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# DL4PuDe: Deep-Learning Framework for Pushing Detection in Pedestrian Dynamics

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## Abstract

In this work, we present a deep-learning framework to help researchers automatically identify pushing behavior in video recordings of the human crowd. Pushing detection is crucial for understanding pushing dynamics, thereby managing the crowd comfortably and safely. The presented framework consists of four modules: (1) Optical Flow Estimator that uses a pre-trained deep optical flow model to estimate the dense displacement fields between successive frames in input videos. (2) Wheel Visualization for generating motion information maps from the dense displacement fields. (3) Adapted EfficientNet-B0 Classifier that is responsible for identifying pushing behavior from the maps. (4) A False Reduction and Annotation module; to reduce the number of false identifications of the classifier, annotate the regions of pushing and output the annotated video. For the evaluation of the framework, we used five real-world ground truth of pushing behavior videos. Experimental results show that the proposed framework achieves 86% accuracy. The framework is open-source and available at <https://github.com/PedestrianDynamics/DL4PuDe>.

**Keywords:** Intelligent Software, Deep Learning Software, Automated Detection Software, Crowd Safety

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