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High-wavenumber compressive Raman spectroscopy: a faster tool for melanoma diagnosis.

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Raman spectroscopy (RS) is a highly-sensitive optical technique based on specific vibrations of molecules, which enables non-invasive and non-destructive monitoring of biospecimens present in tissues, revealing disease-prompted variations and allowing to differentiate healthy from malignant samples with high accuracy, sensitivity and specificity. Nevertheless, pigmented tissues are inaccessible to conventional RS, because of laser-induced tissue fluorescence, unless infrared excitation is used. With these excitation wavelengths, Raman spectroscopy required very expensive pixelated detectors to achieve the necessary signal-to-noise ratio. These detectors are usually associated with liquid hydrogen cooling systems that make the equipment bulky, expensive and difficult to operate.

In order to solve these issues, this work details the design of a new Raman spectrometer, applying compressive sensing, based on spectral multiplexing by spatial light modulators (as a digital micromirror device) and on single-element detection. When applied to RS, these two components allow the acquisition of the same spectral information as in multichannel detectors but at a much higher acquisition speed, which is crucial for time constrained applications (as in clinical scenarios), lowering the cost of the equipment, and allowing for a small instrument since liquid cooling is no longer required. This offers new possibilities for the development of a much-simplified RS instrument that would promote a routine implementation of this technique in many different areas, including melanoma diagnosis.

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