A Comparison in AC Compressor Control System using Adaptive Neuro Fuzzy Inference System and Artificial Neural Network with specific area based IoT sensor data to measure the lifespan of compressor.

Submitted by:

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Introduction

Air conditioning system automation means the monitoring and control of the system integrated objects intelligently for effective usage. Thus efficiency can gained by controlling compressor speed according to input variables.

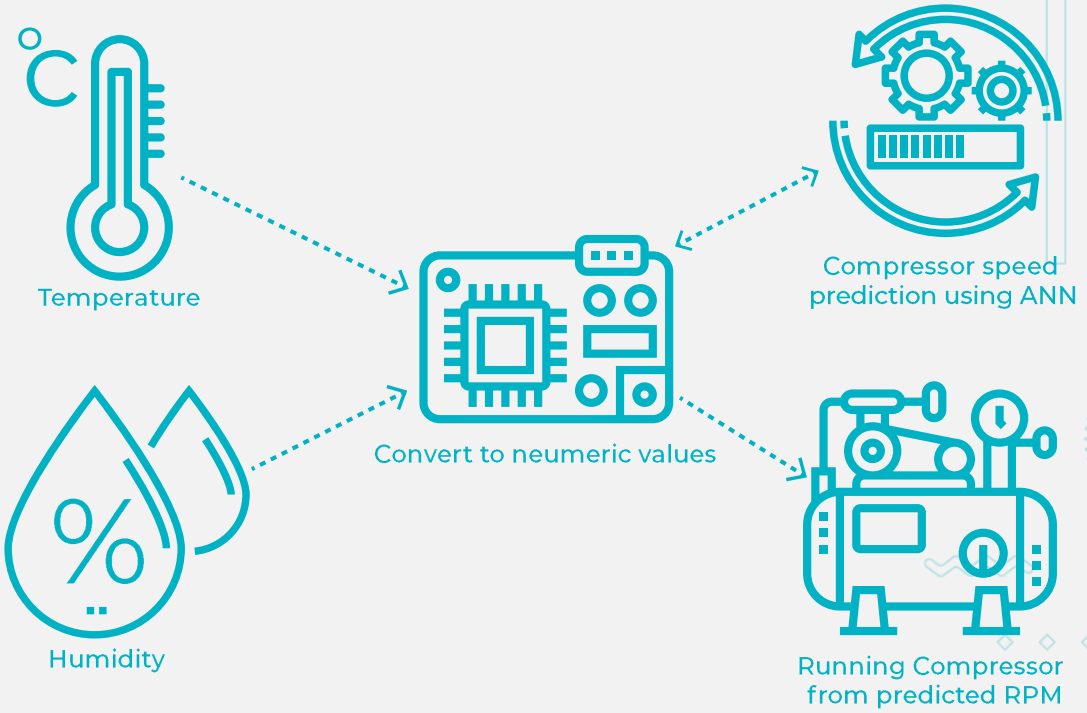


Figure: Possible solution for variable speed air conditioning system

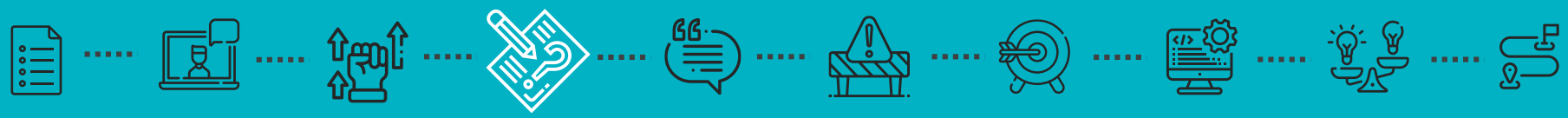
Motivation

Two stage (on and off) air condition compressor system start when room temperature is higher then threshold temperature, ends when room temperature is lower than threshold. This approach turn on compressor at maximum torque and causes massive electricity draw. Which in turns increases number of rotation of compressor creates electricity wastage and shorten life span of compressor.

As opposed to conventional control design, neural network based control focuses on gaining an intuitive understanding of how to best control the process.

