Amirkabir Journal of Civil Engineering

Amirkabir J. Civil Eng., 50(3) (2018) 157-158
DOI: 10.22060/ceej.2017.12599.5240

Prediction of Semi-autogenous mill Power Using Radial Artificial Neural Network Based on Principal Component

F. S. Hoseinian[1], B. Rezai[1], S. Soltani Mohammadi[2]*

[1] Department of Mining & Metallurgical Engineering, Amirkabir University of Technology, Tehran, Iran
[2] Department of Mining Engineering, University of Kashan, Kashan, Iran

ABSTRACT: Providing of semi-autogenous (SAG) mill models for prediction of its effectiveness is one of the most useful tools for better design of grinding circuit. Many SAG mill models have been presented in the literature, but in most of them have not been predicted the mill performance in industrial scale. Semi-autogenous mill power has an effective impact on the mill performance. So in this study, a new model based on combination of radial artificial neural network and principal component is presented to predict semi-autogenous mill power. The feed moisture, mass flowrate, mill load cell weight, SAG mill solid percent, inlet and outlet water to the SAG mill and work index selected as input variables and evaluated the effect of them on the mill power. The results showed that the trained hybrid model of artificial neural network and principal component with R=0.8456 and RMSE= 68.0752 can be used to predict the semi-autogenous mill power in industrial scale. The sensitivity analysis results showed that all model input parameters had a significant effect on the output.

Review History:

Received: 11 March 2017
Revised: 21 July 2017
Accepted: 1 August 2017
Available Online: 19 August 2017

Keywords:

Semi-Autogenous Mill
Mill Power
Radial Artificial Neural Network
Principal Component

1- Introduction

Semi-autogenous grinding (SAG) is used in most mining companies due to its some advantages including of lower investment and maintenance costs, lower physical space requirements and higher processing capacity. The majority of SAG mill models that evaluated in the literature do not investigated the model predict for full-scale SAG mill performance. Morrell developed a new rock breakage characterization test using the small diameter drill core samples to predict the specific energy of AG and SAG mill [1, 2].

Principal component analysis (PCA) is a multivariate statistical method. It predicts the new variables (principal components (PC)) based on the reducing of the predictive variable numbers by the maximum possible variance of the original set. PCs are independent linear combinations of the basic data. In recent years, artificial neural networks with a wide and diverse structures have been developed in the research field of mineral processing. Combination of artificial neural network combined with principal component analysis has recently been used successfully to model the different processes [3].

In this study, radial artificial neural networks and combination of radial artificial neural network and principal component (a combination of artificial intelligence and statistical methods) to predict the SAG mill power are presented.

Corresponding author, E-mail: saeedsoltani@kashanu.ac.ir

2- Methodology

The 142 SAG mill operations collected from Aq Darreh gold processing plant in the 32 km of north of Takab city in West Azarbayjan province, Iran. The variables of work index (Kwh/ton), mass flowrate (t/hr), feed moisture (%), SAG mill solid percent (%), mill load cell weight (t) and inlet (m^3/hr) and outlet water (m^3/hr) to the SAG mill are measured for modeling SAG mill power (kW). Structure of the radial artificial neural networks based on the principle components is shown in Figure 1. In this model, principle component is used as input of radial artificial neural network. Thus, the network structure has less complexity due to lower input variables. Principal component analysis was performed using SPSS statistical analysis software.

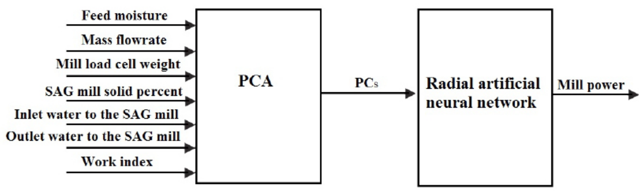

Figure 1. The structure of radial artificial neural networks based on principal component to predict the SAG power

3- Results and Discussion

Network comprehensiveness increases with increasing the number of training dataset in the neural network training. Thus, network response for the new dataset will be more accurate. The 80% and 20% of total datasets were separated randomly for datasets of training and testing of networks, respectively. In order to provide radial artificial neural network model based on principal component and basic variables, a code prepared in MATLAB software for prediction of SAG mill power.

