

# Normalization techniques for gas sensor array as applied to classification for black tea

Bipan Tudu<sup>1</sup>, Bikram Kow<sup>2</sup>, Nabarun Bhattacharyya<sup>3</sup>, Rajib Bandyopadhyay<sup>4</sup>

<sup>1,2,4</sup>Department of Instrumentation and Electronics Engineering, Jadavpur University, Salt Lake Campus, Sector III, Block LB, Plot No. 8, Kolkata-700 098, India. Tel.: +91 33 23352587; fax: +91 33 23357254.

<sup>3</sup>Centre for Development of Advanced Computing(C-DAC), E-2/1, Block – GP, Sector – V, Salt Lake, Kolkata-700 091, West Bengal, India. Tel.: +91 33 23576309; fax: +91 33 23575141.

<sup>1</sup>[bt@iee.jusl.ac.in](mailto:bt@iee.jusl.ac.in), <sup>2</sup>[bkiramkow@gmail.com](mailto:bkiramkow@gmail.com), <sup>3</sup>[nabarun.bhattacharya@kolkatacdac.in](mailto:nabarun.bhattacharya@kolkatacdac.in),  
<sup>4</sup>[rb@iee.jusl.ac.in](mailto:rb@iee.jusl.ac.in)

**Abstract**— Assessment of black tea quality is a difficult task due to the presence of a large number of chemical compounds. The present day practice in the tea industry for this purpose is to employ the tea-tasters, who evaluate the quality based on their experience and professional acumen. There is a dire need in the industry to assess the tea quality objectively using instrumental methods. In this pursuit, an electronic nose instrument with five gas sensors has been developed and deployed for declaring tea-taster like scores. It has been observed that pre-processing of gas sensor data improves the classification accuracy and in this paper, a comparative study of different normalization techniques is presented for black tea application using electronic nose. For this study black tea samples were collected from different tea gardens in India. At first Principal Component Analysis (PCA) is used to investigate the presence of clusters in the sensors responses in multidimensional space. Then different normalization techniques were applied on electronic nose data. Finally the comparison of classification accuracy is presented with different normalization techniques using back-propagation multilayer perceptron (BP-MLP) neural network.

**Index terms:** black tea, electronic nose, gas sensor; normalization technique, principal component analysis, back-propagation multilayer perceptron (BP-MLP).

