ABSTRACT

Multi-sensor, multi-resolution and multi-spectral geo-spatial information, from satellite remote sensing has become a primary & vital source of information for critical, conclusive and instant decision making in varying real-time critical application across a wide array of domains like Environmental studies, Disaster management and Battlefield strategic planning. The Information referenced to geographic location, characteristics of natural and man-made features and boundaries on earth are termed as geospatial information.

The concepts in geospatial sciences are generally vague, ambiguous and imprecise like the Landuse/Landcover, extent of Great Indian Desert Thar, the paleo-channels and the urban sprawl. Also, a combination of spectral, spatial and radiometric resolution of space-borne sensors presents a selective & incomplete look of the geospatial feature/object under its view from the space. The resolution translates the satellite imageries into granular imprints of the geospatial features.

Recently, the Soft Computing, based on the concepts of Modelization of human mind and Swarm Intelligence, has emerged as an efficient mechanism to handle diverse uncertainty characteristics. Soft computing has been crucial means of implementing machine intelligence with human-like behavior and reasoning capabilities.

Researchers have shown keen interest on the applications of Soft Computing in divergent domains. Scanty references are available on the applications of soft computing in the area of remote sensing. The areas which have drawn the attention are as Landuse/Landcover Classification, Estimation of Groundwater availability, Research and development of soft computing in the area of geo-ontology and Semantic Web, Conflict analysis in labeling of pixels either due to the mixed pixels regime in or due to similar spectral signatures of different geospatial features, Expert’s evaluation of an independent classification thematic map.

All these problems, which hitherto are looked for their solution in non-Soft Computing platforms like Probabilistic and Bayesian, have been addressed and presented in this research work with new thoughts processing, based on soft computing techniques of Computational Intelligence.
The significant findings of the research work are summarized below:

a. Discrepant uncertainties inherent in satellite remote sensing images for geospatial features classification can be taken care of by use of soft computing dexterously. Rough Sets, Granular Computing (GrC), Fuzzy Sets, Artificial Neural Network (ANN), Rough-Fuzzy Tie-up, Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO) and Biogeography Based Optimization (BBO) methods are analyzed. Also, semantic-based image classification is attempted, as a special instance. Decision system required for any supervised classification can be made consistent and free from indecisive regions by using this spectrum of methods. The Landuse/Landcover Classification is taken as a case study.

b. It is perceived, from this research, that Kappa coefficient, a well founded metric for assessing accuracy of classification in remote sensing community, may be used for comparative study of the results from soft computing methods.

c. It is observed that the retrieval mechanism of Case Based Reasoning (CBR) system when experimented with either BBO or PSO of swarm Intelligence methods captures aptly and satisfactorily the similarity structures of the cases. The case study covers an import aspect of estimation of Groundwater in an inaccessible region.

d. Conflict resolution related to the complex problem of delineation of Landuse/Landcover classes either having similar spectral signature or contemplated with mixed pixels regime is endeavored in Rough Sets Framework. Novel concepts proposed – Expert Knowledge Support and Strength to capture the concept by a single feature, proved to be efficient in delineating the cause of conflict, in terms of the spectral bands of the remote sensing data.

e. Equally significant is the solution proposed within the schema of rough sets, as a result of this research, to the real-world problem of assessing the accuracy of an independent classification by an expert. This may pave the path for Robotic decision, on the classification accuracy of thematic geo-spatial maps in time and data constrained environment.
The contents of this thesis are based on research papers accepted in refereed and mainstream International conferences.

The thesis is concluded with pointers for prospective future work. Additionally referred briefs are some of the prospective problems in the field that are unresolved as of now.