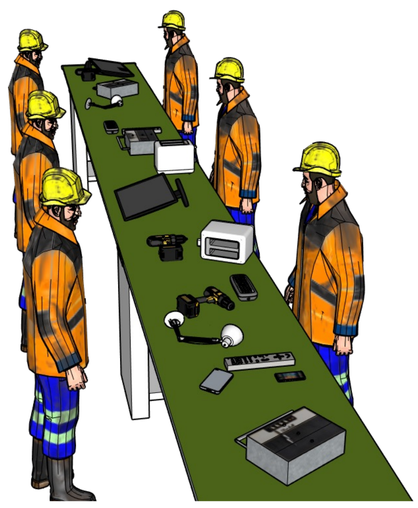
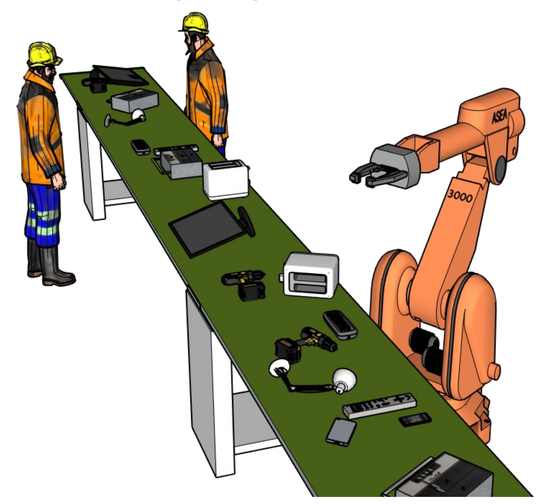
AutoWEEEdakt

Autodidact /ˈɔːtəʊdɪdakt/ *noun* a self-taught person
WEEE = Waste Electrical and Electronic Equipment



Diarie nummer 2020-02848

AI

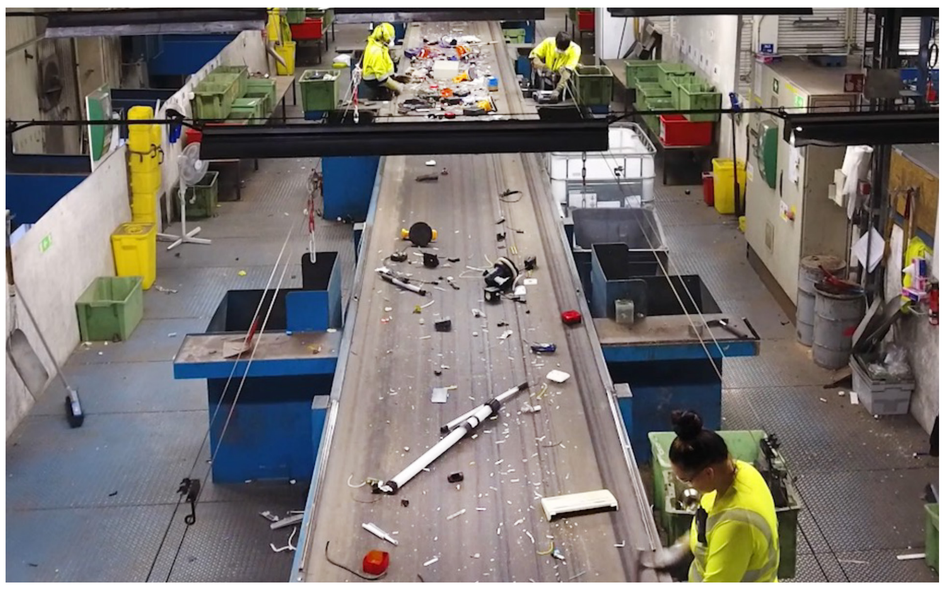


Introduction

In recycling of WEEE (Waste Electrical and Electronic Equipment) manual labor is extensively used in the presorting and categorization of the WEEE. This is mainly because recyclers must ensure that products containing environmentally, and health hazardous components are sorted out for subsequent disassembly. The most common category of components to be removed from products is batteries. Li-ion batteries are sensitive to mechanical damage and can start catastrophic fires further down in the process if they are not removed.

