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Development of a Lightweight Hyperspectral Mapping System for Unmanned Aerial Vehicles

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1. Introduction

Unmanned Aerial Vehicles (UAV) are rapidly becoming an essential tool in small scale remote sensing. Nowadays, aerial RGB ortho-images and Digital Surface Models (DSM) are routinely produced using small and economical UAVs, that are typically capable of carrying 1–2 kg of payloads.

Currently, the optical sensors on such UAVs are mostly limited to RGB or Color-InfraRed cameras, as there are no commercial hyperspectral mapping systems available for this payload range. The most lightweight commercial systems weigh closer to 3 kg, as they exploit rather heavy external flight computers and reflective grating spectrographs.

In this poster, we present a design of a miniaturized UAV hyperspectral mapping system and some preliminary airborne data.

2. System

The system is based on a custom line-spectrometer built out of a transmissive grating spectrograph (*Specim ImSpector V10*, 400–1000 nm, 9 nm FWHM) and an industrial smart camera (*Photonfocus SM2-D1312*). The smart camera has a built-in Digital Signal Processor computer that we exploit in synchronizing acquisition and pushing data to a *Raspberry Pi* data sink. To form a complete acquisition system, the spectrometer is connected to a GPS-Inertia Navigation System (GPS-INS, *XSens MTi-G-700*) and optionally, a photogrammetric camera (*Panasonic GX1*). With the photogrammetric camera the system can produce its own DSM allowing standalone generation of true orthoimages.

The system weighs 1.5 kg with the minimum configuration and 1.9kg with the photogrammetric camera included.
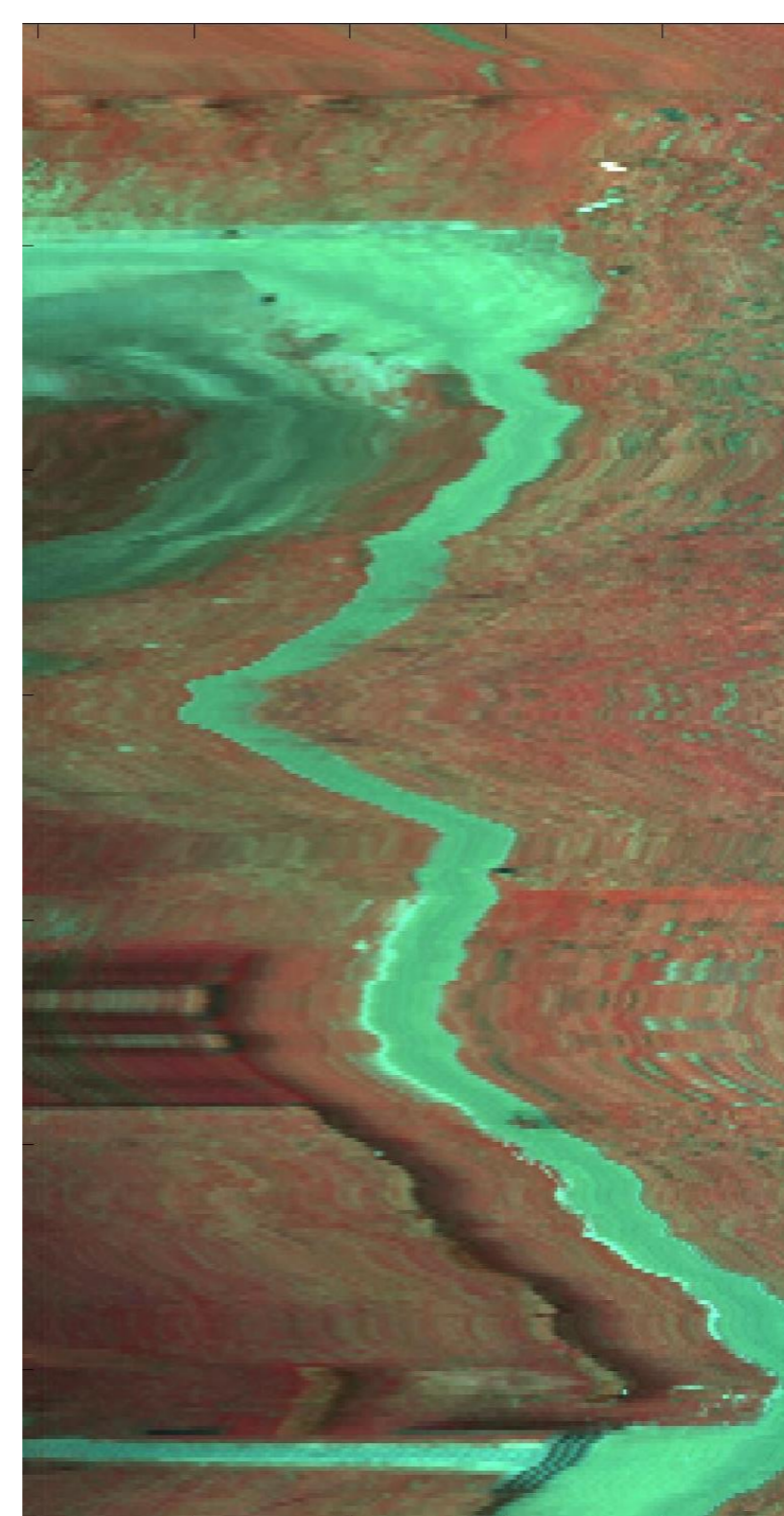

RGB orthomosaic

Digital Surface Model

Unrectified datacube (false color extract)

Georectified datacube (false color extract)

PRELIMINARY
No proper calibrations yet on geometry or sync tuning

3. Processing chain

In the first processing step, the Panasonic GX1 images are calibrated to reflectance factor units using empirical line method and syncronized with GPS-INS data. The images are then processed photogrammetrically (*Agisoft PhotoScan Pro*) producing a georeferenced DSM and a RGB true-orthomosaic. This process also outputs the photogrammetrically determined image positions with higher internal accuracy than is available in the original GPS-INS data. These photogrammetric image positions are used to calibrate and stabilize the GPS-INS data ensuring high internal positioning accuracy.

Next the line-spectrometer data is also calibrated to reflectance factor units and syncronized with the enhanced GPS-INS data. Finally, the hyperspectral lines are projected over the DSM (*ReSe PARGE*) producing the hyperspectral true-orthoimages of the target area.

4. First Results

The calibrations are still in not finished, but we have recently ran the first airborne tests with the system. In the first test flight we flew in windy conditions a single flight line at altitude of 35 meters with the system mounted on a small octocopter (*Aerialtronics Altura AT8 Pro*). A dataset consisting of a single 20-m flight with line 330 hyperspectra lines and about 10 GX1 images was collected. The dataset was processed yet without proper calibrations. Once the calibrations are finished the accuracy of georectification will improve significantly.

Already at this stage, the system has been shown to be able to produce georeferenced RGB orthomosaics, DSMs, and sensible hyperspectral readings. The system will be finished in the coming months. During summer 2013 it will be used in a number of precicion agriculture and habitat monitoring applications.

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