Fault Prediction of Electronic Equipment

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Abstract. Fault prediction is the precondition of Condition Based Maintenance (CBM), accurate prediction for equipment can not only make warning before failure occurs, but also reduce the cost of maintenance of complicated equipment and system. This paper analyses some typical fault prediction method of electronic equipment, and presented improvement measures for the practical problems, finally proposed a combination of fault prediction model, and it was applied to the electronic equipment with complex structure verification.

Keywords: Condition Based Maintenance, electronic equipment, combination fault prediction model, LSSVM

1 Introduction

Condition Based Maintenance (CBM), can be called predictive maintenance, is that the sensor or inside the equipment which will be installed in the test equipment on the outside of the equipment, in order to obtain accurate system running status information of the current time, and then evaluate current running state of equipment. By the method of predicting can understand the development of equipment failure, and before it happen significant performance degradation to implement the effective maintenance activities.

With the development of status maintenance technology, we put forward to the CBM with open system structure which can be divided into seven modules as shown in Figure 1.

Fig. 1. composition of non-destructive testing instrument
Due to the fault prediction technology is more and more attention, the prediction algorithm is also more and more, but how to according to actual condition to select the appropriate algorithm for fault prediction is the key problem, the appropriate algorithm can effectively improve the prediction precision. Failure prediction accuracy should be validated by real devices, but the actual equipment performance degradation and expectations are not necessarily the same, which makes the prediction results of verification cannot be achieved, in fault prediction research in the future how to verify the predicted results will become the difficulty of research.

According to the different principle, we always make to fault classification. For electronic equipment on the basis of fault occurrence, development process can be divided into sudden failure and progressive failure. Progressive failure is accumulated over time, electronic devices work in certain components or systems with the increase of working times finally exceed the limit of his scope of work and down. The progressive failure does not make the equipment component or system function complete loss, equipment can still work. In the electronic devices of this kind of failure occurrence proportion is stronger regularity.

2 Least Squares support vector machine fault prediction methods

Least Squares (LS) method is regarded as a fitting in the form of the mathematics. LS minimize the square sum of error determine the accord with the function of work with the data. Most is currently LS algorithm is used to implement the curve fitting and extrapolation, the algorithm is also applicable to solve the problem of linear and nonlinear mathematical model, so the LS method may be to realize fault prediction.

Support vector machine (SVM) classification problem is divided into for processing data of SVC (support vector classification), basic principle and used to solve the problem of predicting the SVR. SVR can better deal with high dimension and local minimum value, practical problems such as small sample. SVM in the face of a large amount of data is difficult to solve optimization problems. Therefore LSSVM was proposed to improve the shortcomings of the SVM, LSSVM turn the inequality constraint condition into the equation, the nonlinear regression problem is converted into linear regression problem, apply the error sum of squares to the objective function, then through the KKT (Karush-Kuhn-Tucker) optimal conditions for the optimization problem of SVM into solving problem of linear equations, improves the training speed and convergence precision.

LSSVM prediction model is established, the first turn on the training data input in the model, determined by corresponding relations between input and output of the phase space reconstruction, the prediction model was established, then input model to predict the test data, so as to realize the prediction of some point in the future, below is the LSSVM learning samples.
LSSVM prediction process is shown in figure 2.

Based on LSSVM failure prediction steps are as follows.

Determine the characteristic parameters and data processing. For a given prediction system were analyzed, and find out reflect characteristic parameters of the system state changes to obtain sample data; On the sample data preprocessing, model training and test data needed for; In order to avoid the influence of the sample data of magnitude, can first of all sample data normalization processing.

Determine the model parameters. First of all, according to the need to choose the appropriate LSSVM prediction model, and then enter the learning samples LSSVM, according to the formula of the embedding dimension, mapping relation model is obtained by studying input and output.

Model training. The sample data is divided into training data and the test data, the training data input model for training.

Predictions. The test sample input model to prediction, the output value is predicted.

Evaluation prediction model. To evaluate results than those obtained by the analysis, if can't achieve the ideal prediction results, the training again, until they get
the prediction results are satisfactory. In this paper, the evaluation index for the absolute error and relative error.

Absolute Error (AE):
\[ AE = |\hat{y}_i - y_i|, i = 1, 2, \ldots n \]  \hspace{1cm} (2)

Relative Error (RE):
\[ RE = \frac{\hat{y}_i - y_i}{y_i}, i = 1, 2, \ldots, n \]  \hspace{1cm} (3)

4 Conclusions

For the complex structure of the electronic equipment and the existing single fault prediction methods cannot state projections for electronic equipment directly. This paper introduces the LSSVM and HMM working principle and working process of LSSVM with HMM combination prediction model is put forward, analysis the advantage of the combination model and applied to a mixed structure of electronic devices.

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References