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ROZPRAWA DOKTORSKA

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Analiza możliwości przeprowadzania oceny stanu technicznego infrastruktury kolejowej w oparciu o zastosowanie technologii bezzałogowych pojazdów, w tym pojazdów latających

Analysis of the feasibility of carrying out a technical condition assessment of railway infrastructure using unmanned vehicle technology including flying vehicles

Promotor

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Abstract

The aim of this study was to analyse the feasibility of implementing an original solution in the field of monitoring railway infrastructure condition by replacing infrastructure inspections of the carried out by the manager's staff with inspections carried out by unmanned aerial vehicles. Infrastructure maintenance regulations stipulate that cyclical inspections are mandatory as they are part of the infrastructure manager's safety management system. Literature analysis shows that UAV technology is developing very rapidly, however, there is still a lack of a systematic solution for the inspection of railway infrastructure. Therefore, it was reasonable to carry out research to confirm the feasibility of such solutions on the railway. To this end, images were acquired with UAVs equipped with vision cameras and an algorithm was taught to automatically recognise infrastructure defects. An image segmentation model was developed to identify large infrastructure elements such as rails and sleepers. The algorithm was very successful in recognising such objects, achieving an IoU of 0.9. Based on the RetinaNet algorithm, a model was developed to detect small objects such as screws, bolts and clamping claws.

In this case, good results were also achieved, although there were a few cases of false detection due mainly to difficult weather conditions during the flights. Very good results were achieved in detection of rail joints and an algorithm for detection of rail cracks was developed on this basis. Despite attempts, it was not possible to find a practical solution for rail buckling and rail burn detection.

A LIDAR laser scanner was used in the study and the results proved that it is possible to detect rail burns based on a point cloud but more flights are required. Based on the research carried out, it was proven that replacing conventional inspections with aerial monitoring is possible. A calculation showed that the use of the new inspection method is almost twice as fast as the current method and leads to significant savings. It was proven that photo documentation provides unequivocal and readable material about infrastructure condition, increasing rail traffic safety and, in combination with a preventive maintenance system, will increase the benefits for infrastructure managers and their stakeholders.

Key words: unmanned aerial vehicle, UAV, rail infrastructure monitoring, defect detection