World Academy of Science, Engineering and Technology
International Journal of Electronics and Communication Engineering
Vol:17, No:05, 2023

Hyperspectral Imagery for Tree Speciation and Carbon Mass Estimates

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Abstract : The most common greenhouse gas emitted through human activities, carbon dioxide (CO2), is naturally consumed by plants during photosynthesis. This process is actively being monetized by companies wishing to offset their carbon dioxide emissions. For example, companies are now able to purchase protections for vegetated land due-to-be clear cut or purchase barren land for reforestation. Therefore, by actively preventing the destruction/decay of plant matter or by introducing more plant matter (reforestation), a company can theoretically offset some of their emissions. One of the biggest issues in the carbon credit market is validating and verifying carbon offsets. There is a need for a system that can accurately and frequently ensure that the areas sold for carbon credits have the vegetation mass (and therefore for carbon offset capability) they claim. Traditional techniques for measuring vegetation mass and determining health are costly and require many person-hours. Orbital Sidekick offers an alternative approach that accurately quantifies carbon mass and assesses vegetation health through satellite hyperspectral imagery, a technique which enables us to remotely identify material composition (including plant species) and condition (e.g., health and growth stage). How much carbon a plant is capable of storing ultimately is tied to many factors, including material density (primarily species-dependent), plant size, and health (trees that are actively decaying are not effectively storing carbon). All of these factors are capable of being observed through satellite hyperspectral imagery. This abstract focuses on speciation. To build a species classification model, we matched pixels in our remote sensing imagery to plants on the ground for which we know the species. To accomplish this, we collaborated with the researchers at the Teakettle Experimental Forest. Our remote sensing data comes from our airborne “Kato” sensor, which flew over the study area and acquired hyperspectral imagery (400-2500 nm, 472 bands) at ~0.5 m/pixel resolution. Coverage of the entire teakettle experimental forest required capturing dozens of individual hyperspectral images. In order to combine these images into a mosaic, we accounted for potential variations of atmospheric conditions throughout the data collection. To do this, we ran an open source atmospheric correction routine called ISOFIT1 (Imaging Spectrometer Optiman FITting), which converted all of our remote sensing data from radiance to reflectance. A database of reflectance spectra for each of the tree species within the study area was acquired using the Teakettle stem map and the geo-referenced hyperspectral images. We found that a wide variety of machine learning classifiers were able to identify the species within our images with high (>95%) accuracy. For the most robust quantification of carbon mass and the best assessment of the health of a vegetated area, speciation is critical. Through the use of high resolution hyperspectral data, ground-truth databases, and complex analytical techniques, we are able to determine the species present within a pixel to a high degree of accuracy. These species identifications will feed directly into our carbon mass model.

Keywords : hyperspectral, satellite, carbon, imagery, python, machine learning, speciation
Conference Title : ICHIRS 2023 : International Conference on Hyperspectral Imaging and Remote Sensing
Conference Location : Vancouver, Canada
Conference Dates : May 22-23, 2023