Problem Statement

- Given temperature and humidity of certain room , control air condition compressor speed according to given variables.
- Collect real world temperature and humidity data.



Literature review

- A non-adaptive fuzzy logic controller (FLC) with an online self-tuning mechanism which adjusts the membership functions of the fuzzy rule set for live steam temperature regulation in a coal-fired power station has been suggested. [1]
- For speed modulation of a separately excited DC motor (SEDM) using a chopper circuit, an adaptive neuro-fuzzy inference system (ANFIS) controller utilizing error and derivative of error inputs has also been introduced.[2]
- Another approach has been proposed of a system design for the air conditioning unit incorporating fuzzy logic and the neuro-fuzzy approach using temperature and humidity data. [3]

1. P. Isomursu and T. Rauma. A self-tuning fuzzy logic controller for temperature control of superheated steam. In Proceedings of 1994 IEEE 3rd International Fuzzy Systems Conference, pages 1560–1563. IEEE, 1994.
2. Omar, B.A.A., Haikal, A.Y.M. and Areed, F.F.G., 2011. Design adaptive neuro-fuzzy speed controller for an electro-mechanical system. *Ain Shams Engineering Journal*, *2*(2), pp.99-107.
3. Kaur, A. and Kaur, A., 2012. Comparison of fuzzy logic and neuro-fuzzy algorithms for air conditioning system. *International journal of soft computing and engineering*, *2*(1), pp.417-20.

Limitations

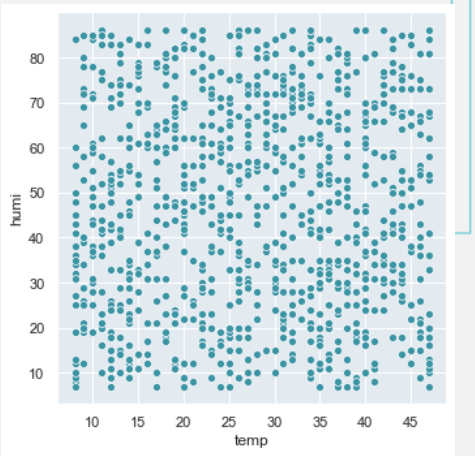
- Two stage or Five stage compressor speed control does not decrease electricity wastage significantly.
- Most of the simulation done previously does not validate all real world situations.

Objectives

- Create dataset from real world data.
- Temperature, humidity and RPM clustering using Likert Scale.
- Train adaptive neuro-fuzzy inference system or (ANFIS) using different membership function and cluster data.
- Train Artificial Neural Network (ANN) using created dataset.
- Predict RPM using ANFIS and ANN
- Compare predicted results

Methodology (Dataset & Likert)

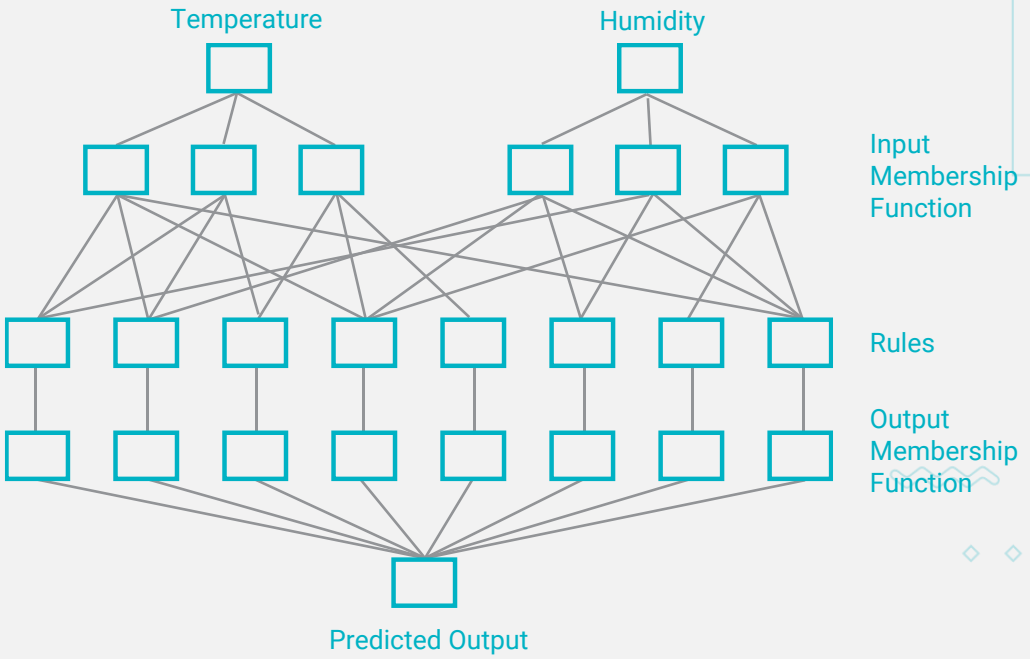
Dataset consist of 100000 data, of humidity and temperature sensors. In normal room condition temperature and humidity almost remains constant in time ranges of days. For better evaluation performance of proposed models additional data is required which represent various ranges of input and output classes. Adjacent figure shows the uniform distribution of temperature and humidity in the final dataset.



