Chapter 6

Conclusions and Scope for Further Work

6.1 Conclusions

In this thesis work, we have analyzed the audio watermarking techniques in spectral domain and consequently proposed high capacity watermarking and steganography techniques in spectral and compressed domain respectively.

In Chapter 3, we have proposed a multiplicative spread spectrum based audio watermarking technique which embeds watermark in DFT magnitude of audio signal. In order to improve two parameters, the embedding capacity and the computational complexity, a new perceptual model for magnitude of DFT coefficients is developed. This model finds the regions of highest watermark embedding capacity with least perceptual distortion. Also the proposed method reduces computations by bypassing the complex psychoacoustic modeling, required for fulfilling the condition of transparency.

Further the scheme uses blind watermark detection i.e. detector does not require original copy of the audio signal to detect watermark from the received audio signal. Theoretical evaluation of detector performance using correlation detector and likelihood ratio detector is undertaken under the assumption that host feature (DFT magnitude) follows Weibull distribution. The performance of scheme is investigated experimentally and statistically and results are compared with the existing schemes in terms of perceptual quality and embedding capacity. The results shown that proposed scheme gives higher embedding capacity as compared to existing high watermark em-
bedding techniques keeping the perceptual quality well within limits. Also, it was observed from experimental results that proposed scheme is robust to various signal processing attacks like presence of multiple watermarks, AWGN and MP3 compression.

In Chapter 4, a high capacity blind watermarking technique for audio is proposed which embeds watermark directly in subbands of MPEG audio encoder during compression process. The scheme is implemented in the compressed stream by modifying the subband coefficients using QIM. Further, the watermarking procedure exploits perceptual frequency masking phenomenon of the human auditory system (HAS) to satisfy the requirements of robustness, security and transparency. It was found that audible distortion is reduced by making the quantization step size of QIM adaptive to masking threshold. The chapter also investigates the effect of elevated masking threshold obtained by incorporating the combined effect of frequency and temporal masking threshold. It was observed that WNR and NC values were improved with combined masking threshold (CMT) at higher bit error rates. Hence robustness of watermark to AWGN attack is increased with CMT. However the quality of speech (ODG) was found to be slightly degraded as compared to SMT, though still within imperceptible limits. Hence we can conclude that when SMT was replaced with CMT, for applying QIM in subbands, robustness was improved keeping the transparency within limits.

In Chapter 5, a steganography technique is proposed which transports a binary secret message with scrambled speech signal. The scheme implements encryption for protecting the audio signal and hides secret message simultaneously using the single technique. This is performed in two ways. First scheme utilizes real random orthogonal matrices for encryption and steganography of signal transforms. These signal transforms are obtained by applying discrete fourier transform on speech segments of size \( N \). In the second scheme the two operations are performed in a single step using Discrete Fractional Random Transform (DFRNT). The major benefit is that the proposed technique provides high data hiding capacity. Also the scheme requires no extra bandwidth for sending the covert message.

At the receiver side, the inverse of these transforms are used for decrypting host signal. Further, secret message is decoded using statistical and heuristic approaches. For this
the autocorrelation property of speech signal is exploited. During the decoding process same secret keys are utilized which were used for encryption and subsequently for data hiding. To consolidate the results, distance between the original and decrypted speech is evaluated for each frame with correct and wrong keys, for both the schemes. This distance is in terms of an objective quality measure known as log likelihood ratio (LLR) and itakura saito (IS) distance measure. From the results, it was observed that the decrypted signal with correct and wrong keys are differentiable with large distance in both the schemes. Lastly, the robustness of watermark is investigated under noisy channel conditions. It was found that there is a tradeoff between data embedding rate and minimum SNR required for error free message detection.

6.2 Future Scope

- The QIM watermark embedding technique can also be implemented on Compressed video (MPEG 2) signal. The binary watermark can be embedded in the direct components (DC) of chroma DCT coefficients of prediction error pictures and intra coded pictures.

- Two dimensional Discrete fractional random Transform can be used for simultaneous implementation of encryption and steganography of images and audio.

- To implement steganography scheme on compressed speech using bit stream hiding. We aim towards reducing the computation power of combined encryption and data hiding technique. The technique provides a reasonable trade-off between the adequate requirement (good security and sufficient capacity) for information hiding and the low latency requirement for VoIP service.

INITIAL STAGE OF FURTHER WORK PRESENTED AT:
