University of
South-Eastern Norway

Anomaly Detection for Packaging Machines Using Machine Learning

Anders Lysgaard Lemme
MSc Industrial IT and Automation

TRONRUD ENGINEERING

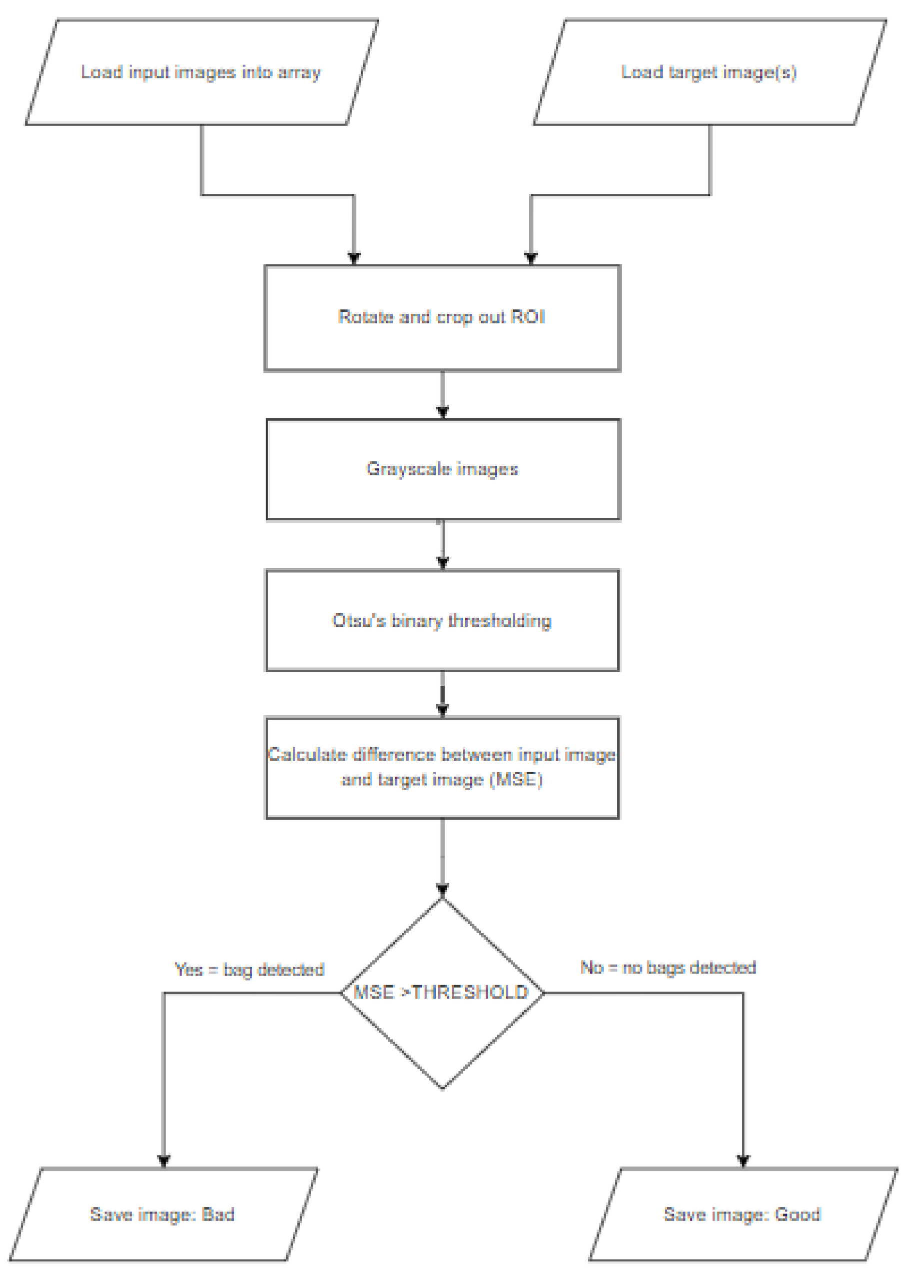
Introduction

The overall objective of this master's thesis is to use computer vision to improve the production quality of the machines produced at Tronrud Engineering packaging technology department. The objective is separated into two parts where each part includes development of a model with techniques used in computer vision.

