

A method based on support vector machine regression algorithm to predict fatigue life of structure

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Abstract

According to the corresponding relationship between load, fatigue damage and material performance parameters, the fatigue life prediction model is established by using support vector regression algorithm, which is used to predict fatigue life. Under the action of load, the fatigue damage is accumulated, and the damage accumulation process is nonlinear, so the damage caused by cyclic load at a certain time should be a function of the cumulative damage of the load and material. After the *n*th cyclic loading, the cumulative damage *D* runs up to the critical value, and the fatigue failure occurs. At this point, the number of cycles is the fatigue life.

Due to the fatigue damage mechanism is complex, collecting fatigue test data of material, using support vector machine to establish the nonlinear relationship between the load and the fatigue damage (Fig.1), obtaining nonlinear cumulative fatigue damage, predicting fatigue finally. The method can reflect the order of fatigue load and realize the nonlinear accumulation of fatigue damage. The method mainly includes the following procedures:

1) collecting fatigue test data of material

The material performance parameters for training samples is obtained from experimental study on the material fatigue property or collected by referring to the data, which mainly include conventional mechanical performance parameters, S-N curve, cyclic stress-strain hysteresis loop curve.

2) Establish training samples

According to the fatigue damage mechanism of different materials, different input and output parameters are selected and different damage formulas are used to calculate the single cyclic load damage, thus construct training sample set.

3) Fatigue life prediction model

According to collecting fatigue test data of material, which is taken into the above formula, different fatigue levels can be got under different load, total cumulative damage and single cycle load damage relationship, construction of training set.

4) Cumulative total damage

The fatigue load spectrum is converted to load input parameter type model of the fatigue life prediction model, successive substitute to fatigue life prediction model, the fatigue damage corresponding to different loads can be calculated, the total cumulative damage caused by single cycle load.

5) Fatigue life calculation

Through the iterative calculation, the cumulative damage reaches the critical damage value, that is, to determine the fatigue failure, calculate the number of load cycles, the results of fatigue life is acquired.

The effectiveness of the method is demonstrated by an example, the training samples are input into the support vector machine (SVM) algorithm, and the critical damage value is set to 0.85. The fatigue life is calculated and compared with the experimental results. The fatigue life of the specimen is 16974 times, and the calculated result is 15632 times, and the error is about 7.91%. The results show

that the method can reflect the influence of the fatigue load sequence effect on the performance of the material.

The results show that this method predicts precisely material fatigue life with less data on fatigue property, which can satisfy the accuracy of engineering.

Keywords: Fatigue Damage, Life Prediction, Support Vector Machine (SVM).

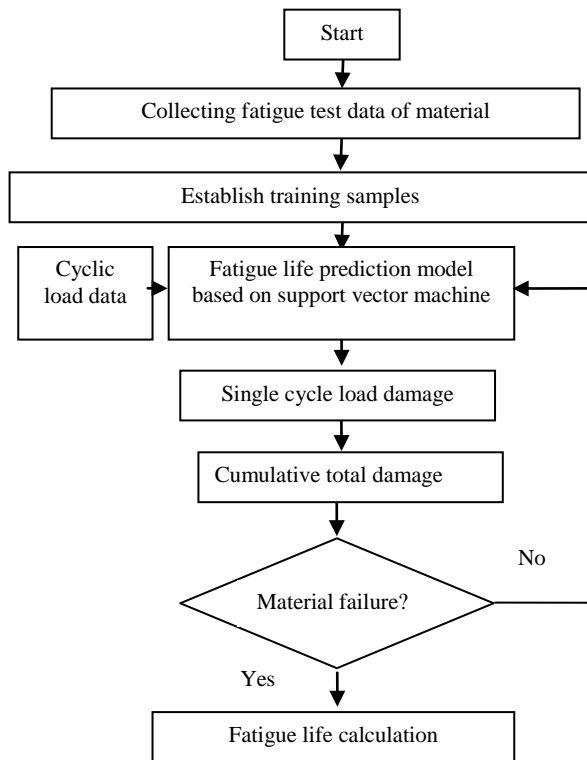


Fig.1. Damage prediction using SVM

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