EXAMINING THE POSSIBILITY OF CORRECTING IMAGERY ACQUIRED FOR THE PURPOSE OF OBTAINING SPECTRAL REFLECTANCE COEFFICIENTS IN THE INFRARED RANGE USING PHOTOMETRIC MEASUREMENTS

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ABSTRACT:

In recent years there had been significant developments in sensor technologies, methodologies and electronics, that lead to the construction of more sensitive and precise measurement devices. In turn, this has become the driving force behind developments in remote sensing nowadays.

Spectroscopy, as the foundation of modern remote sensing, is the science which deals with recording and the interpretation of the reflectance properties of objects in different ranges of the electromagnetic spectrum. Reflectance coefficients represented as a function of wavelength are commonly known as "spectral characteristic" and are described by a curve presented in the Cartesian coordinate system, being a graphical representation of the dependence of the reflectance coefficients of an object's surface from the wavelength of the incident radiation. Because each object is characterised by different reflective properties at different wavelengths, these characteristics allow for the identification and evaluation of the state of a vast majority of objects.

The most common method of acquiring spectral reflectance coefficients is using a spectrometer (either spectrophotometer or spectroradiometer). These methods are however mainly reserved for *in-situ* measurements. The research team at the Military University of Technology has been working for many years developing imaging methods for acquiring spectral response coefficients. Over the past 8 years we had proposed methods for processing both data acquired from panchromatic, hyperspectral and multispectral sensors. In order to obtain spectral characteristics of an investigated object using a panchromatic imaging sensor, it is necessary to additionally use suitable filters – traditional inference filters or tuneable electrooptical filters. Spectral reflectance coefficients are determined during post-processing on the basis of calculating the ratio between the digital number (DN) value of the investigated object in every band of the electromagnetic spectrum and the DN of a reference sample with a known reflectance value in each spectral band. This method therefore requires direct access to the objects of interest, in order to be able to place a reference panel in its vicinity. Such an approach is therefore impossible to conduct in dangerous and/or inaccessible areas, for eg over floodwaters.

We had proposed a method for acquiring precise spectral information of objects using a panchromatic camera with a set of interference filters without the need to place a reference panel on the observed scene. The methodology is based on the concept, that if a sensor has fixed exposure parameters (f-stop and exposure/integration time) and used to acquire imagery in stable lighting conditions, the sensor response will always be the same within a small margin of error resulting from the system's SNR. If we however increase the exposure time two-fold, the sensors response (DN value) will also increase by the same factor. Using empirical methods, it is possible to determine a dependence between these 4 parameters - how will the DN chance in relation to changes in integration time, f-stop and the amount of light illuminating the scene.

The tested sensor is the XEVA XS-1.7.320 camera, which is a small, light-weight sensor ideal for UAV applications, which registers imagery in the 900-1700nm range. This camera will be used on board an UAV for monitoring water pollutants as part of research conducted within the IRAMSWater project conducted by the Military University of Technology. The IRAMSWater - "Innovative remote sensing system for the monitoring of pollutants in rivers, offshore waters and flooded areas"(PBS1/B9/8/2012) project is being financed by the National Centre for Research and Development. Its main aim is to detect, identify and monitor water pollutants in rivers, offshore waters and flooded areas.

It was therefore crucial to determine precise methodologies for acquiring spectral data using this sensor. Preliminary experiments were held in laboratory conditions using stable ASD Pro Lamp lighting. The scene illumination was measured using a photometric instrument - a Minolta T10 luxmeter. The developed methodology gave very good results, the repeatability of which was within 1-2%. Next, the experiments were continued outdoors, where the lighting conditions were much less stable. The methodologies developed in the laboratory seemed to no longer apply to results obtained in field conditions. This was due to changes in the light's composition in the 900-1700nm range, where the luxmeter was not registering luminance data. Once the luxmeter was substituted with an ASD Fieldspec 4 spectroradiometer with an RCR probe for irradiance measurements, the measurement repeatability rose to 1-2%. Even though the newly developed methodologies were giving very good results, there was a need to continue developing this method. The Fieldspec 4 instrument is, in contrast to the T-10 luxmeter, a very large and heavy piece of equipment that would be impossible to place onboard an UAV. There was therefore a need to find a relationship between luminance readings taken by the luxmeter and the irradiance data recorded by the spectroradiometer.

This paper will present the set up of consequent experiments, the problems encountered and obtained results. The main aim of this research was to determine a link between these two quantities (luminance and irradiance) in order to be able to eliminate the need of

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using such a large, heavy and expensive instrument when acquiring spectral reflectance data from a XEVA XS-1.7.320 camera mounted on an UAV without using a reference panel.