Deep learning for detecting contaminants in poultry

A comparison of several deep learning methods for anomaly detection in X-ray images

Graduate

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Introduction: In food processing plants, X-ray machines are used to inspect products for contaminants such as machine parts or food by-products. The X-ray images need to be automatically analysed to detect these contaminants. The automated method must be adaptable for different types of products being inspected and should also have a low false positive rate (FPR). A low FPR is desirable to avoid expensive and time-consuming manual inspections. A machine learning approach could simplify the process for inspection of new products and reduce labour cost. In this research project, different machine learning models are trained and tested on the given dataset of X-ray images of chicken to detect contaminants.

Approach: Two approaches were tested to detect contaminants in X-ray images: a classification approach, where the model is trained with labels from the existing algorithm, and an anomaly detection approach, where the models learn the distribution of normal data that is not contaminated. The anomaly detection approach evaluates whether the sample is within the distribution of normal data or not. On the other hand, the classification approach learns features that are indicative of a contaminant. The models were trained using the given dataset and evaluated based on their classification accuracy, localisation performance, computational intensity, and setup time needed to get the models running.

Result: For the given dataset and available resources, the classification approach identified contaminants reasonably well, but could not locate them as intended. One anomaly detection approach was able to learn the normal data distribution and detected some contaminants, but struggled with accurate localization of anomalies. The other anomaly detection approaches failed to learn the distribution of normal data and could not detect any anomalous samples. As a result, it can be concluded that the conventional algorithm cannot be easily replaced without a significant amount of data, computational resources and a skilled machine learning engineer. If an anomaly detection approach can identify bone fragments in chicken X-ray images, it is likely to be effective in detecting all anomalies in X-ray images. The complexity of the images is high and the anomalies are difficult to detect. The models are likely to perform better when applied to other simpler products. To further evaluate the machine learning approaches, it would be interesting to train them on different datasets for different products and compare their performance.

X-ray image of a piece of chicken contaminated with a bone fragment indicated by the frame
Own presentment

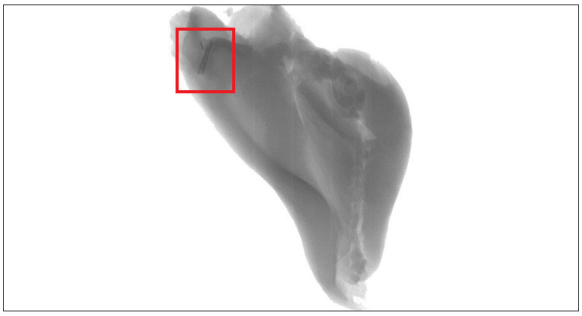
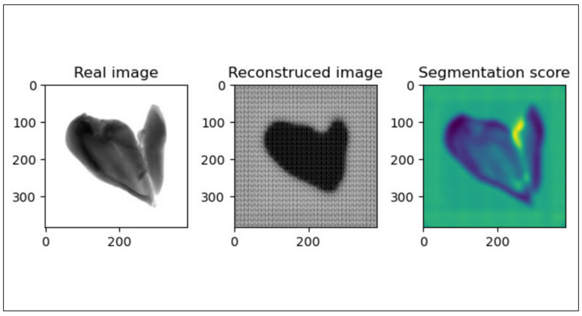
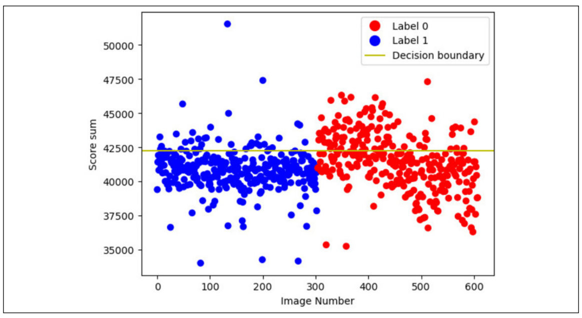


Image reconstruction of an anomaly detection approach
Own presentment



Reconstruction error and decision boundary for the classification for an anomaly detection approach
Own presentment



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