UTILIZING MODERN TECHNOLOGY IN VEGETATION INVENTORY IN THE ENERGY SECTOR

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Airborne laser scanning technology, combined with advanced remote sensing techniques constitutes an effective tool for acquiring geospatial data. Mobile acquisition systems are tailored for specific applications and enable the collection of diverse data. This allows for the creation of comprehensive and versatile sets of geospatial data, which serve as a valuable resource for conducting research in various scientific fields. This dissertation was carried out as part of the "Industrial Doctorate" project. The project's theme was "Supporting vegetation inventory processes in the energy sector using modern technologies." The project aimed to address technological challenges faced by Vimap company. by leveraging the latest scientific advancements, high-resolution geospatial data obtained through the Vimap remote measurement system, and information technologies. As part of the project, research was conducted to develop solutions and tools for locating tree stems and identifying tree species and their types. The outcome of this work includes modules prepared and implemented within the Vimap company application environment, enabling tree localization and species/type identification.

The process enabling automatic determination of tree stem location was developed based on laser scanning data. This process was implemented using circular Hough transform, data denoising procedures, and iterative fitting of circles using the robust least squares method. The tree locations obtained from the research serve as input data for the process that automatically determines their species and type. The proposed tree species and type identification process relies on RGB and CIR aerial imagery, harnessing the potential of deep learning through the ML.NET platform and the ResNet-50 architecture. The constructed classification model achieved an accuracy of 94.6% for tree species classification and 95.1% for tree type classification when validated on an independent dataset.

The structure of the dissertation has been adapted to the processes carried out as part of the implementation of the industrial doctorate, which focuses on solving technological challenges faced by businesses. Chapter 1 of the dissertation is dedicated to presenting the objectives and concepts of the Ministry of Education and Science program "Industrial Doctorate" programme and the project participant – Vimap company. Technological issues

of the company are discussed in this chapter, along with the definition of goals and formulation of research hypotheses. Chapter 2 provides a synthesis of previous achievements in the field of tree detection using data from active sensors and tree species classification based on data from passive sensors. This chapter serves as an introduction to the research topics covered in this dissertation. Chapter 3 contains a detailed description of the conducted research related to determining the location of tree stems based on data from laser scanning. Chapter 4 presents experiments conducted to develop a dedicated process for automatic classification of tree species and types using aerial imagery obtained by the Vimap system.

Keywords: airborne laser scanning, stem tree detection, tree species classification, deep learning, ML.NET