measure as Hausdorff distance (HD). The sensed and reference images are registered binary images obtained by edge detectors which are used for transforming translation and rotation. The proposed HD algorithm has been compared with Cross Correlation algorithm.

In the method proposed by Berthilsson et al (1998) even finely deformed images are matched. A method is proposed for maximizing affine correlation between images. The method is based on coordinates change at certain positions in the images and use Fast Fourier Transformation (FFT). Simper (1996) has proposed a method where a divide and conquer system has been adopted and Cross Correlation technique adopted for registering images differing by perspective changes as well as changes due
to lens imperfections. However if the transformation complexity increases then computational complexity also increases.

Two robust distance measures have been studied from an algorithmic perspective. The first is the method of partial Hausdorff distance matching, introduced by Huttenlocher et al (1992). The other is the absolute difference, introduced by Hagedoorn & Veltkamp (1999). Both of these algorithms are based on a branch and bound search of transformation space. Kedem and Yarmovski (1996) have proposed an algorithm for stereo matching based on partial Hausdorff distance.

Correlation ratio based methods are used in the area of multimodal registration. This similarity measure can handle intensity differences between the sensors comparison of this approach to other algorithms which are used for multimodal images by Roche et al (1998).

Extended Cross Correlation methods based on increment sign correlation has been used in case of images with partially occluded objects by Kaneko et al (2002).

The SIFT algorithm (Scale Invariant Feature Transform) proposed by Faraj Alhwarin et al (2008) is an approach for extracting distinctive invariant features from images. It has been successfully applied to a variety of computer vision problems based on feature matching including object recognition, pose estimation, image retrieval and many others. However, in real-world applications, there is still a need for improvement of the algorithm robustness with respect to the correct matching of SIFT features. The main idea is to divide the features extracted from both the test and the model object image into several sub-collections before they are matched. The features are divided
into several sub-collections considering the features arising from different octaves that are from different frequency domains. To evaluate the performance of the proposed approach, the method was applied to real images acquired using the stereo camera system of the rehabilitation robotic system FRIEND II. The experimental results show an increase in the number of correct features matched and, at the same time, a decrease in the number of outlets in comparison with the original SIFT algorithm.

Liu & He (2012) have combined Harris algorithm, standardization, cross-correlation algorithm and least mean square algorithm to automatically match the Landsat-TM images. This method produces matching points with high precision, and without manual work and it also saves a lot of time.

Li (2014) has proposed an image matching algorithm combined with SURF feature-point and DAISY descriptor. Based on the feature point detection of SURF algorithm, a principal direction distribution method for DAISY descriptor is put forward, and a novel daisy descriptor is obtained according to the rotation of the principal direction. The algorithm improves the image matching capability of the classic SURF algorithm on image rotation. The experimental results show that the proposed algorithm has a stronger robustness in a variety of complex cases, such as image blurring, illumination variation, JPEG compression ratio variation, field of view variation, etc. The proposed algorithm can not only keep the merits of the original SURF algorithm on computation speed, but also improves the matching accuracy on rotation invariance.
2.7. IMAGE MINING TECHNIQUES IN PILL IDENTIFICATION SYSTEM

Geradts & Bijhold (2002) have used shape features, such as the size of the bounding box, density inside the bounding box, and contour of imprints. To decouple the variants of translation, rotation and scale, the images are first translated from orthogonal coordinates to log polar coordinates and then the two-dimensional crosscorrelation function is used for matching log polar data. The authors have chosen three different pills (out of 432 pill images) as the query set and synthetically generated 75 images by rotating those three pills at 25 different angles. Given 75 queries (only three distinct imprint patterns) with a gallery database of 432 pill images, the authors have reported a 100% matching accuracy.

