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Extended Abstract

A software tool for plasmonic biosensors

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Abstract: There has been a constant increase in innovative plasmonic biosensors for the specific and fast measurement of several substances of interest in the last few years. Therefore, the necessity of a software tool to analyze the acquired data exploiting this sensing approach has pushed to develop software simple to use. In this work, this kind of software is presented and could be applied in several plasmonic sensor configurations, where the measurements can be carried out in spectral mode. In fact, combining the proposed software with small-size plasmonic sensor systems will make it able to be used in several applications fields.

Keywords: Sensor systems; software; tools; surface plasmon resonance.

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1. Introduction

In many application fields, chemical and biological sensors require smart and simple to use devices to monitor them, such as a laptop with specific software installed. Numerous biochemical sensors are based on plasmonic platforms with high sensitivity. In particular, the sensors based on a surface plasmon resonance (SPR) phenomenon represent a very sensitive method for detecting specific substances, exploiting several kinds of receptors combined with them.

For instance, a simple SPR sensor in POFs has been already described in an extended way in [1]. During tests in the laboratory, interesting results have been presented exploiting this low-cost SPR-POF sensor in the field of medical diagnostic, for instance, with cancer biomarker detection [2], for celiac disease antigen monitoring [3], or iron detection [4]. More generally, biosensors configurations based on simple probes can reduce the biosensor device's cost and dimensions [5]. In this work, we present a universal tool that can be used for several plasmonic sensor configurations, realized in optical waveguides and based on a spectral interrogation.

2. Experimental Setup

Figure 1 shows the experimental setup connected to PC in a laboratory scenario for monitoring an SPR-POF sensor [1]. It includes a halogen lamp (model HL-2000-LL, weight: 500g, manufactured by Ocean Optics, Dunedin, FL, USA), an SPR-POF sensor, and a spectrometer (model AvaSpec-Mini2048CL-Mos2, weight: 200g, manufactured by Avantes, Apeldoorn, The Netherlands). The power consumption of the whole sensor system is about 25W. These aspects of the sensor system are interesting for several application fields.

The typical configuration of these kinds of sensors is arranged to measure the transmitted light spectrum. In particular, first, the light is radiated exploiting a halogen lamp, illuminating the SPR-POF sensor, and then it is collected by a spectrometer connected to a Laptop, as shown in Figure 1.

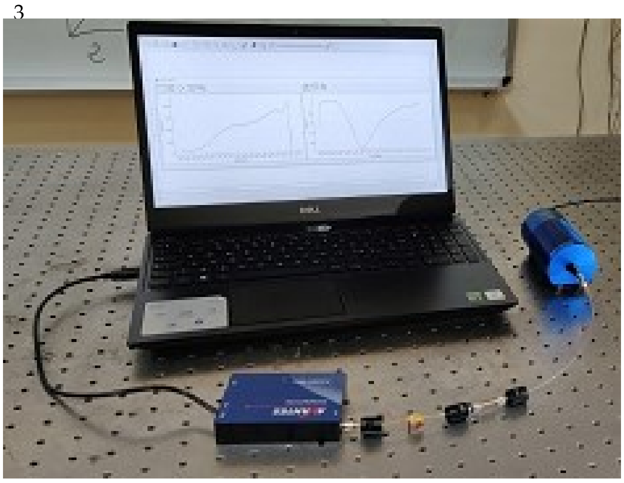

Figure 1. Picture of the experimental Setup.

3. Developed Software

The proposed measurement system is managed by a developed software titled "Spectra Analysis by Universal Tool" (SAUT), here reported. This software has been realized with the logic of the GUI "Graphical User Interface" and library modules. The application has been developed through the "QT Creator" development environment with the language C++. This allows the application to be installed on various Operative System so making possible to work on several kinds of processors. In fact, the main goal is to bring this solution also on mobile devices to allow it in various areas. The developed tool can configure the instrumentation, the network (in remote connection), the database and the folder to save the experimental results. The sensor's response can be acquired in several modes exploiting the developed tool. It is possible to distinguish two principal operating modes, called "Static Mode" and "Real-Time Mode", with a dedicated user interface. More in detail, the "Static Mode" (see Figure 2) foresees that the transmitted spectra can be acquired through the GUI whenever the user desires. The result will be a normalized spectrum on a reference spectrum (i.e., the spectrum acquired with air as surrounding medium [1]) previously acquired.

