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Development of Neuro Fuzzy Algorithm for Load Sensor

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Abstract — This paper presents the development of load sensor by using neuro-fuzzy algorithm. Neuro-fuzzy system combines the learning capabilities of neural networks and control capabilities of fuzzy logic system. It is two inputs and one output model, inputs and output are taken from the optical fiber sensor. Load and displacement are taken as inputs for load sensor and voltage is taken as output. The model is simulated using ANFIS Edit GUI Toolbox and simulation results are shown in this paper

***Index Terms*— load sensor, neuro-fuzzy, Optical fiber sensor**.

I. INTRODUCTION

Neuro-fuzzy approach combines two powerful computing disciplines neural networks and fuzzy set theory. Neural networks are well known for their ability to learn and adapt to unknown or changing environment to achieve better performance [1]. Fuzzy logic was first proposed in 1965 as a way to imprecise data by Lofti Zadeh, professor at University of California[2].Fuzzy set theory on the other hand, can be effective handling linguistic information, incorporate human knowledge, deal with imprecision and uncertainty, and clarify the relation between input and output variables. However, the neural networks have the capability of identification of a system that can be extracted from the input output data. This learning capability of neural network can be combined with control capability of a fuzzy logic system [1]. A Load sensor is a sensor that converts a load or force acting on it into an electronic signal. This electronic signal can be a voltage change, current change or frequency change depending on the type of load sensor and circuitry used [3]. Load sensors can be simulated by Neuro fuzzy model. Load sensors are being used in different type of structures e.g. bridges, wind mills, roofs of sport centers, blades of helicopters, airplanes wings etc through the use of embedded or surface bonded sensors. In the case of wind mill blades, optical fiber sensors based on fiber brag grating is embedded in composite material(GFRP & CFRP) used in wind mill blade to monitor the load on wind mill blade[4]. The data acquired using load sensors are typically not directly usable as they suffer from three problems :(a) noise because of inaccuracy in hardware sensing and transmission and unfavorable environmental conditions and limited battery power further exaggerates this problem. (b) Missing values usually occur due to packet loss and node failure.(c) Incompleteness, since sensors sample have continuous physical phenomena at discrete time intervals. All these problems seriously impact the quality of data obtained from such sensors. The aim of the industry, indeed, is to manufacture tiny, cheap sensors that can be deployed everywhere and disposed when depleted. Consequently, noise, imprecision and inaccuracies are inevitable in these cheap sensors. It is extremely important that data from these sensors be reliable since actions are usually taken based on their readings [3].

Nowadays, optical fiber sensors have been commercialized. Optical fiber sensors have certain advantages such as immunity to electromagnetic interference(EMI), lightweight, small size, high sensitivity, large bandwidth, and easy in implementing multiplexed or distributed sensors. Strain, temperature and pressure are the most widely studied measures and the fiber grating sensor represents the most widely studied technology for optical fiber sensors. Fiber-optic gyroscopes and fiber-optic current sensors are good examples of rather mature and commercialized optical fiber sensor technologies. Today, some success has been found in the commercialization of optical technology. In this paper, we use neuro fuzzy to implement algorithm for load sensor with two inputs as load and displacement and one output as voltage and these inputs output is taken by the optical fiber sensor. and gives the relation between input and output[5]. The rest of the paper is organized as follows: Section II gives the neuro fuzzy algorithm and .Section III provides the results. Section IV Conclusion.

II. NEURO-FUZZY ALGORITHM

Neuro-fuzzy algorithm for load sensor system is developed using ANFI Edit GUI. Fuzzy inference system for the system is generated with two inputs and one output. The two inputs correspond to load and displacement of the load sensor and take the name ‘input1’ and ‘input2’ respectively. The output corresponds to the load sensor and takes the name ‘output’. The two inputs each having four triangular membership functions and output has four membership functions of constant nature. This generated FIS is then trained for an input output data set

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gathered from technical expertise. Then the membership functions of input1 take the range of 1200 –1800 gm and the input2 takes the range of 0-100 mm respectively as shown in Fig.1.and Fig. 2. Neuro-fuzzy architecture for the load sensor is shown in Fig.3The membership function of output (voltage) is given in Table II. ANFIS rules for the design is given in Table I.

