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Unsupervised Discrepancy-Based Domain Adaptation For Multiple Damage Detection Of Maglev Rail Joints

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As one of the vital components serving as connections between the adjacent F-type rail sections in maglev guideway, damage to maglev rail joints such as bolt looseness may result in rough suspension gap fluctuation, failure of suspension control, and even sudden clash between the electromagnet and F-type rail. The condition assessment of maglev rail joints is highly desirable to maintain safe operation of maglev. Therefore, an online damage detection approach based on unsupervised domain adaptation is proposed for diagnosing the multiple damage conditions of maglev rail joints under various operation modes of the maglev train. The damage detection model based on convolutional neural network is first trained using the labeled time-frequency spectrograms extracted from the acceleration data of rail joints when the train is passing at a constant speed. To detect multiple damage conditions of maglev rail joints under different operation modes of the train, the testing set is composed of the unlabeled acceleration data of rail joints when the train is at two operation modes, i.e. uniform passing and decelerated passing. The statistical discrepancy of the covariance who considers both the mean and variance is minimized to realize the time-frequency feature learning from training set to testing set. Results show that the rail joints in three different conditions (bolt-looseness-caused rail step, misalignment-caused lateral dislocation, and normal condition) are successfully identified by the proposed approach, even when the operation mode of maglev train is changed.