DEVELOPING A NEURAL-NETWORK-BASED BRDF MODEL FOR THE UAE COASTAL AND INLAND ZONES

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1. ABSTRACT

The reflected radiation by observed surface is highly dependent on both sun illumination and satellite observation angles. These two angles are also described, respectively, as incident and reflected angles. The geometry-dependence of surface reflectance is usually corrected by a tailored Bi-directional Reflectance Distribution Function (BRDF). It is the most common tool used to eliminate or to reduce the effects of sun-sensor geometry on the reflected radiation. Generally, BRDFs are derived empirically (or semi-empirically) for a specific land cover by analyzing a large set of observations (training set) made under different illumination and observation angles. This approach involves fitting the model to collected observations and inverting it. However, obtaining a generalized BRDF for a geostationary sensor becomes more complicated due to the wide range of variation of both illumination and observation angles compared to polar orbiting platforms.

The need for a strong BRDF model for potential applications of SEVIRI-MSG visible channels is especially important for UAE due the very large viewing angles (between 60 and 70 degrees). This study is a first attempt to apply a Bidirectional Reflectance Distribution Function (BRDF) model to quantify the effect of sun illumination and SEVIRI-MSG observation angles on measured reflectance for both land (mostly desert) and coastal water pixels in the UAE. These two features cover more than 95% of the UAE inland and coastal zones. The BRDF model is intended to be used to quantify the effect of SEVIRI-MSG viewing geometry on measured reflectances.

An Artificial Neural network technique has been developed to train and validate the BRDF model. A similar technique has been developed for SEVIRI-MSG data as a part of sea-ice mapping and classification tool [1]. Artificial neural networks have been widely utilized in remote sensing applications. Multi-layer perceptron trained by backpropagation algorithm is the most common neural network used for image classification. This type of neural network has been successfully applied to image processing and has shown a great potential in the classification of different types of remotely sensed data. In contrary to traditional techniques such as regression analysis, neural network uses its complex configuration to find the best nonlinear function between the input and the output data without any constraint of linearity or pre-specified non-linearity [2-3].

In this work, the BRDF model describes an existing relationship between three angles i.e. satellite, solar and azimuthal angles and observed reflectances. Trigonometric functions such as the sine and cosine of these angles were also utilized in the BRDF model formula. As shown in the following equations, a total of nine inputs are needed to estimate reflectance values:

satellite (SAT), solar (SOL) and azimuth (ARZ) angles; their sine; and cosine. R_{water} and R_{desert} are the observed reflectances manually selected for a set of water and desert pixels collected at different solar angles under clear sky conditions.

$$R_{water} = f_w\ [ARZ, SOL, SAT, \cos(ARZ), \cos(SOL), \cos(SAT), \sin(ARZ), \sin(SOL), \sin(SAT)]$$
$$R_{desert} = f_d\ [ARZ, SOL, SAT, \cos(ARZ), \cos(SOL), \cos(SAT), \sin(ARZ), \sin(SOL), \sin(SAT)]$$

The graphs presented in the figure below show the hourly variation of reflectance for three water and three desert pixels in SEVIRI optical channels: HRV (High Resolution Visible: 0.6-0.9 µm), R01 (0.6 µm), R02 (0.8 µm), and R03 (1.6 µm). The six pixels were selected at three different latitudes to illustrate the effect of viewing geometry on reflectance. This data were collected on November 3rd 2008 under an exceptional clear sky condition. The x axis represents the number of daylight views (with 30 minutes intervals) and the y axis represents the reflectance in percentage (not normalized to solar zenith angle). These graphs show the sensitivity of measured reflectance to the solar angle (local acquisition time) especially in the early hours. The use of early SEVIRI morning scenes is primordial for many applications such as fog detection and monitoring.

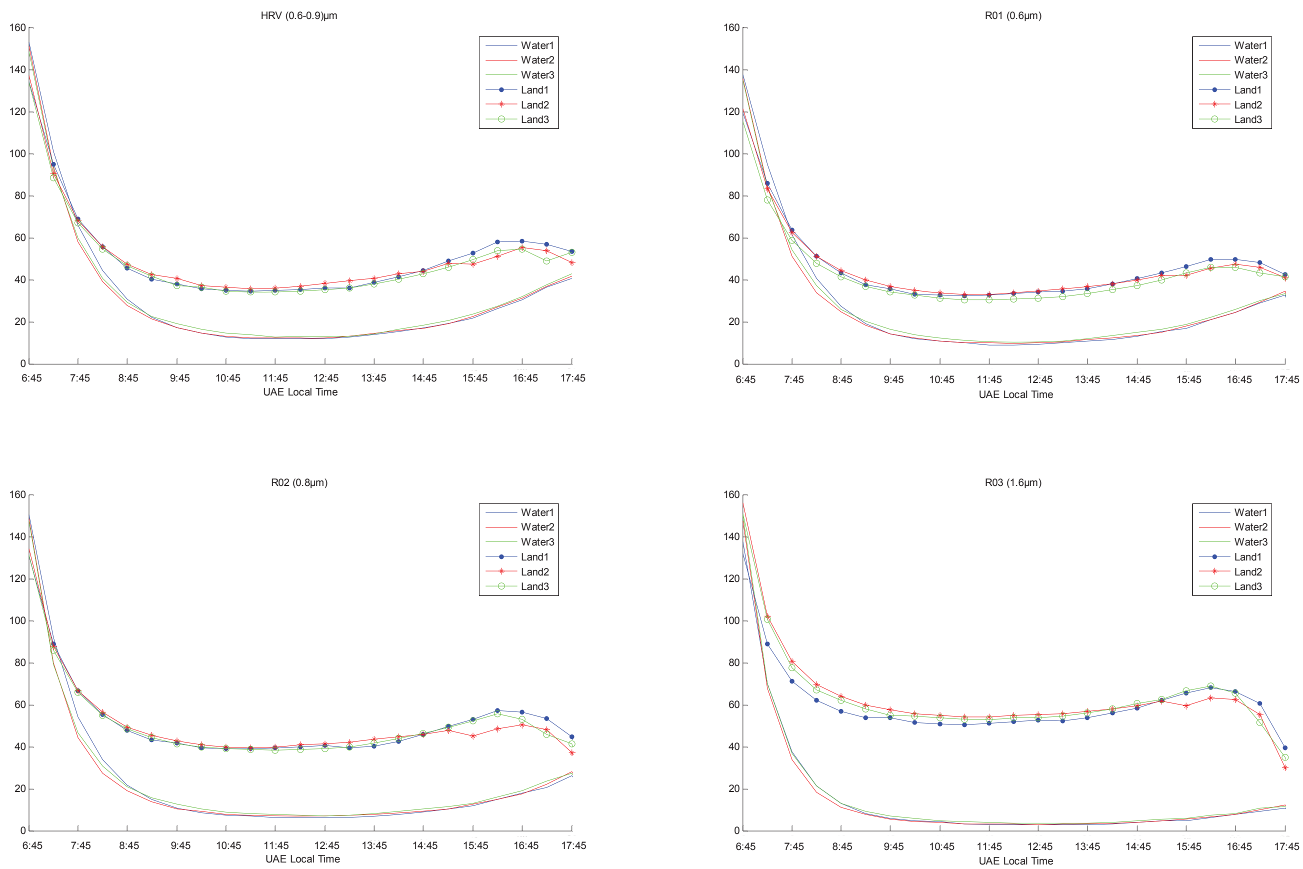

Figure 1: hourly variation of reflectance for three water and three desert pixels.

2. REFERENCES

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