CHAPTER 2

LITERATURE REVIEW

2.1 WAVELET TRANSFORM

A lot of work that has been carried out with respect to wavelet transforms mainly focus on the key techniques of digital watermarking for images, which include robustness and invisibility. In this work, a novel digital watermarking algorithm based on the wavelet transform has been proposed, which employs the Arnold transformation to scramble watermarking. It embeds watermarks into the mid-frequency sub-band of the original image Discrete Wavelet Transform, and adjusts the embedding strength adaptively using properties of the human visual system.

Raval (2003) proposed that a low-frequency embedding of the watermark increased robustness with respect to image distortions that have low-pass characteristics like filtering, lossy compression and geometrical distortions. On the other hand, schemes with low-frequency watermarks are more sensitive to histogram modifications such as contrast/brightness adjustment, gamma correction, histogram equalization, and cropping. Watermarks inserted into middle and high frequencies are typically less robust to low-pass filtering lossy compression and small geometric deformations of the image, but are extremely robust with respect to noise adding and nonlinear deformations of the gray scale. It is easy to comprehend that the advantages and disadvantages of low and high frequency watermarks
are complementary. It appears that by embedding both watermarks into one image, one could achieve properties possessing extremely high robustness with respect to a large spectrum of image processing operations.

Margarita et al (2010) investigated some of the findings during iterations when image analysis was carried out, from where the regions of interest of images were drawn manually on the ICA separated component images, and the volumes of interest (VOI) were automatically segmented from the component images during diagnosis. The exchange of patient history was given to the medical provider or the physician. The values obtained from the above methods were compared between the manually drawn regions of interest with respect to various medical images. The medical diagnosis was found to be very effective and it covered all remote areas rapidly.

Niilo Saranummi (2009) dealt with the recent progress carried out in the personal health records of patients, and found that telemedicine technology is suitable for collaboration among health care providers over distance in delivering prompt service to the customer. The home healthcare system is often seen as a modality of telemedicine. They must be utilized to act as co-producers in cooperation with healthcare professionals.

Chiou-Ting Hsu et al (1998) dealt with a multi-resolution based technique for embedding digital watermarks into medical images. The proposed watermarking technique was utilized for hiding secret information in the images so as to discourage unauthorized copying or editing the origin of the images. In their method, the advantage of multi-resolution signal decomposition was relied upon specifically. Both the watermark and the host image were composed of multi-resolution representations with different structures and the decomposed watermarks of different resolutions were
embedded into the resultant resolution of the decomposed images. The quality degradation and low resolution rendition of the watermark was preserved within the equivalent resolutions of the image. The proposed watermarking technique resulted in differences between the watermarked image and the original image being invisible. This offered great robustness to common image processing operations and JPEG lossy compressions.

2.2 WATERMARK EMBEDDING

With the rapid growth of multimedia and imaging technology, digital watermarking has become one of the widely used copyright protection methods. Invisible watermarking requires a reasonable robustness against attacks such as JPEG compression, as well as no degradation in the subjective and objective image quality standards. In the frequency domain, watermarking is more robust than the spatial domain, because the watermarked information can be spread over the entire image.

Klaus Rheinberger’s (2008) proposition in his algorithm was based on the state-space model and its corresponding Kalman recursions. This allowed for changing regression coefficients stochastically. The residuals of the Kalman estimation could be determined and identified with a filtered ECG signal. The wavelet coefficients were selected to bear the watermark of the medical image. After processing and performing a comparison using ordinary least-squares regression, the proposed algorithm demonstrated a higher SNR, for low signal-to-noise ratio (SNR) corrupted signals, and the mean frequency and the mean amplitude of the signal shows a marked improvement. The results of previous studies not only used different algorithms but also used different data pools. Thus, the algorithm carries the
possibility for further optimization. The image used for watermarking is shown in Figure 2.1.

