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Pedestrian detection for underground mine vehicles using thermal imaging

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Abstract

Vehicle accidents are one of the major causes of deaths in South African underground mines. A computer vision-based pedestrian detection and tracking system is presented in this research that will assist locomotive drivers in operating their vehicles safer. The detection and tracking system uses a combination of thermal and three-dimensional (3D) imagery for the detection and tracking of people. The developed system uses a segment-classify-track methodology which eliminates computationally expensive multi-scale classification. A minimum error thresholding algorithm for segmentation is shown to be effective in a wide range of environments with temperature up to 26 $^{\circ}C$ and in a 1000 m deep mine. The classifier uses a principle component analysis and support vector classifier to achieve a 95% accuracy and 97% specificity in classifying the segmented images. It is shown that each detection is not independent of the previous but the probability of missing two detections in a row is 0.6%, which is considered acceptably low. The tracker uses the Kinect's structured-light 3D sensor for tracking the identified people. It is shown that the useful range of the Kinect is insufficient to provide timeous warning of a collision. The error in the Kinect depth, measurements increases quadratically with depth resulting in very noisy velocity estimates at longer ranges. The use of the Kinect for the tracker demonstrates the principle of the tracker but due to budgetary constraints the replacement of the Kinect with a long range sensor remains future work.