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Running State Detection of HTS Pining Maglev System Based on Deep Learning Algorithms

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By the merits of self-stable levitation, low energy cost and no-contact friction, high-temperature-superconducting (HTS) pinning maglev system has a great potential to become an ultra-high-speed transportation. Recently, with the mature of the HTS pining maglev technology, the first HTS maglev engineering prototype vehicle was successfully established in our group. As the most important factor in engineering, operation stability and safety reflected by the monitoring of vehicle running state is significant. In the previous research, the detection of HTS pinning maglev running state is usually calculated by the mathematical interaction among mass, levitation force, guidance force, and vehicle stiffness matrix. However, with the growing data dimension, large-scale stiffness matrix operation has high computational and time complexity. And the large quantity of being processed data and low accuracy of state detection will also hinder the real-time monitoring of the HTS vehicle operational state. But the high efficiency of deep learning can well solve this problem. Hence, this paper proposes a way for HTS state detection based on deep learning. Initially, accelerometers and levitation gap sensors are placed on the testing apparatus, respectively. Secondly, the data under different operational conditions is collected. Then, these aggregated data with features are denoised. Next, four mainstream deep learning clustering methods are selected to distinguish the maglev vehicle operational states based on the above dataset. Finally, the detection accuracy and calculation time for deep learning method are compared with traditional stiffness matrix calculation approach. And the results verify the effectiveness and applicability of deep learning algorithms. This hybrid application can realize the real-time monitoring of HTS vehicle operational states which will facilitate control system to adjust strategy based on the running conditions in future engineering application as well.

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