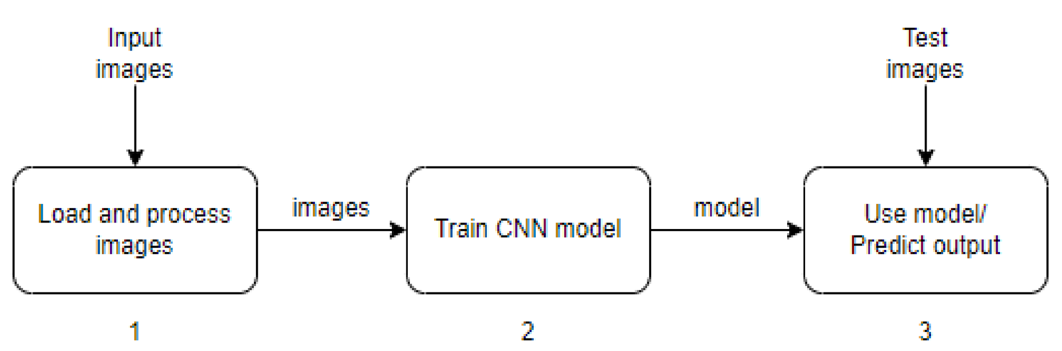
- **Model 1 Bag detection**: develop an algorithm to compare images against a target image to detect differences that occur in undesirable situations.
- **Model 2 Anomaly detection using CNN**: develop a machine learning algorithm to classify if there are any errors or anomalies with the products inside an image.

