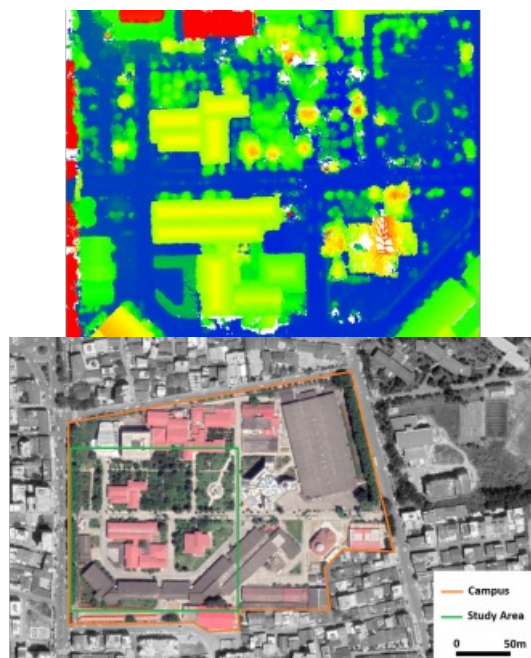
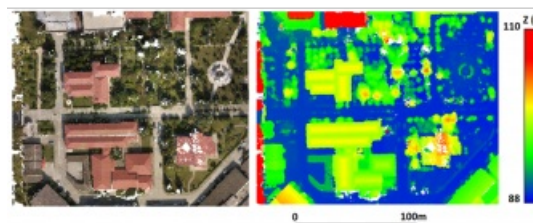


AN INVALUABLE SOURCE OF DATA FOR GREEN AREA MANAGEMENT

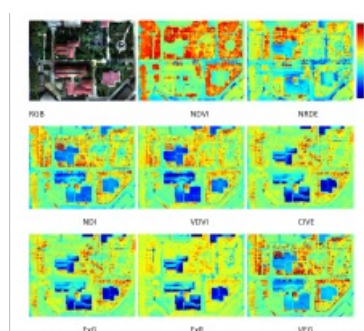
Vegetation Mapping Using Multispectral UAV Images



DJI recently introduced the P4 multispectral, a high-precision unmanned aerial vehicle (UAV or 'drone') which exploits the integration of multispectral cameras to facilitate agricultural and environmental monitoring applications. Therefore, imagery data collection for vegetation mapping is now simpler and more efficient than ever before.



In the DJI P4 multispectral, images are collected by an RGB camera and a multispectral camera array with five global shutter cameras covering blue, green, red, red-edge, and near-infrared bands at a resolution of 1,600 x 1,300 pixels (Figure 1). Real-time, centimetre-accurate positioning data on images captured by all six cameras within DJI's built-in system is used to align the flight controller, RGB/multispectral cameras and RTK module. This fixes the positioning data to the centre of the CMOS and ensures that each image uses the most



Index	Equation
NDVI	Normalized Difference Vegetation Index (NIR-R)/(NIR+R)
NDRE	Normalized Difference Red Edge Index (NIR-RE)/(NIR+RE)
NDGI	Normalized Green-Red Difference Index (G-R)/(G+R)
VIDVI	Visible-band Difference Vegetation Index (2G-R-B)/(2G+R+B)
CIVE	Colour Index Vegetation Extraction $0.441R-0.81G+0.385B+18.7874$
ExG	Excess Green VI $2G-R-B$
ExR	Excess Red VI $1.3R-G$
VEG	Vegetation $G/R^{0.5}$ with $a=0.667$

accurate metadata. All cameras benefit from the calibration process whereby radial and tangential lens distortions are measured and saved into each image's metadata to ease post-processing of the images.

More importantly, an integrated spectral sunlight sensor on top of the UAV captures solar irradiance to maximize the accuracy and consistency of data collection at different times of the day. This enables the most accurate NDVI results to be achieved.

Figure 1: DJI P4 multispectral UAV.

Study Area and Data Collection

Babol Noshirvani University of Technology (BNUT), which is the leading university in Iran according to the Times Higher Education World University Rankings, is located in north of the country. The campus comprises 11 hectares of several buildings

and a green area which is mainly covered by orange trees (Figure 2).

The dataset was collected on 24 October 2020. The flight was planned in the DJI GS Pro iPad app at an altitude of 70 metres with 65% forward and side overlaps. The image collection was done at noon to minimize the shadows, and it took approximately ten minutes to cover the campus with 522 geotagged vertical RGB and multispectral images.

□ Figure 2: BNUT campus (orange line) and study area (green line).

Data Processing of UAV Images

The photogrammetric processing of the UAV images was carried out using [Agisoft](#) Metashape software. The processing workflow – including image alignment to produce sparse point clouds, build dense cloud, build mesh, build texture, build the digital elevation model (DEM) and build the orthomosaic – was performed and lastly, to generate a 3D map of the study area, the multispectral point clouds and orthomosaic were exported in (.las) and (.tiff) formats, respectively. The 3D point cloud with a density of 900 points/m² and orthomosaic with a ground sampling distance (GSD) of 3 centimetres were generated from the point clouds and the images (Figure 3).

□ Figure 3: True and colour-coded dense point cloud of the study area.

Results of Multispectral Orthomosaic Derived from Photogrammetric Processing of UAV Images

The multispectral orthomosaic derived from the photogrammetric processing of the UAV images was used to calculate vegetation indices as indicated in Table 1. The well-known multispectral and visible-band vegetation indices such as NDVI, NDRE, NGRDI, VIDVI, CIVE, ExG, ExR and VEG were utilized. The corresponding vegetation index maps for the study area are shown in Figure 4.

Although trees and lawns are highlighted by all vegetation indices, vegetation areas are more distinguishable by NDVI. Additionally, buildings and non-vegetated areas are clearly highlighted by all indices. The NDI and VEG indices provided similar results and outperformed other visible-band indices. The CIVE, VDVI, ExG and ExR indices are sensitive to shadows. As a result, shadow areas are highlighted as vegetation.

□ Table 1: Vegetation indices. R: Red, G: Green, B: Blue, NIR: Near-infrared, and RE: Red-edge.

Conclusion - Value of Multispectral UAV Images

Multispectral UAV images can be used for many applications such as urban tree mapping, horticulture, precision agriculture and more. In addition to opening up a new era of applications, the RGB-derived vegetation indices can be calibrated and validated more accurately using multispectral UAV images. As a result, UAV-based RGB images will be an invaluable source of data for green area management in urban and rural areas.

□ Figure 4: Vegetation indices.

Future reading

McKinnon, Tom, and Paul Hoff. Comparing RGB-based vegetation indices with NDVI for drone-based agricultural sensing. *Agribotix. Com* 21.17 (2017): pp. 1-8.

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