7TH ESTAD

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EUROPEAN STEEL TECHNOLOGY AND APPLICATION DAYS

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Application of Deep Learning technique to improve the scrap quality

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BACKGROUND

Accurate scrap identification is essential to control tramp elements, enhance steel quality, and drive low-carbon, circular steel production.

When uninvited elements join the melt...

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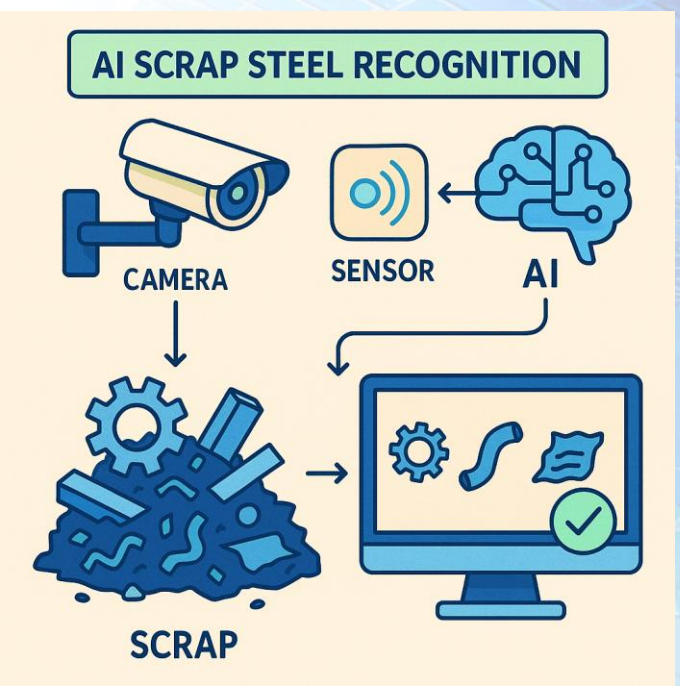
BACKGROUND

The application of DL techniques for scrap task is crucial to enhance scrap recycling technology and exploit the application of AI in metallurgy.



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PURESCRAP - PURity improvement of SCRAP metal”

Objective: increase the use of **low-quality scrap** grades by applying the best available technologies to reduce impurities.

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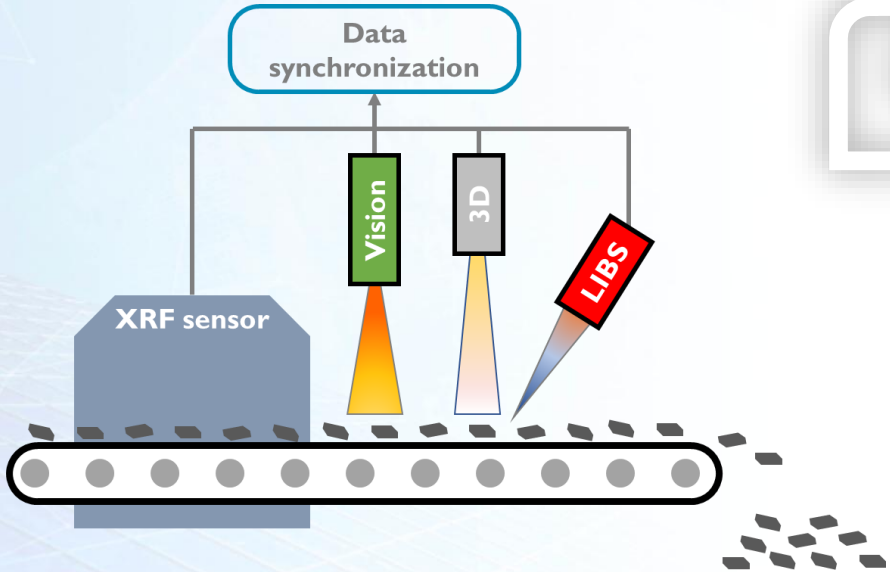
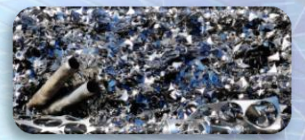
PURESCRAP PROJECT – Shredded line





Provide an integrated set of measuring technologies to increase the average scrap quality for optimising the melting furnace's charge

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PURESCRAP PROJECT – Test line

Test Line installed at Stena Recycling in Sweden

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2D CAMERA –
Automatic detection and identification of copper

Images collected during the experimental tests

Development and evaluation of Deep Learning based models

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DATASET

Four datasets were created reflecting successive stages of data collection. Each new version of the dataset was built upon the previous one, gradually increasing the volume and variability of the data (except Dataset 3).

