Sorting faster and better

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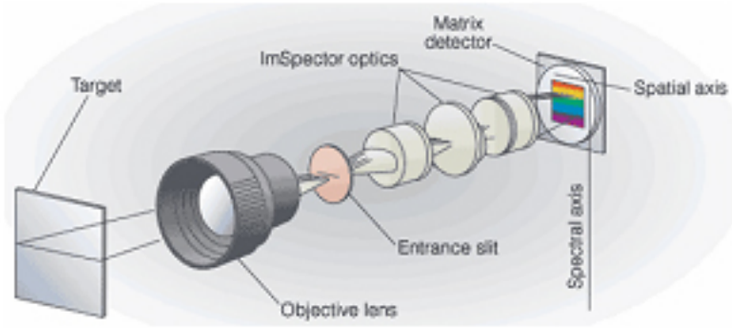
Where should I throw away my old mobile phone? For the past few years, our companies are also major producers of an increasing variety of waste. Thus, with the arrival of new technologies "that everyone has", a new category of waste is becoming increasingly invasive: non-ferrous metals. This includes aluminium, copper, zinc and lead, whose high levels in our waste is becoming a problem. The solution is therefore recycling, but to recycle you have to sort. And to sort, the various components have to be separated. Easy for an office chair, less so for a mobile phone or a computer.

Every year in Europe, there is six million tons of electrical and electronic waste - also called WEEE (Waste from Electric and Electronic Equipment, mobile phones, computers, GPS, etc.). Approximately 13 % of it is composed of non-ferrous metals. This is where the European project, Sormen, comes in: it aims to develop a faster and more profitable sorting technique. It uses the hyperspectral imaging principle, which enables the various components of waste to be sorted according to the **wavelength** (i.e. the colour) of the **light** they reflect. While the cameras are similar to those used in television, they do however benefit from technological advances particular to the space sector, i.e. those mastered by **CSL** (Liège Space Centre). "*Space attracts technology and, in general, must greatly benefit industry*," remarks **Pierre Franco**, an industrial engineer working at CSL. And while "*the technology isn't revolutionary*," he confides, "*its application is*." The sorting of this type of material is, indeed, relatively slow. In Asia, where sorting is done by hand, though in precarious conditions, it is just

as fast as it is in Germany; however, the profitability threshold is insufficient owing to the costs generated by the techniques used.

Hyperspectral imaging

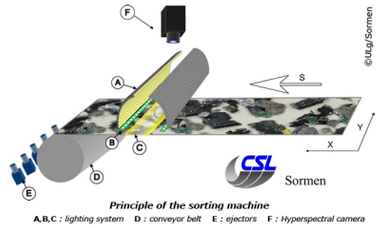
The first stage in the process is to crush the objects we want to sort. Nothing very technical up until this point. In the more rigorous second stage, this waste is scrutinised by the camera to spot "what is what". The camera used for this purpose is a hyperspectral camera. This is a traditional black and white or colour camera with a prism and/or a network added after the lens, allowing the light to be separated into its various components.



Therefore, while an ordinary colour camera "sees" three colours (red, green and blue), a hyperspectral camera can distinguish up to 512 colours, and even more beyond that which is visible, from ultraviolet to infrared. Each colour is then associated with its wavelength, which allows a curve to be drawn composed of the various wavelengths of the light reflected by the material. A precise curve therefore corresponds to a certain material, which constitutes its "ID card".

Liège's contribution

Optics is one of CSL's strengths and although the centre in Liège masters hyperspectral imaging, CSL's contribution to the programme concerns the lighting of elements to be sorted and the automation of the system. While the latter only requires traditional industrial techniques, it is another matter for lighting. In order to optimise the perception of the material filmed, CSL was given the responsibility of developing the purest and most uniform beam of light possible. Because variations in light intensity are expressed by variations in colour (we all know about this phenomenon with halogens, for instance), the luminous flux must be as constant as possible. Of course, the luminous flux must also be even along the entire conveyor system. The flux tested by CSL is 10 millimetres wide and 650 millimetres long. It is obtained thanks to the reflection of a light in a double concave space.



Principle of the sorting machine

A, B, C : *lighting system* **D** : *conveyor belt* **E** : *ejectors* **F** : *Hyperspectral camera*

When the materials have been picked up by the camera, the final operation is the actual sorting. The system notes the spatial coordinates of the elements and activates small pneumatic ejectors, which tips them into the appropriate containers.

Benefits

There are a great many benefits to this technique. There is a very clear gain in speed associated with the digital means used. The sorting speed is one item every 5 milliseconds, which is ten times faster than a traditional camera, with 500 times more data. This is the second benefit. Hyperspectral imaging coupled with the lighting system does indeed allow a clear increase in sorting quality.

Profitability is the third benefit. As the price of materials depends largely on purity (the p obtained are currently sold at a lower pri the pure product), this project will allow the products to be sold at a higher price, thus inc the added value of the recycling process.

ULg's partners in this programme are the company Robotiker, who is in charge of company Specim (Finland), who is design hyperspectral camera, Hevac, IGE and Indu all industrials active in the domain of re and Aclima, who is responsible for obtaini distributing the results.