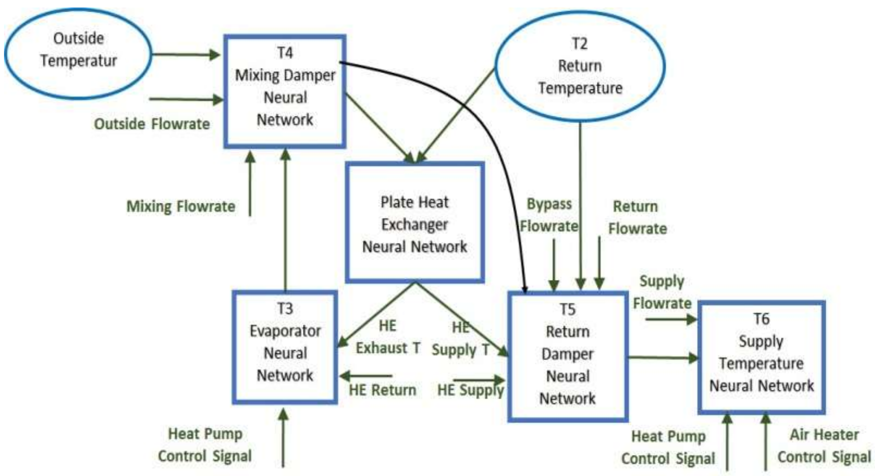
Nonlinear Economic Data Driven Model Based Predictive Control for a Swimming Hall Ventilation System

M. Sc. Hossein Rezazadeh (Hochschule Emden/Leer), Prof. Dr.-Ing. Sven Steinigeweg (Hochschule Emden/Leer), B.Eng. Christian Seltz (HANSA Klimasysteme), Dr.-Ing. Matthias Lamping (HANSA Klimasysteme)

Model predictive control technic has been widely under study for thermal comfort in residential buildings and have reported considerable amount of energy saving. This study deals with the application of model predictive control technic for the air handling units in a swimming hall located in Ramsloh, Germany. The air handling units in the swimming hall have the ability to work in different operating modes depending on the weather condition. The aim is to use a nonlinear multiple input multiple output (MIMO) model predictive controller to find the optimum operating point considering different factors like outside weather condition and the number of people in the hall. The unit behavior is nonlinear with mutual influence of different control parameters on each other. Two data driven models have been created for the unit. 1) A grey box model based on the physical correlations and parameter estimation in Matlab Simulink. 2) A black box neural network model trained by the recorded historical data throughout the year. In order to reduce the dimension of the neural network the system has been broken down to several sub models. Each sub model is a neural network model that calculates the temperature or pressure at a specific location. Each neural network receives its input from its preceding network and passes its output to its subsequent network.



Figure(1) Black Box Model Break Down

The grey box model is created using resistance model for the flow network in the unit and RC-network model for the building. The models are validated using the recorded data and the generalization capability and precision of each model is studied. In order to consider all different operating modes the models are linearized at several operating modes. A multidimensional matrix containing the linearized models of the unit at different modes is used to design the controller. The optimum operating point is found by considering the energy consumption of the unit as an objective for the predictive control algorithm along with thermal comfort objectives such as hall temperature and humidity and the supply air temperature. The results show the potential for optimizing the energy consumption comparing to classic control strategy by changing the usage pattern of the heat pump, air heater and ventilators and different recirculation rates at different weather condition and taking into account the electricity and thermal energy prices.