![Medical image of brain showing watermark](image)

**Figure 2.1 Medical image of brain showing watermark**

Amit Phadikar (2010) demonstrated a robust information data hiding method that utilized the spectrum efficient OFDM technique applied on a gray scale image onto another gray level carrier image. For simplicity, the data mapping in the complex domain utilized 4-QAM. To improve the robustness of the image, a modified QIM technique was used, but the robustness analysis was not common practice for QIM based data hiding. The result demonstrated a large amount of information hiding capability along with a substantial improvement in robustness against intentional impairments. The information hiding algorithms based on OFDM have demonstrated a large capacity information hiding on a gray scale image. A noticeable fact is that during attack analysis, the robustness of data hiding of an image cannot be justified. Performance measures for data hiding techniques also play an important role in helping to distinguish this particular method from other more conventional digital modulation techniques. Hence, the demand for high capacity robust information hiding techniques is showing an increasing trend when compared to conventional low capacity robust methods.
Chiou-Ting et al (1998) proposed a multi-resolution based technique for embedding digital watermarks into medical images. The watermarking technique was proposed by hiding information into images so as to discourage unauthorized copying or to attest to the genuineness of those images. The advantage of this technique relies on multi-resolution signal decomposition. The watermark and the host image are composed of multi-resolution representations with different structures, and the decomposed watermarks with different resolutions are embedded into the corresponding resolution of the decomposed images. The image’s quality will not show any degradation, and the low-resolution rendition of the watermark will be preserved within the corresponding low-resolution components of the image. Experimental results reveal that the proposed watermarking technique results in a difference that is almost invisible between the watermarked image and the original image, and also displays ample robustness with respect to common image processing operations.

2.3 DETERMINING LOCATION MAP

Vidaurre et al (2007), Jun Tian (2003) have focused on a principle employing different on-line adaptive classifiers using various feature types. Two classifiers were tested and analyzed based on their classification and logarithmic band power estimation of the location map for a medical image that covered all pairs of pixels, a continuously linear discriminate analysis classifier was found to be the best choice of all images that possessed a location map. Experimental results show that the systems are stable with respect to their original values.

Hyoung Joong Kim et al (2008), in his proposal stated that reversible data embedding, also known as lossless data embedding, can embed invisible data (also known as payload) into a digital image in a reversible fashion. The theory had marked a new epoch for data hiding and
information security. Being reversible, the original data and the embedded data can be completely restored. In reversible data-hiding schemes, a difference expansion transform is found to be a truly remarkable breakthrough. The difference expansion method achieves high embedding capacity and keeps distortion low. In this method, with the assistance of the simplified location map and new expandability, more embedding capacity is achieved by maintaining the distortion at the same level. Thus, the difference expansion is free of the location map which is highly desirable. However, it is not easy to generate the location map. The size of the location map can be reduced, i.e., to half the image size. The performance of the work that has been proposed is better than the original difference expansion scheme proposed by Tian because, in this method one bit of the informative image is divided into pairs of pixels. Its improved version is exploited by Kamstra and Heijmans. This improvement can be carried out by exploring the difference values. Thus, the proposed method outperforms the existing schemes in terms of embedding capacity and image quality.

2.4 VISIBLE WATERMARKING AND HISTOGRAM MODIFICATION

A digital watermark is a kind of marker embedded in a noise-tolerant signal such as an audio or an image data. It is typically used to identify ownership of the copyright of signal security, authentication etc. Watermarking is the process of hiding digital information in a carrier signal, but the hidden information need not possess any relation to the carrier signal. Digital watermarks may be used to verify the authenticity or integrity of the carrier signal, or to display the identity of its owners. Both steganography and digital watermarking employ steganographic techniques which embed data covertly into noisy signals. The main objective of steganography is to create a sense of imperceptibility with respect to the various human senses. Moreover,
digital watermarking tries to control the robustness, making it top priority. Hun-Hsiang et al (2010) proposed that visible watermarking schemes are important Intellectual Property Rights (IPR), which is used as protection mechanisms for digital images and videos that have to be released for certain purposes where illegal reproductions are prohibited. Visible watermarking techniques protect digital contents in an active manner, which is quite different from invisible watermarking techniques. Digital data embedded with visible watermarks contain recognizable copyright patterns and the details of the host data. When employing an attacking scheme against visible image watermarking techniques, selected watermarked areas may contain some amount of human intervention. Watermarks of thin patterns can recover the image by image recovery techniques. For general watermarks consisting of thick patterns, the information lies within the surrounding areas that are unmarked, and the watermarked areas will be utilized to fully recover the host image as shown in Figure 2.2. Although the proposed scheme does not guarantee that the recovered images will be exactly identical with the unmarked originals, the structure of the embedded pattern will be seriously destroyed and a perceptually satisfying recovered image can be obtained.

