CHAPTER 6 OUTCOMES AND FUTURE DIRECTIONS

6.1 EXPERIMENTAL RESULTS AND OUTCOMES:

(i) Choice between co-polar or cross-polar depends on the incidence angle and for the case of ship detection, it is preferable to take cross polar component if incidence angle is less than 45 deg and same is verified experimentally.

(ii) RBF SVM gives higher accuracy with reduced probability of False alarm and hence modification of the constraint, sigma & with cross validation produce better results[3].

(iii) The semi empirical model for estimation of Gross tonnage was congruent with the validation data by detection of all the ship of corresponding class and the positional accuracy/measurement accuracy revealed that SVM based method increased the error while saved time for interpretation and automated the process.

(iv) Detection Performance of Sentinel-1A GRDH data revealed that the detection was high and also the false detection with SVM increased indicating precise detection capability of SVM detector.

(v) Histogram frequency slicing method offers better logical classified output in a computationally efficient manner to be a source for further GIS (Geographical Information Systems) analysis.

6.2 VALIDATION OF RESULTS:

(i) Positional accuracy & Dimensional accuracy: The positional accuracy of the manual methods is comparably better with Sentinel-1A data with low noise conditions; while with the increase in the background clutter or noise, it the SVM detector which gives the best source of detection especially Radial Basis Function kernel based SVM.

(ii) Detection performance: The analysis of medium resolution products of both Sentinel-1A and RISAT-1 revealed a lot of scope for the increase in the robust detection and classification. The semi-empirical model approach has also verified the same with the ground truth. But final verification of the identity of the ship can be accomplished by the use of polarimetry and AIS data.

(iii) Detection comparisons: The algorithm has worked with multiple datasets and is also independent of the type of SAR data while the polarimetric analysis is specific to create a unique identity. It was found that SVM based approaches had better performance than manual method under high clutter or noise conditions and the same was verified by the cross validation with Sentinel-1A and RISAT-1 data.

(iv) Accuracy Assessment: The classification accuracy assessment was carried out by using confusion matrix technique of Exelis Envi software which revealed better performance by SVM detectors. Also with the use of polarimetric signature, the ship recognition is enhanced.

6.3 DISCUSSION AND FUTURE WORK

This section discusses some solutions that may help improve these methods to further, so that detection of ships can be carried out more accurately. The problem addressed is generic in nature which is restricted to the detection of ships in ocean areas of interest. Though, it is not possible to do this perfectly, there are various tradeoffs required. These tradeoffs are made within the framework of surveillance scenarios with specific objectives. The various considerations that should be taken into account include:

(i) Dimension of the surveillance area.

(ii) Type, class, size and velocity of target.

(iii) Ocean environment factors — sea state, wind conditions.

(iv) Time constraints and revisit rate of the sensor.

(v) computational resources.

(vi) Radar parameters - Frequency, Resolution, Incidence angle & Polarisation.

Preferably, one would have a given surveillance/reconnaissance mission and the radar parameters would be chosen accordingly. Hence, the ship detection algorithms would then be designed to suit the resulting imagery. However, this research is not aimed at addressing any definite surveillance scenario. Rather it aims to be a general methodical review of techniques for ship detection strategies in SAR imagery.

Future work would solve detection of ships constructed with material like small wooden boats and fibre glass boats may also be picked up by the microwave imagery. Object Based Image Analysis may be carried out on the

processed image for image segmentation for better extraction of naval features.

6.4 CONTRIBUTIONS OF THE RESEARCH

Specific solutions the research will give lead thorough in the domain of ship detection using PolSAR are listed as follows:-

(i) Ship detection in dynamic situations without prior knowledge can be done as this has given the enterprise level processing for the single image processing without any external input for detection using SVM detector and further improvisation using modifications of SVM detector as per the image source.

(ii) The techniques proposed are in a way robust as it give a clear readymade classification ideology to have a clear idea of the target of interest which could be modified to meet the requirements of the user.

(iii) Target identification has been entrusted to the CFRS data or compact polarimetric data due to the technical and engineering advantages which is proven by the prospective future mission objectives and application developments. The future missions with Indian participation like NISAR, Risat-1 repeat will get benefitted by this proposal and further research would help not only in the application development but will also accentuate the requirement of fundamental research in this domain of compact polarimetry.

(iv) Challenges faced by the search and rescue missions over vast oceans have been becoming more difficult even with lot of advancements in the active or passive tracking of aircrafts or spacecrafts but this

proposal can lead to a more simplified processing especially over high seas / oceans for target detection to render immediate assistance provided the oceanic coverage by satellite missions are undertaken.

(v) Dynamic switch over of the modes of scan is future for target identification and will lead the way forward to provide a complete standalone system of shield against any seaborne threats to our nation. Switching from the systematic coverage to the required mode has been explored and the same will lead to design of satellites having the control systems for optimising the target selection to tracking and even engagement.

(vi) The choice of various software tools and the design methodology has been done even though there is no specific customised software package or toolbox existing for processing and specifically to solve the ship detection. The software design in this research has been done using original coding of Matlab and this has not only shown the potential of existing softwares for design of tools but also given the way ahead for the utilisation of various tools for processing of Risat-1 data and compact polarimetry data.

(vii) The enhancement of the algorithm by usage of advanced machine learning techniques and design of the codes for application in the remote sensing perspective.

6.5 LIMITATIONS OF THE RESEARCH

It is indispensible to know the limitations of the research in order to gauge the strengths while applying to solve real world problems. While the

research has various contributions, it has a fundamental limitation of application primarily to the ship detection. However if the following are clearly understood by the users, it would enable them to effectively use:-

(i) The scope of the research is for ship detection with the aim of semi-automation and hence all efforts have been made to meet the requirements of problem. Hence the design of the detector algorithm has been made from manual to semi-automation for a particular type of data for further application and it does not assure a complete automation as the expert needs to provide the sample at least once before the algorithm can be deployed for complete operations.

(ii) The research has attempted to carry out a single scene analysis with assumptions akin to bare soil which has been proven to be nearly applicable for oceanic surface for target detection. Hence due care must be take to apply such assumptions and also while extrapolating the methodology for unknown terrain or imaging applications.

(iii) Terrain masking or land sea mask has not been applied in the pre-processing or image analysis to explore the potential for use in other applications. This should normally be applied to remove the anomalies and false alarms that are beyond the seas and becomes more critical with low tide and in areas near tidal zones or shorelines. Hence the user has the discretion to carry out the masking as per the application area and specific scenario to meet the user target requirements.