Dataset	Total number of images	Total number of ground truth annotations	Annotation per image
Dataset 1	2330	4220	1.81
Dataset 2	2798	4818	1.72
Dataset 3	1877	3959	2.11
Dataset 4	3394	5665	1.67

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LABELLING

The target object is annotated using a black bounding box.
These annotations serve as ground truth during training and evaluation, enabling the model to learn the spatial and visual characteristics of the object across varying contexts.

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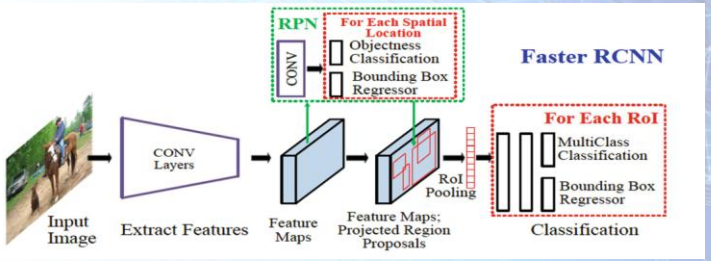
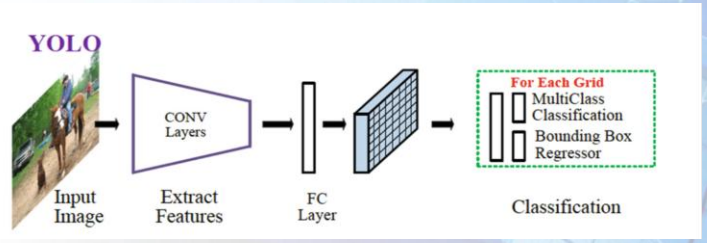
IMAGE PROCESSING - Copper Detection Models

Model based on the **FasterRCNN + ResNetX-101** architecture: ImageNet pre-trained ResNext101 weights as a backbone and Feature Pyramid Network in Faster RCNN as Neck.



[1]Rocha, Á., Adeli, H., Reis, L. P., & Costanzo, S. (Eds.). (2018). Trends and Advances in Information Systems and Technologies: Volume 1

Model based on **YOLO architecture,** one-stage detector proposed by Redmon et al[2].



[2] Redmon, J.; Divvala, S.; Girshick, R.; Farhadi, A., "You only look once: Unified, real-time object detection", In Proceedings of the IEEE conference on computer vision and pattern recognition, 2016.

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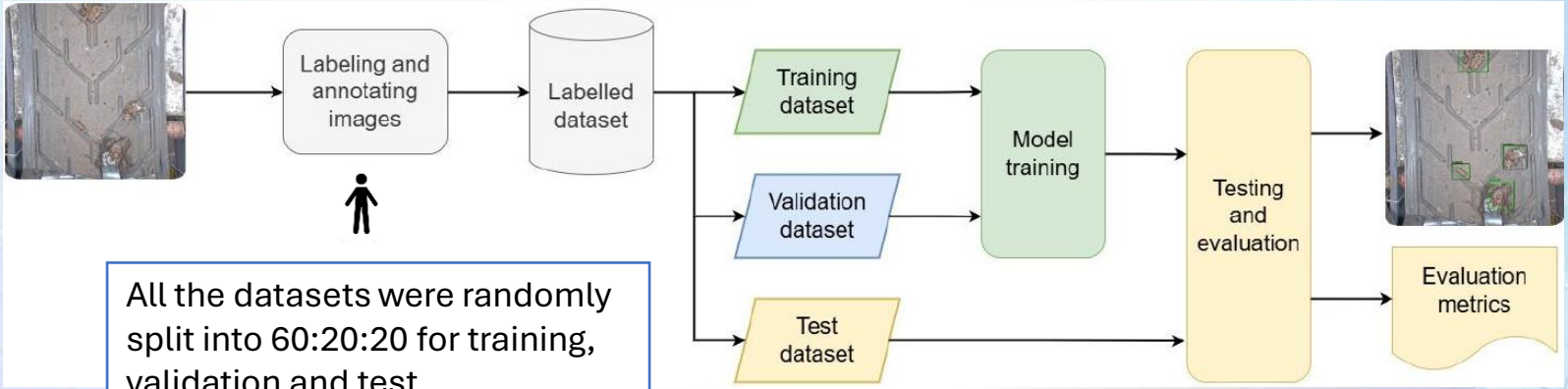
IMAGE PROCESSING - Copper Detection Models

Pipeline for training and evaluating the deep learning-based computer vision models for copper detection tasks. The pipeline is designed to follow a supervised learning approach.



