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Exploring Remote Sensing Opportunities Through GNSS – IRNSS/NavIC Missions

Raju Garudachar
JAIN (Deemed-to-be University), Bangalore, India, email: raju_garuda@yahoo.co.in

A number of GNSS (Global Navigation Satellite Systems) missions have been operating in recent years primarily for obtaining position information of various objects is space, on ground and over oceans. The major missions are: GPS (USA), GLONASS (Russia), Galileo (Europe), Beidou/Compass (China), QZSS (Japan) and IRNSS /NavIC (India). Their primary utilization is for security and commercial applications. The currently operational global missions consist of dozens of satellites with many more expected in the near future.

With the vast constellations of satellites, a great opportunity in remote sensing applications has emerged by using the well-known techniques of bi-static radar measurements. While the satellites transmit RF power needed for navigation applications, they also incidentally serve as radar transmitters. A suitable receiver on ground or space will complete the bi-static radar configuration. The transmitters essentially have omni-directional antennas and the receivers can be suitably designed to receive scattered power from specific targets using directive antennas.

The characteristics of the scattered electrical signals in terms of their range, amplitude, Doppler, time delay, phase, etc., contain rich information about the targets similar to radar remote sensing of Earth and atmosphere. However, in context with GNSS, they are limited to the navigation frequencies that presently operate in L (1-2 GHz) and S (2-4 GHz) bands. Nevertheless these bands are important as they experience less atmospheric attenuation and have capabilities to penetrate through atmosphere, vegetation and soil. Thus they have offered a new dimension to microwave remote sensing techniques with their applications in soil moisture and vegetation cover studies, crop monitoring, tropospheric humidity measurements, ionospheric activities, and studies related to ocean surface winds and surface characteristics.

The GNSS remote sensing applications are broadly categorized under GNSS reflectometry, space weather (Earth's ionosphere TEC), and atmospheric/tropospheric profiling of temperature, humidity and pressure through radio occultation (RO) techniques, and so on. The missions also facilitate in situ measurements of geophysical parameters for calibration/validation of spaceborne sensors. The major attraction of this technique is its simple and low cost instrumentation.

The Indian Space Research Organisation (ISRO), under the IRNSS/GAGAN – UP (Indian Regional Navigation Satellite System/Navigation through Indian Constellation Utilisation Programme), has provided receivers and research support to a number of academic and research institutions in India for encouraging research in GNSS applications. JAIN (Deemed-to-be University), Bangalore, has been provided with receivers which are being used for studies related to navigation and remote sensing. The teams at the University have taken up several research topics related to remote sensing of land/atmosphere/ocean and space weather.

A first-cut methodology for correcting L/S band SAR data for errors due to ionosphere, under NavIC and NISAR programmes will be presented. Simulation and some preliminary results on atmospheric and ionospheric studies will be presented to show the feasibility of the proposed applications.

The uniqueness and relevance of the overall research outline presented here are that the opportunities that are available from both the IRNSS/NavIC and the NASA-ISRO Synthetic-Aperture Radar (NISAR) missions are expected to be running concurrently in the near future. This is further exemplified by the fact that both the missions operate at the same L and S bands and provide significant complementary and supplementary science data. It is therefore significant that the research work at the JAIN (deemed-to-be University) could provide good support and preparedness towards use of the spaceborne NISAR data.