Likert scale is a method of ascribing quantitative value to qualitative data, to make it amenable to statistical analysis. Data are clustered using 5 scales Likert scale . In dataset temperature ranges from between 8 to 48 degree Celsius, humidity ranges from between 7 to 20 % and compressor RPM ranges from 0 to 7200.

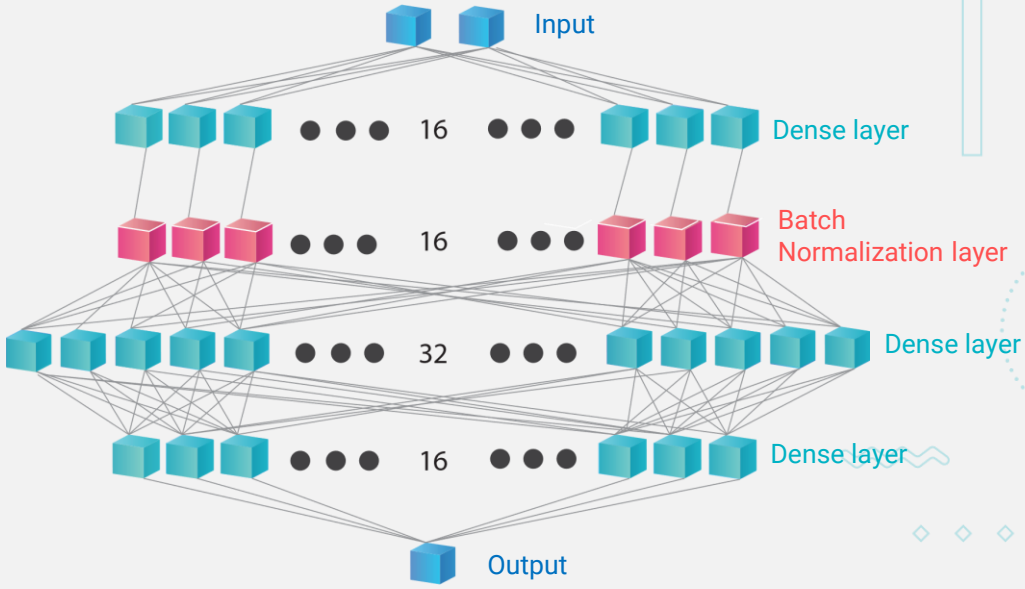
Methodology (ANFIS)

Adaptive neuro-fuzzy inference system (ANFIS) learning capability to design inference system are integrated with IF –THEN rules. Different membership function is being utilized for ANFIS. The experimental input data produce output according to the train data and also which membership function was used.