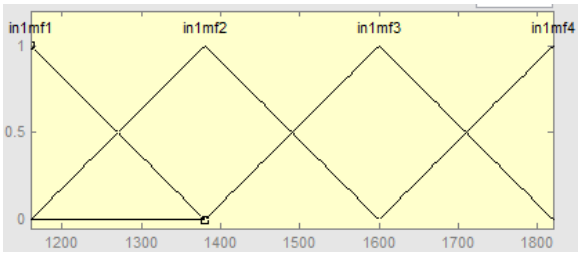

Fig. 1 Input 1 Membership Functions

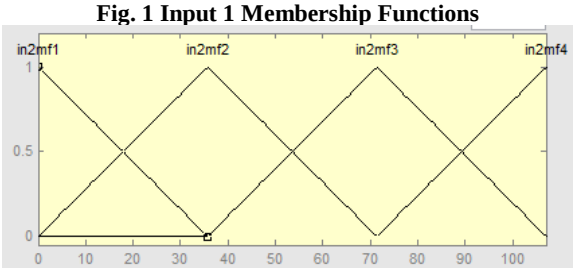

Fig. 2 Input 2 Membership Functions

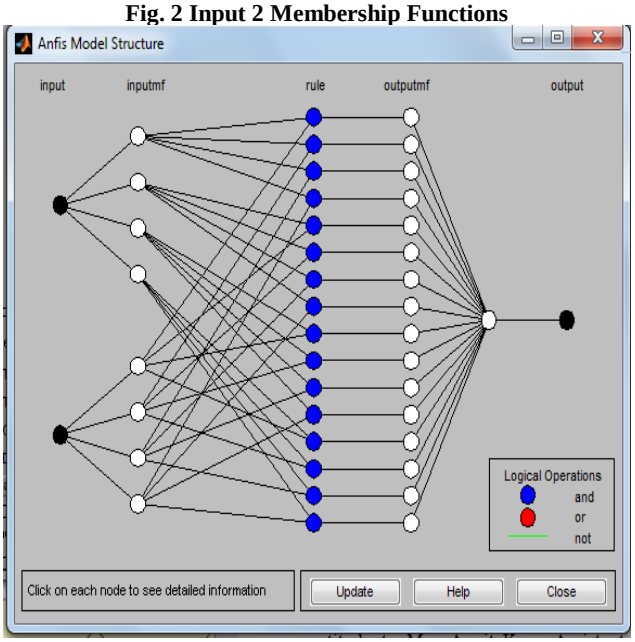

Fig. 3 Architecture of neuro-fuzzy system

TABLE I. ANFIS RULES FOR THE DESIGN

Rules	Input1	Input2	Output
1	In1mf1	In2mf1	Out1mf1
2	In1mf1	In2mf2	Out1mf2
3	In1mf1	In2mf3	Out 1mf3
4	In1mf1	In2mf4	Out 1mf4
5	In1mf2	In2mf1	Out 1mf5
6	In1mf2	In2mf2	Out 1mf6
7	In1mf2	In2mf3	Out 1mf7
8	In1mf2	In2mf4	Out 1mf8
9	In1mf3	In2mf1	Out 1mf9
10	In1mf3	In2mf2	Out 1mf10

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11	In1mf3	In2mf3	Out 1mf11
12	In1mf3	In2mf4	Out 1mf12
13	In1mf4	In2mf1	Out 1mf13
14	In1mf4	In2mf2	Out 1mf14
15	In1mf4	In2mf3	Out 1mf15
16	In1mf4	In2mf4	Out 1mf16

Table II. Membership functions of Voltage

Voltage	Constant value
Low	0
Medium	0.33
High	0.66
Max	1

III. EXPERIMENTAL RESULTS

The neuro-fuzzy for load sensor system is simulated using MATLAB. Following are the curves obtained (as shown in Figs.4, 5, 6):

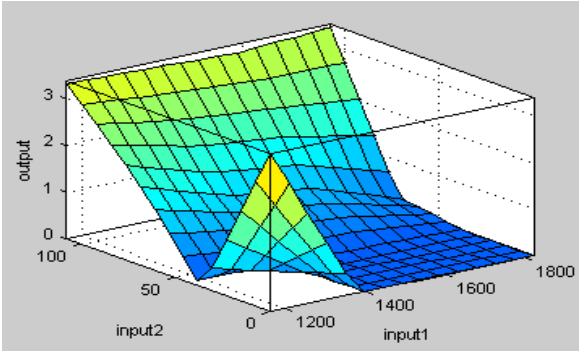

Fig. 4 Surface view of neuro-fuzzy algorithm

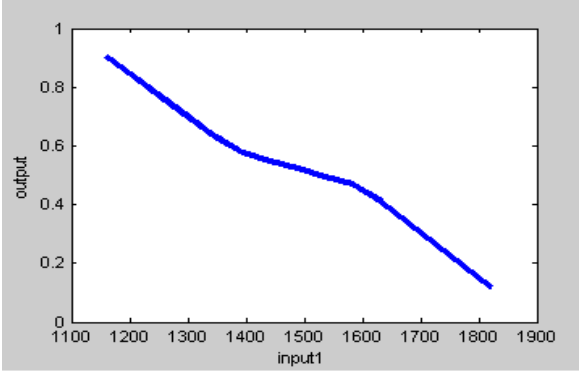

Fig. 5 Output with Input1 (load)

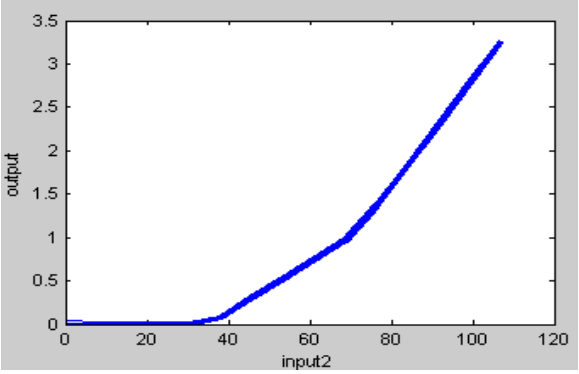

Fig. 6 Output with Input2 (displacement)

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From these experimental results, it can be deduced that using neuro-fuzzy algorithm to design the load sensor. From the curve in Fig. 5, it is evident that voltage is decreasing as load on the sensor is increased. And from the curve in fig.6 it is evident that as displacement is increased, voltage is also increased. This gives the loading capability of the sensor.

IV. CONCLUSION

In this paper, the implementation of load sensor using neuro-fuzzy algorithm with load and displacement as two inputs and voltage as one output is shown. It is shown that how voltage is changed when load and displacement are being changed. It is concluded that voltage is inversely proportional to load and voltage is directly proportional to displacement .Neuro-fuzzy algorithm is definitely superior to fuzzy logic algorithm as it inherits adaptability and learning. By using neuro-fuzzy algorithm, the system becomes adaptive to individual user, environment and weather.

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