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Online Validation of Soft Calibration Circuit for Capacitance Pressure Sensor

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Support Vector Machine (SVM) based intelligent pressure measurement technique operating in harsh environments is proposed in this paper. The technique that automatically calibrates, linearizes and compensates for the nonlinear response characteristics and complex nonlinear dependency of the sensor characteristics on elasticity modulus, thickness, dielectric materials, and temperature. To show the potential of the proposed soft calibration circuit, it is subjected to simulation. Further, validated online by real life data. Results show that the proposed intelligent technique has fulfilled the objectives.

Keywords : Adaptive, Calibration, Nonlinear Estimation, Sensor Modelling, Support Vector Machine.

1. INTRODUCTION

With the steam age came the demand for pressure measuring instruments. Bourdon tubes or bellows, where mechanical displacements were transferred to an indicating pointer were the first pressure instruments, and are still in use today. Pressure metrology is the technology of transducing pressure into an electrical quantity. Normally, a diaphragm construction is used with strain gauges either bonded to, or diffused into it, acting as resistive elements. Under the pressure-induced strain, the resistive values change. In capacitive technology, the pressure diaphragm is one plate of a capacitor that changes its value since pressure-induced displacement. Among all, capacitive technologies play an increasingly important role in the fields of industrial and automotive sensors because of its low power consumption and high sensitivity. However, its highly nonlinear response characteristics give rise to several difficulties.

Literature survey reveals a lot of reported work in [1], linearization of pressure sensors for a certain range is carried on with analog circuits. A generalised method for linearization of sensors using neural network is discussed in [2]. A computing method for linearization of pressure sensor is reported in [3] and compensation for zero drift is carried on using redundant sensors. In [4], calibration of fibre optic pressure sensor is carried on using signal processing. Calibration of pressure sensor using neural network algorithm and its compensation for temperature changes is carried on using redundant sensor [5]. In [6], an implementation of calibration circuit for pressure transmitter is discussed. Design of calibration circuit for pressure transmitter using HART protocol is reported in [7].

Calibration of CPS using analog circuits is reported in [8]. In [9], calibration of pressure sensor using digital signal processing techniques is discussed. A method for calibration of pressure sensor is discussed in [10]. In [11], calibration of CPS using functional link artificial neural network is discussed. Laguerre neural network algorithm is reported for calibration of CPS is reported in [12][13]. In [14], a calibration technique for reluctance type pressure transducer is discussed using analog circuits. In [15], relation between diaphragm properties and CPS output is discussed. In [16], effect of dielec-

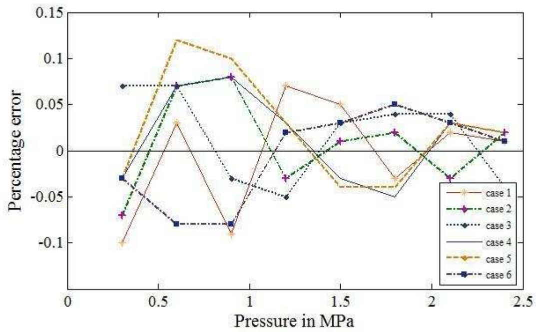

Figure 10. Percentage Error in Validation with Practical Data for Proposed Pressure Measurement with CPS

ther, some reported works have not utilized the full scale of measurement. In comparison to these, the proposed measurement technique achieves linear input output characteristics for full input range and makes the output adaptive of variations in physical parameters of diaphragm, dielectric constant and temperatures. All these have been achieved by using SVM model.

It is also evident form Table 2 and Figure 10, that the proposed technique produces accurate results in real time situations. The root mean square of percentage error when computed for all six cases from the proposed technique yields 0.053%. This real time results shows that the proposed technique was able to fulfill the desired objective set.

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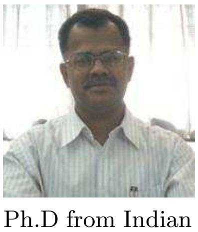

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