Popular Science Summary

Simulating X-ray Scans to Improve Material Analysis at Tetra Pak

What if time-consuming X-ray scans could be replaced with realistic simulations? This thesis shows how virtual imaging can replicate such scans and generate synthetic data to train machine learning models to segment complex materials accurately.

X-ray computed tomography (XCT) is an imaging technique that allows one to see inside objects without cutting them open. It is widely used in medicine, but also plays a large role in industry. It is, for example, used as a tool by Tetra Pak to analyse the internal structure of paper packaging materials. This is however a very time consuming process and analysing the large volumes that are produced can be very challenging. This thesis explores how to overcome these limitations in two separate objectives.

First, a virtual XCT scanner was developed with the goal of being capable of mimicking the behaviour of a real scanner. By adjusting simulation parameters based on real settings and sample information, the virtual scanner was able to produce data which closely matched real experimental data. This showed that simulation can be used to test scanning settings, saving time by reducing the need for repeated physical experiments. The current model is however limited to specific scanning conditions and further work is needed to make it more generally applicable.

The second part focused on applying the virtual scanner to generate artificial XCT images of fibres. The main advantage of this is that the artificial data includes the exact location of the fibres, which is very difficult and time consuming to find manually in real data. Using this data, machine learning models were trained to automatically identify fibres in real XCT images with great success. This showed that even though the models had been trained on artificial data, they could perform well when applied to real data.