Future advancements of hyperspectral imaging

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Preserving forensic traces at a crime scene is a crucial part of collecting evidence – It is important that these traces are detected and identified in a way that is as non-destructive as possible.

One technology that has great potential to serve as a future analytical tool in forensics is Hyperspectral Imaging (HSI). Due to its non-contact method of analysis, the speed at which it can gather and process information, and the ease with which the results can be interpreted, HSI proves itself to be an excellent alternative to many forensic techniques used today.

Hyperspectral Imaging combines conventional digital imaging and spectroscopy to gather and process information from across the electromagnetic spectrum.
Every object in the world will reflect and absorb various wavelengths of radiation differently. These interactions can be measured and used to identify different chemical and material properties. This can be thought of as every object having their own unique spectral fingerprint. HSI is particularly useful as it could also be used to analyse chemical changes that have occurred within the sample, which can help with estimating age.
Currently, HSI is mainly used for analysing fingerprints. Producing a multispectral image allows one to see details that would otherwise be invisible, even after dusting for prints. This creates a more detailed image than standard photography could produce and reveals elements which would otherwise have gone unnoticed. As HSI can identify the chemical composition of a sample, it could also be used to rapidly identify the residue

that created the print.

It is also used in questioned document analysis to identify whether handwritten or printed documents have been altered by analysing the ink used. In Fire Investigation, HSI can detect flammable liquid residues in quantities as small as a microliter that have soaked into surfaces.

While HSI technology has existed for around 20 years and is used in forensics today, it is becoming increasingly more relevant due to the rapid decrease in size of hyperspectral sensors, the decrease in the cost, and the increase in image processing power.

In the future, it is possible that all the power of hyperspectral imaging will be integrated in regular digital cameras or even smartphones. This would open up a world of new possibilities within forensic science. Crime scene investigators could go into a crime scene and gather information about the size, age, density, and chemical composition of a sample as easily as they could take a photograph of it. This would mean that the chance of a sample being destroyed or contaminated would be drastically reduced as CSI would not even have to come into contact or move the traces to get an accurate analysis of what those traces are. If there are particular crime scenes where events have occurred that pose dangers to investigators, (eg. Crime scenes involving explosives), a remote controlled robot could be equipped with a HSI system so that investigators can take the samples they require in a non-destructive matter without stepping foot in the crime scene. By using HSI instead of traditional methods, the process of identifying and analysing forensic traces would be drastically sped up. In addition, HSI requires little to no sample preparation, further increasing the speed at which progress can

be made and thus improving the chances of the case being solved successfully.

Another advantage of Hyperspectral Imaging is that the results are easy to interpret even if you don’t come from a scientific background. Consequently, when the results are presented to a jury in court, they will quickly be able to understand the data and make an informed decision.

If need be, additional processing steps can be taken when analysing the HSI data without having to re-examine the physical evidence.

The main problem for Hyperspectral Imaging in forensics is that crime scenes tend to be very complex which can make image analysis difficult. Sunlight, external light sources, reflections from surfaces and shadows are all variables that can cause inaccuracies in readings. To combat this, specialized algorithms are required during the processing of information in order to distinguish which variables have been caused by non-uniform illumination.

With image processing technology as a whole becoming more advanced, and several forensic science applications of HSI recently being explored successfully, it is easy to imagine HSI replacing some old techniques and becoming an integral part of crime scene investigation in the not too distant future. Despite the challenges that will be faced with interference and unknown variables, it is likely that the technology will be refined and the techniques will be modified so to maximize the effectiveness of the technology, and allow future investigators to analyse useful traces non-destructively.

Hyperspectral imaging has many uses in forensics but it also has a vast number of uses in a wide variety of fields: in agriculture, where HSI can be used to detect animal proteins in cattle feed to avoid mad cow disease; in medicine, for early diagnosis of diseases; in mineralogy, to rapidly identify minerals in geological samples; and in astrology, to identify materials and chemicals present on distant planets. There are many examples of HSI being used in professional environments however it is also a possibility that it will end up becoming integrated with the technology used by the general public on a daily basis.

Roughly two billion people on earth use smartphones, most of which come equipped with built in digital cameras. In the future, it is possible that these cameras will be built with components that can be used to detect other electromagnetic waves than just visual light. Using cloud computing, a library of different spectral signatures could be created and made available to the public and used for reference. Access to such a technology could prove to be particularly useful when it comes to monitoring one’s own health. People would be able to use their phones to scan fruit and find out whether or not it is fresh depending on its sugar content and moisture levels; people could also use it to check if perishable foods are still safe to eat or to check whether or not their milk has gone off.

Many smartphones nowadays can measure how many steps you walk a day and your heart rate, but a phone equipped with hyperspectral imaging technology would be able to detect biochemical changes due to disease development like cancer cell metabolism. A non-intrusive retina scan could be performed in the comfort of your own phone merely by taking a photo of

your eye, or a suspicious looking mole could be checked out and diagnosed all within an application.

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