CHAPTER 1

INTRODUCTION

Analytical and iterative reconstruction algorithms are the two methodologies in computer tomography for the investigation of image quality. Analytical model is one in which it attempts to find the direct solution for the image reconstruction from the unknown projections. It is computationally stable and noise free. It tries to formulate the solution in a closed form. Analytical algorithm is limited to incomplete projections and sparse in view. In iterative reconstruction, Image estimate is progressively updated towards an improved solution.

It tries to formulate the final solution as the solution either set of equation or solution of an optimization problem which is solved in iterative fashion. It can improve the image quality. One of the major drawbacks of image reconstruction in iterative reconstruction is the high computational time and complexity. The high computational time and complexity will reflect the result as lack of convergence of optimum solution to ill posed problem. Further, this may introduce noise on reconstructed image. Therefore, it is desirable to reduce the computational time and complexity.

To lighten the iterative image reconstruction algorithm, many approaches have been presented in literature. Among these methods, the projection based method is an efficient and a distortion less technique. The following challenges are widely faced in literature to design iterative image reconstruction algorithms for computer tomography:

- Memory consumption and computation time are usually seen as the challenging faced by iterative algorithm when being compared to analytical algorithm.
Most time consuming part in the reconstruction process is forward and backward projections in iterative reconstruction algorithms.

Computation time must not be a hindrance in the clinical settings.

The algorithm needs to be efficiently handling large, sparse, inconsistent data sets.

Algorithm must reflect accurate modeling of the physical processes involved in the image modality.

In this research work, an attempt has been made to develop efficient image reconstruction algorithms for computer tomography.

### 1.1 Image Reconstruction based Discrete Wavelet Transform (DWT) for Computer Tomography

The design and implementation of wavelet transform is proposed in reconstruction of image for computer tomography. Wavelet transform is suitable in de-noising for reconstruction of original image from noisy projection. Due to multi resolution property of wavelet, the image is constructed from detail and approximated level. The significance of the particular wavelet filter selected is considered in terms of the accuracy of reconstruction of the spatial location. The coefficient selection is performed by different thresholding methods are proposed. This wavelet transform method will perform better than Fourier transform and to reduce computational complexity of the system.

### 1.2 Discrete Wavelet Transform (DWT) Performance in the Imaging Systems

In recent years, there have been significant efforts by the industry and researchers to develop computer tomography (CT) imaging systems in terms of new processing and reconstruction algorithms. A CT scanner has considerable attention to improve both hardware and software to enable high resolution CT images to be generated. The quality and speed with which they are generated
is in part due to improvements in efficient image reconstruction algorithms. This field is still growing and new algorithms are currently used that adapt to the variety of issues like model and handle the projection noise, low detector count, non-uniform arrangements of sensor, scatter etc., Two major classification in image reconstruction algorithms are analytical and Iterative algorithm. Analytical model is computationally efficient and speed with the several assumptions like scanner geometry and raw data, such as continuity of the projections and noiseless measurements, etc., which are typically violated.

To achieve better image quality from the same raw data, more realistic assumptions about scanner geometry and noise statistics must be made. This is done in the more computationally complex iterative reconstruction methods. Such iterative reconstruction methods may result in longer reconstruction times but also in substantially less image noise from the same raw data through more complex modeling of detector response and the statistical behavior of the measurements. Iterative reconstruction algorithm is much efficient than analytical algorithm. Among which, Iterative reconstruction is considered in this research. Now-a-days, Iterative reconstruction is playing a major role in computer tomography to improve quality of image and reduce the motion artifacts. Hence a lot of research work has been done in order to improve the reconstructed image in both visual and error analysis.

1.3 Need for the Study

The Discrete Wavelet Transform (DWT) is one of the most effective methods in the field of Image compression and Image coding. Joint Pixel Expert Group (JPEG) is the first standard technique for the image compression. The coding competence and image quality is efficient in the Discrete Wavelet Transform (DWT) when compared to the traditional Discrete Cosine Transform (DCT). JPEG is explained the irreversible form of the Discrete Wavelet Transform for the efficient image compression. Digital
Image is one of the main requirements for both real time applications as well as research area. The requirement of the Image compression is relatively high due to the traffic produced by the multimedia sources. The One Dimensional and Two-Dimensional Discrete Wavelet Transform is the key function for image processing. The Multi-resolution signal analysis is achieved in both time and frequency domain in Discrete Wavelet Transform. The Discrete Wavelet Transform is widely used in the image compression in JPEG 2000 due to its time and frequency characteristics.

The image reconstruction is defined as the technique of adding two-dimensional images into PC by investigating the shape of the image. The image reconstruction is mainly used in various applications like Medicine, Robotics, and Gaming. In Discrete Wavelet Transform, there are some set of wavelet functions that are used for the compression, noise reductions, and reconstruction process. In general, all communication channels have random noise due to these characteristics, and these channels are affected by bad connection from the source of the channel. The image reconstruction is performed by the up sampling followed by the digital filters.

