7.1 Summary

In this thesis, we have reviewed various image-based rendering techniques to render realistic looking novel views of an object (or a scene) in computer graphics literature and contributed a family of algorithms for improvements in these techniques for computer and mobile devices. Our work is based on the 3D warping (or image warping) technique. 3D warping is an image-based rendering (IBR) technique that maps all pixel positions in 2D reference image plane to their correct position in the desired image plane. This technique is particularly appropriate for low-cost implementation, because it requires a relatively small input data set. To represent a scene, it requires a reference image together with per-pixel depth information and a description of the camera and viewpoint. Given this information, one can synthesize new virtual views of an image corresponding to the changed camera position or viewpoint.

First, we propose a framework which improves the time efficiency of traditional 3D warping technique. In the proposed framework, we perform the restructuring of warping order cases and make use of scan line coherency to do the reference image to desired
image mapping efficient. The proposed framework has been implemented using JavaSE and through experiments it has been proved that the proposed framework achieves 7-8% average improvement in rendering time as compared to our evaluated traditional 3D warping technique.

Then we further propose a framework based on the computationally efficient 3D warping technique to perform interactive 3D rendering on mobile devices. The framework is implemented with JavaME based MIDlet architecture and its performance evaluated with JavaME Phone emulator and some real Java-based mobile devices. Further, the performance of the framework is compared with our evaluated performance of geometry-based Phong shading. The experimental results show that the proposed framework performs better in terms of rendering time as compared to Phong shading. Moreover, the rendering time of the proposed method is independent of scene complexity; while in Phong shading the rendering time depends on the polygon count in the scene which in turn depends on the scene complexity. Thus for complex and highly detailed models, the interactivity of the user with the scene is strongly affected in geometry-based Phong shading. Further, the results show that the proposed framework gives visually realistic renderings from photographs which are easy to capture while Phong shading will give the same level of realism only if trained artists spend a lot of time to model the scene. In addition, the memory requirement of such a model is high as compared to the input parameters of the proposed framework. Therefore, the proposed framework is more suitable for interactively rendering 3D graphics applications like visualization, navigation system etc. on mobile/ handheld devices.
However, an issue associated with the mobile devices is that processing takes considerable time if the reference image is of large size. As the mobile devices have limited screen-size, therefore, methods to down-sample these large images can be utilized. We further propose a framework that extends the computationally efficient 3D warping technique in wavelet-domain to render novel views of down-sampled images in mobile devices. By applying Haar-wavelet transform we represent the reference and disparity images in terms of low-resolution images and a set of detail coefficients. By ignoring the detail coefficients and simply warping the approximation image we get the novel view of the reference image. As the rendering time of the warping technique is directly proportional to the image size rather than image complexity, this improves the rendering time. The proposed framework is implemented with Android Development Tools (ADT) and its performance is evaluated with Android Virtual Device (AVD) emulator and some real android-based mobile devices. The experimental results show that the proposed framework gives 39-41% better results in terms of rendering time as compared to the computationally efficient 3D warping technique if the framework down-sample the images to one quarter of its original size. Further, the compressed rebuilt image has visual quality close to the original image.

7.2 Thesis Contributions

The main contributions of the thesis in the field of image-based rendering are:
• Design of a computationally efficient framework for 3D warping technique that achieves 7-8% average improvement in the rendering speed over our evaluated traditional 3D warping technique.

• Design of a framework for interactive 3D rendering on mobile devices based on the computationally efficient 3D warping technique that performs better in terms of rendering time, visual quality and memory requirements as compared to our evaluated Geometry-based technique.

• Design of a framework that extends the computationally efficient 3D warping technique in wavelet-domain to render novel views of compressed images on android smartphones. The proposed framework gives 39-41% better results in terms of rendering time as compared to the computationally efficient 3D warping technique if the framework down-sample the images to one quarter of its original size. Further, the compressed rebuilt image has visual quality close to the original image.

7.3 Future Work

The research work presented in this thesis has some potential areas that can be addressed in future:

• An important area for future research involves enhancing the field of view of the rendered images. As the proposed framework has been implemented with a single reference image, therefore the field of view of the rendered images is limited. In
future, we intend to include multiple reference images to create a wider field of view.

- Another area of future work involves adding hardware support to the proposed framework. As the proposed framework has been implemented with software architecture, therefore hardware acceleration will be definitely helpful for high-resolution image-based rendering.