SUMMARY

While the usefulness of SAR backscatter alone at different polarisations has been extensively studied, relatively less work has been carried out in the field of SAR polarimetry in comparison to SAR backscatter alone. Further, applicability of SAR polarimetry over large areas for target parameter retrieval is yet at its initial phase. The research work carried out for the PhD study was aimed at exploring the potentials of SAR polarimetry (including hybrid-mode case i.e., circular transmit/linear receive that would be available from India’s RISAT-1 SAR) for target parameter retrieval.

To study the utility of SAR polarimetry for target parameter retrieval, different polarimetric parameters were obtained from polarimetric scattering matrices. Followed by this, their temporal variation with the variation in various land covers like forest plantation, water, human settlement (in a broad classification sense) was studied. This gave an insight into the capability of SAR polarimetry to capture characteristic interaction that takes place when a SAR signal interacts with a given target. e.g. a study of variation in polarimetric parameters of crop covered soil reflected that the scattering mechanism changed from odd bounce to volume component as the growth of crop transformed the land form from bare soil to completely vegetation covered which, upon crop harvest, once again changed to odd bounce.

Efforts were also put to understand the capability of SAR Polarimetry in capturing characteristic interaction of SAR with targets by applying physical model based Wishart Entropy-Anisotropy-Alpha (H-A-\(\alpha\)) fully polarimetric target vector decomposition
classification. In order to explore the utility of the hybrid polarimetric data, that would be available from RISAT-1 SAR mode, the degree of polarisation-relative phase degree of polarisation-relative phase (m-δ) space decomposition was studied for land cover segmentation. For understanding how well can different land cover categories be separated from each other, transformed divergences were calculated for major land cover categories present within the scene over the m-δ space. It was observed that while major land cover categories were well separated from each other in m-δ space, some of the categories like fallow, crop and forest plantation exhibited overlap in some of the months. In a quest to reach a better separability between different land cover targets a third dimension to the m-δ space was added using the circular polarisation ratio \( \mu_C \) which indicates if the scattering is odd or double bounce. A study of transformed divergence for major land cover categories present within the scene, over the \( m - \delta - \mu_C \) (degree of polarisation-relative phase-circular polarisation ratio) space revealed that as compared to the m-δ space, land cover categories were better separated from each other in the m-δ-\( \mu_C \) space for all the nine scenes.

Finally, with the aim of retrieving the target parameters, a detailed experiment was conducted by observing ground data synchronous to satellite observations, and developing the statistical relationships between various polarimetric parameters and target parameters. The study area was a district in northwest India and the data span ranged from July 2008 to March 2009 covering 3 out of 4 seasons and 2 crops cycles. Retrieval models have been developed for bare soil, wheat crop covered soil and mustard crop with a limited validation. For bare soil condition, the target parameters for which retrieval
models were developed include soil moisture and three measures of surface roughness namely rms height, slope and shrinkage. Target parameters for which attempt has been made to develop retrieval models for the case of wheat as well as mustard crop covered soil, consisted of moisture of the soil underneath the crop cover, crop fresh biomass, dry biomass, plant moisture, and volume of the plant.

In order to study usefulness of SAR polarimetry over SAR backscatter alone, retrieval models were developed for all the target parameters for three cases namely fully polarimetric, hybrid polarimetric as well as SAR backscatter alone. It was observed that amongst the three cases, fully polarimetric mode data provided the highest retrieval accuracy for all the target parameters, followed by hybrid polarimetric mode while SAR backscatter alone provided the least amongst the three cases for almost all the target parameters. While fully polarimetric mode data always provided superior relationship, the importance of the finding that hybrid polarimetric mode is superior in target parameter retrieval as compared to 4 linear polarised SAR backscatter alone should not be undermined. The reason why this finding is of great significance is that in the light of the fact that RISAT-1 SAR will be providing the hybrid polarimetric mode data, over larger swaths, we may achieve operational parameter retrieval using hybrid polarimetric mode data. At the same time, even though in comparison to SAR backscatter alone for the linear four polarisation hybrid polarimetric mode is better, the fact that fully polarimetric mode yielded the highest retrieval accuracy for all the target parameters, indicated that it is always desirable to obtain data in fully polarimetric mode for target parameter retrieval.