ment over a wide water area. Multidimensional data representation of water quality measurement channels, using Kohonen self organizing maps (K-SOM) to express the WQ class, permits a quick identification of pollution events and offers a global representation of the water quality in the assessed areas.

References

[1] S. Haykin, "Neural Networks - A Comprehensive Foundation", Prentice Hall, Upper Saddle River, NJ, 1999.
[2] Jang J. S. R., ANFIS: adaptive-network-based-fuzzy-inference-system, IEEE Trans. Syst. Man Cybernet, SMC23, 665-85, 1993.
[3] J. C. Patra, A. Bos. A. C. Kot, "An ANN-based smart capacitive pressure sensor in dynamic environment", Sensors and Actuators, vol. 86, 2000, pp. 26-38.
[4] T.,Kohonen, Self Organizing Maps, 2nd Ed. Springer Verlag, 1997.

CONDUCTIVITY CELLS FOR WATER SALINITY MEASUREMENT

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1. Introduction

The water electrical conductivity correlates with the content of solved salts. In the sea water the conductivity is essentially due to the ions of sodium chloride. In river estuaries the water conductivity also depends on the presence of other solved elements, namely those originated by undesirable pollutants.

In this article we present our work on the development of water conductivity cells to be displayed continuously under the environmental conditions, which impose constraints on robustness.

The electrical conductivity of liquids can be measured using cells with nude metallic electrodes. However these cells are not useful to work under environmental underwater conditions. The need for permanent operation of the measurement apparatus poses a maintenance problem related to the continuous growing of biological organisms and to the continuous deposition of other inorganic materials which foul the equipment and degrade the acquired data.

In our system, inductive conductivity cells will be used [1]. Figure 1 shows the structure of these cells. Their relevant characteristic consists on the complete electrical insulation of the active metallic conductors. To help the protection against environmental conditions, the cell is enclosed in a plastic container, provided with some holes to allow the access to the water stream.

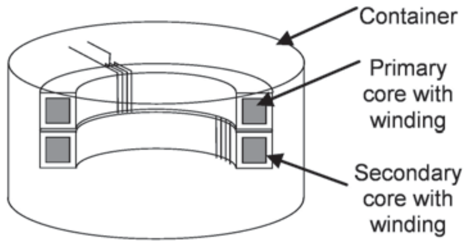

Figure 1. Cell structure: two cores with windings inside a plastic container.

2. Electrical Measurements

The inductive cell may be considered as a double transformer. A sinusoidal voltage is applied to the primary winding of the first transformer. The secondary winding of the first transformer is the water circuit which, as represented in Fig.2, is considered as a single turn. The second transformer is a symmetric replication of the first

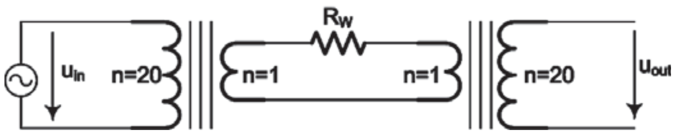

Figure 2. Schematic circuit: RW represents the resistance of the water circuit.

When a sinusoidal voltage is applied to the primary of the first transformer, an output voltage can be measured on the secondary of the second transformer. In our implementation, the output voltage is measured, separating the components in phase and in quadrature with the input. This is done by using integrated multipliers, as is shown in the measuring circuit represented in Fig.3. Being the water conductivity dependent on the temperature it is necessary to measure it as well. The three slow varying signals are fed into an integrated low-price processor which controls also the communication with a transceiver module.

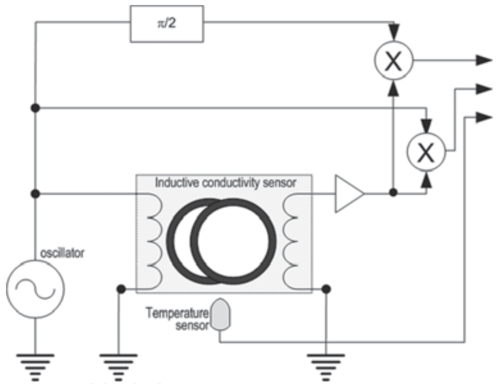

Figure 3. Circuit block diagram

3. Results and Discussion

The cell was first tested in dry conditions. This is possible if the water circuit is replaced by an external variable resistor. In the next test the cell was immersed in a bath with controlled temperature [2] as shown in Fig.4. The operating conditions were varied in order to optimize the overall behaviour. The operating frequency f=50 Hz was chosen because it was found that the relation between applied and output signal amplitudes is good for the lower values of RW, and the second order effects, resulting from the high water dielectric permittivity or from the limited penetration depth of the varying field in salty water were negligible.

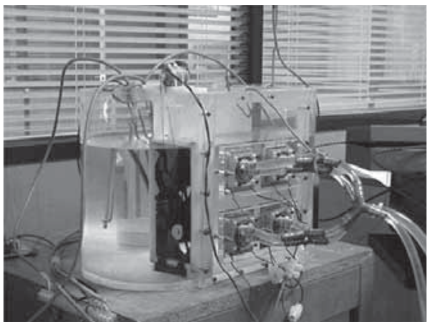

Figure 4. Water bath for test measurements.

