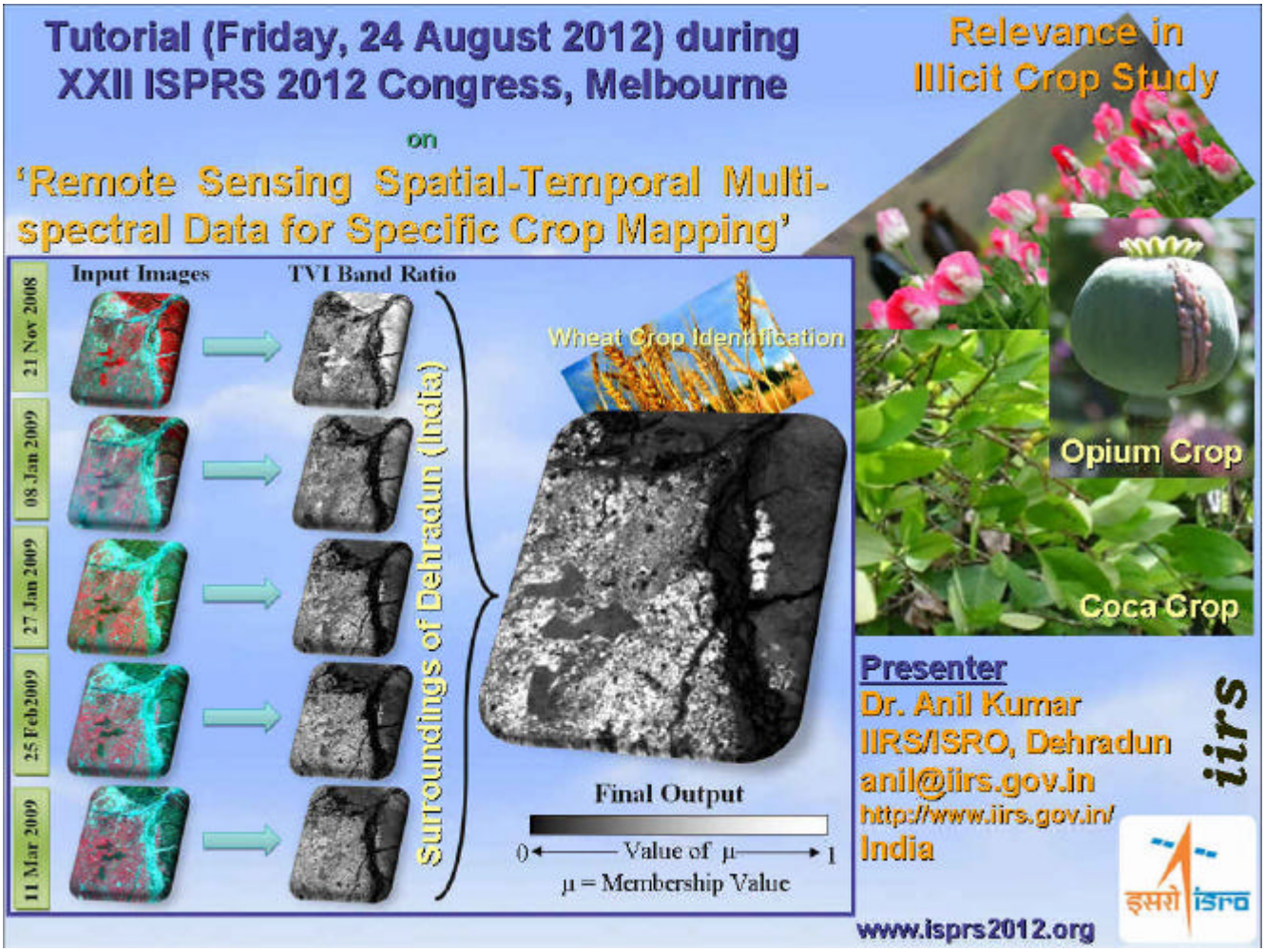
"Obstacles are those frightful things you see when you take your eyes off your goal." - *Henry Ford*



Tutorial Details

Resourcesat Satellite Series Overview

IRS-P6 (Resourcesat Series) is envisaged as a continuation of IRS-1C/1D with enhanced capabilities. The satellite is designed to provide both multi-spectral and panchromatic imagery of the Earth's surface. It has three sensors on-board: an Advanced Wide Field Sensor (AWiFS), a Linear Imaging and Self Scanning sensor (LISS-III) and a high resolution multi-spectral camera LISS-IV.

(1) **Advanced Wide Field Sensor (AWiFS):** AWiFS camera is an improved version compared to the WiFS camera flown in IRS-1C/1D. AWiFS operates in four spectral bands identical to LISS-III, providing a spatial resolution of 56 m, covering a swath of 737 Km with 12 bit radiometry.

