Development of Electronic System to Examine the Quality of Drinking Water

M.Venkata Sudhakar , K.Lakshmi

Abstract*: This paper presents design of electronic tongue to monitor the quality of drinking water by differentiating the water under test from the reference water to be used for consumption. The system will use sensing electrodes, data acquisition system and data processing math to detect the quality of water under test. This system has to be automated to measure the quality in real time. The result can be an identified of the sample, estimation of its concentration or its characteristic properties.

***Index Terms*: electronic tongue; sensing electrodes; automated system.**

I. INTRODUCTION

Human body is equipped with the best possible sensors to perform its normal operations, these five biometric sensors are to taste, hear, smell, see and feel. These are much advanced and the complete working principle is still not understood. Some of these functionalities if made automated can be applied in most of the engineering and house hold applications.

There are some areas where the biometric sensors are not capable of differentiating the quality of measured. For example quality of drinking water on the guidelines of medical standards, which describes upper and lower limit for the content of calcium and magnesium for safe consumptions. If the presence of these metal contents in water can be detected with some process and indicating whether they are in safe limits for consumption.

Marta Podraz˙ka et al [1] reviewed various electronics tongues and their utility along with limitations. Jon shlens et al.[2] presented the derivation and single value decomposition of Principle Component Analysis (PCA). And also discussed clearly mathematical relations which are useful for deriving the PCA. Linday I Smith et al.[3] presented mathematical background which are used in PCA with one good example. It covers standard deviation, covariance, eigen values and eigen vectors.

A survay conducted by WHO gives water quality effects on human health. Trace elements in water, and consequences of deficiency of different minerals in water on human environment. And water contamination by different environmental sources. Specified specifications of minerals on certain conditions for drinking water for good health.

This project is an attempt to monitor the quality of drinking water by differentiating the water under test from the reference water used for consumption. The system uses sensing Electrodes, data acquisition system and data processing math to detect the quality of water under test. This system has been automated to measure the quality in real time. The result can be an identification of the sample, estimation of its concentration or its characteristic properties. This method has many advantages, problems associated with individual variability, impossible of online monitoring are of no concerns.

II. THEORY

The system for identification of drinking water quality is shown in fig.1. ASV signal is given as input to the sensor element. Sensor element is working with three electrodes; first one is working electrode, second one is reference and third one is counter electrode. If we sense the reference water it will give less magnitude current because of less contents of calcium and magnesium ions.

The main focus of work is to reduce the working electrode data. Data acquisition system is used for acquiring data from working electrode, after acquiring the working electrode by DAQ this data is processed and analyzed through software like C, fortan, LabVIEW etc.

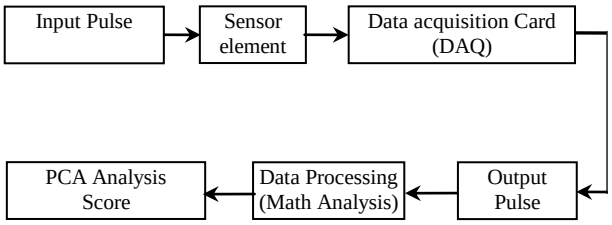

Fig. 1 Main building blocks of water quality sensor system

Data is displaying and analyzing by LabVIEW. This scheme works on anodic stripping voltammetry method (ASV). Where in ASV pulse is applied to reference electrode (inconel) and the current signals are received from the working electrodes (copper and platinum). The received current signals have unique signature of each sample of water. The three electrode system is used in this scheme is inconel, platinum, copper. In that inconel is reference electrode and platinum, copper are working electrodes.

Another three electrode set up also used in this scheme are copper, Agcl/cl, copper; one copper is acting

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as a working electrode and another copper electrode is working as a counter or auxiliary electrode, last one Agcl/cl is working as a reference electrode.

The ASV signal is emulated by PC to reference electrode through DAQ card analog output channels. The sensor system is dipped into water under test. Current signals are received from analog input channels of both copper and platinum. The raw data is stored in PC. And further this data is analyzed by MATLAB for getting PCA score. This total process is done by LabVIEW only. This data is processed by PCA analysis. The main function of PCA is to reduce the large sets of data into small sets of data.

