Monitoring agricultural crops using a light-weight hyperspectral mapping system for unmanned aerial vehicles

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Remote sensing has been identified as a key technology to allow near real-time detection and diagnosis of crop status at the field level. Although satellite based remote sensing techniques have already proven to be relevant for many requirements of crop inventory and monitoring, they might lack flexibility to support anomaly detection at specific moments over the growing season. Imagery taken from unmanned aerial vehicles (UAV) are shown to be an effective alternative platform for crop monitoring, given their potential of high spatial and temporal resolution, and their high flexibility in image acquisition programming. In addition, several studies have shown that an increased spectral resolution as available from hyperspectral systems provide the opportunity to estimate biophysical properties like leaf-area-index (LAI), chlorophyll and leaf water content with improved accuracies.

To investigate the opportunities of unmanned aerial vehicles (UAV) in operational crop monitoring, we have developed a light-weight hyperspectral mapping system (< 2 kg) suitable to be mounted on small UAVs. Its composed of an octocopter UAV-platform with a pushbroom spectrometer consisting of a spectrograph, an industrial camera functioning as frame grabber, storage device, and computer, a separate INS and finally a photogrammetric camera. The system is able to produce georeferenced and georectified hyperspectral data cubes in the 400-1000 nm spectral range at 10-50 cm resolution. The system is tested in a fertilization experiment for a potato crop on a 12 ha experimental field in the South of the Netherlands. In the experiment UAV-based hyperspectral images were acquired on a weekly basis together with field data on chlorophyll as indicator for the nitrogen situation of the crop and leaf area index (LAI) as indicator for biomass status.

Initially, the quality aspects of the developed light-weight hyperspectral mapping system will presented with regard to its radiometric and geometric quality. Next we would like to present the relations between sensor derived spectral measurements and crop status variables for a time-series of measurements over the growing season. In addition, the spatial variation of crop characteristics within the field can be adopted for variable rate application of fertilizers within the field. The outcome of the experiments should guide the operational use of UAV based systems in precision agriculture systems.