Commentary

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Demodulation Techniques are Standard Techniques for Detecting Fault Characteristics in Analysed Signals

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Description

A fault prognosis technique for Discrete Manufacturing Processes (DMP) that is based on the extraction of a Health Indicator (HI) from a large amount of raw sensor data is the subject of this paper. Finding the machine's significant points that are connected to the degradation is how the HI is extracted. Utilizing a suitable stochastic process, the dynamics of HI are then analysed and modeled. An actual case provided by ST-microelectronics is used to test the developed method and the results show that it works well. A decentralized strategy for fault isolation and detection in wireless SHM systems is presented in this paper. Neural networks are embedded in the wireless sensor nodes installed in the monitored structure using the analytical redundancy approach, allowing each sensor node to independently detect and isolate sensor faults in real time. The structure of the paper is as follows: An overview of FDI concepts is provided first. Following that, a wireless SHM system that is capable of fault isolation and detection is described, with a strong emphasis on the embedded neural network approach. The wireless SHM system's performance is then validated through a series of laboratory experiments. The prototype SHM system is installed on a test structure for the laboratory experiments. The sensor data obtained during normal (*i.e.*, non-faulty) system operation is used to train the SHM system's fault diagnosis capabilities. After that, faults are injected into the wireless sensor nodes to verify that the system can independently identify and isolate sensor faults.

Health Indicator

The main objectives to develop integrated Fault Detection, Isolation and Identification (FDII) schemes for nonlinear systems that can function even in the presence of partial state measurements and are resistant to sensor noise and system disturbances. Not only are the FDII schemes capable of accurately estimating the severity of anomalies after they occur but also of reliably detecting and locating them in nonlinear systems. In addition, the FDII system is robust against system disturbances and measurement noise to reduce false alarms when the system is operating normally. In addition, the FDII system can function with sufficient precision even when only a portion of the system's states can be measured (partial state measurement). As a result, one more goal of the work is to create a state estimation algorithm that is robust to fault occurrence and can accurately estimate the system's unmeasured states even in the presence of faults or anomalies. This algorithm will eventually be incorporated into the FDII system.

The tracking control problem of a class of unknown non-affine dynamic systems with unpredictable sensor and actuation failures is the focus of this work. Control design for a non-affine system becomes extremely challenging due to the nonlinear and implicit way in which control inputs enter the system and affect its dynamic behavior. If the system dynamics are not available for control design but there are unanticipated sensor and/or actuator faults, the underlying issue becomes even more complicated. To achieve Uniformly Ultimately Bounded (UUB) stable tracking control of a group of non-affine systems, a structurally simple and computationally inexpensive control scheme is proposed in this work. The control that is being proposed has a generalized PI form and can handle problems with both the sensor and the actuator. Theoretical analysis and numerical simulations confirm the proposed control strategy's efficacy.

Amplitude Modulation

For nonlinear, uncertain and possibly large-scale dynamical systems, a continuous-time distributed fault detection and isolation approach is presented in this paper. An adaptive approximation of the interconnection with neighboring subsystems and knowledge of the local subsystem dynamic model serve as the foundation for the local diagnostic decision. A consensus-based estimator is developed to enhance the detectability and isolation of faults affecting variables shared by multiple subsystems. The proposed distributed scheme's detection and isolation capabilities are characterized by theoretical results.

Amplitude Modulation (AM) and/or Frequency Modulation (FM) typically characterizes the vibration or acoustic signal from rotating machinery with a localized fault. Demodulation methods are standard methods for identifying fault

characteristics in analyzed signals. The Time-Scale Manifold (TSM) ridge demodulation method is one of these methods. It has the advantages of good time-frequency localization and in-band noise suppression. However, the envelope extraction of fault-induced impulses will still be disrupted by the survived in-band noise on the achieved TSM due to the essential property of wavelet ridge. By combining the advantages of the first two TSMs, this paper presents an improved TSM ridge demodulation method known as exchanged ridge demodulation of TSM: The first TSM's noise suppression and the second TSM's noise separation. More specifically, the fault-induced impulses can be precisely captured by the ridge on the second TSM while intelligently avoiding in-band noise. The Instantaneous Amplitude (IA) waveform that corresponds to the actual envelope of pure faulty impulses can be represented by placing this ridge on the initial TSM. For the best time-scale representation of the analyzed signal, an adaptive selection method for Morlet wavelet parameters based on the Smoothness Index (SI) in the time-scale domain is also proposed. A simulation study and applications to the diagnosis of gear faults and bearing defects demonstrate the method's efficacy. An actuator-fault isolation strategy is suggested. A collection of invariant set-based FDI conditions are established for the proposed method to guarantee reliable FDI for each and every actuator fault that is taken into consideration. During the transition caused by fault occurrences, all considered faults can be detected and isolated under these guaranteed FDI conditions. The proposed method outperforms the existing set-based FDI approaches by combining the advantages of interval observers in the transient-state functioning with those of invariant sets in the steady-state functioning. Non-linear interaction patterns between process variables have been reasonably detected and predicted using the proposed approach. The chapter also includes another quality assurance mechanism-third party certification embodied by health care report cards. Despite widely cited unanticipated and undesirable consequences, report cards for health insurers and providers seem to offer several benefits: They move market share away from the worst sellers, encourage all sellers to improve quality, and facilitate matching between severely ill patients and the best providers. The chapter also explores pay for performance schemes, which combine elements of incentive contracts and quality certification.