ABSTRACT

This doctoral dissertation presents holistic description of acquisition methods and processing and analysis of spectral data in selected industrial and scientific applications, along with a proposal of the author's application-specific imaging and processing methodology. Verification of the research hypothesis established in the dissertation:

"Hyperspectral systems with a simplified optical design and a significantly reduced number of spectral channels can perform most of the basic tasks of object classification and identification with an efficiency comparable to classical hyperspectral systems with a high number of spectral channels, provided that the bands are optimally selected and advanced data processing methods are used"

required to carry out a series of studies and analyses, including a detailed analysis of the strengths and weaknesses and also the scope of application of the techniques developed so far for the implementation of multi- (MSI) and hyperspectral imaging (HSI). This made it possible to draw conclusions and identify key steps in the chain of data acquisition and processing. Among them are the ways of filtering spectral channels, in which such optical elements as diffraction gratings, prisms and Fabry-Perot filters or gradient (linear variable) filters (LVF) are used. The research performed and the compilation of spatial-spectral characteristics of the filter elements studied, provided information on the optimal selection of key components of imaging systems due to the target application (e.g. in agliculture or in waste sorting facility). Another key stage analyzed in the work was the performance testing of data processing and analysis (HSI) algorithms.

As a result of the research performed, an original method was developed for the synthesis of spectral imaging systems with reduced to only a few, key spectral channels. The work performed made it possible to verify stated hypothesis, as well as to outline areas for further development in the direction of wider use and dissemination of spectral imaging methods in technology. The results of the completed dissertation were created in cooperation with and implemented at Scanway S.A. within the framework of the project Implementation Doctorate Edition V (contract number DWD/5/0280/2021*)*.