There has been several attempts at automating these steps using AI based image recognition. All these efforts have however failed due to the large variability of the electronic equipment that can come into a recycling plant, and the fact that new products are coming to the market everyday. Manual labelling of WEEE objects required for training AI based computer vision systems is labor extensive and as result expensive procedure.

To tackle this problem, automated labeling procedure based on monitoring existing industrial recycling processes were suggested and developed. This work has been done on two different recycling facilities, El-Kretsen sorting and categorization station at EXSE plant in Arboga, and NG Metalls recycling plant at Katrineholm.



El-Kretsen

EXSE AB works on behalf of external business operators with statistics, sorting, analyzes of electrical & electronic products.

- At the plant, the waste is analyzed to improve the efficiency of the collection system.
- Around 2 per cent of the assorted electronics collected finds its way here to be turned into statistics and provide us with information. This information is used to make sure our pre-treaters receive the correct compensation for their work, but also to map out how our waste changes over time, but also to see how our electricity waste changes over time.
- The task of the statistics coordinator is to check, compile and clarify the data that arises in different computer systems. To read more about El-Kretsen *www.el-kretsen.se/english/*

Image acquisition system based on cloud camera was developed for automated labeling of WEEE which is going through sorting at the EXSE plant.

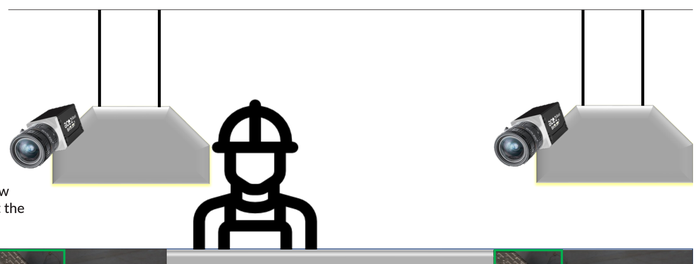
Collected images of different WEEE object were labelled using reports from EXCE sorting facility in order to form a dataset. Dataset at this point includes 5100 images and has labels corresponding to 80 classes.

NGMETALL

On the NG Metall site, algorithms have been created that can observe and see which WEEE objects the process operators have to handle before sending it further down the process line for shredding.

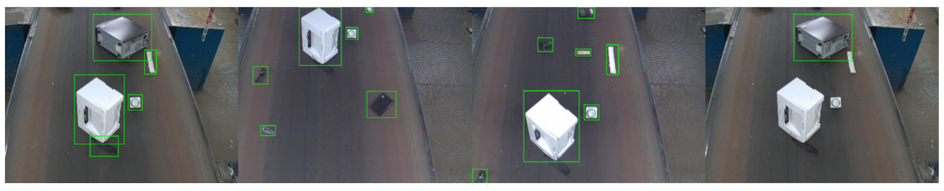
To do this cameras have been installed which record video streams of WEEE objects coming down the conveyer belt of before and after the WEEE objects have passed by a process operator. The AI based algorithms can then detect which objects have been handled, and by this way create dataset that continuously grows with WEEE objects that need to be handled.

This ever evolving dataset is then used to train and update AI based image recognition models to recognize WEEE that need to be handled before shredding.



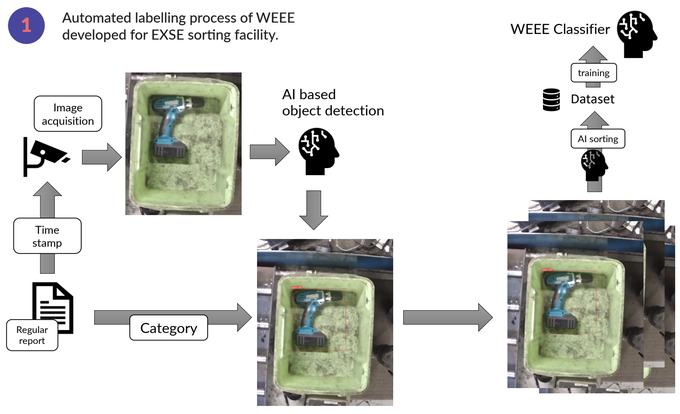
1 Overall schematic showing how the detection is made on what the process operator has handled.

Before After1 After2 Missing/handled object



2 Above images show how the developed algorithms detect WEEE objects on the conveyer belt, and then by comparing the before picture with after images during a short interval of time can detect the object that was handled/removed.