Query Based Image Content (QBIC) or Content-Based Image Retrieval (CBIR) have several advantages of allowing users to retrieve images using user constructed sketches and drawings, selected colors and texture patterns or other graphical information as queries. In spite of the various proposals, the general performance of QBIC systems still has a long way to reach the accuracy desired. In Recent years, in search of improving QBIC systems, Researchers have turned their focus from general-purpose solutions to domain-purpose solutions. In the medical field, the use of CBIR has shown to improve the diagnostic process (Aisen et al., 2003) and is termed as Content Based Medical Image Retrieval (CBMIR). On the other hand, Image Retrieval in Medical Applications (IRMA) focuses on retrieval of images from radiology image archive. The Cervigram Finder system is a web accessible Content Based Image Retrieval (CBIR) tool with color, texture, shape, and location based CBIR.
functions that operate on a subset of the cervigram image collection. CANDID is another content based image retrieval system that focuses mainly on retrieving pulmonary CT images. The Second National Health And Nutrition Examination Survey (NHANES II), developed by the National Library of Medicine, is employed to retrieve cervical and lumbar spine X-ray images.

Zeno Geradts et al (2001) has designed a drug identification system that combines IBM’s Query by Image Content (QBIC) and the iMatch system. Zeno extracts features follow the format of MPEG-7. The features are entered into QBIC and iMatch to identify the specific drug. However, Zeno’s proposed method only identifies a small nub of drugs, a fraction of the large and constantly expanding number of drugs used.

Hsieh et al (2005) has proposed a Real Drug Identification System (RDIIS). RDIIS uses the features of color and texture to each for images in a database. However, in the RDIIS, many drugs have similar colors and shapes which mean that the queried image is often not found.

Lin et al (2007) proposed a tablet drug image retrieval system to raise the drug recognition of white tablets. Lin’s system extracts features including the shape, color and size. It uses neural networks and combines moment invariants and Zernike moments to identify the drug. However, Lin’s method is not effective in identifying drugs, because many drugs are similar and have the same size and color. This system still cannot effectively extract the representative features of drug.
The work of Hsu et al (2009) describes the implementation of a Web-based retrieval system called Spine Pathology & Image Retrieval System (SPIRS), which permits exploration of a large biomedical database of digitized spine X-ray images and data from a national health survey using a combination of visual and textual queries. While the number of publications related to medical image matching and retrieval is high, on contrary, studies related to pill image matching and retrieval are less.

Young-Beom Lee et al (2010) proposed an automatic method to match drug pill images based on the imprints appearing on the tablet. This will help to identify the source and manufacturer of the illicit drugs. The feature vector extracted from tablet images is based on edge localization and invariant moments. Instead of storing a single template for each pill type, multiple templates are generated during the edge detection process. This circumvents the difficulties during matching due to variations in illumination and viewpoint. Experimental results using a set of real drug pill images show 76.74% matching accuracy.

A new approach for pilling evaluation based on multi-scale two-dimensional dual-tree complex wavelet transform (CWT) is presented by (Deng et al 2011) to extract the pilling information from pilled fabric images. The CWT method can effectively decompose the pilled fabric image with six orientations at different scales and reconstruct fabric background texture and pilling sub-images. This study uses an energy analysis method to search for an optimum image decomposition scale and dynamically discriminate pilling image from noise, fabric texture, fabric surface unevenness, and illuminative variation in the pilled fabric image. For pilling objective rating, six parameters are extracted from the pilling image to describe pill properties. A
Levenberg–Marquardt back-propagation neural rule has been used as a classifier to classify the pilling grade. The proposed method has been evaluated using knitted, woven, and non-woven pilled fabric images photographed with a digital camera.

Lee et al (2012) has proposed Pill-ID system, to help law enforcement. The Pill-ID is based on several features like shape, color and imprint that are extracted from the tablet. The color and shape information is encoded as a three-dimensional histogram and invariant moments, respectively. The imprint of the pill image is encoded as feature vectors derived from SIFT and MLBP descriptors. Experimental results using a database of drug pill images show 84.47% retrieval accuracy.

