Condition Based Maintenance Optimization Considering Multiple Objectives [*]

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Abstract

In condition based maintenance (CBM) optimization, major objectives include maximizing reliability and minimizing maintenance costs, which are often times conflicting objectives. In this work, we investigate the application of the physical programming approach to deal with the formulated multi-objective optimization problem. Physical programming presents two major advantages: (1) it is an efficient approach to capture the decision makers' preferences on the objectives by eliminating the iterative process of adjusting the weights of the objectives, and (2) it is easy to use in that decision makers just need to specify physically meaningful boundaries for the objectives. The maintenance cost and reliability objectives are calculated based on proportional hazards model and a control limit CBM replacement policy. An example is used to illustrate the approach.

Key words: Maintenance, Physical Programming, Proportional hazards model, Reliability

1   Introduction

Condition based maintenance (CBM) aims to achieve reliable and cost-effective operation of engineering systems such as aircraft systems, manufacturing systems, power stations, etc. CBM is based on the understanding that a piece of equipment goes through multiple degraded states before failure. The health conditions can be monitored and predicted, and optimal maintenance actions can be scheduled for preventing equipment breakdown and minimizing total operation costs [1].

A CBM optimization approach based on proportional hazards model (PHM) has been developed, aiming at determining an optimal replacement policy, that is, an optimal risk threshold control limit in this approach, for minimizing long-run replacement cost [2, 3]. This approach was developed into the CBM optimization software EXAKT [3], and it has been successfully applied in many industries, including mining industry, food processing industry, utility industry, manufacturing industry, etc. In Section 2, we will summarize the basics of PHM and the applications of the PHM based CBM method.

The current method considers only a single optimization objective [3]. In some cases in the approach, minimizing cost is the only optimization objective. In some other cases, maximizing reliability, or minimizing failure probability, is the only optimization objective. When cost is the optimization objective, for example,

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