DOI: 10.3969/j.issn.1003-501X.2017.05.002

A portable optical sensing system for rapid detection of fluorescence spectra

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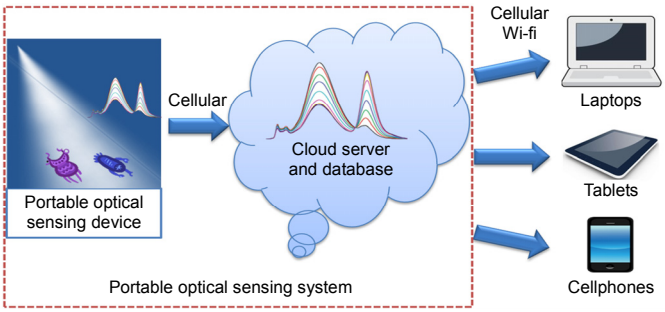

Real-time optical sensing system implementation.

Abstract: Fluorescence has a wide variety of applications, including gemology, mineralogy, medicine, chemical sensing, printing dye, and biological labellings. Detection methods based on spectral analysis techniques are an interesting alternative for performing sensitive, selective and reliable measurements. The application of fluorescence in spectral analysis techniques is fluorescence spectrometry which has been successfully utilized as a basic measurement method to obtain the characterization of chemical constituents for food classification, water pollution, bacterial pathogens detection and plant species characterization with minimal sample preparation and relatively low-cost instrumentation. Much effort has been done to improve the performance of the fluorescence spectral analysis devices to increase the precision and speed. Although various methods have been explored to improve the instruments' design and manufacture, the portability remains a huge challenge.

This paper provides the details regarding the fundamental of a portable optical sensing system to fast detect the fluorescence spectra of the samples. A compact configuration is achieved by integrating a small spectrometer as an optical sensor, a microcontroller for issuing commands, a USB Host Shield for internal communication, a network module for external communication, and a web server for storing database and distributing results. The system can offer real-time detection capability, and the test results can be revealed in a short time and downloaded by users to their laptops, tablets or cellphones anytime and anywhere.

The main components of the system include a spectrometer (Ocean Optics), a Microcontroller Board (Arduino), a USB Host Shield (Arduino), a 3G+GPS Shield (3E Gadgets) and a Webserver (Amazon). In working condition, the Arduino microcontroller first initializes the USB650 Spectrometer, through the Arduino USB Host shield. Then it sends commands to the spectrometer to acquire spectra of the sample taken. Through the GPS system, the microcontroller acquires the location of the sample and capture an image of the collected sample using Hayes command sets (AT command). Next, together with the spectra data, the microcontroller sends this information up to the web server through the 3G network using 3G + GPS shield for Arduino. In the final step, the web server categories them and processes the spectra data by linking it to the database. The analyzed results are returned to the web server for users to view from any mobile devices that have web browsers, by logging into the web server.

In the experiment, three water samples were analyzed, firstly tea water, secondly sea water from West Coast Park of Singapore, and thirdly laboratory tap water. It is concluded that the tea water emits the strongest fluorescence, followed by sea water, while laboratory tap water has no fluorescence emitted. The fluorescence spectra of three water samples have been detected using our system within a short time, thus validating the system's effectiveness.

Keywords: optical sensing; real-time detection; fluorescence spectra

Citation: Li Xiaoguang, Yu Haoyu, Yew Yuenkeong, *et al.* A portable optical sensing system for rapid detection of fluorescence spectra [J]. *Opto-Electronic Engineering*, 2017, **44**(5): 483-487.

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