Road Material Identification using Compact Polarimetry Airborne SAR data

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Abstract

There is an extreme requirement for an evaluation of road condition because of having key role in many civilian and military applications, such as road maps, traffic monitoring, navigation applications, and topographic mapping. Failure in transport condition impacts on vehicular maintenance cost, increase in travel time, accident rate, economy of the city. Therefore, the road network needs continuous evaluation. SAR datasets provides an abundance of information as it has high penetration capacity. Various techniques for feature extraction has developed rapidly in the recent times. Information from SAR imagery such as intensity, phase, backscattering, polarization, etc. have used to identify features depending upon its incidence angle and dielectric constant. The tendency of the microwave signal is such that, the reflection of the signal is specular for the smooth surface and smooth road visualize very dark in radar image. In the case of crack on the road surface, microwave backscatter would observe very bright in the radar image. Thus, L-band (1.25 GHz) and S-band (3.20 GHz) may have capability to identify precise and irregular features.

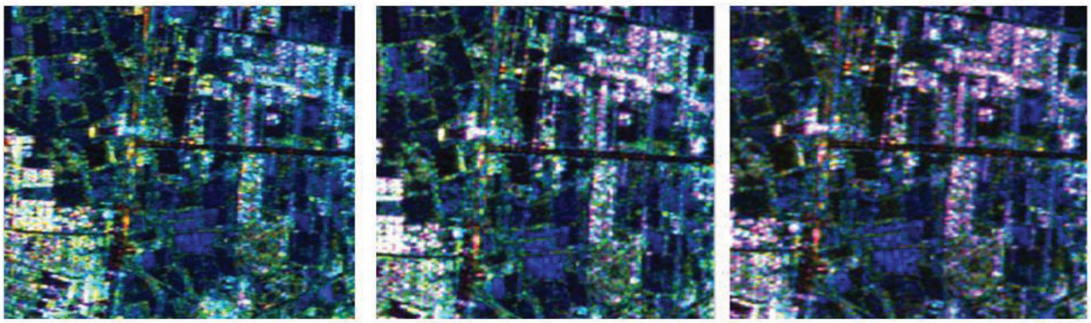
The aim of the study is to extract the road materials using L and S band Airborne SAR (CP) data having 7m resolution for Ahmedabad, Gujarat, India and to investigate the suitability of L and S band airborne SAR data for the same.

After acquiring image, pre-processing steps like complex image generation, amplitude image generation, multi-looking, slant range to ground range conversion, geo-referencing, calibration of RH-RV complex data and calculation of stokes vector are carried out. After pre-processing data, the hybrid decompositions (m-δ, m-χ, m-α) are implemented. Road material like concrete and bitumen are identified based on backscatter signal. The road materials are classified using unsupervised ISODATA classification method. Moreover, supervised classification methods like Support Vector Machine (SVM) and Neural Network are carried out.

By observing the scattering mechanism of road materials by spectral signature analysis, the result shows that in M-delta decomposition (as shown in fig. 1(a)), the mean value of diffused scattering and standard deviation value of even bounce scattering is highest in concrete and bitumen roads. In M-chi decomposition (as shown in fig. 1(b)), the mean value of odd bounce scattering in both concrete and bitumen roads are the highest. In M-alpha decomposition (as shown in fig. 1(c)), the mean value and standard deviation of even bounce scattering is the highest in concrete and bitumen roads. Whereas, the standard deviation value of even bounce scattering is highest in concrete and that of odd bounce scattering is the highest in bitumen roads. Bitumen roads consists the higher mean and standard deviation values of all the scattering mechanism for all the three decomposition; compared with concrete roads. This

study helps to appreciate the significance of hybrid polarimetric parameters to get precise information about road features. Scattering decomposition mechanism for hybrid polarimetry data has proven helpful for road material identification. In compact polarimetry, evaluation of stokes' parameters is proven beneficial to fully characterize the microwave backscatter.

Keywords: Airborne SAR, Road, Polarization, Material identification, M-chi, M-delta, M-alpha, Compact Polarimetry, Decomposition, Backscattering, ISODATA, SVM, Neural Network.



(a) (b) (c)

Figure 1. Hybrid decompositions (a) m-δ (b) m-χ (c) m-α

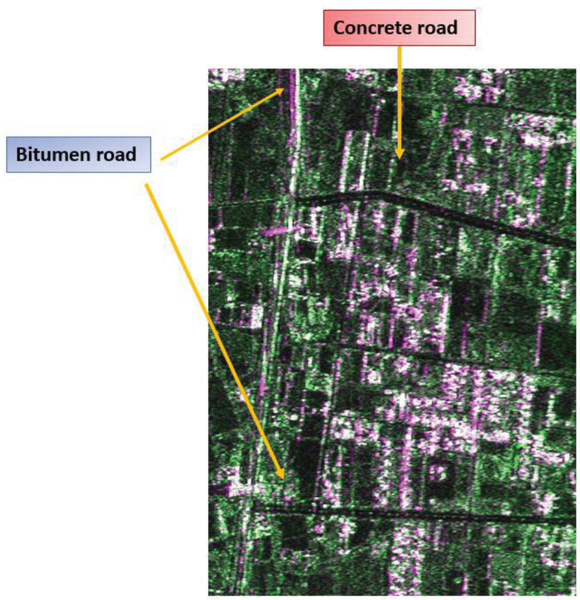


Figure 2. Backscatter image (R:G:B = RH:RV:RH)