THE reasoning draws conclusions, but does not make the conclusions certain, unless the mind discovers it by the path of experience which provides the reasoning that will defend the conclusions made. Therefore, the analytical and simulation studies made and reported in the previous chapters are utilized to draw a set of conclusions. The conclusive remarks are included in the following section along with future scope of the work.

7.1 CONCLUSION

This study contributes in the area of multirate signal processing and also describes the convergence in between multirate signal processing techniques and multicarrier communication systems. Several developments also took place during this course of study, which were also included and considered in drawing the conclusions, as reported in this chapter. After introducing the area of multirate signal processing in the first chapter of this thesis, the literature review was carried out and reported in next chapter. The literature review helps in identifying potential areas where improvisation can be made successfully. It has been observed that the performance of QMF bank depends upon the window function used in the design of prototype FIR filter. In this direction, a novel window by taking linear combination of three term truncated cosine series ($a_0 = 0.4$, $a_1 = 0.5$ and $a_2 = 0.1$) with Papoulis window has been designed [118]. This three term coefficient window gives the best MSLL with first null at three (normalized frequency). Similarly, Populis window provides the first null at three (normalized frequency). Their linear algebraic combination with $\delta = 0.207$ provides the best MSLL -59.61 dB, of this combinational family. With the use of this particular window function, the prototype FIR filter for QMF banks has been designed with various set of parameters. In the design of QMF banks two optimization techniques has been applied, viz- linear gradient based bi-section and Levenberg-Marquardt (LM) methods. The proposed window function gives the minimum reconstruction error with better far end attenuation and filter order for 50 dB stop-band attenuation. With various examples and constraints, it has been also shown that the proposed novel window outperforms existing used window functions in terms of stop-band attenuation, far end attenuation, order of filter and reconstruction error with the appropriate choice of optimization technique. In chapter-3, it has been concluded that the proposed novel combinational window function with bi-section optimization algorithm provides better QMF bank in terms of reconstruction error, order of filter, far-end attenuation and stop-band attenuation [58].
Similarly, the literature survey in chapter-2 revealed that a better QMF banks can be obtained by using cosine modulation. Cosine modulation is one of the efficient techniques which provide minimum computational cost in the design of filter banks [12 and 33]. In this context, the cosine modulated NPR type QMF banks have also synthesized and there are included in chapter-4. During the process of optimization, both the algorithms (bi-section and Levenberg-Marquardt) were again tried with newly proposed window function. It has been observed that peak reconstruction error is found $7.32 \times 10^{-4}$ as against of $2.30 \times 10^{-3}$ of PC6 window. Similarly for the 16-channel CMFBs designed with proposed window function is a better candidate with reconstruction error of $1.35 \times 10^{-6}$ in comparison to $4.04 \times 10^{-4}$ of PC4 window. In both these examples, bi-section algorithm was used. **It is important to mention that LM algorithm is used first time with window based design of QMF banks and CMFBs.** Results of proposed window function is found also better against all existing window functions used for such QMF banks with LM algorithm. There is significant improvement in reconstruction error, aliasing error and filter order in contrast to some other window functions.

The application of cosine modulated quadrature mirror filter banks is considered in the design of transmultiplexers. Based on the literature surveyed in chapter-2, it can be concluded that the transmultiplexers can also be designed with the help of optimum cosine modulated quadrature mirror filter banks. Chapter-5 deals with synthesis of transmultiplexers. After describing various design issues and performance metric for evaluating these transmultiplexers, design examples of transmultiplexer are included. Again, these transmultiplexers are designed with the help of proposed window and found better as compared to other existing window functions. In the design examples, it has been observed that for 50 dB attenuation in the stop-band with order of filter as 48, the ICI is found as -103.5 dB which is comparable with PC4, PC6 and modified Blackman [88 and 90]. However, the ISI is found the best amongst all as -77.52 dB. The transmultiplexers for fixed stop-band attenuation with order independent are again found better with the proposed window in terms of both ICI and ISI. If transmultiplexer order is dependent then again proposed window performs better in terms of ICI and ISI. The proposed window function with bi-section optimization algorithm provides a comparable transmultiplexer.

As it has been found and discussed about the convergence of two domains, the transmultiplexers which are designed with the help of proposed window function and optimization algorithm are used in OFDM (multi-carrier communication) system. In chapter-6, the block diagram of OFDM system has been described and shown that the L-point IFFT and L-point FFT blocks can be replaced with transmultiplexers. The performance of such needful system has been determined and found that the modified OFDM system with TMUX is performing better in terms of Bit Error Rate (BER) and the
improvement in significant when the narrow band interference increases. The performance has again evaluated by both optimization algorithms [58].

Finding of this study confirms that window function plays a very important role in defining the performance of QMF bank, cosine modulated quadrature mirror filter banks and transmultiplexers. The proposed window function outperforms all existing window functions in all three configurations (i.e. QMFB, CMQMFB and TMUX). The transmultiplexers designed with the help of proposed window function and bi-section optimization algorithm perform better in OFDM system and its performance is very significant when narrow band interference increases [109].

7.2 FUTURE SCOPE

“No one ‘discovers’ the future. The future is not a discovery neither it is destiny. The future is a decision based on a continuous effort starting from the past, motivated by the present which certainly leads success thereafter. In the long run it is the cumulative effect that matters. One can do much. And one and one and one and one can move mountains”. Initiated by this thought, all the reported work in this thesis leads to their respective extensions that will strengthen their impact and role in real life applications. The desired and expected extensions are termed here as the future scope of the reported work which can be outlined as –

Efficient designs with negligible errors and interferences are still main research area in the field of transmultiplexers and filter banks. The trend is also now to use inbuilt functions for optimization like spline function, particle swarm method etc. The proposed optimization can optimize only one performance parameter. It is possible to develop optimization algorithms which simultaneously control more than one parameters. The work in 2-D environment is also one of the major research areas on transmultiplexer and filter design.