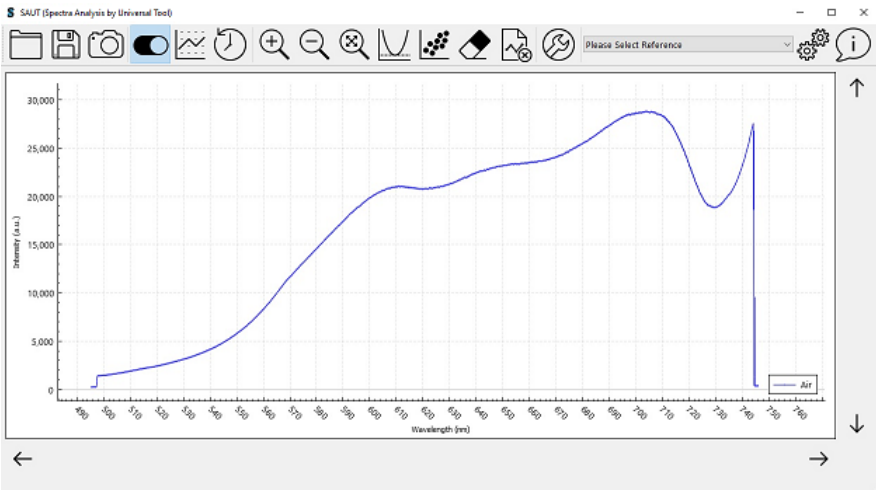

Figure 2. "Static Mode" user interface.

When choosing the "Real-Time Mode" (see Figure 3), the panel is split into two different parts. On the left, there is the spectrum acquired continuously; at the same time, on the right, fixing a reference spectrum is also possible to show the normalized spectrum in real-time.

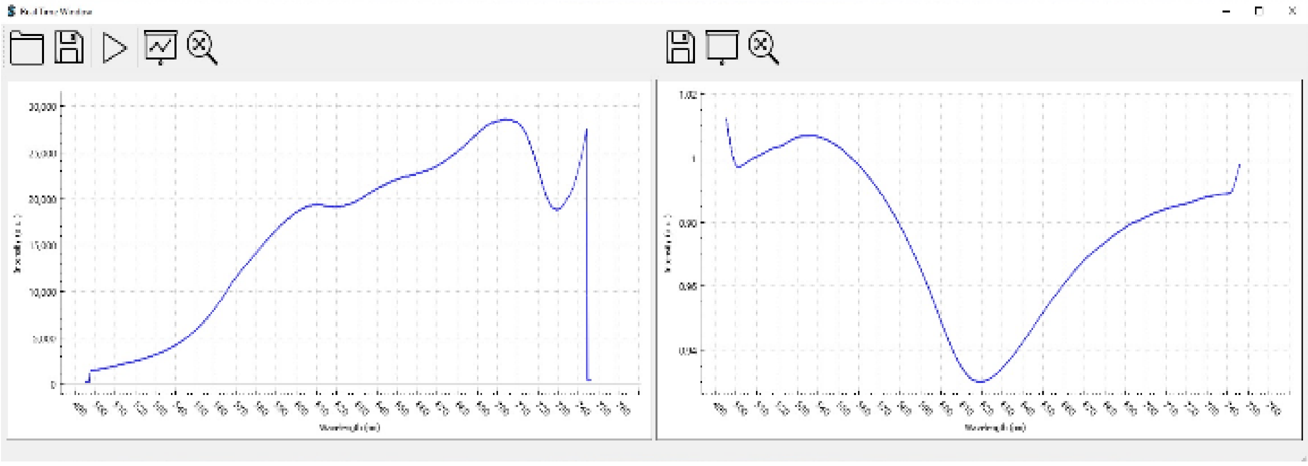

Figure 3. "Real-Time Mode" user interface.

3. Experimental Results

To test the developed software tool, we have used an SPR sensor based on D-shaped POFs [1], also reported in the experimental setup shown in Figure 1. For instance, Figure 4 shows the normalized SPR spectra obtained by the SAUT tool in "Static mode" using six different water-glycerin solutions, having a refractive index ranging from 1.332 to 1.382. These spectra are automatically normalized on a reference spectrum and plotted with a different colour, as shown in Figure 4.

Figure 4. A working example of SAUT "Static Mode".

4. Conclusion

We have presented a universal software tool that monitors several types of SPR sensors based on optical waveguides. This tool could be used in several application fields where a user-friendly interface is required, e.g. in point-of-care applications, environment monitoring [6-12], Internet of things (IoT) applications [13], security, and industrial applications.

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