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Mitigating Skips with Remote Sensing, DGPS and GIS Intergration.

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Summary

This paper aims in introducing a modern technique of topographical surveying for mitigating skips by integrating Remote Sensing (RS), Differential Global Positioning System (DGPS), Digital Elevation Models (DEMs) and other data with Geographical Information System (GIS).

Seismic surveying demands complete details of logistics, topography of the terrain, vegetation, soil type etc., statics of all source/ receiver locations falling on each land cover, likely skips due to logistics, and possible recovery locations well in advance for planning / execution of seismic survey, to get the maximum possible seismic coverage of the area of interest by reducing turn around time and cost. .

This can be easily achieved with around 90% accuracy by processing the digital image of remote sensing data and GIS integration. The method and technique involved will be discussed in detail. A case study in this regard has been carried out in the highly challenging area of Geleki, Assam, India, having varied topography with different species of vegetation, forest, good number of producing wells with a huge network of oil and gas pipelines. Results obtained were highly encouraging.

Introduction

The latest Indian Remote Sensing (IRS-1C) pan sharpened multispectral data having a spatial resolution of 5m (approx.) was used for the area and the digital image was processed using ERDAS Image processing software.

The original raw data was in polyconic projection and Everest spheroid. The image was first re projected to Lambert conformal conical projection. Since the ground accuracy of the supplied RS data was in the order of around 100 M, the image was Geo corrected by Ground truthing. Leica's latest state-of-art technology 1200 series Real Time DGPS was used for ground truthing and real time DGPS observations were taken at prominent locations like road crossings, bridges etc which can be easily correlated with the RS data.

The image was then geo corrected with DGPS values by Polynomial method. After geo correcting, coordinates of RS data were cross checked with DGPS values at different locations and found that coordinates from RS data are almost matching with DGPS coordinates. Now the RS data / image is ready for further processing and interpretation.

RS Data Processing & Interpretation

The objective is to process the raw image and to discriminate various features based on their spectral reflectance, and then to do further analysis using GIS software

To understand the logistics, the source / receiver locations of Geleki 3D prospect was overlayed on RS image (plate 1), from the image it is clear that the major logistics in the working area are tea gardens, paddy field, oil installations, villages, forest etc.

Various enhancement techniques like contrast stretching, spatial filtering, edge enhancement, spectral rationing, vegetation components etc were carried out for visual interpretation .

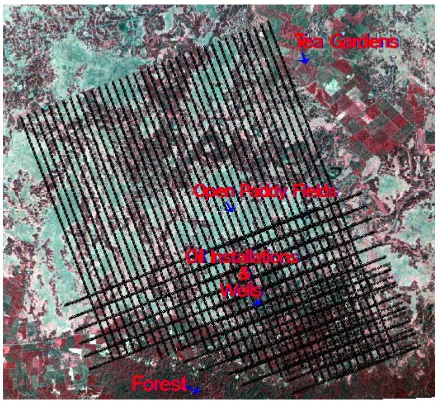


Plate : 1

Raw data being multi spectral, more emphasis was given for the spectral analysis by choosing the appropriate spectral signatures to identify various features. Supervised and Unsupervised classifications were also carried out and different thematic maps for various land covers like forest, tea gardens, paddy fields, water bodies etc. were produced.

Paddy, tea garden, forest and other vegetations were discriminated with supervised classification by assigning training sets for the corresponding features. Both tea gardens and thick forest are almost having same spectral signatures, resulted as same feature. Yet, as tea gardens are having regular patterns, they could be easily distinguished from the forest.

Mixed vegetation and grown paddy fields were brought out in a different class. Open paddy fields and barren lands could be easily identified since it gives the maximum reflectance. Since water is a good absorbent of infrared, water bodies could be easily be distinguished in the infrared band.

Regarding habitation, particularly villages, this feature is getting mixed up with barren lands and with other classes due to its reflectance matching with various classes. Hence some enhancement techniques were carried out to bring features like villages, oil installations, roads etc.

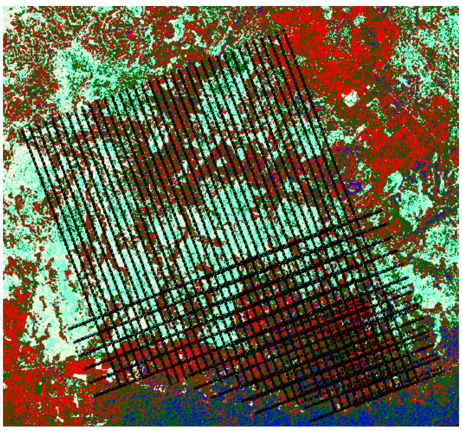


Plate 2

Unsupervised classification was carried out and various features were brought out as shown in Plate 2. In the above image, red colour indicates the high reflectance in the infrared band of forest and tea gardens. It is worth noting the blue colour (water content) in the southern part of image is because of the high chlorophyll and water content in the forest leafs.The beige colour indicates open paddy / barren land . Green colour indicates the mixed vegetation.

