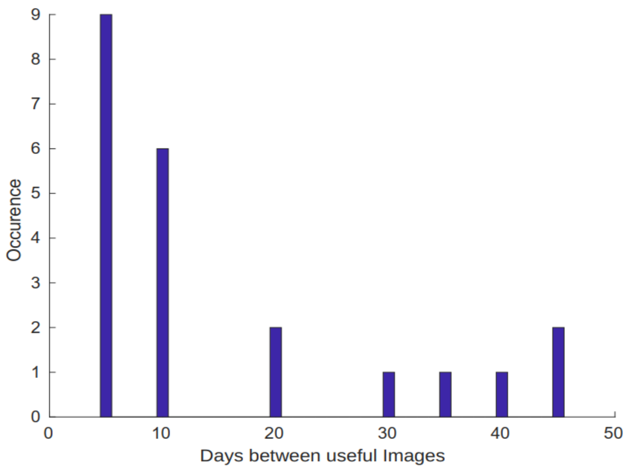
UAS system to ensure continuous monitoring of basic water parameters in the reservoir

Context

The amount and spatial distribution of key parameters in reservoirs like suspended solids, chlorophyll and the temperature at the water surface can be assessed by multispectral and hyperspectral remote sensing. This kind of reservoir monitoring is low-cost, continuous and provides full spatial coverage with high resolution. It provides valuable information for modellers to set-up boundary conditions and assimilate models and it can be supportive to optimize the water sampling and avoiding biased sampling.

State of the art techniques are based on space-borne multispectral data which produces reliable results, but provides no or only limited information during and after rain events when the major sediment input occurs. Statistics for Sentinel-2 at the Passaúna reservoir show that approximately two third of the year, the time gap between cloud free satellite acquisitions is equal or larger than 20 days. This is where the UAS based remote sensing system jumps in to ensure a continuous monitoring, in particular during the rainy season.



Objectives

- ✓ A remote sensing system with state of the art monitoring of optical active water quality parameters like total suspended solids (TSS), turbidity, chlorophyll and surface water temperature.
- ✓ To ensure continuous remote sensing of surface water quality parameters, independent of cloud coverage.
- ✓ Provision of a remote sensing monitoring system with flexible timing in case of special needs.

Equipment and Method

The UAS is equipped with a multi sensor imaging system consisting of three cameras:

- Hyperspectral snapshot camera (Cubert GmbH, 125 channels, 450 nm – 950 nm) combined with a Qmini UVIS spectroradiometer for irradiance control
- Thermal camera (FLIR)
- RGB camera (MAPIR)

The processed data of the hyperspectral camera, shows estimates of water quality parameters like suspended solids and chl-a not only at a single point, but in a spatially extended area. The thermal infrared camera is able to capture the thermal radiation and therefore allows to retrieve images of the temperature of the water surface. All sensors are mounted on a multicopter with up to 15 min flight time, which equals a spatial coverage of 0.15 km². The system provides differential GNSS positioning for each image acquisition point in order to generate mosaiked maps of the respective water quality parameters in a high spatial resolution and with an accuracy comparable to in-situ sensors.

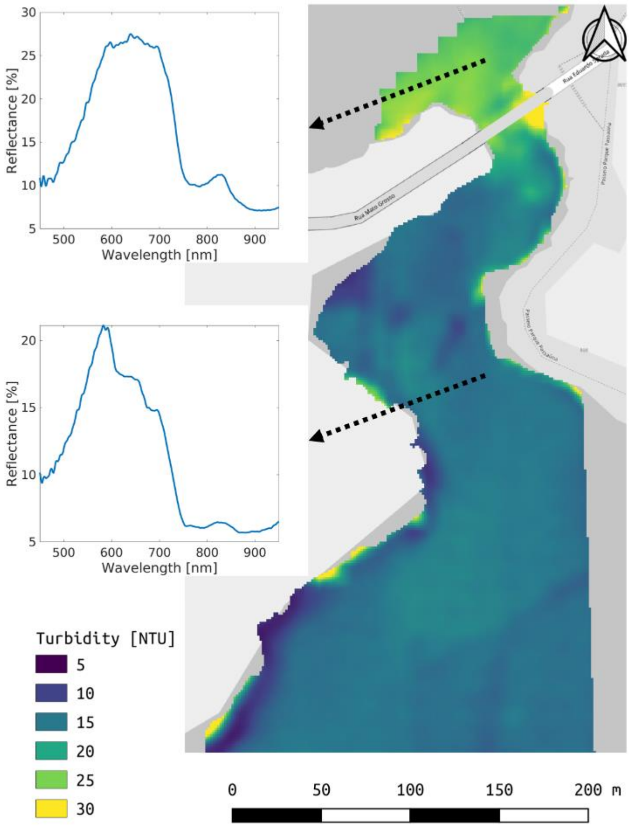
Methodology

The hyperspectral camera and the spectrometer are pre calibrated in a lab. Variable cloudiness and changing conditions during the flight and between segment flights are handled by calculation of corrected reflectance values using a reference panel in field and the spectrometer measuring the incoming light during the flight. Further processing accounts for sun-glint and geometric distortions like pitching of the copter in windy situations. Following, the desired target parameters are estimated by choosing from different state of the art machine learning regression algorithms like partial least square (PLS) and artificial neural networks (ANN). Finally, individual images are mosaiked to parameter maps using the pose information of the copter and further processing.

The whole processing is implemented in a fast processing pipeline, which allows the user to get first results quickly even on low cost hardware.

Innovation and Outlook

- ✓ The UAS monitoring system provides intuitive maps of water quality parameters with high spatial resolution independent of cloud cover.
- ✓ Parameter estimation from full continues reflectance spectra and their derivatives advantageous to multispectral optical acquisitions.
- ➢ For reservoir scale applications and larger areas, a fixed-wing UAS with a comparable sensor system is recommended. An autonomous vertical take-off and landing copter (VTOL) can be used to accomplish fully autonomous close range monitoring.



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