![Figure 2.2 Retinal image with watermark](image-url)
Guorong Xuan et al (2005) in their paper presented a novel reversible data-embedding method for digital images using the Integer Wavelet Transform and the companding technique. In this scheme, as the distortion is quite small between the marked image and the original, it takes advantage of the Laplacian-like distribution of the integer wavelet coefficients in high frequency sub-bands, thus facilitating in the selection of the compression and expansion functions. The authors stated that for a given image, after data has been embedded into high frequency IWT coefficients, it is possible to cause overflow and/or underflow, implying that after the inverse Integer Wavelet Transform is applied, the grayscale values of some pixels in the marked image may exceed the upper bound (255 for an eight-bit grayscale image) and/or the lower bound (0 for an eight-bit grayscale image). To prevent overflow and underflow, histogram modification was adopted to narrow the histogram on both sides. The data generated as a result of histogram modification needs to be embedded into the image as a part of the overhead data, which will be used for recovering the original image. An example of information that is embedded into the cover media (image) is shown in Figure 2.3, along with the overhead and recovery of the original image that has been performed successfully.

![Figure 2.3 Host image and the recovered image](image_url)
2.5 DISCRETE WAVELET TRANSFORM

Er Kanika et al (2012) have proposed a Comparative Analysis of the Discrete Wavelet Transform (DWT), and its modified version of the Fast Wavelet Transform on Image Compression. The Fast Wavelet Transform (FWT) highlights the benefit of fast compression processing when compared to DWT with higher compression ratios, and maintaining good image quality at the same time. This work summarizes the features of wavelet transform of still images, along with the quality of images which have been degraded as a result of wavelet compression and decompression, thus checking for results in terms of image quality metrics PSNR and computing the compression ratios using DWT and FWT. The algorithm follows a quantization approach that divides the input image into 4 filter coefficients and performs further quantization on the lower order filter. These have been developed using MATLAB. This research paper proves that FWT is better than DWT. But as the number of research articles on DWT is far higher, one feels that DWT offers better performance against any other wavelet coefficient.

Phan Nguyen (2014) proposed construction of multi-wavelets from multi-scaling functions. The scaling vectors and their associated multi-wavelets are piecewise differentiable. The constructions of scaling vectors are accomplished using interpolation functions. The filters possess properties which enable them to construct new pairs of vectors and associated multi-wavelets with different approximation orders. Hence, this work needs an approximation to enable the construction of scaling for the various wavelet functions.
2.6 WAVELET HISTOGRAM SHIFTING

An image histogram is a type of histogram that acts as a graphical representation of the tonal distribution in a digital image. It plots the number of pixels for each tonal value. Image editors have provisions to create a histogram of the image being edited. The histogram plots the number of pixels in the image (vertical axis) with a particular brightness value (horizontal axis). The algorithms in the digital editor allow the user to adjust the brightness value of each pixel and dynamically display the results as adjustments are made. Many improvements in picture brightness can be obtained after these experimental results were published.

Francesco Buccafurri & Gianluca Lax (2010) proposed techniques like synopses based on histograms, sketches, sampling, and so on, which helped to make embedding very effective and required multiple scans on data, proving to be prohibitive from a computational point of view. From the techniques mentioned above, histogram-based approaches are considered one of the most advantageous solutions in case of range queries. It is a matter of fact that histograms also demonstrate an excellent capability to shorten data requirement, by preserving quick and accurate answers to range queries. The author also suggested that a novel histogram-based technique reduced sliding windows and supporting approximate arbitrary range-sum queries.