As the image is coarse in nature, is was smoothened by resampling the image with Neighborhood anaysis which is shown in Plate 3.

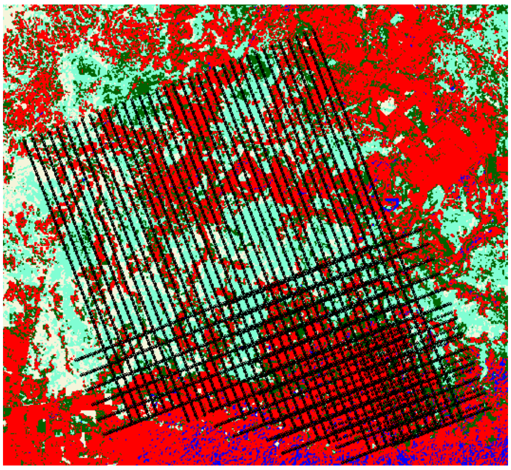


Plate : 3

Geocoding was done to merge similar features and to bring out only the major classes. Natural colours were assigned to the features for better visualization.

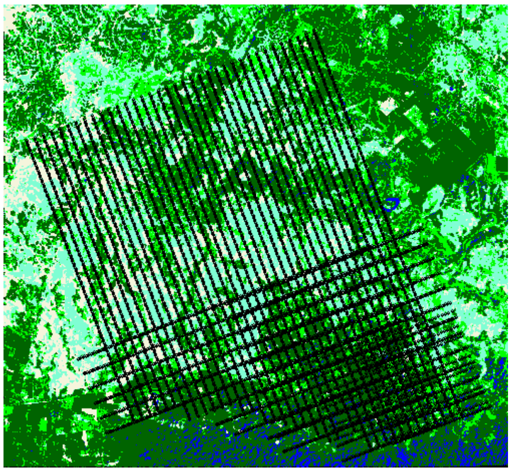
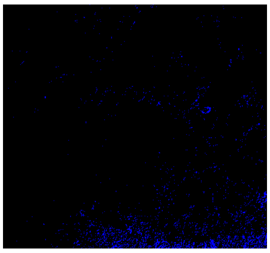
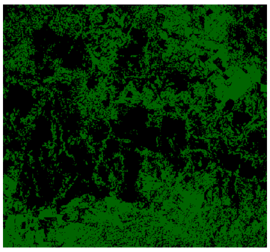


Plate : 4

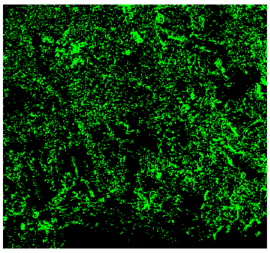
Plate 4 shows the geocoded image, in which, the dark green represents thick forest and tea gardens, light green represents paddy field and mixed vegetations, beige represents barren land, bluish green represents open paddy field and water is shown in blue colour. Now these features can be separated out and the following are the thematic maps of various features.



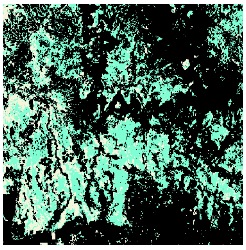
Water



Forest & Tea Garden



MixedVegetation



Open Paddy Field & Barren Land

The above images are in raster format. For further analysis in GIS these images are to be converted in vector format..

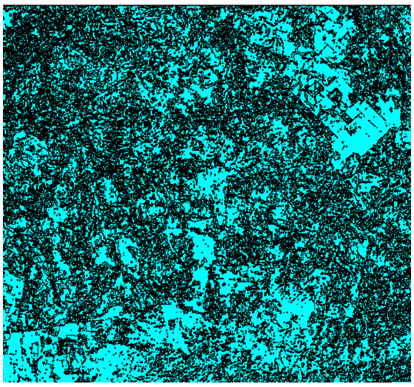


Plate : 5

Plate 5 shows the vector format of the classified image, all features converted into polygon with different Ids for different classes. This will be the input for GIS for further analysis.

GIS Analysis

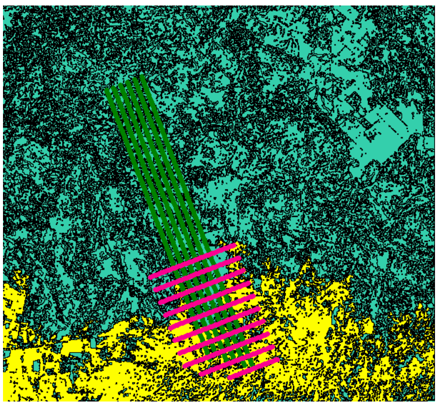


Plate 6

As an example source / receiver locations of a particular swath was overlayed on this vector polygon (Plate 6) using GIS. Overlay analysis (point in polygon) was carried out in GIS to identify the source / receiver points falling in the polygon of forest.