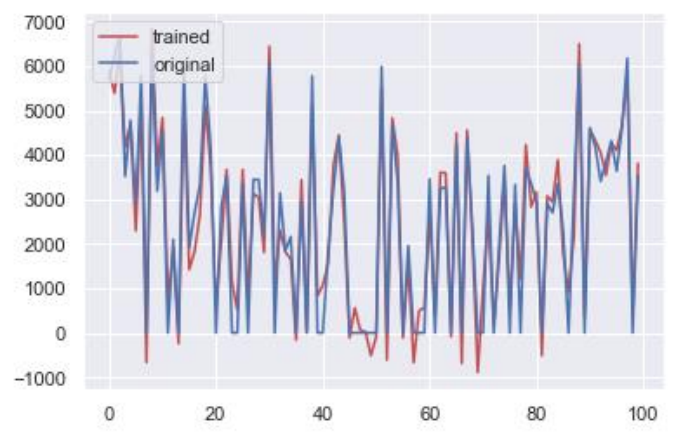
Methodology (ANN)

Artificial Neural Network (ANN) contains a wide number of linked processing units that work together to process information. Typically, the artificial neural network is structured into layers. Layers have been made up of several interconnected nodes which include an activation function.

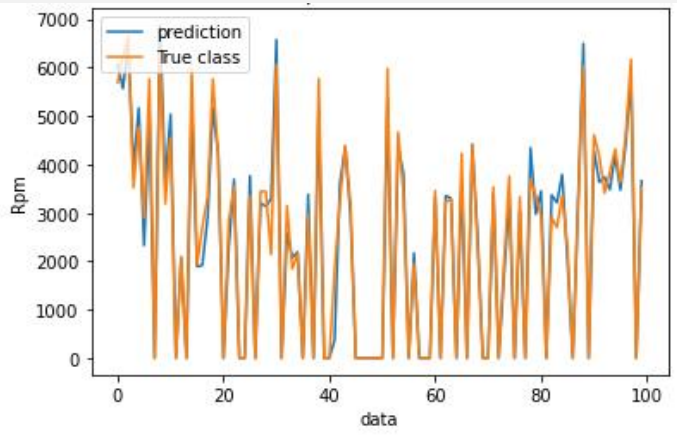


Experimental analysis

After training both ANFIS and ANN models for comparison temperature and humidity data is given to make prediction. Following figure shows predicted RPM by each model:



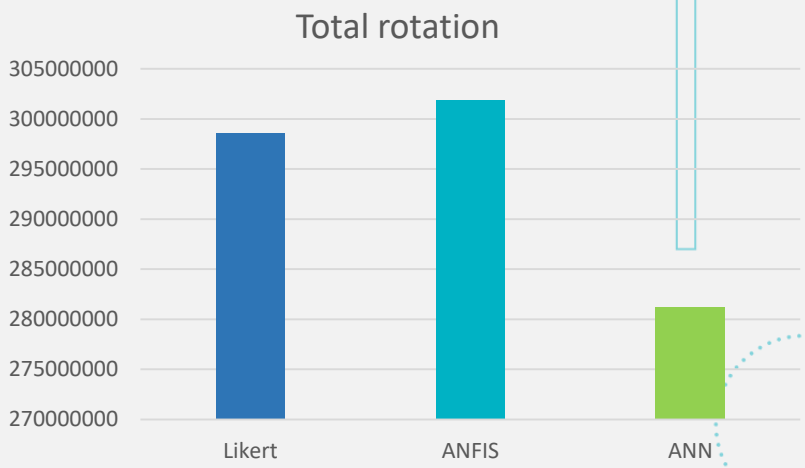
ANFIS



ANN

Experimental analysis

Power consumption and lifespan of any motor/compressor directly proportional to speed (RPM) [4]. Again life expectancy can be estimated Power consumption [5]. If torque remains constant for some data points , the method with least rotation yield to less power consumption and improve life span. Following figure shows total rotation for dataset.



Number of rotation for each method

4. Wen Technology Inc, "Power-Torque," WEN Technology, 2002. [Online]. Available: http://wentec.com/unipower/calculators/power_torque.asp?print=false. [Accessed 20 November 2018]
5. Oraee, H., 2000. A quantative approach to estimate the life expectancy of motor insulation systems. *IEEE Transactions on dielectrics and electrical insulation*, 7(6), pp.790-796.

Conclusion

- Predicted output from ANFIS and ANN matches with actual compressor speed.
- The performance also compared with existing five scale variable compressor output (Likert).
- Among ANFIS and ANN, ANN outper performs ANFIS both in less error and less power consumption.

Thank You