Hyunkyung Shin (2009) stated that histogram analysis had played an important role in the study of degradation and retrieval of images. The process of retrieval of images consists of several forms of statistical discriminate measures, and is constructed using histogram analysis. This research work is adopted with histogram analysis for the image of a brain as a tool for comparison as shown in Figure 2.4. In the field of medical imaging,
histogram analysis is also regarded as a very useful technique for object segmentation.

![Brain image for histogram analysis](image)

**Figure 2.4 Brain image for histogram analysis**

Peter Van Vugt & Michael Adams (2004) dealt with a reversible integer-to-integer (ITI) transform that approximates linear wavelet transforms and have demonstrated its application with respect to signal coding. Coding efficiency is achievable with such reversible transforms. However, it also depends on how well they approximate their parent linear transforms.

Te Lung Yin & Xu Ren Luo (2012), in their proposition stated that reversible data hiding has attracted more attention in the field of imaging. Reversibility implies that the original media can be recovered without any loss from the marked media after extracting the embedded message and also explores the feature of large wavelet coefficients. This in turn achieves the goal of high capacity with imperceptibility.

Wei Pan Cuppens-Boulahia et al (2012) dealt with a method which differs from the previous ones in which the wavelet coefficients histogram is manipulated. Besides, clever shifting rules are introduced into the histogram to avoid the decimal problem in pixel values after recovery to achieve reversibility. This paper proposes a new reversible watermarking scheme. The
first contribution is a histogram shifting modulation which adaptively takes care of the local specificities of the image content. By applying it to the image prediction-errors and by considering their immediate neighborhood, this technique inserts data in textured areas where other methods fail to do so. Furthermore, the scheme makes use of a classification process for identifying parts of the image that can be watermarked with the most suited reversible modulation. This classification is based on a reference image derived from the image itself, which has the property of being unmindful to the watermark insertion. In that way, the watermark embedder and extractor remain synchronized for message extraction and image reconstruction. Even though watermark removal is possible and its imperceptibility has to be guaranteed, since most applications have a high interest in keeping the watermark in the image for as long as possible, the advantages that continuous protection that watermarking offers in the storage, transmission and processing of the information, is taken into consideration. This is the reason why, a need still arises for reversible techniques that introduce the lowest distortion possible with high embedding capacity.

Xianyi Chen et al (2013) provides a new perspective approach for the research on reversible watermarking based on histogram shifting of prediction errors. An asymmetric error histogram is then constructed by selecting a suitable error from these errors. The histogram reduces the amount of shifted pixels, thus improving the watermarked image quality. Moreover, a complementary embedding strategy is proposed by combining the maximum and minimum error histograms

2.7 OVERALL CONTRIBUTION OF IMAGE RETRIEVAL WITH OTHER WORKS

Senthilkumar & Senthilmurugan (2013) have stated that Content-Based Image Retrieval (CBIR) has been one of the most vivid research areas
in the field of computer vision over the past 10 years. Digital images are produced in increasing quantities and used for diagnostics and therapy, especially in the field of medicine. The radiology department of the University Hospital of Geneva alone produced more than 25,000 images a day in 2012. The field of cardiology is currently the second largest producer of digital images. Hence, Digital Imaging and Communication in Medicine (DICOM), has been established as a standard for image communication, which allows for the storing of patient information and their history within the actual images themselves. Keeping this in mind, our proposed research embeds the information of patient in the images of iris and retina as shown in Figure 2.5.

![Retinal and Iris Images](image)

**Figure 2.5 Retinal and iris images for retrieval**

Md. Mahmudur Rahmana et al (2008) presented a Content-Based Image Retrieval framework for the diverse collections of medical images of different modalities such as anatomical regions, acquisition views, and biological systems. For image representation, the probabilistic output from multi-class Support Vector Machines (SVMs) with low-level features as inputs are represented as a vector of confidence of pre-defined image categories. The outputs are combined for feature-level fusion and retrieval is based on the combination rules that are derived by following the principles of
Bayes’ theorem. In this paper, the authors propose a framework which allows one to select the most appropriate features that will help to analyze images that have been freshly obtained, thereby improving the retrieval accuracy and efficiency. An improved algorithm to achieve this has been proposed here. The algorithm includes designing feature vectors after segmentation, which can be used in similarity comparison between the query image and database images. The feature weights are calculated by considering both the precision and the rank order information of the highest placed relevant images that have been retrieved, as predicted by SVMs. The weights are updated by the system for each individual search dynamically in order to produce effective results.

