



## **Evaluation of Pan-Sharpener Methods for Automatic Shadow Detection in High Resolution Images of Urban Areas**

Samara C. de Azevedo (1,2), Ramesh P. Singh (2), and Erivaldo A. da Silva (1)

(1) Postgraduate Program in Cartographic Sciences, Department of Cartography, Univ. Estadual Paulista, FCT-UNESP, 19060-900, Campus Presidente Prudente-SP, Brazil, (2) School of Life and Environmental Sciences, Schmid College of Science and Technology, Chapman University, Orange, CA 92866, USA

Finer spatial resolution of areas with tall objects within urban environment causes intense shadows that lead to wrong information in urban mapping. Due to the shadows, automatic detection of objects (such as buildings, trees, structures, towers) and to estimate the surface coverage from high spatial resolution is difficult. Thus, automatic shadow detection is the first necessary preprocessing step to improve the outcome of many remote sensing applications, particularly for high spatial resolution images. Efforts have been made to explore spatial and spectral information to evaluate such shadows. In this paper, we have used morphological attribute filtering to extract contextual relations in an efficient multilevel approach for high resolution images. The attribute selected for the filtering was the area estimated from shadow spectral feature using the Normalized Saturation-Value Difference Index (NSVDI) derived from pan-sharpening images. In order to assess the quality of fusion products and the influence on shadow detection algorithm, we evaluated three pan-sharpening methods - Intensity-Hue-Saturation (IHS), Principal Components (PC) and Gram-Schmidt (GS) through the image quality measures: Correlation Coefficient (CC), Root Mean Square Error (RMSE), Relative Dimensionless Global Error in Synthesis (ERGAS) and Universal Image Quality Index (UIQI). Experimental results over Worldview II scene from São Paulo city (Brazil) show that GS method provides good correlation with original multispectral bands with no radiometric and contrast distortion. The automatic method using GS method for NSVDI generation clearly provide a clear distinction of shadows and non-shadows pixels with an overall accuracy more than 90%. The experimental results confirm the effectiveness of the proposed approach which could be used for further shadow removal and reliable for object recognition, land-cover mapping, 3D reconstruction, etc. especially in developing countries where land use and land cover are rapidly changing with tall objects within urban areas.