All the datasets were randomly split into 60:20:20 for training, validation and test.

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RESULTS

Model	Split	mAP50%	GT	TP	FP	FN	FPS
FasterRCNN	Validation	92.66	1222	1155	96	67	2.51
	Test	91.26	1174	1096	131	78	2.46
YOLO	Validation	92.91	1222	1152	72	70	11.95
	Test	92.44	1174	1098	99	76	11.74

High-precision (>90% mAP) ready for system integration.

Key performance metric for real-time applications.

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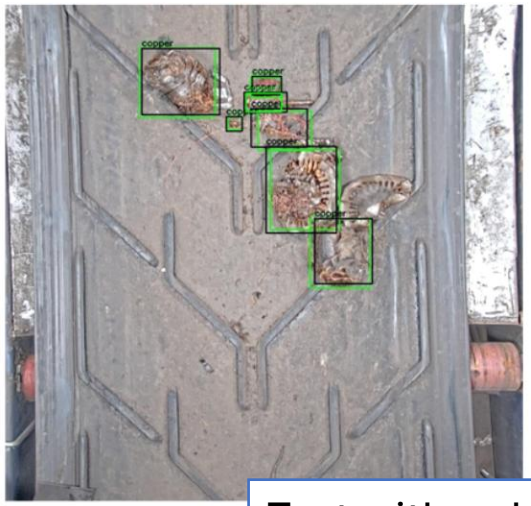
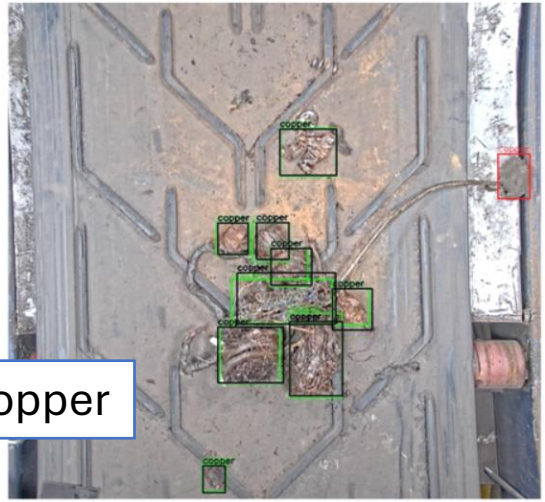
RESULTS



Test with only copper



Real case scenario

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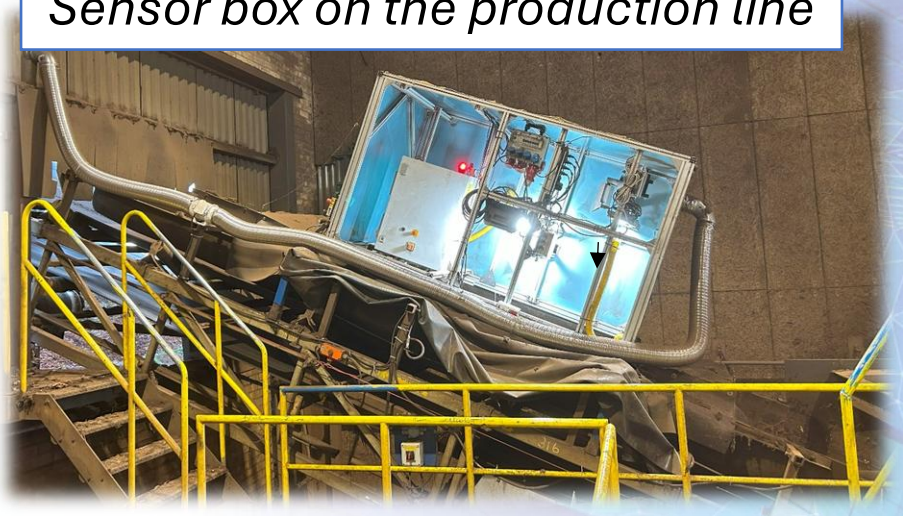
ON GOING WORK

We are testing the model on the process line images

Sensor box on the production line



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FUTURE WORK ON THE PRODUCTION LINE

Synchronization of data

Merge image processing, LIBS data and LiDAR data

Development of ML model to merge all data

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THANK YOU!

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