In-Situ and Real-Time optical Measurement System for Characterizing the Quality of Water Bodies

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ABSTRACT

For drinking water use and bathing water use, there is a high public interest in the detection of contaminations of water bodies. In the public's mind, water quality is primarily associated with the extent of bacterial and chemical contamination. For holistic water protection, these parameters should checked as regularly and promptly as possible in order to plan appropriate preventive and remedial measures for these forms of pollution. The aim was to check the quality and condition of the water resource with an online monitoring system. The system is used stationary near the water body or is part of a buoy on it.

The innovative character lies in the in-situ real-time measurement of these parameters such as chemical oxygen demand (COD), biochemical oxygen demand (BOD5), dissolved organic matter (DOM), Temperature, Nitrate, Nitrite, biological-index (BIX), fluorescence-index (FIX), spectral absorption coefficients at the wavelengths 254nm (SAC254), Phosphor, Ammonia, and as a microbiological parameter, the fecal load based on the cultivable e-coli germs present.
In the first step, a sensor probe was realized which measures the parameters COD, BOD5, SAC254, DOM, BIX, FIX and the temperature.

A peristaltic pump takes the water sample and transfers it to an optical measuring chamber. Inside the measuring chamber, there is a flow-through cuvette (Starna, 46F/Q/10, volume of 4ml, UV grade fused silica). The chamber consists of four optical channels for measuring the parameters. Two channels are for fluorescence measurement and the other two for light absorption measurements at specific wavelength. The fluorescence-index (FIX) is determined by calculation of the ratio of the fluorescence emission intensities at 450nm and 500nm by an excitation wavelength of 370nm. The ratio of the fluorescence intensities at 380nm and 430nm by excitation at 310nm determines the biological-index (BIX). The two fluorescence indices characterize the origin of dissolved organic matter (DOM) [1]-[2]. The parameters COD, BOD5 and SAC254 are calculated by absorbance measurements at the wavelengths 254nm, 435nm and 550nm [3].
The light of all LED light sources is spectrally narrowband filtered. A photomultiplier measure the fluorescence and two photodiodes the light absorbance, illustrated in Figure 1. At the end of the measurement cycle, a second peristaltic pump rinses the measuring chamber with a rinsing solution to protect the system against contaminations.

Results

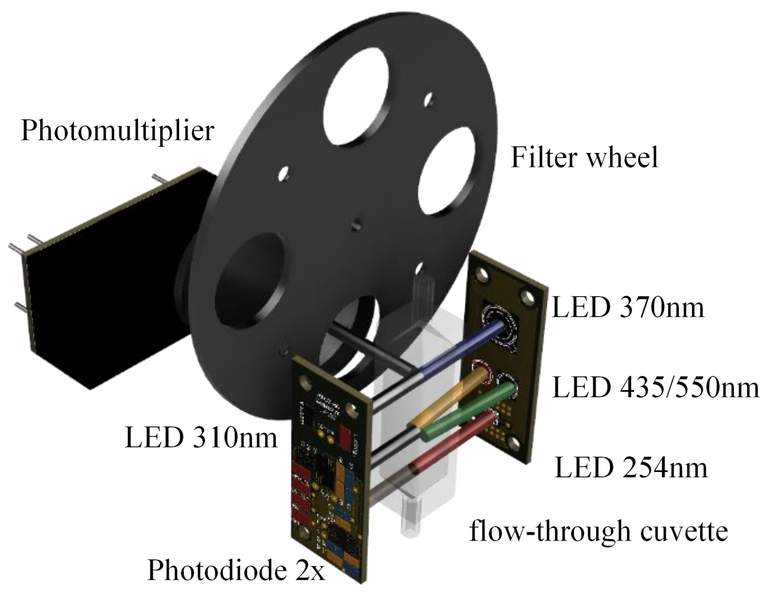

Figure 1: Illustration of the optical LED beam paths through the cuvette to the photomultiplier and the photodiodes.

