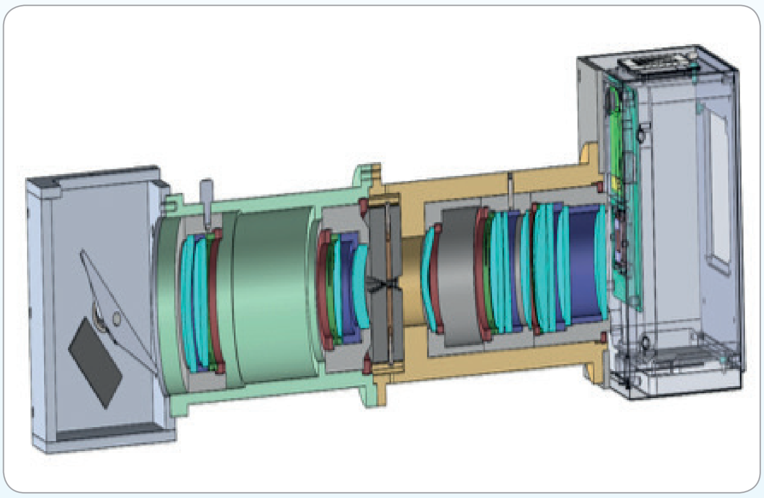
Project no.:	VG20132015110
Provider:	Ministry of the Interior of the Czech Republic
Realization period:	1st February 2013 – 31st December 2015

Project Title:

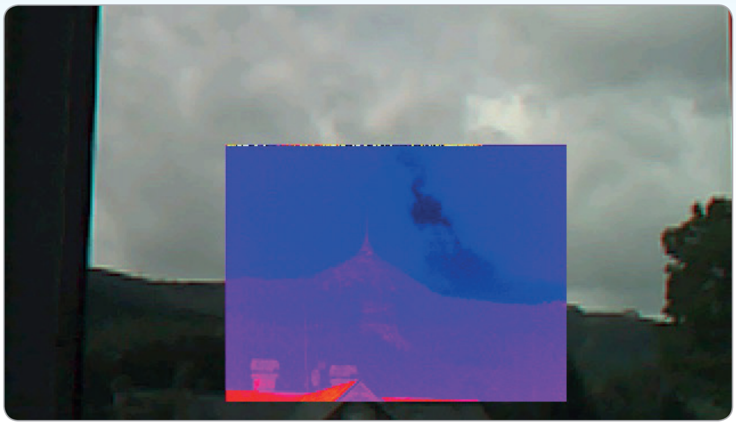
Hyperspectral Detection System for Hazardous Substances (HDES)

Integrated Rescue System (IRS) units, in particular the Fire Brigade, often encounter emergency situations where there is a risk of leakage of hazardous substances. The rescue action must take place in the shortest possible time, which demands a quick analysis of the presence of such substances in the area. The most widespread means, among IRS units at district level, is the detection tube. The problem is the need for a person to enter the contaminated zone, thus creating a safety risk, and the difficulty of gaining a spatial overview of the spread of a dangerous substance from a single point measurement.

The HDES Project, solved in cooperation with an industrial partner – APPLIC s.r.o. – within the framework of the Security Research Program of the Ministry of the Interior, addresses the aforementioned problems by implementing the remote detection method by means of hyperspectral infrared imaging. Systems employing this method are commonly available on the market but their disadvantage is the high cost caused by the use of cryogenically cooled sensors. The main objective of this project was to develop an affordable hyperspectral detection system.



There are 10 optical members with 9 aspherical surfaces in the final system. The complexity of the optical system increased requirements on production and accuracy of assembly. Special care was taken to optimize the shape of the optical elements with respect to available production technology (in this case, the SPDT – Single Point Diamond Turning – method).



Great care was taken to optimize the required spectral resolution with respect to the detection of 10 selected chemical compounds and the detection reliability of the system. Sensor models and experimental data were not available to optimize the system numerically at the time of the project realization. Therefore, a compromise of high spectral resolution and a widely adjustable slit was chosen to allow delaying the selection of spectral resolution and signal-to-noise ratio until the experimental stage.

While working on the project, the APPLIC s.r.o. partner team developed its own infrared IRCA camera, which features an open and deterministic data processing chain. The processing does not affect the performance of the detection algorithms for processing hyperspectral data (unlike commonly available infrared cameras). The body of the IRCA camera also incorporates a scene camera for recording in the visible spectral range.

The system includes a software package for data analysis and chemical component detection. It provides data retrieval, preprocessing, and normalization based on system calibration and decomposition of the acquired spectra using the fingerprints of selected chemical components. A map of the probable presence of the detected chemical substances can be displayed along with an image of the scene in thermal and visible range.

The most important results of the project are prototypes of system and special components and results falling into the category of intellectual property (utility models, patents).

The results of the project can be used separately in applications other than hyperspectral imaging. The IRCA camera can be employed in security and surveillance systems or industrial process diagnostics applications. The optical part is specialized for hyperspectral imaging, but the know-how of design and production of infrared optical systems is also exploited in thermal imaging applications.