AS2M Department, CNRS UMR 6174
PROMI research team
24, rue Alain SAVARY
25000 Besançon, France

Contacts :
K. MEDJAHER
kamal.medjaher@ens2m.fr
Tel. : +333 81 40 27 96

N. ZERHOUNI
noureddine.zerhouni@ens2m.fr
Tel. : 03 81 40 28 05

Contribution to process degradation modeling: application to failure prognostic

1. Context and positioning

The performance requirement of industrial systems needs an increasing availability and reliability of equipments while reducing the maintenance costs. Consequently, traditional maintenance policies such as corrective or timed preventive must be replaced by new and intelligent ones, where the maintenance actions are scheduled based on the real or observed health state of the equipment. In this case, we speak about Condition-Based Maintenance (CBM).

CBM is a process composed of several modules going from data acquisition to decision support systems. Among these modules failure prognostic is considered as one of the key modules. It has for main objective the anticipation of the failure's time and thus permits to well plan the maintenance actions. The standard ISO 13381-1 defines failure prognostic as the estimation of time to failure (TTF) and risk for one or more existing and future failure modes. In the reported scientific literature, the TTF is commonly called RUL (for Remaining Useful Life). The estimation of the RUL can be achieved according to several methods and by using different formalization tools. These methods can be grouped in three main approaches, namely: model-based prognostic, data-driven prognostic and experience-based prognostic. Among these approaches, the data-driven prognostic offers better tradeoff in terms of precision, implementation cost and applicability.

2. Description of the subject

The principle of data-driven prognostic relies on the transformation of the monitoring data provided by the sensors into behavioral models that best represent the degradation process. Among the tools which can be used to model the degradation, one can cite the probabilistic graphical models. They permit to model degradation in a form of stochastic model in which the states are physically inaccessible, but observable through the sensors of the monitoring system. Research works in failure prognostic using stochastic models, particularly Hidden Markov Models (HMMs), have been proposed in the scientific literature. However, these works consider stay durations in the hidden states governed by exponential laws, hypotheses not always realist and thus do not reflect the real stay durations. In addition, only few of these works consider the variable operating conditions in which evolve the physical component or system.

Our objective in this thesis is to develop a probabilistic approach for modeling degradation processes of critical physical components, integrating explicit stay duration laws in the stochastic models and considering variable operating contexts. Indeed, in order to obtain better predictions of the remaining useful life with a good associated confidence value it is necessary to have a reliable and precise model. The existing algorithms for parameter learning of stochastic models and for inference must then be improved and adapted in order to take into account these new contextual constraints related to industrial applications.

A possible application can correspond to a process of modernization of the maintenance services of Besançon city. This concerns an implementation of a supervision and failure anticipation system for the technical equipments managed and maintained by the city of Besançon and the Grand Besançon. This approach is considered within the innovative PHM (Prognostic and Health Management) concept.

3. Requested profile

The applicant must have an Engineer or Master degree in one of the following disciplines: engineering sciences or applied mathematics. In addition, the applicant must have strong skills in the following domains:

- Fault detection, isolation and diagnostic. Skills in failure prognostic would be appreciated for the applicant.
- Modeling by using artificial intelligence tools, particularly probabilistic models.
- Data and signal processing.
- Matlab programming.
- Good level in English: spoken and written.

4. Type of financing

Public financing (Grant of the French Ministry of Education and Scientific Research)

5. Candidature

Send by e-mail to kamal.medjaher@ens2m.fr and noureddine.zerhouni@ens2m.fr:

- a CV and a motivation letter ;
- the grading during the last year of studies (Master or Engineering level) ;
- a letter of recommendation from the head of the research department (or from the head of the last year of studies).