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FAULT PROGNOSTICS USING AN ARIMA-BASED PREDICTION COMBINED WITH A CASE-BASED REASONING METHODOLOGY

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ABSTRACT

This paper presents a methodology for system forecast based on indicative parameter time series of the equipment condition. The time series of degradation index is divided in different candidate scenarios according to modifications on exogenous variables that represent external environmental conditions. Each valid scenario is associated with a specific progression model built based on ARIMA time series analysis. The forecast model is determined by merging the current scenario progression model with the progression model associated with most similar past scenario, providing prediction of the future state of the machine with improved accuracy. The feasibility and effectiveness of the approach proposed is demonstrated through the prediction of the degradation characteristics provided by DC machine benchmark fault simulator.

Keywords: time series, case-based reasoning, dc motors, fault prognostics.

INTRODUCTION

The methodology for fault prognostics adopted in this work belongs to the group of techniques or prognosis based on evolutionary trend. This method can be used in systems in which it is possible to extract a degradation index thus allowing an estimate of the remaining useful life (RUL) of the component. In general, the proposed algorithm is based on an automatic procedure that integrates the methodology of case-based reasoning with ARIMA time series models. Then, this work is inspired by a technique called CBR in two layers developed in (Rocha, 2011), composed, of an external layer called Scenarios CBR and an internal layer called Progression CBR. In the Scenarios CBR, the goal is to estimate the system future condition based on a set of exogenous variables that defines the current scenario. On the other hand, in the Progression CBR, the goal is to estimate the system future condition based on the system condition time series data available for the current scenario.

To apply the method in the prognostics of equipment, a benchmark which describes a drive system of a dc machine, proposed by (Palhares, 2009), is then used. The measurement of the condition of the system was raised from the construction of a degradation index that considers failures in the ventilation systems and lubrication failure generated by the fault model of a dc motor. Once well-established the failure threshold of the equipment condition, the algorithm proposed succeeds in calculating the RUL of the equipment.

RESULTS AND CONCLUSIONS

In Fig. 1 the predicted values of the degradation index obtained from prognostics algorithm, exceeding the failure threshold in $t_{f_{est}} = 723.5$. The time interval between $t_{f_{est}}$, when the degradation index reaches the failure threshold, and the current time ($t_{actual} = 700$) is the remaining useful life (RUL) of the dc motor.

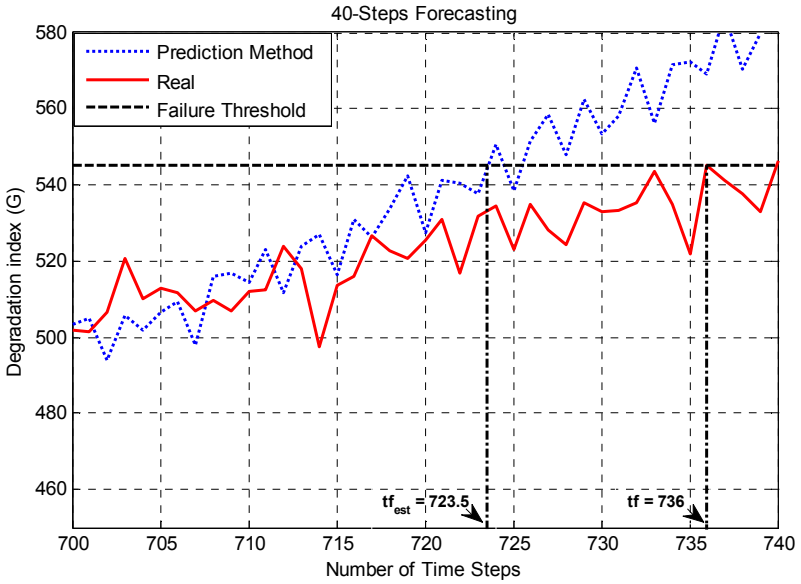

Fig. 1 - Forecasting results of degradation index

The time taken for each iteration is one hour, then calculates the RUL of the machine by the equation below,

$$RUL = \left(t_{f_{est}} - t_{atual}\right) * \Delta_t = (723.5 - 700) * 1 = 23.5\ hours$$

Evaluating the curve with data of degradation simulated by the dc motor, one observes that the value reaches the failure threshold in $t_f = 736$, which is reasonably close to the value estimated $t_{f_{est}}$.

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REFERENCES

[1]-In: IEEE International Conference on Systems, Man and Cybernetics SMC´11.

[2]-BOX GEP, Jenkins GM, Time Series Analysis: forecasting and control. São Francisco: Holden-Day, 1976.

[3]-Palhares RM. DC machine benchmark fault simulation - MATLAB code, 2009, http://www.cpdee.ufmg.br/~palhares/deteccao.html.