Analysis of XRF spectra with Machine Learning techniques for sorting non-ferrous metal alloys

Description

Based on a technology developed by the ULiege department "Gemme" for recycling non-ferrous metal scraps by families of alloys, the industry "Comet" developed an industrial line, MULTIPICK using 16 robots taking their sorting instructions from a bench of sensors (3D, hyper-spectral and X-ray Topography (XRT)). The metal sorted by MULTIPICK are mixtures of different alloy grades generally remelted for low-end applications. Sorting specific alloys permits thus to generate added economic and environmental value. The objective of a new project is thus the integration in the MULTIPICK line of Laser Induced Breakdown Spectroscopy (LIBS) and X-Ray Fluorescence (XRF) analytical sensors and data processing algorithms to sort specific alloys, in this case, aluminum and stainless-steel alloys. These algorithms will exploit the most recent developments in Artificial Intelligence (AI) and in particular in Machine Learning (ML) to process the data generated by all the sensors and provide identification of elements of the alloys of interest.

The "Electronics" and the "Signal Processing" labs of the Centre Spatial de Liège (CSL) contribute to this project, the "Electronics" lab, by developing a new analytical XRF setup dedicated to stainless-steel and aluminum alloys, the "Signal Processing" lab by developing an ML method to process the XRF data, *i.e.* spectra. For this work, a XRF simulator hase been developed, a dataset made of simulated XRF spectra has been created and a theoretical supervised ML methodology was designed. This method is based on the combination of an Auto-Encoder (AE) that represents the data in the form of compact information (a code) and a mapping module that transforms the code into a vector of concentrations of elements. The AE is composed of an "encoder" that generates the code and a "decoder" obtained by the developed XRF simulator synthesing the spectra from this code. This method has been developed and assessed with the help of a master student. Its performances can be improved trough some techniques as data augmentation, replacement in the decoder of the XRF simulator by a ML model and replacement of the AE model by a Variational AE (VAE) model.

In this context, the "Signal Processing" lab is looking for a motivated master student to explore the proposed improvements for the current project application. The student will be responsible for understanding their theoretical concepts, developing them, proposing and analyzing their performances. The outcomes of the internship / master thesis are expected to contribute to the field of automatized identification of metal alloys from XRF data.

Supervision

The internship / master thesis will be carried out at under the supervision of Murielle Kirkove from the "Signal Processing" lab of CSL. Regular meetings (every week or every two weeks) will be organized during the year.

Recommended skills/courses

- Machine learning (Deep Learning)
- Programming (principles, algorithmic, Python language)

Contact person

Dr. Murielle Kirkove (M.Kirkove@uliege.be)