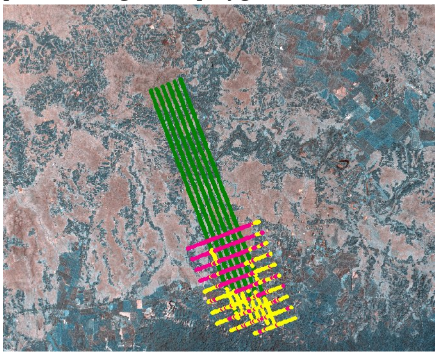


Plate 7

Plate 7 shows the output of the overlay analysis, the yellow points represent the source / receiver locations falling in the forest area. The X, Y and Z etc of these locations can be generated using GIS which will be the input to various Geophysical softwares like MESA, GEOLAND etc to calculate the achievable coverage of the area in advance and also to plan / execute seismic surveys, reducing turn around time and cost.

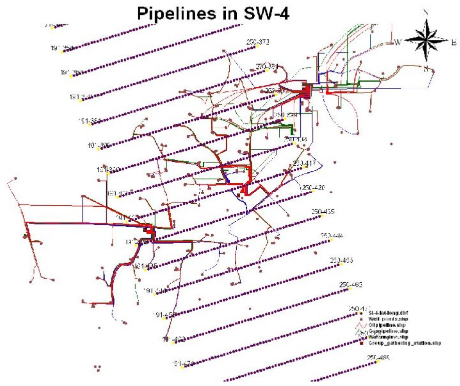


Plate 8

Apart from logistics, huge pipe line network is running in the area (Plate 8). To identify the possible source / receiver locations falling within a distance of 20m from pipelines, buffer analysis of 20m was carried out in GIS and possible locations which are not safe for shot hole drilling identified.

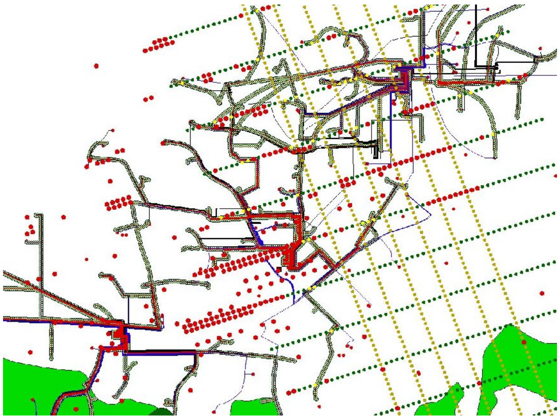


Plate 9

Plate 9 shows the output of the buffer analysis. Yellow spots represent the unsafe locations for taking shots and the red spots show the actual skip locations since they fall within the oil installation areas..

To identify the locations falling in oil installations, villages etc various enhancement techniques were carried out and Plate 10 shows one of such enhancements. After enhancement, automatic/manual digitization can be carried out for demarcating the oil installations, villages etc.

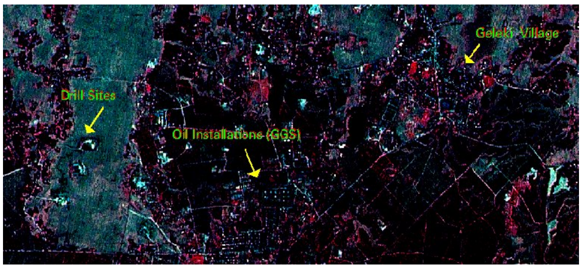


Plate 10

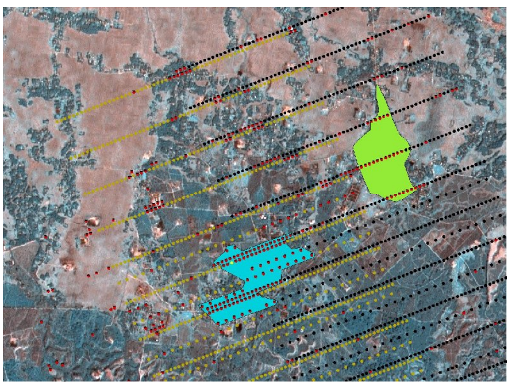


Plate: 11

Plate 11 shows the portion digitized on the image. Blue colour indicates oil installations and green colour indicates Geleki village. GIS analysis was carried out and source / receiver locations falling in these area identified. The red spots of Plate 9 are exactly matching with those in Plate 11 .