(2) **Linear Imaging Self Scanning Sensor (LISS-III):** The LISS-III camera is identical to the LISS-III flown in IRS-1C/1D spacecraft except that the spatial resolution of SWIR band

(B5) is also 23.5 m (same as that of B2, B3, B4) and 10bit radiometry. LISS-III covers a swath of 141 Km in all the 4 bands.

(3) **LISS-IV Camera:** LISS-IV is a high resolution multi-spectral camera operating in three spectral bands (B2, B3, and B4). LISS-IV provides a ground resolution of 5.8 m (at Nadir), 10bit radiometry and can be operated in either of the two modes. In the multi-spectral mode (Mx), a swath of 23.5 Km (selectable out of 70 Km total swath) is covered in three bands, while in mono mode (Mono), the full swath of 70 Km can be covered in any one single band, which is selectable by ground command (nominal is B3 – Red band). The LISS-IV camera can be tilted up to ± 26° in the across track direction thereby providing a revisit period of 5 days.

The uniqueness of Resourcesat Series satellite is to provide multi-spectral data from 60m to 5.8m with higher temporal resolution. This gives an opportunity for specific crop mapping with temporal data approach using AWIFS data. The mixed pixels present in AWIFS data can be handled by soft computing approach. But to evaluate soft computing outputs, the conventional accuracy assessment will not work due to non availability of soft reference data which can not be generated from ground truth data. In past, researchers has acquired aerial photograph as reference data on same date as of satellite data date used for classification, which will be costlier affair for operational projects. So, image-to-image accuracy assessment can be better solution. The reference temporal finer resolution satellite data with same acquition dates as of data used for classification is possible from Resourcesat Series satellites. Due to this capability Resourcesat Series satellites can be called as *'Complete Data Solution'* satellite for specific crop mapping.

Course Summery:

Remote sensing data provides an effective approach for preparation of land use/land cover map and extracting specific class of interest. While extracting specific crop from contiguously occurring other crop/vegetation in an area from remote sensing imagery is a problem, which is often faced in classification of remote sensing data with digital method. In past, researchers have tried decision tree approach using temporal NDVI data sets. A decision tree classifier becomes complicated with higher dimensional data set. This tutorial will cover mathematical understanding of remote sensing mutlti-spectral image, basic understanding of digital image classification with importance of training and testing data. The core focus of this tutorial will be on soft computing techniques such as; Fuzzy based, learning based, statistical learning based and statistical based soft classifiers. The final outcome from this tutorial will be to discuss how to extract specific crop of interest using spatial temporal coarser multi-spectral remote sensing data sets while incorporating spatial information as well. It is also very important to check the accuracy of soft classified outputs and it becomes complicated to evaluate the soft classified outputs with respect to ground data, as to collect ground data for evaluation is not possible. So, soft classified output evaluation method using fuzzy error matrix with single and composite operator with also be discussed.

This tutorial will provide inside depth for using spatial temporal multi-spectral remote sensing data for extracting specific vegetation/crop like; monitoring specific crop growth in an area, growing of restricted crop like Opium. Extraction of specific crop of interested will be

covered using in-house developed SMIC – Sub-pixel Multi-spectral Image Classifier tool (figure 1) with minimum ground information and minimum human intervention to be called as automatic extraction approach.

