UAV photogrammetry and hyperspectral remote sensing of regeneration forests in Brazil, the first experiences

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In Brazil, the Atlantic Forest has one of the highest levels of species and endemism rates in the planet. However, almost 90% of the original forest has been decimated and the remaining areas are spread in small fragments, about which insufficient information for guiding conservation actions is available. Field measurements are complex and laborious in tropical forest. It is hard to enter and walk through the forest due to the density of plants, branches, and leaves. Besides, it is noteworthy that the inhabitants of the tropical forest are wild animals such as jaguars, wild pigs and poisonous snakes. The large number of tree species hampers the process of tree species identification and measuring heights of individual trees using conventional field measurement tools is an infeasible task. Thus, indirect methods for estimating forest parameters, such as remote sensing using laser scanners or digital images, are a potential alternative to destructive and expensive direct methods.

Low-cost tools for photogrammetric surveys and remote sensing by unmanned airborne vehicles (UAVs) are hot topics amongst the remote sensing community at the moment. Forest DSMs can be provided by LiDAR data or by photogrammetric means using image matching. Hyperspectral images give detailed spectral information for each pixel in an image, which aids the segmentation and classification process in forest areas. The lightweight hyperspectral camera based on a Fabry-Perot interferometer (FPI) developed by VTT Technical Research Center of Finland is one of the highly interesting tools for UAV based remote sensing of tropical forest.

The Department of Cartography of the São Paulo State University (UNESP) and the Finnish Geospatial Research Institute (FGI) have a joint research project "Unmanned Airborne Vehicle-based 4D Remote Sensing for Mapping Rain Forest Biodiversity and Its Change in Brazil" (UAV_4D_BIO), funded by the Academy of Finland and São Paulo Research Foundation. The objective of this investigation is to develop biodiversity and biodiversity change mapping technologies, using UAV as the sensor platform, complete object model, consisting of hyperspectral, 3D geometry and BRF response as features, and time series of complete object models to reveal changes in time to be used for biodiversity mapping and for developing indicators of environmental change. The methodology will be used in Finland in Evo test forests and in regeneration areas of Rain Forest in the interior of São Paulo State (inside Atlantic Forest). It is expected that hyperspectral images and laser scanning will complement each other and result in improved modelling capabilities once combined, especially for modelling of multi-layered forests.

Field campaigns have been performed in the area of interest to establish a set of reference plots. Stereoscopic data sets were captured by UAV using RGB and FPI-hyperspectral cameras, and by a manned aircraft using a photogrammetric mapping camera. DSMs were generated from these data sets by dense image matching technologies. The first analyses of the DSMs have shown that they are feasible for performing different analyses, such as the study of the successional stage of the forest, tree species identification and tree density calculation.