The possible skips due to Villages, oil installations and pipelines were brought out well in advance, and cross checked in field with DGPS. Ground truthing with DGPS reveals that all information extracted from remote sensing data are almost accurate.

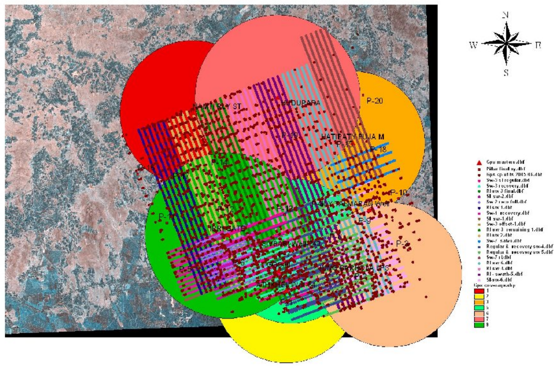
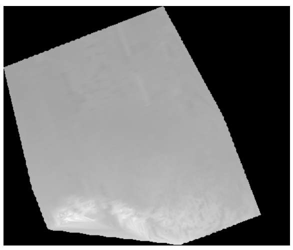


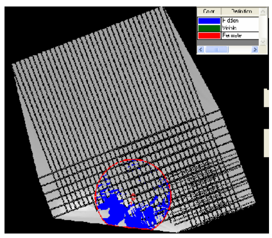
Plate :12

Plate 12 shows the DGPS control points established in the area for both staking and leveling operations. Master stations are placed at the center of circles and the radius represents the range for real time kinematic survey. The range for real time survey was restricted to 3.5 to 4 km, for better vertical positioning accuracy, apart from using EGM96 Geoid model.

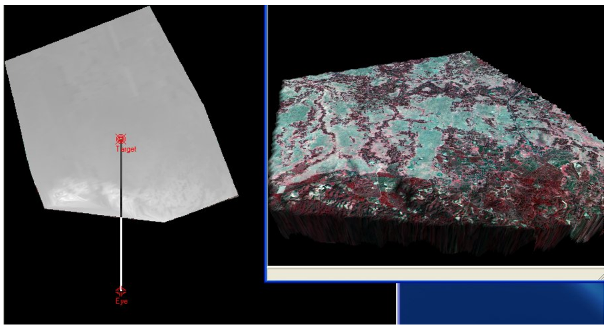
Various 3D terrain analyses like DEM creation, visibility analysis, raster contour generation, image draping, fly through analysis, longitudinal section and cross section analysis etc. were carried out using GIS and Image processing software.



DEM of the Area



Visibility Analysis



Satellite Image Draping,
3D Perspective Viewing

The Satellite imagery was draped on the DEM for 3D and perspective viewing. With this one can visualize the area in 3D and by overlaying a seismic profile on it, one can get the longitudinal and cross sectional of the profile, which may be useful in modeling Upholes and deciding Optimum depths.

Thus the raw satellite data was processed and interpreted in the ERDAS, Image processing software, the output was then fed into GIS software for further analysis and finally likely skips due to villages, oil installations, pipe lines etc. and possible recovery locations for the same suggested.

Also the summary statics of all source / receiver locations falling on each land cover, area and perimeter details of different land covers generated. This helps in arriving the cost involved for crop compensation and total project cost etc.

Conclusions

Ground truthing with DGPS to verify the RS data reveals that all information extracted from remote sensing data is almost accurate. Therefore details of likely skips and possible recovery locations can be modeled using softwares like MESA, GEOLAND etc to calculate the achievable coverage of the area well in advance and also to plan / execute seismic surveys effectively by reducing the turn around time and cost.

Highly recommended for close grid 2D survey where the group intervals will be in the order of 5 to 10m, huge skips can be avoided by slightly changing the orientation of profiles. Also recommended for 3D surveys where skips can be minimized by slightly shifting / tilting the entire grid.

To know the likely skips and possible recovery locations of the entire area in advance will be difficult by conventional reconnaissance survey. Also if the area is large and hostile it may not be possible to venture into the area. RS data along with DEM of the area gives the complete insight of the logistics and topography of the area, thus enables us to visualize, interpret and analyze any area of interest in 3D without venturing in the area for

a) Predicting the effective coverage of the area before starting survey
b) Planning / executing seismic survey to reduce turn around time and cost.
c) Deploying suitable methodology and inputs for producing the best possible data.
d) Arriving time and cost of the project for bidding blocks in any remote locations in India and abroad.

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Reference:

"Remote Sensing and Image Interpretation" by Thomas M.Lillisand, Ralph.W.Kiefer and Jonathan W.Chipman, 2005.