Chapter-I

INTRODUCTION
1.1 Background

Image processing plays a vital role in a wide variety of applications in recent years. One of the important and emerging fields in the area of medical imaging applications. Quality of the image in terms of its resolution is a major parameter for accurate diagnosis of diseases. Hence, image enhancement is the key area for the researchers, especially to improve the resolution.

Image resolution is defined as the smallest discernible or measurable detail in a visual presentation and the process of obtaining a high-resolution image from a set of low-resolution observations is called super-resolution imaging. It means that pixel density within an image is high, and therefore an HR image can offer more details that may be critical in various applications [1].

It has been well over three decades now since the first attempts at processing and displaying images by computers. Motivated by the fact that the majority of information received by a human being is visual, it was felt that a successful integration of the ability to process visual information into a system would contribute to enhancing its overall information processing power. Today, image processing techniques are applied to a wide variety of areas such as robotics, industrial inspection, remote sensing, image transmission, medical imaging and surveillance, etc. For example, Vision-based guidance is employed to control the motion of a manipulator device so as to move, grasp and then place an object at a desired location. Here the visual component is embedded in the feedback loop in the form of a camera which looks at the scene, a frame grabber which digitizes the analog signal from the camera into image data and a computer which processes these images and sends out appropriate signals to the manipulator actuators to affect the motion. A similar set-up is required for an industrial inspection system such as a fault detection unit for printed circuit boards or for detecting surface faults in machine parts [2].
In almost every application, it is desirable to generate an image that has a very high resolution. Thus, a high resolution image could contribute to a better classification of regions in a multi-spectral image or to a more accurate localization of a tumor in a medical image or could facilitate a more pleasing view in high definition televisions (HDTV) or web-based images. The resolution of an image is dependent on the resolution of the image acquisition devices. However, as the resolution of the image generated by a device increases, so does the cost of the device and hence it may not be an affordable solution. Therefore we are emphasizing our work to avoid hardware updating solution which is more costly and complex.

1.2 Imaging Problems

Medical images typically suffer from one or more of the following imperfections:

- Low resolution (in the spatial and spectral domains)
- High level of noise
- Low contrast
- Geometric deformations
- Presence of imaging artifacts

These imperfections can be inherent to the imaging modality (e.g. X-rays offer low contrast for soft tissues, ultrasound produces very noisy images, and metallic implants will cause imaging artifacts in MRI) or the result of a deliberate trade-off during acquisition. For example, finer spatial sampling may be obtained through a longer acquisition time. However, that would also increase the probability of patient movement and thus blurring. Here our interest is only in the processing and analysis of images, and we will not be concerned with the challenging
problem of designing optimal procedures for their acquisition. It is proposed to focus on brain MRI images in this thesis.

The following several tasks can be performed semi-automatically to support the brain system of medical practitioners:

i. Smoothing is the problem of simplifying the image while retaining important information.

ii. Registration is the problem of fusing images of the same region acquired from different modalities or putting in correspondence images of one patient at different times or of different patients.

iii. Segmentation is the problem of isolating anatomical structures for quantitative shape analysis or visualization.

The ideal clinical application should be fast, robust with regards to image imperfections, simple to use, and as automatic as possible. The ultimate goal of artificial vision is to imitate human vision, which is intrinsically subjective. For ease of presentation, the techniques we applied to two-dimensional grayscale images. The majority of them, however, can be extended to higher dimensions.

1.3 Challenges in Super Resolution

Super resolution imaging is the process of obtaining HR image from the set of LR observations. The imaging system presents number of peculiar and challenging situations some of which are unique to brain MR image acquisition scenario.

i. Image registration: small image displacements are crucial for beating the sampling limit of the original camera or machine, but the exact mappings between these images are
unknown. To achieve an accurate super-resolution result, they need to be found as accurately as possible.

ii. Magnetic field variation: when the images are aligned geometrically, there may still be significant magnetic field variation, because of different voltage levels or machine exposure settings when the images were captured.

iii. Blur identification: due to patient movement blurs introduced in the image, these stages are modeled by a point-spread function (PSF) [3].

1.4 Motivation for the Work

As the world is going towards new trends and technologies, image processing plays an important role in different valuable domains like Military, Medical, Security, etc.

Due to the unique inherent advantages and wide spread use over the century for Medical and other applications Super Resolution is most preferred method over other one like bilinear method, Tikhnovo Regularization method, Wavelet. Accuracy of the SR depends on the quality of the input image, preprocessing (Noise, blurring) and post processing (image enhancement, FFT, etc).

Here we are concentrating on medical imaging especially on MRI (Brain) imaging. For proper diagnosis it is very important that MR images should be more clear and observable. Super Resolution helps to achieve best quality of MR images. By proper selection of sensors (resolution) and maintaining the physical parameters, a good quality images can be acquired.

The literature survey reveals algorithms and the techniques provided by the researchers are based on lot of mathematical computations and are complex for implementation. It is hence
desirable to develop effective Super Resolution image enhancement algorithm which is comparatively simple but efficient for Super Resolution imaging by pixel splitting and interpolating.

1.5 Thesis Objectives

Given a low-resolution image as input, Super Resolution imaging recovers its high-resolution counterpart for a particular medical application. In this proposed research work the technique intended to achieve Super-resolution, includes enhancement in spatial resolution for gray-scale images, suppression of signal dependent noise, and various other associated artifacts.

In view of the above discussion and considering the necessary of simple and effective model for super resolution of images, objectives of thesis are:

- To study of various medical images used for clinical diagnosis
- To study various methods of Super Resolution imaging.
- Comparative study of different SR algorithms for Medical imaging.
- To propose a new Super Resolution algorithm for MR (Brain) imaging.

Performance comparison of results obtained from individual implementation of new algorithm over existing algorithms.

1.6 Thesis Outline

The complete thesis is organized in seven chapters and they are reported as follows.

Chapter 1 - Introduction briefly discusses the background of DIP and image enhancement. it also introduces HR, SR and imaging problems. The SR method used for medical imaging,
preferably for MRI Brain imaging. The problems and challenges of SR are then addressed. The detailed objectives and motivation for carrying out the present work are discussed next. It concludes with organizational aspects of thesis report.

Chapter 2 - Review of literature describes the comprehensive literature survey that was undertaken to review the different techniques of MRI imaging and its operations for resolution enhancement. It also consists of International journals like, IEEE transactions on image processing, Pattern Recognition, Computer vision and others are scanned to review the work done and presented by the researchers round the globe. Finally the significant conclusions derived from the survey are summarized and the need for present investigation has been defined.

Chapter 3 – Medical imaging briefly discusses the different medical imaging with concept of HR images, its necessity and methods of super resolution. Historical developments in the medical imaging and comparatively study of SR based methods are reported in brief.

Chapter 4 – MRI image acquisition and reconstruction starts with explanation of the methods of image acquisition, different types of MRI machines with their specifications and reconstructing of the images. It explains various methods of SR image enhancement, enhancement in spatial resolution for both gray-scale and color images, suppression of signal dependent noise, and various other associated artifacts.

Chapter 5 – Super resolution image reconstruction with AIT covers FFT, adaptive signal processing SR reconstruction using AIT based algorithm the detailed experimentation with parametric measurement has been elaborated. the results are also presented at the end.

Chapter 6 - Performance Evaluation describes the existing methods for super resolution and enhancement. The comparative performance evaluation of existing and the proposed methods
with their respective results are also presented.

Chapter 7 - Conclusions and future work describes the significant conclusions obtained from the present experimental results. It also gives the scope for the future work in this area.