Multispectral characterization of minerals in flooded mines at 500 m depth

Norbert Zajzon[1], **Csaba Vörös**[2], **Ferenc Ujhelyi**[3], **Tamás Sarkadi**[3]

[1]Institute of Mineralogy and Geology, University of Miskolc, H-3515, Egyetemváros, Miskolc, Hungary, nzajzon@uni-miskolc.hu, [2]AFKI, University of Miskolc, H-3515, Egyetemváros, Miskolc, Hungary, [3]Budapest University of Technology and Economics, Department of Atomic Physics, H-1111 Budapest Műegyetem rkp. 3.,

ABSTRACT:

The main target of the UNEXMIN H2020 project (www.unexmin.eu) is to develop a fully autonomous submersible robot (UX-1) which can map flooded mine workings, and collect information about potential resources remaining in them. The most recent information about these abandoned mines could be more than 100 years old; some of them still could hold significant reserves of resources.

To identify the ores/minerals in these mines many technological challenges have to be overcome: limited space and weigh for instrumentation, the UX-1 is continuously moving without contacting the mine walls and limited energy consumption because the whole robot is running only on its own battery pack. Multispectral imaging was selected as a feasible and promising method to characterize minerals.

The often more than one metre of water severely limits the useful electromagnetic wavelengths available for sensing, so the multispectral unit is designed to work between 400 to 850 nm where the water has acceptable transparency. The use of classical spectrometers is limited to single point measurements, the maximum that they can be used for is for line-scan, but this requires a powerful light source with high energy consumption. Even with the development of the 2D multispectral CCDs, there is no camera on the market which has the required channel number together with the required resolution. With the availability of high power, energy efficient monochromatic light sources (LEDs) which can be switched on and off with millisecond accuracy, the "reverse spectrometry" seems a good solution. This is where a sensitive, high resolution greyscale camera is used to record the different wavelengths in a sequence synchronized with the triggering of different wavelength light sources. The spectra of the individual points are built/ merged by the combination of the sequential images during post-processing and referred to every xyz-point.

Because the mine waters can have very high dissolved ion content it can have very intense colour which can have strong effect on the measured mineral colour. Thus a reference path will be in the multispectral imaging unit continuously measuring the water

transmittance to allow correction of colour effects. The wavelength selective absorption effect of the water will also be corrected with the measured distance of the multispectral imaging unit and the actual measured point.

The surface roughness and inclination will also effect the actual measured intensity of a point, which can be corrected only to a certain degree, thus detected points with high inclination (higher than ca. 15–20°) will be omitted from post processing and offline interpretation.

To have the best possible identification of the minerals, a database will be built, starting with the most common minerals from the test sites of the UX-1. This database will be populated with information acquired by the same multispectral imaging unit to minimize the instrumental differences of the spectra.

The software control, data storage and post processing of the data is under development with Research Computing International Ltd in the UNEXMIN project.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 690008.