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Prognostics and Health Management (PHM) - State-of-the-art in Predictive Maintenance

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Abstract:

With the growing advancement in sensor technology and automated controls in engineering systems, trend of on-board data recording has greatly increased. The data analysis tools along with the real-time sensor data, have resulted in a paradigm shift in the way systems are maintained. After the industrial revolution, the first generation of maintenance philosophy was corrective maintenance, in which, components or systems were fixed once they got failed. In safety critical systems, this maintenance philosophy produced catastrophic results. The next generation of maintenance philosophy was preventive maintenance, in which maintenance was performed based on the manufacturer's or OEM specified life. Although, this maintenance philosophy has been able to achieve better results in terms of safety, however, in perspective of life-cycle costs, preventive maintenance philosophy is wasteful. Therefore, a few decades back, the concept of predictive maintenance became popular. Ever since it came into being, predictive maintenance has gone through several evolutionary stages. Reliability centered maintenance or RCM, makes calculated estimates of maintenance schedules based on the archived statistical data from the field. With the development in MEMS sensor technology, Condition-Based Maintenance (CBM) using real-time data has become the prevalent maintenance philosophy. The recent advances in data processing technologies have enabled us to determine not only the present health but also to predict the future health of systems. In other words, system's health is can not only be estimated but health can also be managed. Therefore, another phase of predictive maintenance, that is Prognostics and Health Management (PHM) has evolved. In PHM, two key modules are fault diagnostics and failure prognostics. In fault diagnostics, the current health of the system using sensor data is estimated, while in failure prognostics future evolution of health is predicted. This lecture consists of a review of fundamental concepts of fault diagnostics / failure prognostics, which will be followed by the tools and techniques used to develop PHM algorithms. The lecture also includes a review of the state-of-the-art in this field. A few case studies related to fault detection / prediction in aircraft engine, electromechanical and electrochemical domains will also be discussed.

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