Some preliminary finite element modelling and the subsequent experimental tests allowed the determination of the cell constant kC=110 m^{-1}, which is the relation between the resistance R_W and the water conductivity σ_W:

$$R_W = \frac{k_C}{\sigma_W} \tag{1}$$

With the previous result it was possible to correlate the data from the dry experiments with those measured in the salty water bath where the conductivity was measured with a commercial instrument. The output voltages as a function of water resistance are displayed on Fig.5. From this graph it is clear that the cell sensitivity is rather low for low water conductivities. The measuring range was set in the interval $22<RW<440\Omega$ which corresponds to the conductivity range in the interval $0{,}25<\sigma w<5S/m$. This measuring range is appropriate to asses the water conductivity inside the estuary of the Tagus river near Lisbon. Fig. 6 shows the relation between our data and those obtained with the reference instrument.

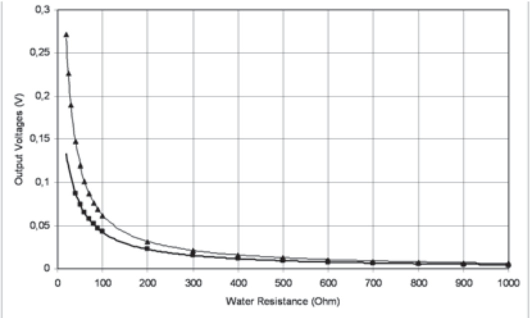

Figure 5. Output voltages as a function of water resistance R_W

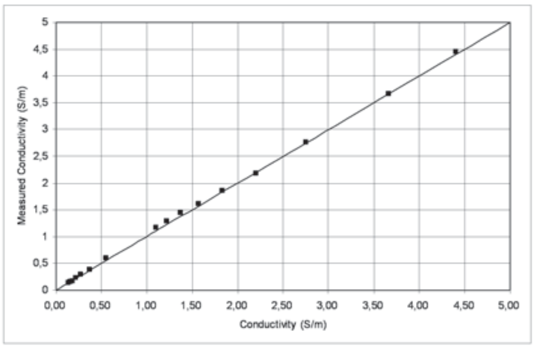

Figure 6. Water conductivity: Calibration experimental results.

4. Conclusions

An inductive conductivity cell to measure the electrical conductivity of the salty water was modeled, constructed and characterized in our laboratory. A number of these sensors will be placed in the river Tagus estuary near Lisbon. The array of sensors will work autonomously. Each sensor will be provided with a microprocessor to automate the measuring process and to control the transmission of data to a central point where the collected information will be processed.

5. References

[1] K. Striggow, R. Dankert, "The exact theory of inductive conductivity sensors for oceanographic applications", IEEE Journal of Oceanic Engineering, Vol. 10, N. 2, pp. 175-179, April 1985.

[2] H. Ramos, F. Assunção, A. L. Ribeiro, P. Ramos, "A Low-Cost Temperature Controlled System to Test and Characterize Sensors", Proceedings of the 10th IEEE Africon Conference, Vol. 01, pp. 57-60, Gaborone, Botswana, Sept. 2004.

ENVIRONMENTAL ASSESSMENT OFDOLPHIN' SADO ESTUARY BASED ON MULTI-PARAMETRIC PROBE, HYDROPHONE ARRAY AND GLOBAL POSITIONING SYSTEM

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Abstract – The work presents a distributed measurement system for olphin live environment conditions, expressed in the water quality parameters and underwater acoustic noise. The design and implementation of an embedded turbidity sensor as well as the software of distributed measurement system for underwater acoustic source localization based on passive sonar techniques and GPS are included in the paper.

1. Introduction

The Bottlenose Dolphin, Tursiops truncates, community is unique in Portugal, and one of the few in Europe living permanently in an estuary or bay. In the 80's, the population of dolphins counted with more them forty individuals, but since then they've seen their numbers reduced, currently forming a family of twenty seven members. In this particular case of the Sado estuary dolphin population, industrial sound pollution and effluents in the inner region of the estuary have a negative impact over the community ability to orient and feed. In addition, intense harbour activity and high ship traffic affects dolphin's distribution and behaviour.

Therefore, the work reported here has implemented a collection of technologies in order to allow the study of this species in their natural environment, the levels of acoustic and water pollution, as well as pin-point the position of the dolphins sighted, mapping their activity within the estuary. The distributed measurement system can be framed under two entwined sections: a multi-parametric probe for water quality parameters measurements and underwater acoustic signal measurement component based on an array of three hydrophones. The system software performs multi-parametric probe remote control, underwater acoustic signal acquisition and includes an algorithm for sound source localization on a global position basis. The probe comprises several sensors to determine water quality parameters, such as temperature, level of pH, conductivity and turbidity. The array of hydrophones allows determining the source of sounds through a triangulation algorithm, as well as the quantification of acoustic pollution coming from nautical vessels and the surrounding industries in the Sado estuary region. Using a global positioning system (GPS), which provides the coordinates of the measurement location, and sound source relative position based on passive sonar technology the global position of the sound source can be determined.