Multi-resolution wavelet transform is the traditional approach of reconstruction. The main disadvantage of conventional approach is the highest hardware requirements to store the intermediate values. The computational delay of the fixed is also great. To overcome these problems, the multi-band wavelet transform is mainly used for the image reconstruction process. By using the proposed multiband wavelet transform, the frequency overlapping of the equipment is reduced. The summation filters are mainly used to build the reconstruction block. The image contrast and intensity are efficient in the multiband wavelet transform when compared to conventional multi-resolution wavelet transform.
1.4 Statement of the Problem

Wavelet Transform is one of the main tools which is responsible for a wide range of applications such as Signal Processing, Image Processing, Data Compression and many more. The main advantage of using Discrete Wavelet Transform over other wavelet transform is temporal resolution: it confines both frequency component as well as time of the occurrence of the component.

- The Wavelet transform can be implemented by two methods that is Filter bank method and lifting technique. The Discrete Wavelet Transform (DWT) is applied to the input source of the image to compress the image, but the spatial resolution is not up to the mark in a standard wavelet transform.
- The Image segmentations are used to segment the input source of the image, and the spatial resolution is much better.
- Multi Resolution Wavelet Transform is one of the traditional methods of image reconstruction which has large hardware complexity; more delay and low throughput in reconstruct the output
- The overlapping of frequency band image is the other main drawbacks of the Multi-Resolution wavelet transform. In the proposed approach, the summation filter is used instead of the interpolation filters.

1.5 Objective of the study

The main aim of this research work is to design the efficient Discrete Wavelet Transform for the efficient image compression with the minimum number of logical elements counts.

- To improve the spatial resolution, the image segmentation is performed at each stage of the Discrete Wavelet Transform. The new method is designed in a way that uses Discrete Wavelet Transform with the subset of the source of the image.
• Discrete Wavelet Transform based lifting scheme is used to improve image resolution as well as the efficient hardware utilizations. The 2-Dimensional Discrete Wavelet Transform uses 1-Dimensional wavelet transforms with efficient picture resolution.

• To compress the image, the multi-level dimensional wavelet transform is used with the minimum hardware utilizations, the Lifting scheme is implemented. For the effective image compression and image reconstruction, the multi-band wavelet transform is designed.

• To reduce the number of redundant bit utilizations the multi-band wavelet transform is used. The multi-band wavelet transforms based image reconstruction, and compression provides various information about the image and the intensity of the image is improved.

• To implement Lifting Scheme based Discrete Wavelet Transform in hardware to improve its performance.

1.6 Methodology of the Study

The Image Resolution is improved by proposing the Image segmentations to segment the image into the sub-set of Discrete Wavelet Transform. Second, the Lifting scheme based Discrete Wavelet transform is used to improve the picture resolutions for efficient image compression. Finally, the Multi-band wavelet transforms based Image reconstruction, and Image Compression is used to reduce the disadvantages of the Multi-level wavelet transform regarding the VLSI Design Environment.

1.7 Limitations of the Study

The Multi-level wavelet transform is one of the traditional approaches for the image reconstruction. The overlapping of the frequency band image is one of the main drawbacks of the Multi-level wavelet transform. Computation
delay of the proposed multi-band wavelet analysis is not highly reduced when compared to multi-resolution wavelet analysis.

1.8 Organization of the Thesis

The thesis is organized in seven chapters as given below:

Chapter 1: Introduction. This chapter deals with the crucial information regarding Discrete Wavelet Transform (DWT) and Multi-band Wavelet transform. It also discusses about the Image Segmentation, Image Compression, Multi-band wavelet transform based Image Compression and Image reconstruction involved in the Discrete Wavelet Transform (DWT) implementation. Further the advantages of Multi-band wavelet transform and main objectives of the current research work are discussed.

Chapter 2: Review of Literature. This chapter presents the review of literature regarding different architectures of Discrete Wavelet Transform (DWT) and implementations. It gives the detailed study of the work and it reviews Discrete Wavelet Transform (DWT). Also it discusses the issues of the conventional methodologies and the need to propose Discrete Wavelet Transform (DWT).

Chapter 3: Discrete Wavelet Transform (DWT) and Inverse Discrete Wavelet Transform (IDWT) With the Image Segmentation. This chapter discusses regarding the Discrete Wavelet Transform (DWT) with the help of the proposed segmented spatial domain IDWT unit and its performances.

Chapter 4: Lifting Scheme Based Two Dimensional Discrete Wavelet Transform (2D-DWT). This chapter deals with 2D-Discrete Wavelet Transform (DWT) Image Compression by applying lifting based methodology and its area and delay analysis.

Chapter 5: Multi-Band Wavelet Transform Based Image Compression And Image Reconstruction. This chapter describes Image Compression and
Image Reconstruction with the Multi-band Wavelet Transform and its comparison analysis with the conventional Multi-resolution Wavelet Analysis.

**Chapter 6: Hardware Implementation of the Lifting Discrete Wavelet Transform.** This chapter deals with hardware implementation of lifting based Discrete Wavelet Transform.

**Chapter 7: Results and Discussions.** This chapter discusses the result analysis for all the methodologies discussed in the earlier chapters.

**Chapter 8: Conclusion and scope for further study.** This chapter gives the conclusion of the research work and scope for further study is explained.