Methodology

Model 1: Bag detection



Model 2: Anomaly detection using CNN

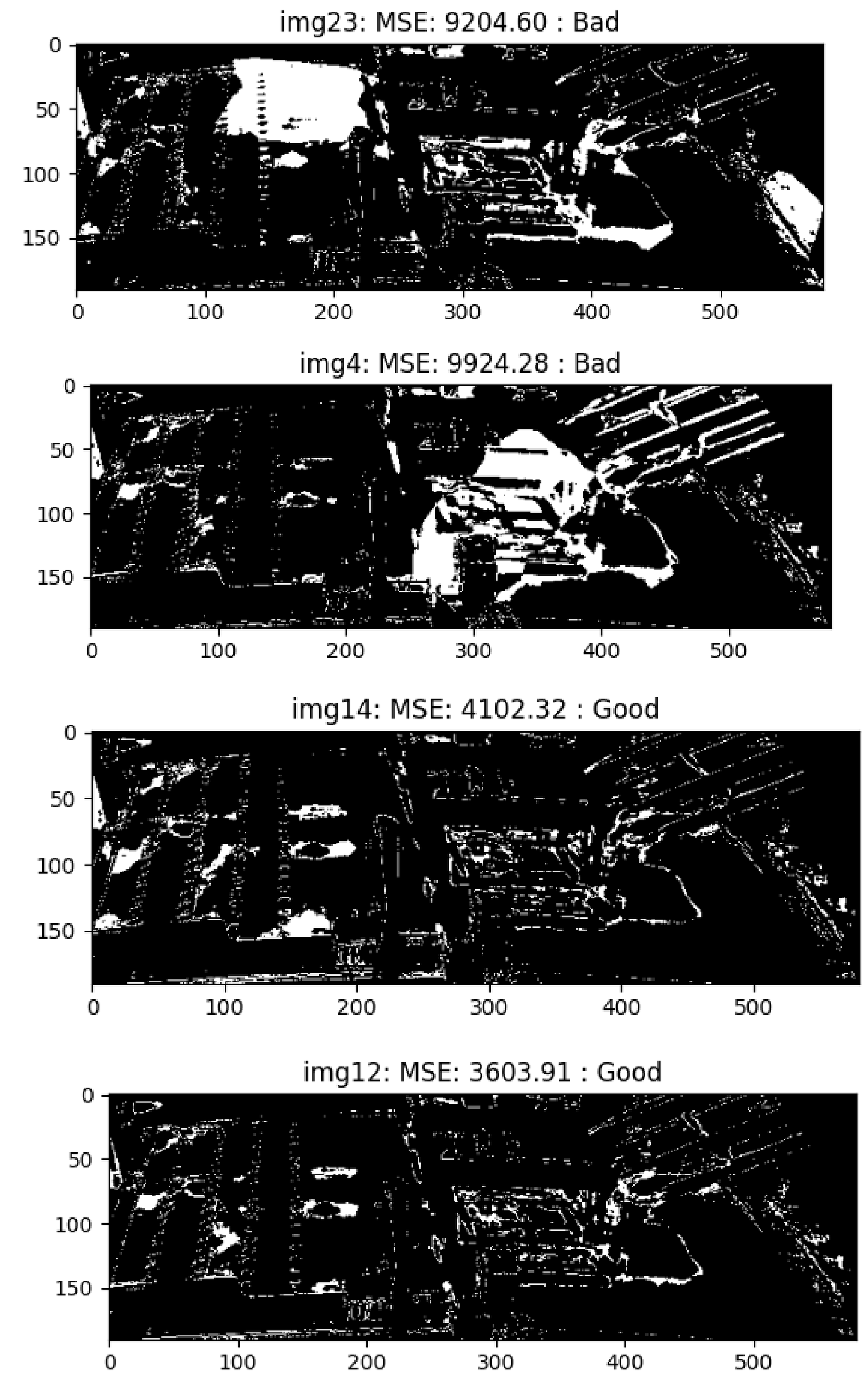


Faculty of Technology, Natural sciences and Maritime Sciences
Campus Porsgrunn

Results

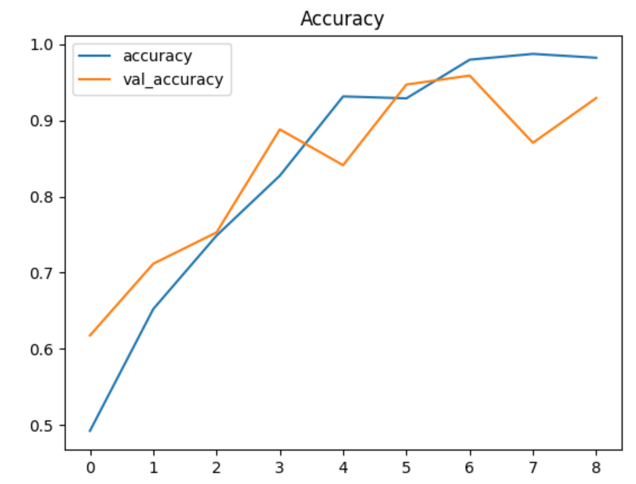
Model 1: Bag detection

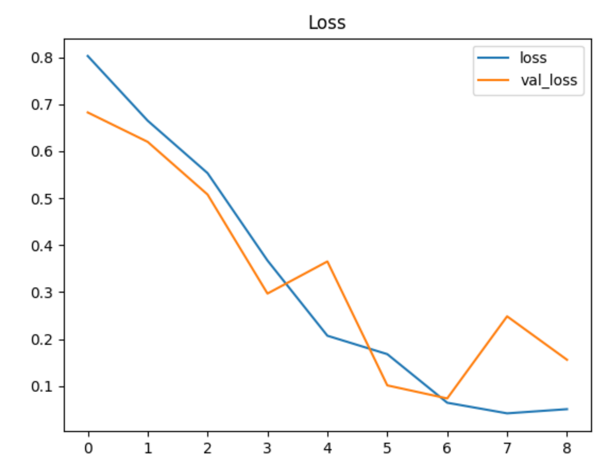
Example result of the image comparison model is shown below. The threshold value separating the classes «Good» and «Bad» are set to 5000. The first two examples are of images where the machine fails to load the products into the case. Consequently, the bags are detected with the MSE higher than the threshold value. The second two results show images without any bags in them which gave a MSE value below the threshold and the images are classified as «Good» when there aren't any bags inside the image.



