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Abstract: Variational mode decomposition (VMD), an effective signal decomposing technique, has attracted considerable attention in recent years. The successful applicability of the VMD method mainly depends on the selection of decomposition parameters. Most of the existing VMD-like fault diagnostic methods only aim to optimize the number of either decomposed modes or balance parameters (or both) by adopting qualitative analysis, priori criteria, or genetic-like algorithms. However, the types of initial center frequencies (ICFs) in VMD are seldom discussed alongside the fault diagnosis of rotating machines. In actual scenarios, the selected ICFs have significant effects on the analytical results. Thus, in this study, the variation features of the center frequency (CF) of extracted modes are investigated with different ICFs, in which the converging U-shape phenomenon is found. Motived by this phenomenon, a novel ICF-guided VMD method is proposed to extract accurately the weak damage features of rotating machines. In particular, the proposed method is composed of two steps. First, an energy fluctuation spectrum is presented to rapidly highlight the ICF of the latent mode. Second, a CF-guided VMD optimization strategy is constructed to extract the optimal mode by adaptively refining the balance parameter. The simulations and experimental verifications confirm the effectiveness of the proposed method to enhance the fault diagnosis of rotating machines. A comparison with existing methods demonstrates the superiority of the proposed method to detect weak faults.

Keywords: *Center frequency, variational mode decomposition, feature extraction, rotating machines*