Zhiyuan Chen & Sei-ichiro Kamata (2013) have proposed an automatic pill recognition technique which takes into account the imprint for better results. It functions mainly based on the imprint feature of the pills, which is extracted by proposing Modified stroke width transform (MSWT) and described by Weighted shape context (WSC). Experiments show that the proposed pill recognition method can reach an accurate rate up to 92.03% within the top 5 ranks when trying to classify more than Ten thousand query pill images into around 2000 categories.

2.8. INFERENCE FROM THE EXISTING WORKS

Most of the existing identifier tools are keyword based where a keyword in text format is used to search a database having pill images and details. When a match is found, it is considered as a legal pill, if not it is declared as ‘Possible Illegal Pill’. The demerit of such approaches is that the keywords are normally subjective and do not
capture all the information about the pill for accurate retrieval. In most of the cases, failure incorrect identification is mainly due to very few or misappropriates keywords.

### 2.9. RESEARCH GAP

Table 2.1: Comparison of the proposed and existing approaches

<table>
<thead>
<tr>
<th>Methods</th>
<th>Existing Techniques</th>
<th>Limitations</th>
<th>Proposed Modification</th>
<th>Advantages</th>
</tr>
</thead>
</table>
| Preprocessing Approaches     | • Interpolation based Discrete Wavelet Transform (DWT)   | • Loss of high frequency (HF) components which are due to the smoothing  
• Expensive  
• Occupies more memory space                                                                 | • Interpolation algorithm which combines wavelet and bicubic interpolation  
• Undecimated wavelet Transformation (UWT) based interpolation algorithm   | • Reduce the artifacts, blurring and jagged edges introduced during up-sampling                                      |
|                              | • Histogram equalization (HE)                            | • Information on the histogram input image will be lost  
• Loss of definition on the edges of the object and over enhancement of noise in the images                                                                 |                                                                                                                 |                                                                                                                      |
|                              | • Normalization                                          | • Degradation of overall image quality  
• Image normalization can be a time consuming process and can add a significant amount of time to the e-Discovery export process in large cases.  |                                                                                                                 |                                                                                                                      |
|                              | • Markov Random Field model                              | • No natural ordering of pixels in image  
• Computing probability is difficult  
• Parameter estimation is difficult                                                                 |                                                                                                                 |                                                                                                                      |
|                              | • Expectation Maximization                               | • It hopelessly slow linear convergence is some case  
• Complex in nature                                                                                                                                         |                                                                                                                 |                                                                                                                      |
|                              | • Variance Stabilizing Transform (VST)                   | • This improves only the contrast of the image and the unwanted tissues are not eliminated                                                                                                           |                                                                                                                 |                                                                                                                      |
| Text & shape feature extraction | • Complex wavelet transform (CWT) | • High computational complexity  
• High memory capacity  
requirement is important disadvantages | • Modified Shape Descriptor (MSD)  
• Haar discrete wavelet transform | • Text and shape features are extracted using Geometrical Gradient feature transformation algorithm  
|  
• Not continuous  
• Not continuous it is also not differentiable | • Canny edge detector | • Sensitivity to noise, Inaccurate  
• Malfunctioning at the corners, curves and where the gray level intensity function varies.  
• Complex Computations,  
• Time consuming | • Mean based region growing segmentation (MRGS) | • Simple,  
• Relatively robust  
