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# Abstract

Title of the dissertation: **A Method for Assessing the Resilience of an Automatic Data Identification System Using Drones**

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The doctoral dissertation presents the development of a method for assessing the resilience of automatic data identification (AutoID) systems using unmanned aerial vehicles (UAVs). The dynamic growth of the Industry 4.0 concept, the digitalization of logistics processes, and the integration of cyber-physical technologies make contemporary warehouse and production systems increasingly complex and demanding. In this context, UAV–AutoID solutions, which combine the mobility and flexibility of unmanned platforms with AutoID technologies such as RFID, barcodes, QR codes, and vision systems, are gaining particular importance. They enable the automation of inventory processes, warehouse space monitoring, and operational safety support. However, the growing significance of these systems entails the need to examine their resilience to technical, organizational, and environmental disruptions that may limit their effectiveness and reliability.

The main objective of the dissertation was to develop a method for assessing the resilience of UAV–AutoID systems, taking into account the specific conditions of their operation in industrial environments, especially in warehouses with diverse technical and organizational infrastructures. The utilitarian aim was to provide enterprises with a practical tool enabling better planning and implementation of AutoID processes with UAVs, by reducing the risk of adverse events, improving system reliability, and lowering the costs associated with traditional forms of inventory.

The proposed method, named M-UAV, is based on a systems approach that integrates the resilience assessment of technical, process, and environmental components. The procedure includes five stages: identification of UAV–AutoID system elements, determination of operational conditions, recording of mission parameters, resilience assessment, and preparation of technical and organizational recommendations. The novelty of the method lies in the consideration of environmental variability, which in the case of service-based warehouse inventory plays a key role in determining the level of efficiency and safety of the entire system. This allows not only for identifying system vulnerabilities but also for proposing solutions that increase its flexibility and adaptability.

The method was validated through implementation in a real industrial environment, in cooperation with NeuroSpace. Empirical studies covered three different case studies: a modern class-A distribution center, a block storage class-B warehouse, and a production-support warehouse. The analysis enabled a comparison of UAV–AutoID system performance in diverse operating conditions, identification of key sources of disruptions, and practical evaluation of resilience. The results allowed for the formulation of recommendations improving both the design and development of technical systems, as well as the shaping of organizational procedures and risk management practices in warehouse operations.

The dissertation broadly discusses theoretical issues related to UAVs, AutoID technologies, the concept of resilience and its assessment methods, as well as global technological trends in UAVs and development forecasts up to 2030. Based on literature analysis and industrial research, research gaps were identified and addressed through the proposed M-UAV method.

The results of the dissertation contribute to the body of research on the development of logistics and production systems within Industry 4.0, integrating modern automation technologies with technical systems engineering. The developed method may serve as a practical tool supporting enterprises in the automation of warehouse inventory processes, increasing operational efficiency, improving data quality and system reliability. Moreover, it strengthens the technical and organizational resilience of UAV–AutoID systems, supporting digital transformation and logistics process automation in modern industrial environments.