Catenary is one of the main components of the power supply system of high-speed railway, which mainly includes contact line, messenger, dropper, supporting device, suspension device, etc. It is responsible for transmitting the electric energy from traction substation to the EMUs (Motor Train Unit). Its working states directly influence the train’s safe operation in high-speed railway. Therefore, efficient detection and estimation of catenary for high-speed railway are very important and necessary.

The book begins with an introduction of detection and estimation of high-speed railway catenary in Chap. 1. First, pantograph-catenary detection technologies are simply outlined. Second, the development of non-contact detection devices using image processing, including catenary image detection device and pantograph image detection device, are presented, respectively. Third, pantograph-catenary image recognition technology is introduced, where some recognition algorithms or methods are reviewed. Fourth, catenary estimation methods including static estimation and dynamic estimation are summarized and reviewed in detail. In the end, the future detection and estimation researches are given. In Chap. 2, the statistical characteristics of pantograph-catenary contact pressure are presented and discussed in detail. These statistical characteristics include stationarity, periodicity, correlation, high-order statistical properties of pantograph-catenary contact pressure. First, the stationarity test methods are introduced and the stationarity of actual pantograph-catenary contact pressure is analyzed in detail. Second, the periodicity of pantograph-catenary contact pressure data is discussed, including periodic trend feature, trend term extraction and evaluation of pantograph-catenary contact pressure data. Third, the correlation of pantograph-catenary contact pressure data is discussed based on EMD (Empirical mode decomposition). In the end, the high-order statistical properties of pantograph-catenary contact pressure data is discussed based on SK (Spectral Kurtosis). In Chap. 3, the wave motion velocity of contact line considering air damping is deduced in detail and the influence factors are discussed first. Then the static aerodynamic parameters of contact line are analyzed. The test experiment of static aerodynamic parameters of contact line is designed and carried out in the wind tunnel. In the end, the dynamic equations of
pantograph-catenary considering air damping is modified and discussed. In Chap. 4, the non-contact detection for the height and stagger of contact line is presented in detail, including the detection value correction of catenary geometric parameters based on Kalman filtering, the detection correction method of contact line height, and the detection method based on mean shift and particle filter algorithm. In Chap. 5, the features of pantograph slipper image including pantograph structure, slipper type and image features of slipper are given and discussed in detail. First, the characteristics of pantograph slipper image based on curvelet transform are analyzed. Second, the pantograph slipper crack extraction based on translational parallel window in curvelet transform domain is given. In the end, the extraction algorithm of cracks and experiment verification are performed and verified. In Chap. 6, some new detection methods of the working state of insulators, clevises, and diagonal tube are presented and discussed in detail. For the insulator detection, affine invariant moments, fast fuzzy matching and Harris corner points are adopted for insulator positioning. Grayscale statistic, wavelet singular value, Chan–Vese model and curvelet coefficients morphology are adopted for insulator fault detection. For the clevis fault detection, SIFT (Scale-invariant Feature Transform) and SUFT (Speed-up Robust Features) are adopted for clevis matching. HOG (Histogram of Oriented Gradient) features, curvature, Hough transform, Gabor wavelet transform and second-generation curvelet are adopted for clevis fault detection. In addition, the detection of clevis pins is presented and discussed. In the end, the diagonal tube fault detection is presented including the diagonal tube detection based on cascaded AdaBoost classifier and detection of loosening and missing of screws from the diagonal tube. In Chap. 7, the time–frequency distributions of pantograph-catenary contact force based on different time–frequency representations are analyzed and discussed. The detection of contact wire irregularity in railway catenary is presented. The ZAMD (Zhao–Atlas–Mark distribution) is presented and discussed as the best candidate for the quadratic time–frequency representation of pantograph-catenary contact force. In Chap. 8, the catenary estimation based on the PSDs (Power Spectrum Density) of dynamic data is presented and discussed. First, the selection of AR (Autoregressive) model order for catenary data is discussed. Then, the correlations between the PSDs and some crucial operation conditions are investigated and a cross-correlation coefficient is presented for evaluating the pantograph-catenary coupling performance. In the end, the quantification method of PSDs is developed based on the second-order polynomial.

In this book, we try to indicate an increasing interest in detection and estimation of high-speed railway catenary for real-life engineering applications. It is hopeful to provide some references and help for other researchers around the world who engage in detection and estimation of high-speed railway.

Chengdu, China

Zhigang Liu

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