Chapter 7
Summary

The purpose of this thesis was to develop methods for SAR data compression. A primary requirement of such methods is that they should take into account the characteristics of SAR image data which are different from the optical image data. Therefore, we need to adopt approaches specifically for SAR images to achieve the goal of SAR compression. Our study involved theoretical and experimental evaluation of a number of techniques for compressing SAR signal data using algorithms suitable for on-board implementation. The main results of the thesis are summarized below:

1. In the thesis the problem of SAR speckle reduction and data compression has been studied simultaneously. In examining the effect of speckle noise on SAR image compression, we have found that speckle noise tends to break the inter-pixel correlation in SAR images. As a result, algorithms which are successfully used for optical image compression perform less effectively for SAR images. For speckle reduction, we have used several filters like, median filter, Wiener2 filter, Sigma filter and Lee multiplicative filters and analyzed their performance on the basis of Entropy, Effective number of looks (ENL), skewness, kurtosis, Entropy, Redundancy and distribution of normal probability. Applying the filters on various real SAR images
and simulated images we conclude that Lee multiplicative filter and Wiener2 filters are suitable for SAR images with less deviation from normal probability standard plot, less skewness, less kurtosis, good entropy and good ENL. So in rest of the thesis while testing our proposed algorithm on SAR test images we have used this filter.

2. Optimization of the BAQ in terms of block size and magnitude and phase error has been done. Since the BAQ is based on the assumption that the SAR data distribution is Gaussian with zero mean and unit variance. It also assumes that the power through out the block remains almost constant compared to the large dynamic range of the complete SAR data. In our study, analysis has been made on the basis of standard deviation of the magnitude error and overhead ratio for block size selection and it is concluded that optimum result is found for minimum 32x32 block and maximum 256 x 256 block size SAR image. BAQ optimization has been done on the basis of phase and magnitude error also in the study as phase plays very important role in SAR data. A look-up table has been designed for 2/3/4/5/6/7 bits quantization of the 8 bits (I & Q) samples having mean values ranging from 0 to 127. The table act as an optimum scale factor table, very useful while encoding and reconstructing SAR images.

3. Yet another contribution made by the thesis is study of mean and standard deviation of SAR data and establishing relation among ASM (Average Signal Magnitude), SDIS (Standard Deviation of input signal) and SDOS (Standard Deviation of output signal). BAQ assume linear relation between the standard deviation and the mean, while as we have tested BAQ and with rigorous analytical exercise, found that the relation is no more linear for whole range of input signal and breaks after the threshold of mean value 40. So we have suggested and studied technique which will preserve the linearity between mean and standard deviation even beyond the value of 40 and this improved the BAQ performance by approximately 2.5 dB even at 100 percent saturation degree.

4. In order to study impact of saturation degree, we have designed ONSQ (Optimum Non-saturated Scalar Quantizer). Max-Lloyd quantizer is considered as standard scalar quantizer in BAQ but this quantizer doesn’t work faithfully under saturation
condition of ADC. Centroid condition of the data changes and all such samples get confined to last interval of the quantizer leading to distortion and hence reduction in signal to noise ratio at high degree of saturation. This problem has been studied on the basis of the power loss and its relation with SDIS, SDOS and mean signal value. We have suggested power loss compensation based on Rayleigh model thus improving the performance by at least 2 dB. We have used this ONSQ instead of Max-Lloyd quantizer while encoding and decoding the SAR data. The developed algorithm outperformed the existing BAQ algorithm at least by 3 dB in the full range of input data.

The study concludes with point target simulation and simulation study of another variant of BAQ i.e. BMPQ based on polar form of SAR data.

Based on the work done in this thesis, the following recommendations are suggested for future work in this area.

1. Introduction of new orientation of the quantizer optimization in order to have a complete and perfect reconstruction of the signal.

2. Non-linear nature of the Gaussian distribution makes it difficult to design optimal quantization boundaries. Further a straightforward implementation of a complex quantizer using look up table would require a very large amount of memory, hence for future work, some other approach can be used to bring down the size of the look up table.

3. Since the saturation of the ADC causes power loss for the input signal, hence the loss is to be compensated while decoding the same data, thus a suitable power loss compensation technique is recommended.