Solar farm degradation modelling and maintenance planning

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1 Subject

Motivation

In the framework of high technology and advanced monitoring, the reliability and lifetime extension of complex systems is one of the major challenges in industrial engineering. To avoid failure and the induced losses the systems must be maintained. Maintenance operations can be corrective or preventive. The corrective action is applied on a failed system and the preventive action is performed before the failure on a highly deteriorated system. A survey of maintenance policies is given in [8]. The maintenance actions can be perfect or imperfect. After a perfect maintenance action the system is as good as new for example after the maintenance of a electronic device an electronic component can be replaced and therefore after the maintenance the system is as good as new. After an imperfect maintenance action the system is not as good as new. There exists many possibilities to consider imperfect maintenance in the literature. For example steel structures are protected by an organic coating which is also deteriorating. Maintenance actions are then done in order to improve the condition of the organic coating. Typical maintenance actions performed on the coating are local and lead to an imperfect maintenance.

Nowadays, one important issue is tge maintenance optimisation of multi-component systems, such as solar panel, solar farm, wind turbine or wind farm. In absence of interaction between components, the reliability and optimal maintenance policies of multi-component systems can be obtained by applying similar approaches as the single unit systems. However, such assumption is often unrealistic because of the internal complex structures of the systems, the set up costs, the common cause failures to the components, etc. There are several types of interaction between components of the multi-component systems such as the economic interaction when the system maintenance cost is related to the components, structural dependence when to repair the failed component one has to remove or even to replace the non-failed components, Stochastic dependence when the failure of components can affect the state (the deterioration level, the failure rate, etc.) of some working components [9–11].

For a complex multi-component system under consideration, the main challenge is to model the interaction between the degradation process of components and to take advantage of this model to plan efficient maintenance operations.

General layout of the thesis

One considers a multi-component system such as a gearbox or a wind farm. The components are deteriorating and the failure, maintenance action and duration of one component impact the degradation level of the other components since the whole system should continue to fulfill its mission and produce the expected result. To propose an efficient maintenance policy, first, it is essential to focus on the degradation interaction modeling and afterward consider the maintenance efficiency modelling. The optimisation problem should take into account all the maintenance constraints.

The different steps of this thesis can be resumed as follows:

1. Degradation and interaction modelling
2. Maintenance effect modelling
3. Maintenance policy optimisation

The key knowledge and required skills to implement the previous steps are as follows:

1. Reliability analysis
2. Probability and stochastic models
3. Maintenance optimisation
4. Simulation and programming software: Matlab, R, Scilab,...

Main collaboration on the subject

The candidate will organise and/or participate to meetings or seminars with the major industrial partners of the UTT on this subject.

2 Research team

Mitra Fouladirad and Antoine Grall research interests focus on maintenance modelling and joint maintenance/monitoring policies by using stochastic models to optimise maintenance and/or inspections policies (see references [1–7,12–14]). Contacts: **antoine.grall@utt.fr, mitra.fouladirad@utt.fr** (refer to www.researchgate.net for more details)

Laboratory

The Systems Modelling and Dependability Laboratory (webpage: http://lm2s.utt.fr/en/index.html) is part of the Charles Delaunay Institute. This institute coordinates all the research activities in the university. The Systems Modelling and Dependability is organised into two main research projects: decision and diagnostic in non-stationary environment and stochastic models for reliability and maintenance. The applicant will be involved in the last team.

National collaborations

P. Do Van Lorraine University (Nancy, France), C. Bérenguer Alpes Grenoble University (Grenoble, France), Vlad Barbu University of Rouen (Rouen, France)

International collaborations

What is more The candidate will be able to work with the usual international partners of the supervisors on the subject that is the research teams of:

- B. Lindqvist from Norwegian University of Science and Technology, Trondheim, Norway, (http://www.math.ntnu.no/ bo/)
- M. Xie from Hong Kong University, China (minxie@cityu.edu.hk)
- P. Scarf from Salford University, U.K. (https://www.salford.ac.uk/business-school/our-staff/business-academics/philip-scarf)

- A. Barros from Norwegian University of Science and Technology (https://www.ntnu.edu/employees/anne.ba

If necessary, a research stay in one of these universities can be organised. Moreover, if the quality of the work is correct, any Ph.D student of the team attends international conferences during the thesis.

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