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Envirobot monitoring of turbidity, conductivity and heavy metals (Pb^{2+}): Integration and testing.

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1. INTRODUCTION

The main objective of the Envirobot project is to develop an autonomous and remote-controlled tool for *on-site* environmental monitoring of different pollutants. With this aim we are attempting to develop and integrate several physicochemical sensors and biosensors for general and specific water quality determination. Herein we present the implementation of three different sensors, namely, turbidity and the bifunctional conductivity/electrochemical sensors. All sensors and required electronics for their control and communication have been almost completely integrated into individual modules of the envirobot system. The turbidity sensor has been tested on-board a remote control boat, while the bifunctional conductivity sensor has been employed for the determination of the water conductance of a sample taken from Leman lake. Moreover, non-treated samples from the same lake were employed as matrix of analysis for the quantification of Pb^{2+} by differential pulse stripping voltammetry (DPSV) showing the capabilities of the integrated electrochemical sensor for the detection of heavy metals in water in a parts-per-billion (ppb) concentration.

2. TURBIDITY SENSOR

Turbidity Sensor | **Electronics and Communication** | **Turbidity Measurements**

Figure 1. a) Optical image of the turbidity sensor that is controlled remotely by **b)** a circuit reader and a custom-built antenna on-board a remote control boat. **c)** Recorded signal as a function of different nephelometric turbidity unit (NTU) samples.

3. CONDUCTIVITY AND HEAVY METAL DETECTION

Bifunctional Sensor | **Electronics and Communication** | **Conductivity Measurements**

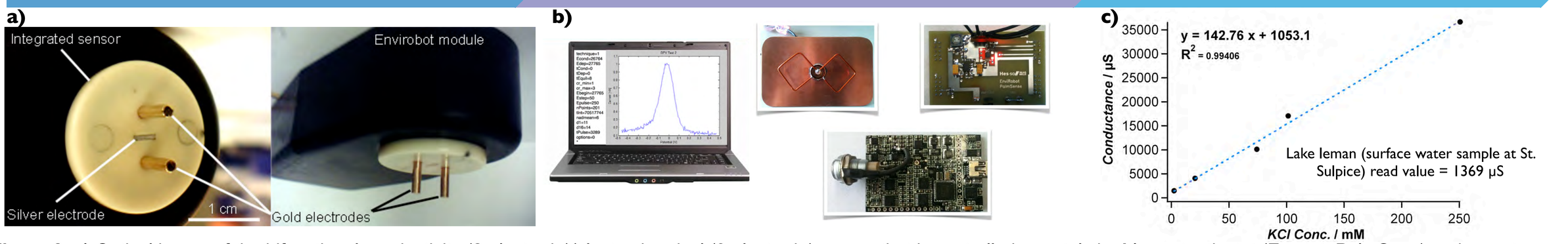

Figure 2. a) Optical image of the bifunctional conductivity (2-electrode)/electrochemical (3-electrode) sensor that is controlled remotely by **b)** a potentiostat (Emstat, PalmSens) and a custom-built antenna. **c)** Measured conductance of different KCl solutions.

Heavy Metal (Pb^{2+}) Detection by Differential Pulse Stripping Voltammetry (DPSV)

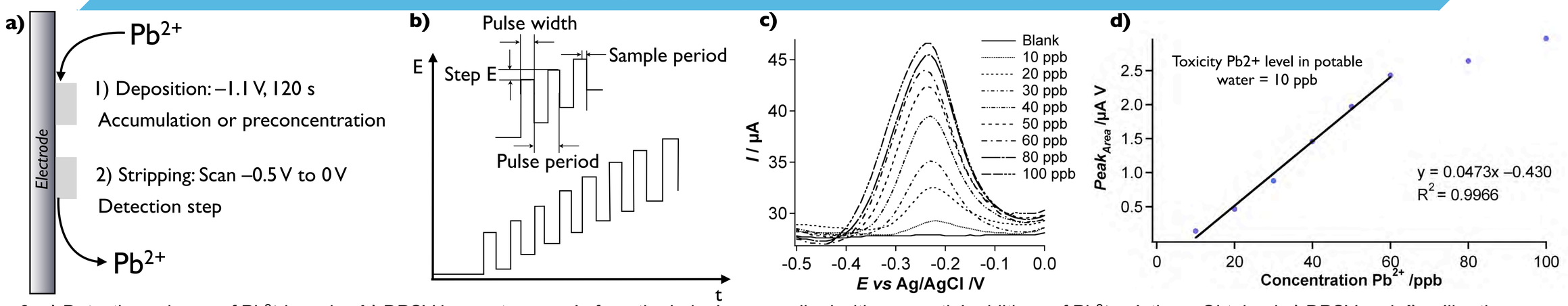

Figure 3. a) Detection scheme of Pb^{2+} by using **b)** DPSV in a water sample from the Lake Leman spiked with sequential additions of Pb^{2+} solutions. Obtained **c)** DPSV and **d)** calibration curves.

5. CONCLUSIONS AND PERSPECTIVES

The presented results demonstrate the integration of different sensors, *i.e.* turbidity and bifunctional conductivity/electrochemical, into the envirobot system. All electronics (*e.g.* printed circuit boards, antennas) required for the remote control and operation have been developed and partially also fitted into individual modules of the envirobot. Moreover, measurements of turbidity, conductivity and the presence of heavy metal such as Pb^{2+} in real water samples have been also achieved by the herein presented sensors. Therefore, different parameters that define the quality of water can be now determined by using the modified envirobot modules. The next step will be the fully testing and improvement of the sensor modules powering and communication within the envirobot system. Thus, on-site measurements with different sensors will be enabled and the recorded response will be used for training the envirobot to make signal-make decisions towards pollution focus.

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