An Intelligent Flow Measurement Technique Using Neural Network

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ABSTRACT

A variable area type flow meter called rotameter, a measuring instrument in which position of the flow is indicated by the stainless steel float which is present in rotameter. In the process industries the readings will be required in control room hence the float is converted into voltage. For non-contact flow measurement a hall effect sensor is kept on the rotameter which acts as secondary sensor. To convert float into voltage the hall effect sensor sense the magnetic field created by the magnet kept on the float, as water flow through to rotameter the float increases and the magnet varies its position and the hall sensor sense the change in magnetic field created by the magnet. The hall voltage varies with different parameters which affect the hall voltage measurement. As temperature is very slow process and water flow is very fast process both are considered for our work as temperature varies non linearly with voltage. The hall sensor output is amplified by instrumentation amplifier and that is given as input to the ANN. For neural network 70% readings has to be used for training and 30% readings should be used for testing process. Error is given back to the input so back propagation algorithm is used. By weight adjustment ANN gives the required output with iterations so we will get the accurate output.

Keywords: ANN, Hall Effect Sensor, Rotameter.

I. INTRODUCTION

A liquid flow is measured by the flow meter which has wide application in process industry. There are different types of flow meters. The five basic flow meters are differential pressure flow meter, positive displacement flow meter, velocity flow meters, mass flow meters, open channel flow meters. Rotameter is a type of variable area meter that measures the flow rate of the liquid through it. It consists of a transparent glass so that one can notice the water level. The float position is transferred to an external indicator via a magnetic coupling. Sunita sinha et al. [1] has designed and tested a real time flow measurement system using hall sensor. A non contact flow measurement system is designed by placing hall sensor outside the rotameter to sense the variation of the magnetic field. The sensed value is converted to 1-5v signal conditioner unit. This is input to the PC through opto isolator and Data Acquisition System card. Lab tech note book pro software is used to indicate the flow. The same software can be used for any system to create a virtual model. But this system has limitation of the float size and the magnet and this system is accepted in the industries. Santosh et al.[2] has designed an adaptive flow measurement technique using the turbine flow meter. Here linear measurement system is designed and tested. Here the blade radius and number of blades varies with the liquid density. Input varies linearly with output for the input range and ANN is used to make output adaptive to

the various parameters. Mandal et al.[4] have also designed a modified flow meter using rotameter as a primary sensor and LVDT as a secondary sensor. The current signal before sending for the remote place the voltage is amplified and filtered. The LVDT has a drawback that it gives linear output for a particular input range then becomes non linear. This setup is reliable in the process industries. Nirupama mandal et al.[3] has designed an improved inductance bridge-type technique, here also the same procedure like above publication where float is converted into current signal. A ferromagnetic wire is kept on the float, which is a sensing element. As the water flow through the rotameter the self-inductance of the coil changes as flow rate changes. This network is used to measure the coil self-inductance. From study it is observed that the coil inductance varies linearly with transducer and transmitter. Chengli Zhang et al. [9] discussed about the flow equation of the rotameter based on water flow in it and the tapered tube inside its body is derived. The results are discussed on flow coefficient with respect to the drag coefficient, which proves the derived equation is correct.

Hall effect sensor is a transducer that varies output voltage in response to magnetic field. They are used for the proximity switching, positioning, speed detection and current sensing application. Permanent magnet is placed on the water level indicator of the flow meter so that the magnet moves upwards with the float when flow rate of a fluid increases then magnet comes near to hall effect sensor which sense its magnetic field. J. Lalnunthari et al. [10] ANN has two inputs voltage and temperature. Using signal conditioning voltage is converted into flow which is output of ANN. As temperature is non linear with hall voltage back propagation algorithm in neural network is used. It has three steps. The readings are sampled and 70% of them are used for training and remaining readings are used for the testing of the neural network. To get the required output the actual and desired output is compared and value obtained by that is back propagated to the input for weight adjustment. ANN tries to give accurate output.

II. METHODS AND MATERIAL

Water from the tank flow through the rotameter as shown in fig 1, a hand valve is used to vary the flow rate. As the flow rate increases the Hall effect sensor (SS490) sense the flux created by the magnet .The output of the hall effect sensor is given to the ANN. As various parameters affect the hall voltage like temperature, density of the liquid, viscosity etc., here temperature is taken into consideration. Temperature sensor is used to measure the varying temperature of the water. Hall voltage and temperature are non linear in nature. Experiment has to be done to analyse the behaviour of Hall effect sensor with respect to temperature. ANN has to be used to overcome this non linearity and accuracy problem. Q is the output flow taken from the ANN through data conversion unit.

Implementation of ANN:

Artificial neural network is a type of artificial intelligence technique that mimics the human brain. The feed forward network is a layered network in which neurons are organized into layers with connections in one direction from one layer to another. ANN model consists of data collection, processing data, building the network, training and testing. MATLAB NN tool is used to write script files for developing MLP. Network is created after adding data to workspace then network is trained and tested for different inputs.
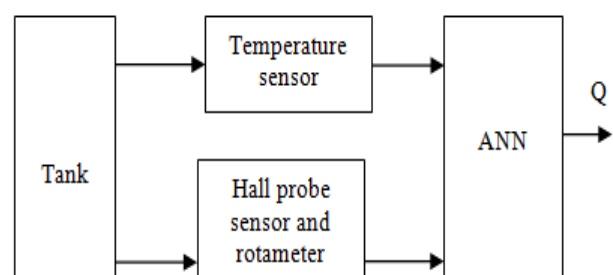

Figure 1. Block Diagram

III. RESULTS AND DISCUSSION

Objective of the project is to make the flow meter smart, the float position will be affected by the liquid density which changes the voltage which automatically varies the flow rate on the system. So ANN is used for calibration which makes flow meter smart. It is expected to monitor the flow control at remote location of the industries.

IV. CONCLUSION

Different parameters affect the flow measurement of the liquid like temperature, viscosity, liquid density are non linear in nature. As temperature is very slow process, we are considering temperature and hall voltage in our work. Temperature and voltage is non linear in nature hence ANN is used to make the flow meter smart with back propagation algorithm. The other affecting parameters can also be compensated using this techniques with the other transducers.

V. REFERENCES

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