TU Clausthal

Abschlussvortrag Research Track Mohanad Al-Ghobari

„Material Detection and Feature Extraction on Conveyor Belts“

In the context of evolving smart cities, material sorting plays a crucial role in achieving a sustainable circular economy across various industries. The increasing complexity of modern products, in both architecture and raw material composition, demands effective sorting mechanisms to recover valuable resources. Traditional techniques, while effective for smaller particles, struggle with a major trade-off between throughput and sorting accuracy. As throughput increases, precision decreases, particularly in sorting attributes like colour and size. This study introduces a deep learning-based inference pipeline designed to enhance material sorting on eddy current conveyor belts by detecting and classifying materials based on size, texture and colour. To achieve this, a custom dataset of fine-grained materials, varying in size and composition, was collected from an operational sorting plant. This dataset was used to fine-tune a pre-trained Feature Pyramid Network (FPN) Mask-RCNN model for precise instance detection. Outputs from this model were further processed to extract features such as colour, texture, and size. These were then fed into a feature engineering pipeline to reduce dimensionality and highlight key attributes for accurate classification. The performance of the proposed system was evaluated using standard metrics, including mean Average Precision (mAP) for detection, Intersection over Unit IoU for segmentation and accuracy for classification. Results indicated a substantial improvement, with a segmentation and detection AP score of 75% and AP @IoU=0.5 of 94.0%—significantly outperforming standard models like Mask R-CNN or HTC on the COCO dataset. The overall average classification accuracy reached 91.7%. These results have demonstrated notable implications for improving sorting processes in smart cities, ultimately promoting sustainability and a circular economy.

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