• Provides better result | • Dynamic color distribution entropy of neighbourhoods (D-CDEN) method | • Complexity of blocks of the same size are difficult to extract | • Color extraction is carried out using color histogram | • Content based image retrieval (CBIR) | • Inherent in metadata-based systems  
• CBIR cannot achieve a satisfactory measurement performance, since the user's high-level semantics cannot be easily expressed by low-level features | • Binary quaternion moment preserving (BQMP) technique | • It may affect the experimental results |
<table>
<thead>
<tr>
<th>Method</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color histogram</td>
<td>Not robust to significant appearance changes because it does not include any spatial information</td>
</tr>
</tbody>
</table>
| Fuzzy c-means algorithm and K-means clustering | Long computational time  
Sensitivity to the initial guess (speed, local minima)  
Sensitivity to noise and One expects low (or even no) membership degree for outliers (noisy points).  
The main limitation of the algorithm comes from its crisp nature in assigning cluster membership to data points.  
Depending on the minimum distance, a data point always becomes a member of one of the clusters. |
| Quad Histogram approach                     | This algorithm has the disadvantage that the majority of its operations happen in the vertex shading units, which generally have a lower level of parallelism than the pixel processing pipeline on non-unified graphics architecture |
| Improved fuzzy C-means clustering           | Long computational time  
Sensitivity to the initial guess (speed, local minima)  
Sensitivity to noise |
| Automatic pill identification system         | Automatic method to match drug pill images based on the imprints appearing on the tablet  
The time complexity is relatively high  
There is a difficulties during matching due to variations in illumination and viewpoint |
| Pill-ID: Matching and retrieval of drug pill images | Automatic pill identification system based on image mining  
The system has been tested on a pill image database containing a total of 15031 images 1029 illicit drug pill images.  
Rank’1’identification accuracy  
Can be applied to many problems, as long as there is some data.  
Can be applied to problems, for which analytical methods do not yet exist  
Can be used to model non-linear dependencies. |
<p>| Image Mining techniques | • A mixture of Poisson (MOP) model expectation maximum (EM) algorithm for segmenting micro PET image | • of 73.17% (84.47%) is obtained in the matching experiment it is not up to the 100%. | • Compared to the MOG model, the MOP method seems to improve the accuracy and robustness under various SNR condition and initial guesses. |
| | • MSWT (modified stroke width transform) and described by WSC (weighted shape context) | • Accurate rate up to 92.03% only | • Perform quickly on noisy data too • System is easy to maintain. |
| | • Content Based Information Retrieval in Forensic Image Database | • Result of this research are limited to three different test case and the database of pills that has been used | |
| | • Content based Image Retrieval Using Color And texture Of Image Sub Block | • The image retrieval using HSV color and GLCM texture features of an image sub block with one to one matching | |
| | • The Adaptive Least Squares Correlation | • It is sensitive to outliers • Shrinkage Effects | • simple, • relatively robust and gives “good enough” answers over a wide variety of data sets, • Fast, robust and easier to understand. • Relatively efficient • Easier for a human to understand |
| | • Classification algorithm using competitive neural network. | • Problems in texture analysis, including the classification of texture | • Proposed image mining technique |
| | • The image mining techniques include object recognition, image retrieval, image classification, | • Design semantically powerful query languages for image databases. | |</p>
<table>
<thead>
<tr>
<th><strong>image clustering, association rules mining, and neural network.</strong></th>
<th><strong>image data.</strong></th>
<th><strong>(c) Incorporate new visualization techniques for the visualization of image patterns.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>• Minimum spanning tree clustering algorithm</strong></td>
<td><strong>• The algorithm is insensitive to the order in which the data points are considered.</strong></td>
<td><strong>• No initial conditions are required, no convergence aspects are involved.</strong></td>
</tr>
<tr>
<td></td>
<td><strong>• The algorithm works well for many cases where the clusters are well separated.</strong></td>
<td><strong>• The algorithm works well for many cases where the clusters are well separated.</strong></td>
</tr>
<tr>
<td></td>
<td><strong>• A problem may occur when a “large” edge $e$ has another “large” edge as its neighbor. In this case, $e$ is likely not to be characterized as inconsistent and the algorithm may fail to unravel the underlying clustering structure correctly.</strong></td>
<td></td>
</tr>
</tbody>
</table>

### 2.10. SUMMARY

This chapter explores the literature on pre-processing techniques, Text and feature extraction techniques, color, feature extraction, Feature matching and the existing image mining techniques in the pill identification system. The comparison of various approaches is also analyzed.