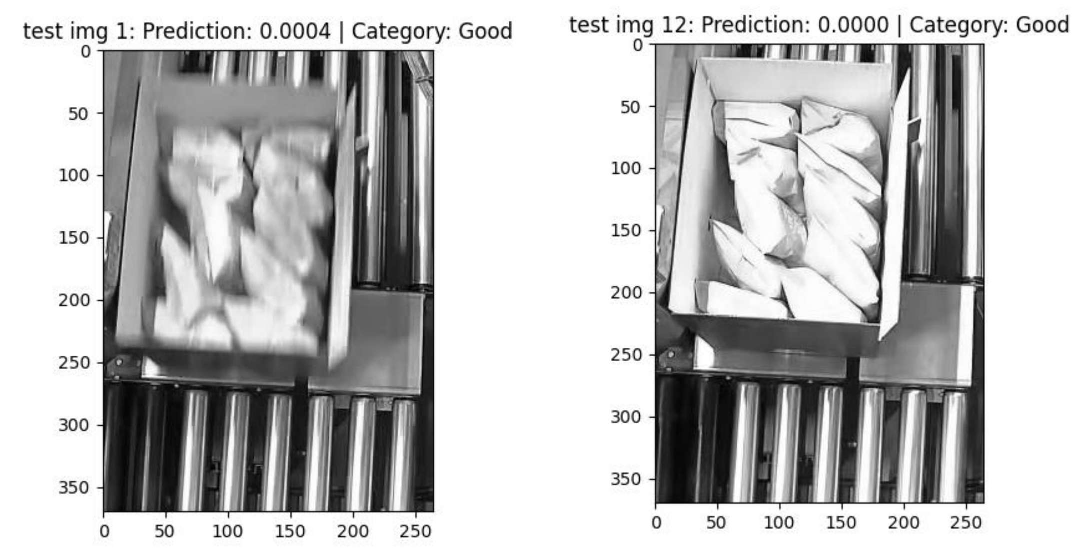
Model 2: Anomaly detection using CNN

The loss and accuracy when training the convolutional neural network are shown in the figures below. The weights stored at the 7th epoch (counting from 0th) gave an accuracy of 0.9797 and validation accuracy of 0.9588, and the obtained loss is 0.0643 on the test data, and 0.0734 on the validation data.

