ICCES, 2023, vol.25, no. 4
DOI: 10.32604/icces.2023.09307

PROCEEDINGS

Detection of Fatigue Cracks in Metal Material Based on Peridynamic Differential Operator

Jiaming Liang[1], Qizheng Wang[1], Yile Hu[1] and Yin Yu[1,*]

[1] Aerospace Structure Research Center, School of Aeronautics and Astronautics, Shanghai Jiao Tong University, Shanghai, 200240, China

*Corresponding Author: Yin Yu. Email: yuyin@sjtu.edu.cn

ABSTRACT

The most common form of damage in aircraft structures is fatigue damage. Accurate detection of fatigue crack tip is the cornerstone for prediction of crack propagation path and the basis for calculation of residual strength and stiffness. It is of great significance to improve structural fatigue resistance design. When simulating the crack growth problem based on the traditional method, the crack tip needs to be re-meshed so that resulting in low calculation efficiency. The expansion of fatigue cracks has a complex shape, for example, the fatigue crack damage on the aircraft skin often shows a curved shape. The current traditional mechanical model cannot simulate this com-plex crack shape. In this paper, the images of the test piece obtained by DIC are used as input, and the corresponding displacement field is calculated by the optical flow method. Since the points in the displacement field calculated by the optical flow method are unevenly distributed points, the displacement field with uniformly distributed points is obtained by interpolation using the Peridynamic Differential Operator. Based on the calculated displacement field, the Peridynamic Differential Operator is used to calculate the strain, and the strain compatibility functional is used to distinguish the cracked area from the non-cracked area. In order to reduce the influence of test noise on the results, the strain compatibility functional is converted into a probability, and the crack area is extracted. Good agreement has been observed between the PD predictions and DIC results, thus, verifying the correctness and effectiveness of the proposed method.

KEYWORDS

Fatigue Crack Tip; peridynamic differential operator; optical flow method; strain compatibility functional

Funding Statement: The authors received no specific funding for this study.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.