Estimation of NDVI from RGB sensor using the machine learning method

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ormalized Difference Vegetation Index (NDVI) is the normalized differences ratio of the red and near-infrared band (NIR). It has been used for over 40 years and is still popular for vegetation-soil discrimination, agricultural monitoring, landcover classification, segmentation, and change detections. But NIR is not common for every sensor like conventional RGB camera. Multispectral cameras are generally heavyweight, have large dimensions, are expensive, and have low spatial resolution compared to RGB cameras. NIR offers a big image size for transferring satellite data and it is a limitation to the use of power for small CubeSats. Therefore, the visible vegetation indices from RGB sensors are derived but the robustness of the visible-based index for accessing the vegetation intensity changes with increasing leaf area remains challenged. Machine learning and the neural network becomes popular in satellite remote sensing because of their superior performance in image, speech, and audio analysis.

In this research, the middle field camera (MFC) equipped in the MMSATS-1 satellite, developed by Hokkaido University, Tohoku University, and Myanmar Aerospace Engineering University, is a simple RGB camera that removes the NIR cut filter. Therefore, the overlapping between each band and coverage of the NIR region are interesting factors in deriving NIR band features from RGB images.

There are two objectives in this research: color correction to satellite image without filter and red and NIR band derivation. Color correction is conducted with an X-rite color checker, and a popular color correction tool by applying different regression methods: simple linear, multilinear and Support Vector Machine (SVM). Laboratory measurement and open field experiments are performed. While the laboratory measurements predicted correctly to the laboratory image, it does not show good results in satellite images. In an open field experiment, SVM performs a good coefficient of determination for each band, 0.9888 for Red, 0.9755 for Green, and 0.9742 for blue band images respectively.

Red and NIR band generation is made by two methods: using a spectrometer and using an image-to-image regression with Band 4 and 7 of Sentinel-2. The generated NIR and Red band images by the first method show a linear correlation between them and calculations based on this method show large errors compared to sentinel-2 datasets. Image to Image regression using the neural network shows promising results compared to sentinel-2 datasets. But lack of atmospheric correction to MFC images results in some noise over the water region.

This study aimed at understanding the derivation of NDVI from RGB images for the small satellite with limited data availability and computing resources. Although previous research models emphasized using the same satellite sensor for RGB and NIR training, cross-sensor training between MMSATS-1 and Sentinel-2 is performed in this study with about 30-meter spatial resolution. Although this result is dependent on the sensors, it shows a promising future in the derivation of the NIR band for future satellites with high spatial resolution RGB sensors and this research could be utilized as the basis for precision agricultural crop monitoring with cost-effective CubeSats with RGB sensors.

Keywords: NDVI, microsatellite, machine learning

