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Study of radiometric variations in UAV remote sensing imagery for vegetation mapping

Remote sensing is a technique used to obtain information about an object from a distance. In the case of vegetation mapping, the objects from which the information is obtained are plants. The devices used for remote sensing of vegetation can be sensors located on platforms such us satellites, airplanes or Unmanned Aerial Vehicles (UAV). The term UAV is applied to any aerial platform that is capable to fly without a person on board, and they are popularly referred to as drones.

The advantages of UAVs is that they provide a flexible method for acquiring very detailed images, they are relatively simple to operate, and they are cost-effective. This technology emerged 30 years ago and it is widely used by commercial, scientific, and military communities due to its versatility. However, new technology brings new challenges. One of them is the radiometric accuracy of the UAV images. Radiometry is the relationship between the value of sun's energy reflected from the target, and the values that a camera captured when recording the same target. In order to obtain more homogeneous and accurate UAV images for vegetation mapping, radiometric accuracy is especially important when working with different illumination conditions, different dates or different cameras. For this reason, radiometric correction is a very important step when processing UAV imagery.

The effect of light variations during the flights was studied in different dates and at different times of the day. The position of the sun in the sky and presence of clouds gave significant variations in UAV imagery. The analysis of the sun's position showed that suitable time for UAV flights in northern latitudes is within 2 hours of solar noon, when there are less shadows in the images. The presence of clouds in the sky reduces the amount of direct sunlight. Because of this, the UAV images will be more homogeneous. Performing radiometric corrections on images taken on days when the sky was clear is more difficult due to higher reflectance in objects when the camera is in direct alignment between the sun and the object.

We tested nine radiometric correction methods, and compared their effect on different vegetation indices. The correction method that gave least amount of error was the irradiance correction method prior to an empirical line calibration. However, the errors are still high when compared with values measured with a field spectrometer (lowest RMSE 38% under overcast conditions for the NDVI).

A simple workflow was developed for vegetation mapping purposes for the Micasense Rededge camera. We suggest to use the automatic dark current-corrected and automatic reduced vignetting effect images, plus irradiance compensation and the use of empirical line calibration to obtain reflectance values in single images before generating a mosaic. We also suggest to perform the radiometric correction process for each spectral band, and to have a new calibration equation for each mission due to the change in sky conditions. Unfortunately, this workflow will not provide good results in the calculation of vegetation indices that assess small variations like the case of chlorophyll indices or vegetation indices that combine several bands. Further research is needed to improve the accuracy of the correction.

Keywords: UAV, radiometric correction, vegetation mapping, vegetation indices

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