III. RESULTS

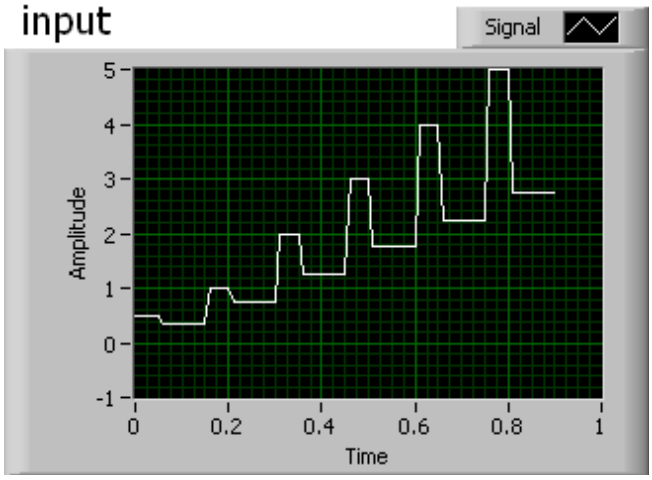

Fig 2. Snap of input ASV signal from LABVIEW

The Fig.2 shows the input signal which is defined in LABVIEW. It is applied to reference electrode through DAQ analog output channels. The maximum voltage transmitting from LABVIEW is 5v and frequency is 1/(2.880) sec.

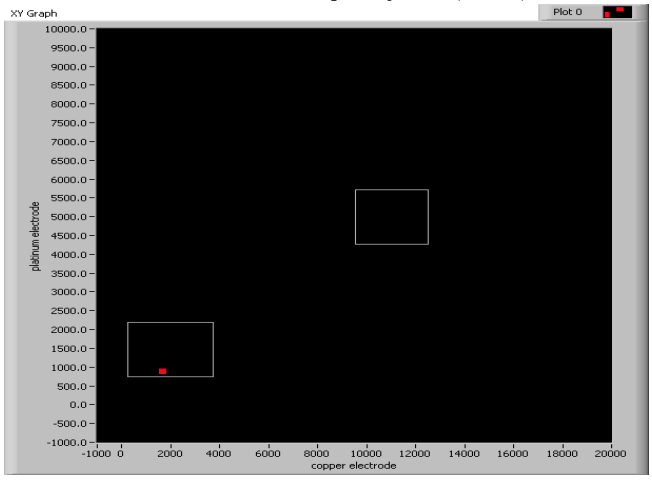

Fig 3. PCA score of Purified water using Platinum and Copper Electrodes

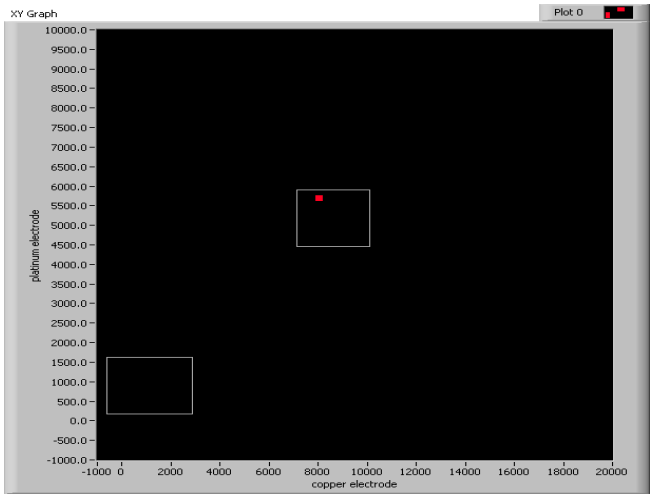

Fig4.PCA Score of Tap water using Platinum and Copper Electrode

The Fig.3 and Fig.4 shows the PCA a score of purified water and tap water using platinum and copper electrode. The red dot spot is the PCA score of tested sample. And these score clearly differentiating purified water and tap water. Purified water gave very less PCA score because of less concentration of minerals. And tap water gave very high PCA score because of very high concentration of minerals.

By observing the Fig.5 and Fig.6 the sensor is clearly differentiating the water for small variations in samples. The PCA score is varied for both samples. Fig. 7 shows the PCA Score of Purified water using Carbon Electrode.

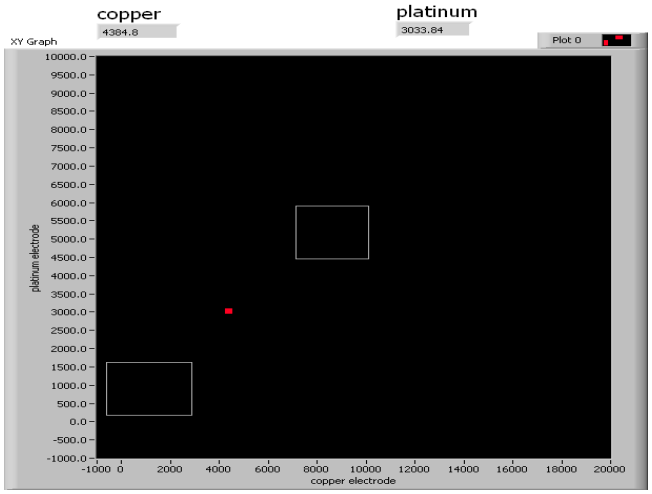

Fig 5.PCA Score of 40ml Purified and 20 ml Tap water Using Platinum and Copper Electrode

