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CPINet: parameter identification of path-dependent constitutive model with automatic denoising based on CNN-LSTM. (English) Zbl 1478.74013

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Summary: Based on convolutional neural network (CNN) and improved long short-term memory (LSTM) neural network, a deep learning model CPINet is proposed for instant and accurate identification of path-dependent constitutive model parameters with excellent denoising performance. The elastic-plastic constitutive model with isotropic hardening is taken as an example for illustration. The results show that the CPINet can capture the intricate relationship between the strain field sequence and the non-temporal features (loading sequence and geometry dimensions) to identify constitutive parameters instantly and accurately. The denoising analysis revealed that the denoising processing and strain feature extraction of CNN provides excellent denoising ability to CPINet. Finally, the CPINet is validated by comparing the identified constitutive parameters of 6061 aluminum alloy with CPINet and finite element model updating method. To our knowledge, this is the first study that demonstrates the feasibility and considerable potential of using a deep learning technique to instantly and accurately identify constitutive parameters.

MSC:

74C05 Small-strain, rate-independent theories of plasticity (including rigid-plastic and elasto-plastic materials)
74A20 Theory of constitutive functions in solid mechanics
74S99 Numerical and other methods in solid mechanics
92B20 Neural networks for/in biological studies, artificial life and related topics

Keywords:

convolutional neural nerwork; constitutive parameter identification; path-dependent parameter; elasto-plastic model; denoising

Software:

DnCNN; CPINet; AlexNet; ImageNet; Adam

Full Text: DOI

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