

INTELLIGENCE MAINTENANCE SYSTEMS BOOST PREDICTIVE MAINTENANCE

Degradation in the performance of machinery and equipment, due to aging and wear, leads to faulty or failed performance, resulting in costly downtime. Technology for predicting and preventing degradation in the performance of a machine, process, system, or service--in contrast to the traditional maintenance approach, which is focused on detecting failure--has potential to allow for essentially eliminating downtime and significantly enhancing product quality.

Intelligent maintenance systems are geared toward proactively predicting a failure, as opposed to just responding to faults detected by machine status monitoring, thereby helping to optimize asset utilization. Moreover, intelligence maintenance algorithms can facilitate improved interpretation of machine performance data.

The WatchDog Agent, an intelligent, prognostic maintenance platform developed by the Center for Intelligent Maintenance Systems, embodies a paradigm shift in product performance degradation assessment and intelligent maintenance systems. The WatchDog Agent is designed to be able to assess and predict the performance of a particular process or piece of equipment in accordance with data input from sensors, historical data, and operating conditions. The intelligent maintenance system would thereby facilitate scheduling maintenance at the optimal time.

The WatchDog Agent, a computational tool, is a set of algorithms that convert multiple sensor readings into coherent information that can predict the health of key parameters. Performance information can be further extracted from multiple sensor inputs via signal processing, feature extraction, and sensor fusion techniques. The future behavior of process signatures can be predicted based on the historical behavior of such process signatures, allowing for forecasting process or machine performance. On the basis of the forecasted performance, potential failures could be predicted before they occur, facilitating proactive maintenance.

The WatchDog Agent, which can be embedded on a machine, can take input from diverse types of sensors, including those that measure such parameters as vibration, temperature, force, acoustic emission, voltage, or current. WatchDog can perform feature-level and decision-level sensor fusion; it can extract features from the sensor and connect the features into a pattern. A WatchDog Agent prognostics tools hardware platform can be used as in-house system to help IMS company members' prototype customized prognostic tools and validate its performance for rapid deployment. The test bed prognostics tools could then be deployed in a commercially available platform.

Jay Lee, IMS' director, told *Advanced Manufacturing Technology* that there is no generic tool or methodology for predictive maintenance. Instead, by applying a set of algorithms and a methodology, you can solve a specific maintenance problem. WatchDog Agent can serve as a toolbox in which different algorithms can be used depending on such factors as the speed and frequency of a particularly machine application.

The WatchDog Agent algorithms have been tested/implemented at such companies as, for example, Toyota Motor Manufacturing (applied to an air compressor at Toyota's Georgetown, KY facility); ETAS (vehicle on-board diagnostics); GM (factory network systems), Komatsu (earth-moving equipment); Harley-Davidson; Intel. WatchDog Agent has also been applied to smart machine tools. A typical application for WatchDog Agent involves rotating machinery.

The WatchDog intelligent maintenance system is being utilized at Toyota Motor Manufacturing to develop a model to predict compressor bearing wear, and to develop a model for predicting surges and backflow. Inputs pertaining to such machine parameters as pressure, humidity, and oil temperature could help determine and predict the optimal surge line. The Toyota Motor Manufacturing facility has also used the intelligence maintenance system to conduct root-cause analysis to better understand the behavior of a particular machine in order to maximize resources.

Lee explained that it is challenging to precisely define the features of the machine's behavior that the WatchDog Agent will process. Within the next two years, the first version of a reconfigurable WatchDog Agent is expected to be applied to such applications as bearing motors and gears.

The Center for Intelligent Maintenance Systems is a National Science Foundation/University Cooperative Research Center focused on "predict and prevent" maintenance technology rather than on the traditional maintenance practices of "fail and fix."

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