CHAPTER 7: CONCLUSIONS, FUTURE PLANS AND SCOPE

7.1 CONCLUSIONS

In the present studies, estimation of LAI and LCC parameters were done using different techniques, mostly from hyperspectral image and multispectral image, and models were generated for the retrievals using various machine learning algorithms.

In first and second chapter, hyperspectral imagery for AVIRIS-NG was simulated by utilizing a spectral reconstruction approach (UPDM) and multispectral images (Sentinel-2 and UAV based RedEdge MX). A chlorophyll map and LAI for the respective regions were also generated to check the validity of simulated images by checking variation in LCC and LAI of different vegetation under different stages, which was validated for by ground truth LCC and LAI taken during data sampling. It was found that the simulated imagery gave good results w.r.t. in situ data. A SAM classifier was used to classify distinct classes in the image generated from Sentinel-2, which yielded an accuracy of 87.4%. Thus, it is concluded that the freely generated HS imagery can be put to use for vegetation parameters retrieval. The CS analysis shown in this chapter could also be verified for different band combinations as to find out which combination would yield the best separation.

Furthermore, the image simulated, HRPHSI in Chapter 4 has 105 bands starting from visible to NIR bands with spectral resolution of 5 nm and a spatial resolution of 4.2 cm (ten times better than the original AVIRIS-NG). Since there are only five bands present in the UAV, that is why the image simulation was restricted to 1000 nm. The image was used to map LAI and LCC for the experimental site and it gave results better than obtained in Chapter 3. The next chapter attempted to show the usefulness of wavelet analysis and different feature selection methods to generate a model for the retrieval of LCC for an image of AVIRIS-NG.

In the previous chapter, the potential of different machine learning algorithms was exploited for the estimation of vegetation parameters. Various VIs were investigated to find out optimum VIs over different crops under different treatments. Among SVR (lin, rad, poly), RFR, PLSR, HyFIS, SVR-rad was best for retrieving LCC and LAI, followed by the SVR model using linear kernel function and PLSR. The least performing models are SVR with polynomial kernel function, HyFIS model, and RFR generated model. As an extension of Chapter 6, we could generate new indices from the LAI and LCC based correlation heat maps. The study mentioned in Chapter 6 would be replicated again to see the authentication of the model generated, and further implement it on a larger field scale.

7.2 FUTURE PLANS AND SCOPE

In the future, we plan to implement an endmember selection process in order to enhance the quality of the simulated image, and we will also investigate the possibility of using other algorithms, such as non-matrix factorization (NMF), for the simulation of images. Expand the use of image simulation to study the plant species succession in Retrogressive Thaw Slumps (RTS) under NASA ABoVE (Arctic-Boreal Vulnerability Experiment) program.

We could further extend the work of image simulation for global coverage of different hyperspectral sensors such as EnMap, PRISMA etc., and these images could find its applicability in different areas.

Furthermore, use of deep learning algorithms like neural network that could be exploited for the vegetation parameters retrieval as well as image simulation such as Convolutional Neural Network (CNN), Recurrent Neural Network (RNN). Although, we explored few of absorption bands selection methods for the vegetation parameters retrieval which is very crucial to avoid data redundancy. NN has advantage over various conventional regression models in terms accuracy, because important features are deduced and automatically tuned optimally w.r.t. the input parameter.

Big data mining is a process that can handle massive volumes of data and this can find application in parameters estimation as well. A new band selection approach based on the statistical characteristic, spectral information divergence (SID), from a hyperspectral dataset can be used for crop classification. The band selection technique works on the assumption that if two crops that are the most similar can be distinguished based on the lowest SID value, then other crops can also be distinguished.

There is always room for improvement in accuracy for parameters estimation by exploring different methods for atmospheric correction on satellite images and preprocessing of images. Radiative Transfer Model (RTM) inversion and modification based on leaf and canopy data in order to retrieve parameters that could be implemented with ongoing and upcoming hyperspectral sensors such as Copernicus Hyperspectral Imaging Mission for the Environment (CHIME), by ESA.