Preface

Hyperspectral remote sensing

Hyperspectral remote sensing is a relatively new field of earth observation offering many advantages over the conventional broadband multi-spectral remote sensing. It deals with measurements in a large number of narrow spectral bands over a contiguous spectral range. It is also known as imaging spectroscopy. Spectral signatures inferred from data obtained by hyperspectral imaging sensors are able to provide subtle spectral variations in surface materials, facilitating better discrimination. Hyperspectral remote sensing data have been found useful in many application areas such as mineral exploration, characterization of soils, crop discrimination and identification of stress, forestry, snow and glacier investigations, ocean colour and planetary studies. Diagnostic absorption features in the visible, near and far infrared ranges due to electronic, vibrational and rotational transitions manifest in these spectra and in turn provide crucial information about the composition of the target material. Characteristic features of the absorption lines such as their position, shape and width hold a wealth of information. Hyperspectral remote sensing in the thermal infrared region is crucial in many mineralogical and strategic investigations. Data from the hyperspectral sensors generally form a cube having two spatial dimensions and a spectral dimension. In view of the large number of spectral bands, generally more than a hundred or so, the volume of data available in any hyperspectral cube is huge requiring special processing techniques. Dimensionality reduction, linear and nonlinear unmixing techniques to compare spectra of a pixel with a known set of laboratory spectra and visualization techniques become important. A number of hyperspectral instruments have been flown from aerial and space platforms internationally. Unattended aerial vehicles are also carrying light-weight hyperspectral instruments for detailed investigations. In India, these efforts have been of more recent origin. The Indian Space Research Organization has built aerial as well as spaceborne instruments. Indian Mini Satellite-1 (IMS-1) and Chandrayaan-1 launched in 2004 and 2008 respectively, carried a Hyperspectral Imager. The Department of Science and Technology, Government of India has initiated a national programme on this topic inviting proposals from various academic and research institutes in the country. Considerable research work has been done under this programme. Considering this scenario, it is indeed an opportune time to bring out this special section on hyperspectral remote sensing studies in India.

The special section comprises ten review articles. In the first article, Ajay Kumar *et al.* (**page 826**) have discussed various aspects of design of hyperspectral sensors and their trade-off, described many of the international sensors flown on-board different space missions and also indigenous efforts made in the development of aerial hyperspectral sensor and also the Hyperspectral Imager flown on IMS-1 and Chandrayaan-1. Various image-processing techniques used in the analysis of hyperspectral data are discussed by Krishna Mohan and Porwal (**page 833**). Senthil Kumar *et al.* (**page 842**) review specific algorithms developed to improve spectral discrimination from Indian hyperspectral data. They also discuss methods of deconvolution of data from overlapping spectral bands into a set of non-overlapping bands. Then there are six review articles dealing with hyperspectral studies carried out in different natural resource disciplines. Sahoo *et al.* (**page 848**) discuss use of hyperspectral data in the discrimination of crops, quantitative estimation of biophysical parameters and in understanding and detection of abiotic and biotic stress in vegetation through a number of case studies. How rapid and reliable assessment of various soil characteristics using hyperspectral data in conjunction with laboratory-measured spectra can be done to facilitate mapping of soils has been discussed by Das *et al.* (**page 860**). Krishnayya *et al.* (**page 869**) have discussed the potential of hyperspectral data in identification of tree species, estimation of forest productivity and other biophysical parameters through a series of case studies carried out in India. Comprehensive description of the use of hyperspectral data available in visible, near infrared and thermal infrared regions for the study of mineralogical composition has been provided by Ramakrishnan and Bharati (**page 879**). Use of both linear and nonlinear unmixing techniques have been discussed through case studies. Negi *et al.* (**page 892**) have discussed use of hyperspectral data in understanding snow reflectance as a function of its various parameters such as grain size, freshness, contamination, liquid water content and retrieval of some of these parameters from the data through inversion. A radiative transfer model to simulate the effects of inelastic scattering on upwelling radiance in coastal and turbid waters using narrow band data has been discussed by Vigneshwaran *et al.* (**page 903**). Hyperspectral remote sensing has proved to be an extremely powerful tool in the exploration of planetary surfaces. Chauhan *et al.* (**page 915**) discuss various international and Indian efforts in the study of planetary surfaces, in particular the Moon and Mars.

These articles together provide a snapshot of the work happening in this field in the country and the trends. Considering that there will be Indian earth observation missions carrying full-fledged hyperspectral sensors in the near future and Chandrayaan-2 and possibly other planetary missions at the anvil, this compilation of review articles should be useful to a large community of researchers.

I would like to acknowledge support provided by each of the contributors in preparing this section and also the editorial board of *Current Science* for assigning me this responsibility.

Ranganath Navalgund
— Guest Editor