Continuous and noninvasive characterization of liquid sample based on continuous-wave photoacoustic technique: accuracy improvements with linear fitting.

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Over the last few years, we proposed two complementary protocols based on continuous wave photoacoustic (CW-PA) technique and dedicated to the noninvasive and continuous monitoring of blood glucose levels (BGLs): the frequency shift (FS) and the optical power balance shift (OPBS) [1]. From the continuous monitoring of temperature [2], we could estimate the accuracy of both protocols and realized that major improvements were needed regarding the OPBS protocol. Compared to FS, OPBS technique is very important towards the selective measurement of glucose among several confounding parameters, an important issue when dealing with in vivo measurements. Here, we then focused on accuracy improvement of OPBS protocol and validated our approach with long-term temperature measurements.

When sweeping the driving voltage (DV) of one light source, raw results exhibit a V-shape response and the OPBS technique relies on monitoring the DV that corresponds to this minimum value or tip of the V-shape (OPBS protocol precise description can be found elsewhere [1]). So far, we used the minimum value as a result, but found strong limitation coming from voltage accuracy of the frequency generator, our DV source. To overcome this limitation, we then proposed to use linear fitting procedure on both arms of the V-shape, and use the intersection of the two curves as result. In order to further optimize the process, we tested several numbers of points for the linear regression on both arms: 10, 20, and 30 points. As one can expect, the resolution increases with number of points, with best results obtained with 30 points (Fig. 1). However, this method has also a major drawback: increasing the number of datapoints up to 30 consequently degrades the sensor response time, from about 2 to 8 minutes. This value exceeds the 5-min response time usually set by other “continuous” systems on the market in order not to miss any episode in the highs or lows. Alternative methods are then under investigation.

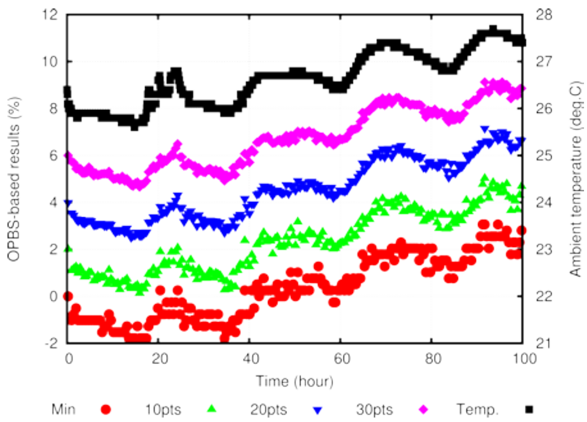

Fig. 1 Continuous monitoring of sample temperature based on several OPBS-based protocols (shifted), and comparison with results from temperature sensor.

[1] S. Camou *et al.*, chapter in "Pervasive and Mobile sensing and computing for healthcare", ISBN 978-3-642-32538-0

[2] S. Camou *et al.*, in proc. of the 75th Autumn JSAP meeting, 2015.