Figure 2 shows the measured values of mill power in comparison with the predictions of radial artificial neural network model based on principal component in testing process. According to this figure, the obtained results for mill power by combination model are close to the measured mill powers. The performance prediction of the developed predictive models for prediction of SAG mill power is evaluated using the coefficient of determination (R) and root mean square error (RMSE).

The obtained results are presented in Table 1. The obtained values of 0.8456 and 68.0752 for R and RMSE for model of radial artificial neural network based on principal component, and also 0.8226 and 73.1450 for model of radial artificial neural network based on basic dataset, respectively indicates the relative superiority of the model of radial artificial neural network based on principal component in predicting SAG mill power.

Sensitivity analysis was also performed to identify the relative influence of each variables of the process. The results showed that all input variables have a significant effect on the SAG mill power.

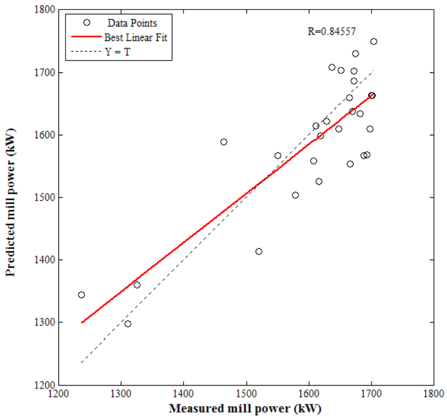

Figure 2. The structure of radial artificial neural networks based on principal component to predict the SAG power

Table 1. Obtained performance indices values for developed models

Network type	R	RMSE
Radial artificial neural network based on principal component	0.8456	68.0752
Radial artificial neural network	0.8226	73.1450

4- Conclusions

Predictive of mill power is one of the important parameters to design the grinding circuits. SAG mill has remarkable advantages that are used in most processing plants. Prediction of mill power can be studied by appropriate modeling and simulation. For this purpose, a power mill prediction model using radial neural network and principal component was developed. The work index, mass flowrate, feed moisture, SAG mill solid percent, mill load cell weight and inlet and outlet water to the SAG mill was considered as input variables to the network. Comparing the output of models based on principal component and basic data showed that the proposed model based on principal component due to its error less has higher efficiency in prediction of SAG mill power. The values of R and RMSE for models based on principal component and basic data were obtained 0.8456, 68.0782 and 0.8226, 73.1450, respectively. The results showed that the model based on principal components has higher performance to predict the SAG mill power. It can be used for prediction of SAG mill power with reasonable error. Sensitivity analysis showed that all input variables have a significant effect on the prediction of the SAG mill power.

References

[1] S. Morrell, A new autogenous and semi-autogenous mill model for scale-up, design and optimisation, Minerals Engineering, 17(3) (2004) 437-445.

[2] F.S. Hoseinian, R.S. Faradonbeh, A. Abdollahzadeh, B. Rezai, S. Soltani-Mohammadi, Semi-autogenous mill power model development using gene expression programming, Powder Technology, 308 (2017) 61-69.

[3] S. Sousa, F. Martins, M. Alvim-Ferraz, M.C. Pereira, Multiple linear regression and artificial neural networks based on principal components to predict ozone concentrations, Environmental Modelling & Software, 22(1) (2007) 97-103.

Please cite this article using:

F. S. Hoseinian, B. Rezai, S. Soltani Mohammadi, Perdition of semi-autogenous mill power using radial artificial neural network based on principal component, *Amirkabir J. Civil Eng.*, 50(3) (2018) 511-518.

DOI: 10.22060/ceej.2017.12599.5240