1 Automated labelling process of WEEE developed for EXSE sorting facility.

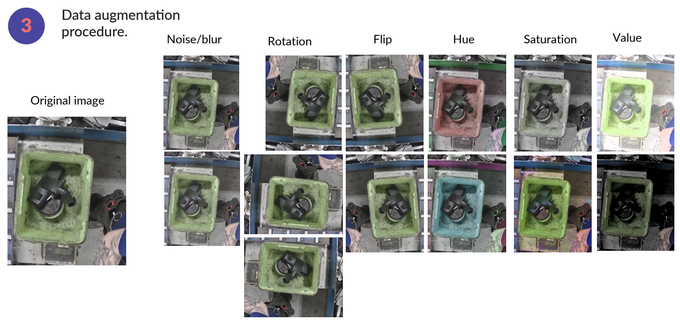


2 The automated process of forming dataset for training AI based WEEE classifier was developed by Chalmers Industriteknik during performing AutoWEEEdakt project. The process includes several steps:

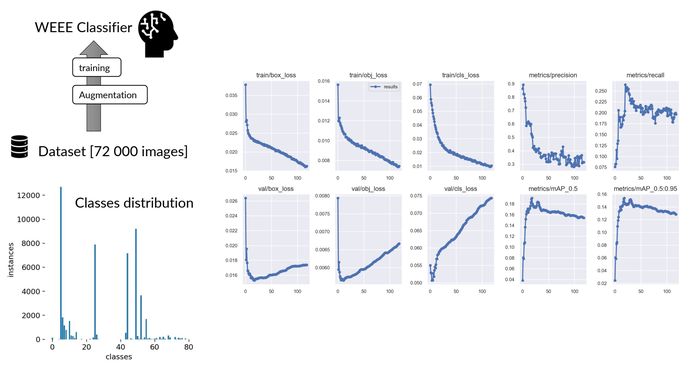
1. Image acquisition. After receiving report from EXSE sorting plant which includes information about the object class, weight and time, when the object was registered, the system request corresponding image from the cloud camera based on the registration time. Image typically includes one or several objects.
2. AI based image localization procedure is applied to the image in order to define the position and size of the object (bounding box). Localization procedure based on the YOLO version 5 [*] computer vision algorithm which was specifically trained for this task.
3. Coordinated and dimensions of the bounding boxes together with corresponding class from the report, are used as the label for this image for the WEEE classifier dataset.
4. Many of the images are not suitable for the final dataset due to the image defects, camera asynchronization etc., so AI based sorting is applied to the collection of images in order to obtain only few suitable for the dataset.
5. Dataset at the latest stage is used to train WEEE classifier based on YOLO version 5 computer vision algorithm.

Due to the slow pace of data collection the size of the dataset is limiting accuracy of the WEEE classifier. Data augmentation technique was used for increasing the size of the dataset as well as for improving robustness of the algorithm. (*https://github.com/ultralytics/yolov5*)

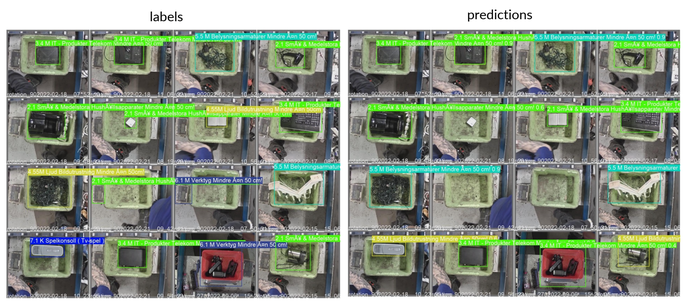
3 Data augmentation procedure.



4 Training of the YOLO version 5 model using augmented data.



5 Training of the YOLO version 5 model using augmented data.



Conclusion

The project is nearing its end and the results are being finalized in the coming months. In the project two different methods were developed for the two different sites that process and recycle WEEE. Both methods, which use different approaches suitable for the different sites, are successful in creating auto-labeled datasets that in turn can be used to train AI based image recognition that can categorize WEEE objects after needed categories for the sites.

Projectpartner

CHALMERS INDUSTRITEKNIK · El-Kretsen · OP teknik ab · NGMETALL

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