Chapter 5
Conclusion and Future Scope

Map making and map updating are the two most important fields today, as the requirement for information retrieval, indexing and identification from the satellite images is playing a major role. Most of the information available about the maps is either very old or has been updated manually periodically. The existing approaches show individually that the use of road models and varying strategies for different types of scenes are promising. However, all the methods are based on relatively Simplistic road models and most of them make only insufficient use of a priori information. Thus they are very sensitive to disturbances like presence of vehicles, shadows or occlusions, do not always provide good quality results.

5.1 Conclusion

Active research and analysis of the urban areas is being done by scientists for feature extraction. Though a lot of work can be found in the rural areas for identification of the type of crop, vegetation etc, but very little work is found for the identification of the roads. Therefore, two different effective algorithms: Modified U-Net and GDSLO were suggested for road extraction in rural and urban areas. Complete description of the algorithm, detailed analysis of the results and comparison of the results has been done in chapter 3 and chapter 4. The review of the results of these various approaches is presented here briefly as below.

- The modified U-Net can effectively segment road images from the remote sensing images. The average value of IoU and Dice score of segmentation occurred at 93.74 %, and 93.28 % respectively during training of the module. During the testing phase, the average value of IOU and DICE scores occurred at 92.19 % and 92.68 % respectively. The training time required for the road network segmentation model was 1.34 hr and the testing time for a single image was 0.3 sec.

- The dataset could be effectively augmented by the rotate and flip method. This could alleviate the over fitting caused by the lack of training samples.
- The results showed that the accuracy of the modified U-Net was higher than that of other algorithms as well as the speed of the detection of the image was relatively high.
- GDSLO algorithm used for road surface, edges and centerline extraction by use of newly developed optimizer based on combination of SLO and SGD algorithm. After extracting road surfaces, road edge detection is done using FCN for extracting single-pixel width boundaries of Roads and Road centerline detections is perform using FCN for detection of the road network from high resolution RS images.
- Furthermore, the developed GDSLO-based U-Net outperformed numerous existing methods and achieved effective performance by considering precision, recall, and F1- measure with maximum values of 0.887,0.930,and 0.809, respectively.

From the detailed research proceedings with regard to road extraction of satellite images it is concluded that Modified U-Net method be the best in terms of the IOU, DICE score and testing time of the single images over the basic U-Net and SegNet. However the GDSLO methods result shows that precision, recall, and F1-score is best over the other methods reported in the chapter 4. Thus the research work on extraction of road images has been justified with the proven results.

5.2 Limitations

Shadows, occlusions, cloud cover presence of vehicles etc., play a very important role in the road network extraction. Owing to the vast amount of satellite imagery data available with increasing resolution, the processing speed and quality of the algorithms need to be improved. Also there is a continuous change in the infrastructure with the development of different villages, towns, cities, states countries etc. This information change needs to be updated.

The modified U-Net was simplified compared with the basic U-Net. The simplified U-Net has lower feature extraction and decoding abilities than the original U-Net.

However, the semantic segmentation was a binary classification between the road and background. Only the road and background segments were targeted. Because of these qualities, the network was simplified, and this simplification diminishes the neural network's capability in complex tasks. However, it improves the accuracy and speed of semantic segmentation of road networks.

However, the determination of wrong road topology and unclosed boundary are the key issues in the GDSLO based technique for road network extraction.

5.3 Recommendations for Further Research

As discussed above, some limitations exist with the developed method. Future work may include:

The capability of the road detection networks can be improved with the use of pre-processing and post-processing filters. Furthermore, the learning capacity of the proposed modified U-Net architecture can be studied by different optimization techniques.

The unclosed boundary and wrong road network detection problem of the GDSLO can be solved out by exploring the loss function and measure the geometric similarity and topology.

In general, presentation of the algorithm on more difficult urban areas is yet to be assessed, which might require some alterations in the measurements. Future purpose is to apply and generalize method that is feasible to detect road edge and lane boundary shapes that can occur in all kinds of complex road configurations .Road extraction research work is very useful for the Geo information society in plotting the road maps and city planning.