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UAS-based hyper-spectral imaging for estimation of water quality parameters in reservoirs

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The advancement of new compact and lightweight hyper-spectral and thermal imaging sensors enables the usage of small UAS for close-range remote sensing of biophysical parameters with a high spatial resolution. UAS based remote sensing is the favourable observation method for several environmental monitoring applications as it has a considerable operational flexibility and lower costs compared to airborne observations and operates independent of cloud coverage unlike space borne methods.

We employ a UAS-based imaging system to remotely retrieve water quality parameters in drinking water reservoirs. The close-range remote sensing system is used as part of an integrated monitoring system complementing in-situ measurements which have usually high accuracy but insufficient spatial resolution. The monitoring system contributes to a multidisciplinary research project on water resource management (MuDak-WRM) which aims to maintain the water quality of drinking water in the Passauna reservoir close to Curitiba, Brazil. The concentrations of chlorophyll-a (chl-a) and total suspended solids (TSS) are two relevant parameters which describe the water quality in reservoirs. The change in concentration of these optical active parameters changes the reflectance spectra at the water surface which can be measured by an imaging spectrometer.

The multi sensor imaging system consists of a hyper-spectral camera, a thermal camera and a standard RGB camera for navigational purposes. The sensors are mounted on a two axis gimbal on a coaxial octocopter with 4.5kg maximum payload. To estimate the chl-a and TSS we choose a hyper-spectral camera with 125 channels in the wavelength range from 450nm to 950nm. The camera features snapshot acquisition mode with an additional high resolution panchromatic channel, which can be used for glint identification.

We use another upward looking mini-spectrometer (225-1000nm, 2500 channels) to calculate reflectance spectra as the ratio between the upwelling radiation from the water surface, captured by the imaging camera and the downwelling irradiation at the UAS. This setup enables the estimation of precise reflectance spectra, even in conditions with permanently changing cloud cover. Precise navigation is ensured by using RTK GNSS. As the images are captured over water without any fixed reference points, it is also necessary for adequate geocoding of images in combination with the IMU.

We present the setup of the multi sensor system, its calibration and the post-processing of the hyper-spectral data cube. A partial least squares regression approach (PLS) is used to estimate the concentration of chl-a and TSS for each pixel in the image. The images are captured nadir, any movement of the copter is compensated by a two-axis brushless gimbal. With this the images can be stitched together using the geometric calibration of the system and the navigation data to generate maps showing the concentration of the water quality parameters. We show first results of two measurement campaigns at the Passauna reservoir in October 2017 and February 2018. Also the usability of the thermal camera for the observation of sewage inflows will be discussed.