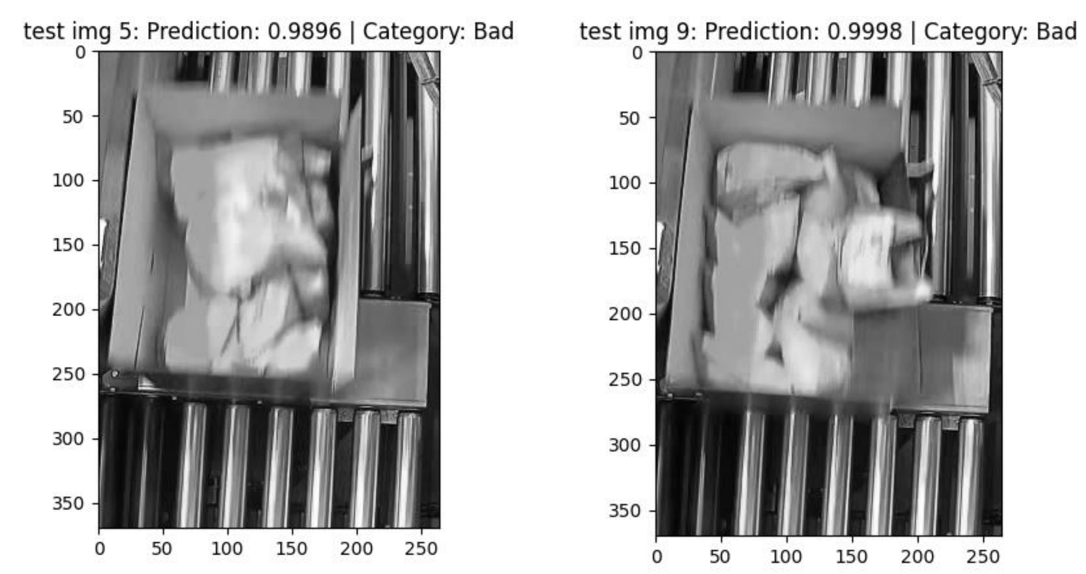




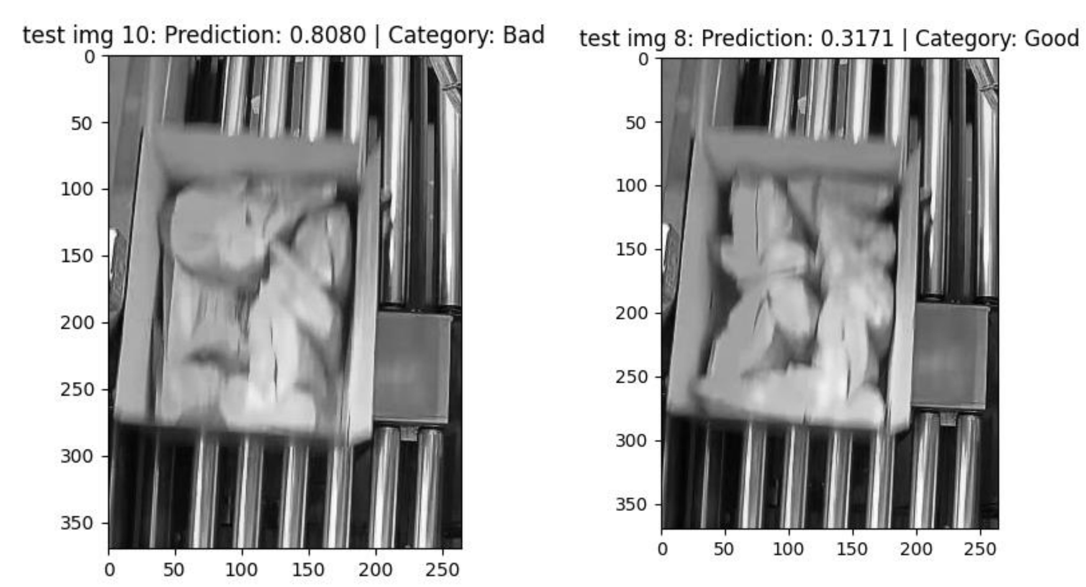
The predicted output from the CNN model are shown below. The first two images show the predicted classification «Good» with high certainty.



The two output predictions of the images below show examples of images classified as «Bad» with high certainty.



The following two images show two output predictions with lower certainty than the above. This is caused by miss-arrangement and blur.



Conclusion

The main goal of this thesis was to develop two different models using two different principles in computer vision.
Model 1: Bag detection was developed using image comparison methods. The final model that used multiple target images for similarity comparison are able to detect bags that are not correctly pushed inside the case.
Model 2: anomaly detection using CNN, was developed using a convolutional neural network. This model also gave good results based on the limited data collected of anomalies, when the dataset size was increased with image augmentation. However, it was desirable to create a model that works for all recipe settings on the TCP. This was not achieved with this model.

Supervisors:
Ru Yan, Ola Marius Lysake