Ramesh Babu Durai & Balaji (2012) proposed an automated system for content based image retrieval with better classifier accuracy and prediction time. SVM classifiers can be accurately trained to interpret data and differentiate brains as normal and abnormal, which mimic manual interpretations by a human user. The system can retrieve a much larger number of images present in the query data base. The proposed classifier was analyzed using the existing Sequential Minimal Optimization (SMO) and the K Nearest Neighbor (KNN) classifier.

Yi Liu & Yuan Zheng (2010) stated in their paper that Support Vector Machines (SVM) were originally designed for binary classification. To extend it usage to a multi-class scenario, a typical conventional method was to decompose an M-class problem into a series of two-class problems, for which one-against-all was the earliest and one of the most widely used implementations. However, certain theoretical analysis revealed a drawback, i.e., the competence of each classifier was totally neglected when the results of classification from the multiple classifiers were combined for the final decision. This paper also traced the reliability measures of SVM classifiers.
based on its classification accuracy. The measures designed were the static reliability measure, and the dynamic reliability measure. SRM works in an offline manner and DRM measures the classifier reliability in a local region surrounded by the test sample. DRM is not as simple as SRM. Based on these two measures, we decided to introduce an SVM classifier and further proposed a new decision strategy that covered all approaches.

Innovative medical image retrieval has been proposed to extract low-level image texture features by Rajakumar & Muttan (2010). These low-level texture features were extracted directly using the Modified Discrete Cosine Transform (MDCT). MDCT coefficients represent dominant directions and gray level variations of the image. This method used a hierarchical similarity measure for efficient medical image retrieval and also reduced the search space in a large image database. In an experiment using a database of 200 images, the method demonstrated a higher performance in the retrieval process. The retrieval image is the relevance between a query image and database image. The relevance similarity is ranked according to measures that are the closest and similar as computed by the Euclidean distance. Blind steganalysis based on classifying feature vectors derived from images is becoming increasingly more powerful as illustrated by Tomáš Pevný and Jessica.

Fridrich (2000) proposed that for the steganalysis of JPEG images, the features are derived directly in the embedding domain from DCT coefficients and appear to achieve the best performance.

Agma J et al (2001) proposed the MultiWaveMed system which was a new software that allowed one to index and retrieve medical images by comparing the features of their textures. The features were extracted by
wavelet transforms, and organized as feature vectors. The system extracted the images texture features, computed the distance between the query images to all images in the database by comparing their features, and retrieved images with the highest similarity based on the nature of features. This system implemented both Daubechies and Gabor wavelets, but failed to demonstrate its accuracy and corresponding images were not retrieved.

Stepan & Jiri (2003) dealt with image retrieval based on affine frames. It provided high retrieval of rigid objects under a very wide range of viewing and illumination conditions and was robust to occlusion and the background. The regions of data were detected. The image patches were extracted and matched with various color intensities, normal patches and comparison of Discrete Cosine Transform coefficients. Using this DCT, the retrieval performance was carried out and the rank was measured. Hence, in this work, depending on the usage of memory, the coefficients were calculated. So, if memory usage was reduced, the rank would not be achieved. In our method, we were able to obtain retrieval accuracy for all the images in the dataset.

Ashish Oberoi (2013) proposed a framework based on Local Tetra Pattern and Fourier Descriptor for content based image retrieval from medical databases. This approach formulates the relationship between the centre pixel and its neighbors considering the vertical and horizontal directions calculated using the first-order derivatives. The texture feature of an image is of prime concern and the images are filtered in response to the query image. In this method, the association of Euclidean distance (ED) with local tetra pattern is also investigated. The work is successfully tested on standard Messidor dataset of 1200 Retinal images which are annotated with Retinopathy and Macular Edema grades. A tool SS-SVM is applied on binary patterns for
endoscopy, dental, skull, brain and retinal images for classification, and this resulted in better classification of images.

