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Monitoring vegetation growth in an experimental plot using balloon-air-photography

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Air-photography is an important tool for ecological monitoring, like in the investigation of the invasion of cultivated pastures by the southern bracken in the tropical mountains of Southern Ecuador. From 2008 to 2010 a tethered balloon has been used to monitor a plot of 1000 m2 (S 3° 58' 18", W 79° 4' 45") covered by pasture grass (Setaria sphacelata) and the southern bracken. With these data, the spatial-temporal development of vegetation cover has been continuously observed. In parallel, the meteorological background conditions have been recorded, which are used to simulate vegetation growth. The initialization and validation of such simulations in a spatial domain depend on canopy data of the fractional projective cover, which are derived from balloon-air-photos for several time steps. To achieve these data, the respective processing of the acquired photos is needed.

The aim of the present work is to present a methodology of the cost-effective acquisition and processing of balloon-air-photos for the initialisation and validation of simulated vegetation growth. The methodology includes:
- The flight strategy for photo acquisition
- Image processing, including brightness correction, stitching procedures, registration and rectification
- Image segmentation by means of a semi-automatic classification using spectral and structural image information to calculate the fractional projective cover (FPC)

The instrumentation used includes a visible and a near infrared digital camera, which were attached to a 3 m3 helium balloon in a frame with an automatic shutter release. Since one mosaic is composed by not simultaneously recorded photos, brightness histograms of each composing photo was normalized based on the visible and near infrared responses of selected targets (green and ripe Setaria leaves, green, ripe and fungi infected bracken fronds and soil). To compose the mosaics the photos were stitched together based on the overlapping area, after applying a polynomial transformation up to third degree. Rectification was carried out using geographical coordinates from visible landmarks installed before image acquisition. Registration was performed based on a selected mosaic, which served as basis to calculate the relative accuracy of the other mosaics. A time series of eight mosaics has been elaborated, which covers the period of three years and the vegetation recovery after two experimental burnings. The resulting mosaics were then classified based on the selected targets first by segmentation and extraction of geometrical properties and then by analyzing these properties together with statistical indicators of brightness and texture.

Previous results from image-processing showed a high spatial resolution with canopy details and a good spatial accuracy. Main problems were related to perspective effects of different geometries composing a mosaic and partial blurring of these mosaics due to weather instability during flight. Regarding the image classification, maps of fractional projection cover have been found to be in good agreement with visual interpretation. Main problems here were the similar reflectance of leaves from both species, in the visible and in the near infrared, being the latter more dependent on illumination geometry. Our achievements give support to the applicability of the balloon-air-photography in the present study, which means the use of the final maps as validation data for simulations of vegetation growth.

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