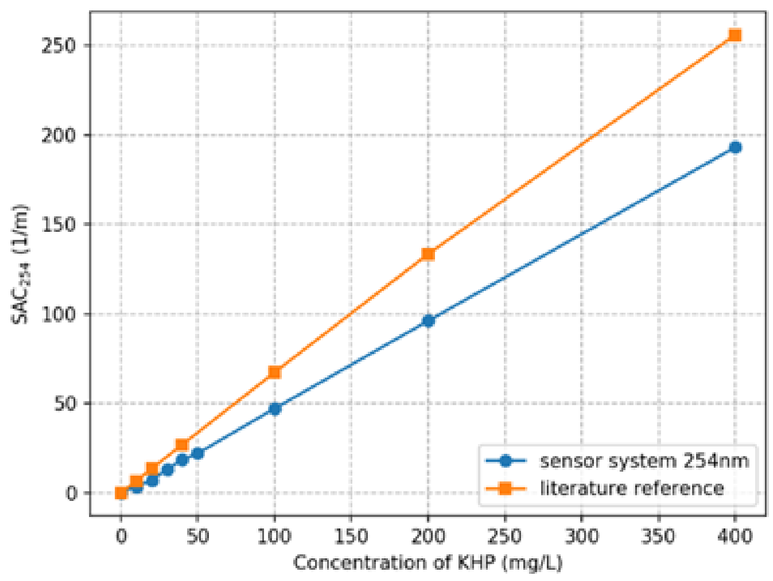

Figure 2: Comparative measurement of SAC data from developed sensor system with data from Literature.

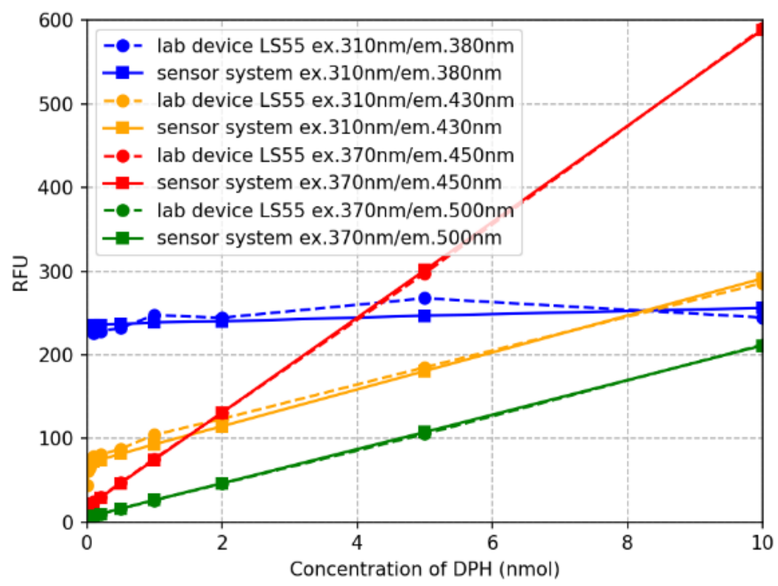

Figure 3: Measurements of different DPH (Diphenylhexatriene) concentrations with our system compared to the lab spectrometer LS55, RFU (relative fluorescence units)

Figure 2 shows a comparative measurement of KHP (potassium hydrogen phthalate, C8H5KO4) with literature reference DIN-standard 38404-3 [4] and our system. Figure 3 shows the measurements of different DPH (fluorescent hydrocarbon - Diphenylhexatriene, 1,6-Diphenyl-1,3,5-hexatriene) concentrations with our system compared to the fluorescence spectrometer LS55 (PerkinElmer, USA).
The evaluated system is a promising tool for online detection of water quality. Moreover, after further developments, we aim to integrate additional sensors for Nitrate, Nitrite, Phosphor and Ammonia as well as e-coli.

CONCLUSION

The goal is to realize a handy and unexpansive device for real time online monitoring of water bodies, which could be used as an early warning system for water contaminations.

ACKNOWLEDGMENTS

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References

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