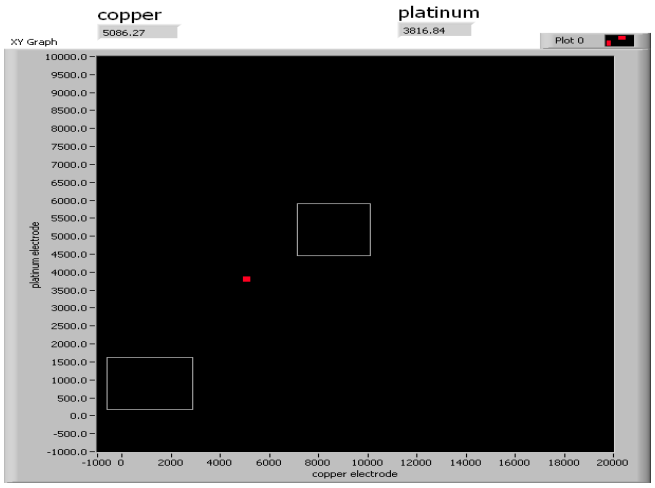

Fig 6 PCA Score of 40ml Purified and 40ml Tap water Using Platinum and Copper Electrodes

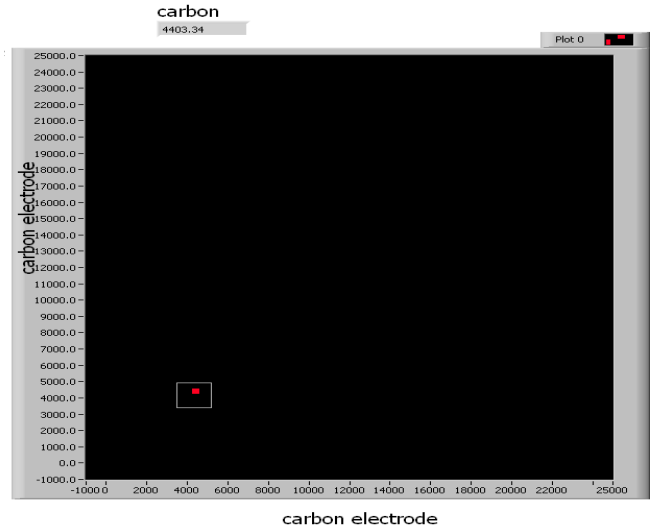

Fig. 7 PCA Score of Purified water using Carbon Electrode

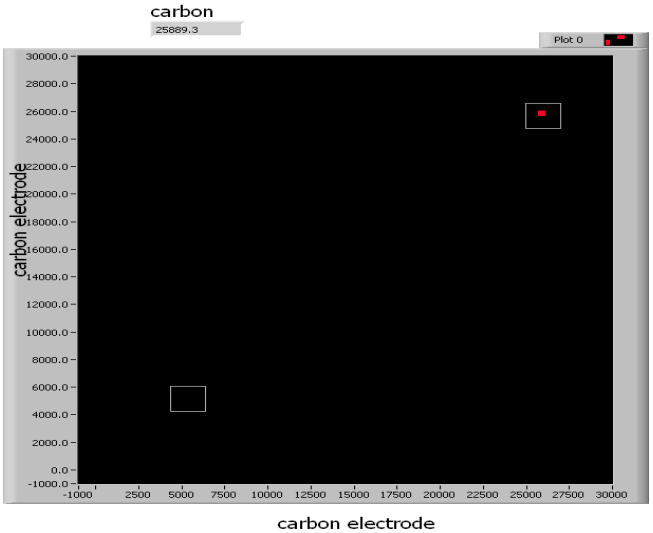

Fig.8 PCA Score of Tap water Using Carbon Electrode

The Fig.8 showing the PCA score of purified and tap water in the case of carbon as electrode. The PCA score is clearly differentiated between purified and tap water. Tap water PCA score is very high compared to purified water. So in tap water carbon electrode observed minerals concentration is high.

IV. CONCLUSION

Sensor element is built using three electrodes (Inconel, Copper and Platinum) with inconel for reference and copper and platinum as working electrodes. Customized algorithm is developed to obtain the score to differentiate the quality of water. Setup is made for online water quality measurement using LABVIEW and MATLAB where in data acquisition is done by Lab View and algorithm was implemented with MATLAB. The setup was successfully able to differentiate between the processed and non processed water.

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