**Fault Identification Using Global- Search Enhanced MOPSO Algorithm**

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**Abstract**

The goal of this research is to utilize a piezoelectric actuator to detect damage in railway tracks. Here we develop an enhanced optimization algorithm that can handle large-scale damage identification problems, demonstrating an identification mechanism. The piezoelectric transducer is bonded to the host structure and used as an active sensor to acquire admittance data, in which the damage information is included. Thus, we can simultaneously identify the damage location and severity by comparing the physical measurements and finite element-based prediction and minimizing the difference. The damage index vector is sparse in nature because the damage in the structure only affects a small area. Therefore, the zero norm is defined to determine the sparsity for the damage index vector. Thus, the inverse identification process forms a multi-objective optimization problem, which can be solved using an optimization algorithm (like MOPSO). However, the damage identification is usually under-determined and a multi-modal problem; thus, the algorithm may get stuck in local extremes and generate inaccurate solutions. To tackle this problem, we develop a series of local search strategies to help the algorithm to jump out of the local minima if possible.

Moreover, Q-learning is used here to guide the algorithm to select the most suitable local search method at each iteration, as shown in Figure 1. Two cases are conducted to verify the proposed method. As shown in the Figure 2, the algorithm identifies the damage location and severity with high precision. These results demonstrate the accuracy and robustness of EMOPSO for piezo admittance-based damage identification. This approach can be applied directly to the railway track.



Figure 1. Diagram of developed optimization algorithm.

 

Figure 2. Identified results for damage cases, (left) true damage located at 35th segment with 8% stiffness reduction, (right) true damage located at 75th segment with 11% stiffness reduction.

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**References**

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