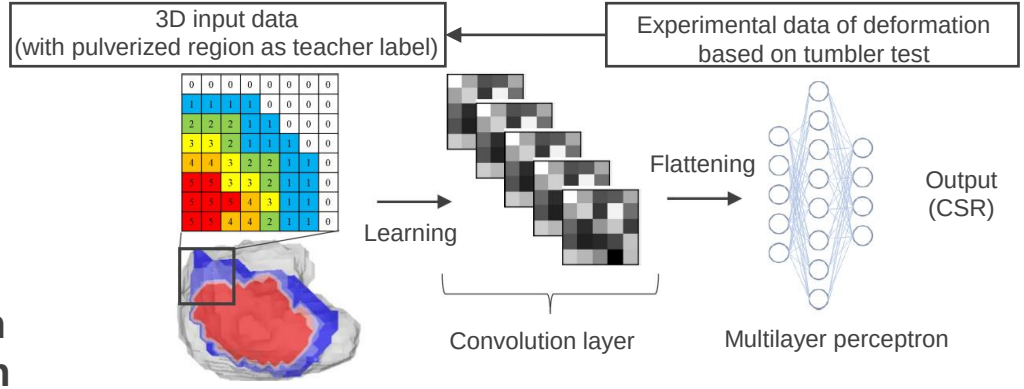
Tohoku Univ. Technology

3D coke deformation recognition system by deep learning

Able to learn and estimate the coke strength after reaction (CSR) and deformation pattern



Overview

The gas permeability in the blast furnace deteriorates due to excessive coke degradation during the low coke rate operation in order to reduce CO_2 emission. The coke strength after reaction (CSR) is a parameter to evaluate coke quality and is used as an indicator of permeability in blast furnace operation.

However, CSR is an index that averages the high-temperature deformation behavior of each cokes, and can't estimate the complex deformation behavior of individual coke particles. Existing method for flow phenomena visualization and clogging prediction using kinetic model is computationally demanding and limited in the ability to analyze stochastic deformation behavior in a scaling manner.

This invention applied deep learning using Deep Neural Network (DNN), which is a typical AI method, to the coke 3D deformation process. Machine learning was performed to estimate of the deformation process using DNN. As shown in fig.1, the loss function (deviation from the "estimated value") decreased with the number of learning sessions, and the recognition accuracy shows over 97%. This indicates that DNN can classify the deformation of every CSR accurately and reduce the computational load for coke deformation prediction remarkably. Therefore, machine learning can easily recognize the coke 3D shape deformation which is difficult to recognize intuitively.

Over 97% CSR recognition accuracy by learning from experimental data

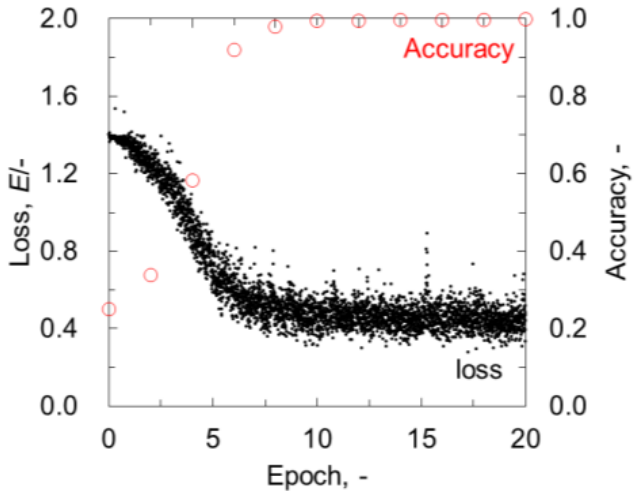


Fig.1 Loss function and recognition accuracy

Product Application

- Periodical measurement of coke deformation pattern based on CSR value in a production site
- A simple blockage estimation system of filling layer for coke mixing process
- Creation of boundary condition data for kinetic model

Related Works

[1] Natsui, S., Hirai, A., Terui, K., Kashihara, Y., Murao, A., Miki, Y., & Nogami, H. (2021). Method for Simulating Gas Permeability of a Coke Bed Including Fines Based on 3D Imaging on the Coke Particle Morphology. ISIJ International, Vol. 61 (2021), 1814-1825

[2] Tammina, S. Transfer learning using VGG-16 with deep convolutional neural network for classifying images; Int J. Sci. Res. Public., 9(10), (2019), 143-150.

IP Data

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