NL Agency
Ministry of Economic Affairs

Project number: IPD120174
Project name: Spectr@phone
Goal: to develop and test a handheld, multispectral imaging device for (forensic) medical applications

Spectral imaging in (forensic) medicine

Combining both optical spectroscopy and digital imaging, spectral imaging holds great promise for forensic medicine and other medical applications. The main drawbacks of the current technology include the high price of commercially available systems, the size and weight of the camera, the long data-acquisition times and the complex data-processing software. All these drawbacks will be solved in the Spectr@phone, a handheld, multispectral imaging device that will soon be tested in the Academic Medical Centre (AMC) in Amsterdam.

"Optical spectroscopy is a commonly used method of chemical analysis based on the absorption of light," says Dr Maurice Aalders, a researcher in the Biomedical Photonics group at the AMC. "It enables you to determine the type of structures or pigments in a sample by illuminating it and then measuring the returning colours and their intensity." In medicine, optical spectroscopy is routinely used to measure the composition of blood or, more experimentally, to distinguish cancer tissue from healthy tissue. The resulting absorption spectrum is only relevant for the tiny spot where the light hits the sample, however. "In the fields of application we are interested in – forensic medicine and dermatology – we want to acquire the absorption spectrum for a far larger surface area. We also want to be able to capture it digitally. So-called spectral imaging systems enable us to take such optical biopsies." This is done with a digital camera that takes multiple pictures of an object or sample using a variety of filters, one for each colour (wavelength) ranging from deep blue to near infrared. These pictures are subsequently combined into a multispectral image.

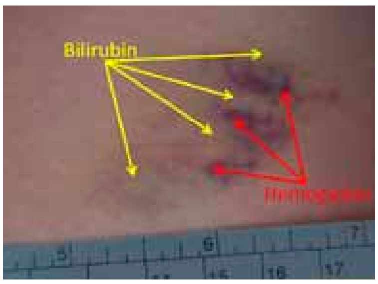
"Spectral imaging systems enable us to take optical biopsies"

Bruises

Two clinical areas in particular stand to benefit greatly from the application of spectral imaging. The first involves the determination of the age of bruises in forensic medicine. "When a paediatrician suspects child abuse, it is very difficult to prove it. Knowing precisely how old the bruises are would be helpful, because that could prove whether multiple bruises were inflicted at the same time and even help identify who had been the caretaker at the time," explains Aalders. Some paediatricians use a colour chart to determine the age of a bruise, but as this method is not very accurate, it is no longer used at the AMC. In an earlier project, AMC researchers discovered that it was possible to determine the age of a bruise to within several hours, based on the area and concentration distribution of the bilirubin and haemoglobin it contains. "Spectral imaging of the bruise enables us to determine these parameters accurately, even in the case of dark skin tissue, where bruises are normally almost invisible." The second clinical area that would benefit from spectral imaging involves the identification of suspicious pigmented skin lesions. "It is important to be able to distinguish a mole from a melanoma as early as possible. Even for experienced dermatologists, that is a difficult task. Spectral images of a skin lesion can give us extra information about the tissue of the lesion and its immediate surroundings, such as blood and melanin content and oxygenation. This would be highly beneficial for diagnostics."

Handheld

Although spectral imaging is a very promising technique, the current systems are unsuited for use in a clinical environment. For one, the acousto-optical or liquid-crystal tunable spectral filters used to scan the required wavelength range are very expensive. Another problem is the camera itself, which is rather large. Also, because of the number of pictures that need to be taken, the images need to be corrected afterwards to compensate for patient movements. Aalders: "In this IOP project, we want to overcome these problems by developing a handheld device using smartphone camera techniques. The Spectr@phone will be cheap to produce and quick and easy to use." The key element of this compact device will be the camera, which will consist of two elements. The first of those is a very small, potentially cheap, tunable Fabry-Pérot filter that was recently engineered by the VTT Technical Research Centre of Finland. This filter transmits not only the principal wavelength, but also the higher-order wavelengths. VTT has invented a method to combine several transmission bands with an image sensor with pixels that are sensitive to different colours. "By combining this filter with a mosaic filter and four lenses, we can obtain four spectral images in one shot. If we then tune the Fabry-Pérot filter to another wavelength, we can get another four images. This significantly reduces the image acquisition time." The completely new lens



The haemoglobin and bilirubin areas of a bruise (Photo: Drs B. Stam, AMC)

The mosaic filter/lens system that will be combined with the Fabry-Pérot Interferometer

Anteryon's WaferOptics® technology (Photo: Anteryon)

Miniature Fabry-Pérot Interferometer device made with MEMS technology (VTT). The principal transmission wavelength is tuned by changing the amount of space between the mirrors (Photo VTT)

module will be made using the WaferOptics® technology of project partner Anteryon, an industrial supplier of miniature cameras for smartphones.

Design

Several partners are working together in the project consortium, representing the total development, engineering and production chain of the Spectr@phone. Avantes, 4PICO, Anteryon and the Delft University of Technology will design, build and test the prototypes of the tuneble Fabry-Pérot filter and mosaic filter lenses. Forensic Technical Solutions, a spin-off of the AMC, will add its expertise on spectral data processing for the two medical applications described above. The design of the prototypes for use with each application will be performed by students of industrial design at the Saxion University of Applied Sciences. The Antoni van Leeuwenhoek Hospital in Amsterdam is involved as an affiliated partner and will facilitate patient measurements in its Dermatology Department. At the AMC, the device will be tested on patients with bruises resulting from trauma, for example. "Besides these two medical applications, there are many others that could benefit from spectral imaging," says Aalders. Examples include the analysis of blood spatters at crime scenes and the monitoring of fruit or food freshness at supermarkets.

Participants:

- Academic Medical Centre (AMC), Amsterdam
- Antoni van Leeuwenhoek Hospital*
- Avantes
- Anteryon
- 4Pico
- Delft University of Technology
- Forensic Technical Solutions
- Saxion University of Applied Sciences
- VTT Technical Research Centre of Finland*

* Antoni van Leeuwenhoek Hospital and VTT Technical Research Centre of Finland are Affiliated Partners of the project

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