Modeling of a steel-heating furnace from real data

WL1-04

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PROJECT OVERVIEW

In this project, the temperature behavior \( y(t) \) in relation to the fuel rates \( u(t) \) of a steel-heating furnace is studied and modeled using real-world data from Baosteel Ltd. in Shanghai.

ARCHITECTURE OF THE FURNACE

Four Modeling Techniques Used

† Linear (Least-Squares Algorithm)

\[
y(t) = \alpha_1 y(t-1) + \ldots \alpha_6 y(t-6) + \beta_1 u(t-1) + \ldots \beta_3 u(t-3)
\]

† Polynomial (Least-Squares Algorithm)

\[
y(t) = \alpha_1 y(t-1) + \ldots \alpha_6 y(t-6) + \beta_1 u(t-1) + \ldots \beta_3 u(t-3) + \gamma_1 y(t-1)^2
\]

† Fuzzy System (Table Look-up Scheme & Clustering)

\[
f(x) = \frac{\sum_{l=1}^{M} y_l \left( \prod_{i=1}^{n} \mu_{A_{l_i}} (x_i) \right)}{\sum_{l=1}^{M} \left( \prod_{i=1}^{n} \mu_{A_{l_i}} (x_i) \right)}
\]

† Neural Network (Back-Propagation Algorithm)

\[
y(t) = \sum_{i=1}^{N} f(w_{i_1}(1)y(t-1) + w_{i_2}(1)y(t-2) + w_{i_3}(1)u(t-1) + \theta_{i}(1))w_{i}(2) + \theta_{2}
\]
Linear Model

Fuzzy System Model
Clustering
Neural Network Model

Simulation results show that the linear and polynomial models are better in terms of average testing error performance. But in terms of training error, fuzzy system and neural network models are better.

The results obtained would be useful to implement a temperature control system, which is of great importance to the quality of steel products and energy saving of a furnace.

Results & Future Work