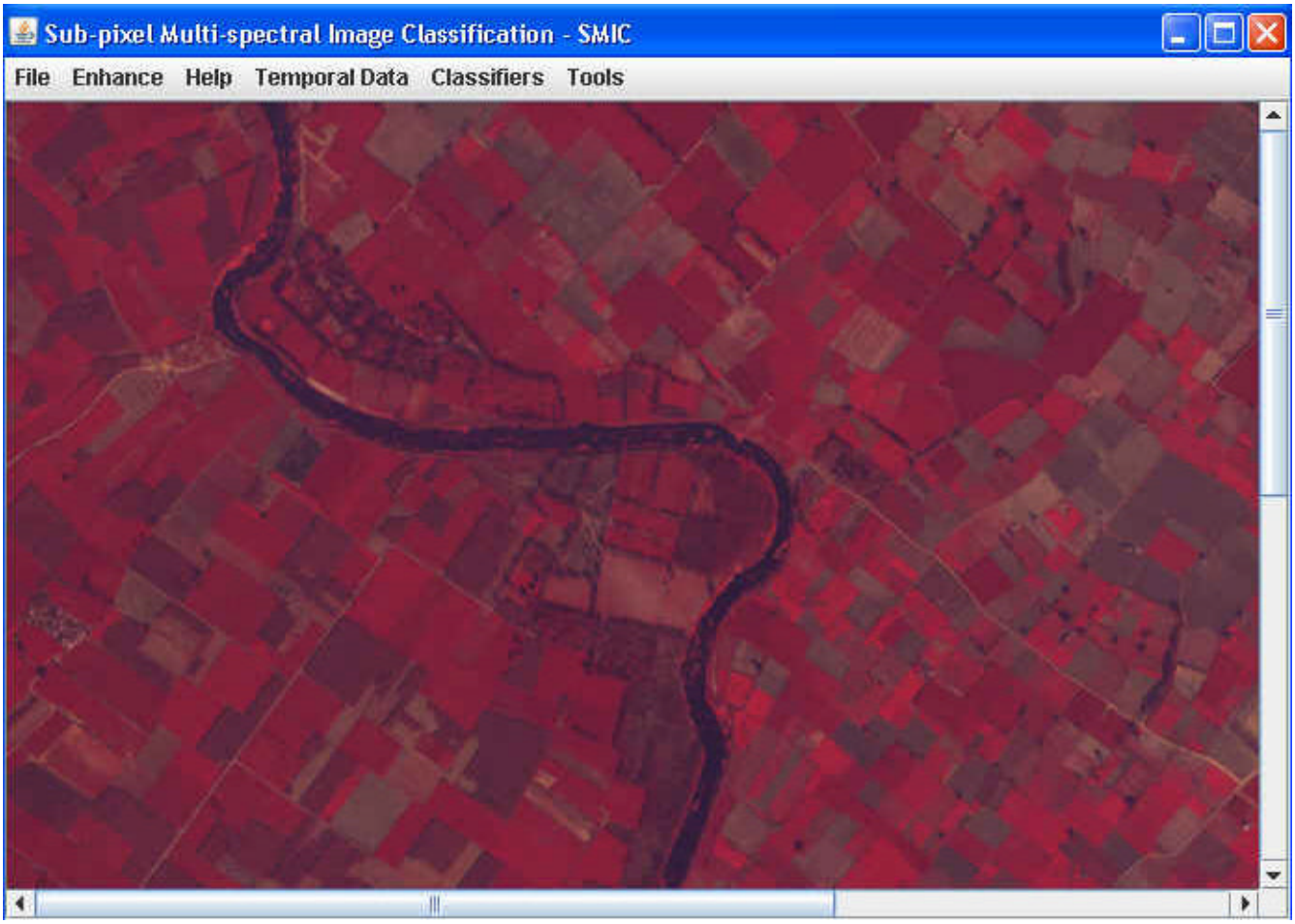


Figure 1: GUI of SMIC tool displaying worldview-2 multi-spectral image

Instructor Biography

Anil Kumar is Scientist / Engineer 'SF' at Indian Institute of Remote Sensing, Indian Space Research Organisation, Dehradun, India. He received his B.Tech degree in Civil Engineering from University of Lucknow, India and Master of Engineering degree in Photogrammetry and Remote Sensing Engineering from Indian Institute of Technology Roorkee, India. He has completed his Ph.D in Soft Computing from Indian Institute of Technology Roorkee, India. His current research interests include Soft Computing, Digital Photogrammetry, GPS and LiDAR.

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Topic Details of
'Remote Sensing Spatial-Temporal Multi-spectral Data for Specific Crop Mapping'
ISPRS 2012 Tutorial (Friday, 24 August 2012)

Topic Details
Remote Sensing – Multi-spectral and Hyper-spectral data Basic of remote sensing, Mathematical understanding - multi-spectral and Hyper-spectral data sets, Importance of resolution in remote sensing
Resourcesat Satellite Series Platform, Onboard Sensors and their characteristics
Basic of Classification, Training and Testing data sets Pixel based Hard classification, Importance of training and testing data, Accuracy Assessment
Soft Computing, Entropy and Contextual based Hybrid Fuzzy Classification Approaches Fuzzy *c*-Means classifier, Possibilistic *c*-Means classifier, Artificial Neural Network classifier, Support Vector Machine Classifier, Fuzzy, Entropy and Contextual based
Specific Crop Mapping - Soft Multi-spectral Temporal data Approach and Accuracy Assessment of Soft classification outputs Fuzzy Error Matrix (FERM) with single and composite operator, Sub-Pixel Confusion-Uncertainty Matrix (SCM)

Sl. No.	Demonstration Description	Tool
Demo - 1	Soft Classification approaches – Fuzzy, Entropy and Contextual based	SMIC
Demo - 2	Specific vegetation mapping - Soft Multi-spectral Temporal data Approach	SMIC
Demo - 3	Accuracy assessment of Soft classification outputs	SMIC

SMIC – Sub-pixel Multi-spectral Image Classifier tool developed at IIRS, Dehradun, India

Participants attending this tutorial will be supported for processing their actual project temporal data with SMIC TOOL during or after the tutorial

"Never, never, never, never give up." - *Winston Churchill*