2.8 FUNCTIONS OF SUPPORT VECTOR MACHINE

The Support Vector Machine is an emerging learning technology that has been successfully used for learning methods. The SVM has been used in various fields of study for analyzing, retrieving and classifying images. The SVM is a powerful supervised classification technique for learning and training of images. Michael Mavroforakis & Sergios Theodoridis (2006) proposed a geometric framework for the Support Vector Machine (SVM) classification. The problem provides an intuitive ground for the understanding and the application of geometric optimization algorithms, leading to practical solutions of real world classification problems. In this research work, the notion of a reduced convex hull is employed and supported by a set of new theoretical results. These results allow existing geometric algorithms to be directly and practically applied to solve separable and non-separable classification problems, both accurately and efficiently.

Glenn Fung & Mangasarian (2005) proposed that in a given dataset, each element of which was labeled by one of the given k labels, it was possible to construct a very fast algorithm, namely, a k-category proximal Support Vector Machine (PSVM) classifier. Proximal Support Vector Machines (PSVM) and related approaches (Fung & Mangasarian 2001; Suykens & Vandewalle 1999) can be interpreted as ridge regression applied to classification problems (Evgeniou et al 2000). Extensive computational results have shown the effectiveness of PSVM for two-class classification problems.

Yan-Shi Dong Ke-Song Han (2005), in their investigations, stated that the Support Vector Machines (SVM) achieved state-of-the-art
performances with respect to Text Classification (TC) tasks. Due to the complexity of TC problems, it becomes challenging to systematically develop classifiers which offer a better performance. We try to tackle this problem by ensemble methods, which are often used for boosting weak classifiers, such as decision trees, neural networks, KNNs etc.

Anuj Sharma & Shubhamoy Dey (2013) dealt with several approaches that have been proposed for the sentiment based classification of online texts. Out of various contemporary approaches, supervised machine learning techniques like Naive Bayes (NB) and Support Vector Machines (SVM) are found to be very effective, as reported in literature. However, some studies have reported that the conditional independence assumption of NBs make feature selection a crucial problem. Moreover, SVM suffers from other issues like selection of kernel functions, skewed vector spaces and heterogeneity in the training examples. In this paper, the author has proposed a hybrid method by integrating weak Support Vector Machine classifiers using boosting techniques. The proposed model exploits classification performance of boosting while using SVM as the base classifier, applied for sentiment based classification of online reviews.

Bhoomika Panda et al (2012) proposed that the Support Vector Machine (SVM) is used as classifier to classify different emotional states such as anger, happiness, sadness, neutral, fear, from a database of emotional speech collected from various emotional drama sound tracks. The SVM is used for the classification of emotions. It gave 93.75% and 94.73% classification accuracy. Thus, SVM forms a perfect decision function and was originally designed for binary classification dealing with medical image classification using the multiclass method. SVMs can be generalized as linear and non-linear classifiers.
2.9 MEDICAL IMAGE RETRIEVAL IN MDCT DOMAIN

Image retrieval system is a computer system for searching and retrieving images from a large database of digital images. Maisen et al (2003), in their proposition stated that the Discrete Cosine Transform has been proved successful at decorrelating and correlating energy data. The feature vector is formed with variance of the first eight AC coefficients. This technique assumes that these eight AC coefficients have the most discriminating features. The run time complexity is small since the length of the feature vector is also small. The coefficients produce sub-bands in multi-resolution decomposition and compute the absolute mean and variance.

![Retrieval of retinal medical image](image)

Figure 2.6 Retrieval of retinal medical image

Muttan (2010) proposed that the modified Discrete Cosine Transform approach is easy to identify objects, like the background of the image and run time, while the time taken for computation is reduced. MDCT coefficients represent dominant directions and gray level variations of the image. Our proposed method uses a hierarchical similarity measure for efficient medical image retrieval and also reduces the search space in a large image database, thus improving the accuracy of image retrieval. The sample of the retrieval class of an image in our proposed research work is shown above in Figure 2.6.