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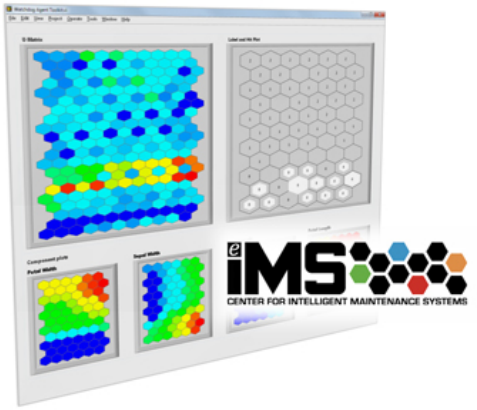
Last Revised: 2014-11-06 07:15:11.0

Watchdog Agent Prognostics Toolkit



- Prognostics and predictive algorithms toolkit
- Adds neural networks, Gaussian mixture modeling, and statistical pattern recognition to NI LabVIEW
- Self-organizing maps and health radar charts to help you streamline data presentation
- Ideal for condition monitoring applications

Overview

The Watchdog Agent Prognostics Toolkit was developed over the past 10 years through National Science Foundation-granted research by the Center for Intelligent Maintenance Systems (IMS) at the University of Cincinnati. Using a patented analysis technique and industry-standard algorithms, the toolkit adds ready-to-use prognostics health management algorithms and graphic displays to your NI LabVIEW applications. The toolkit algorithms include neural networks, logistics regression, Gaussian mixture modeling, statistical pattern recognition, autoregressive moving average, and match matrices. With these algorithms, you can perform feature extraction and principal component analysis as well as pattern matching to detect and predict faults in everything from critical machinery to human organs. By combining the powerful built-in analysis techniques with intuitive graphics such as self-organizing maps, health radar charts, and hierarchical tree clusters, the toolkit helps you build user interfaces that easily convey information about its predictions and analysis of the asset under test to your users.

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Application and Technology

Watchdog Agent Approach to Prognostics

Researchers at the IMS Center have refined their approach to prognostics over the past 10 years to offer an industry-tested method of classifying and predicting asset failure. Their technique involves five basic steps: data acquisition, feature calculation, principal component analysis, fault classification and health monitoring, and health prediction.

The first step is to define your operating regimes for the asset. At its simplest, the asset could be healthy or faulty. You can create this definition through modeling or actual data collection that is used for model training. Then you calculate several training data features to classify the asset using analysis tools in NI LabVIEW software, the LabVIEW Advanced Signal Processing Toolkit, and the NI Sound and Vibration Measurement Suite. After that, perform principal component analysis to determine which features are the most different between the various operating regimes or, rather, which analysis calculations are the best indicators for determining whether the asset is healthy or faulty.

You can now record and compare online data to the various operating regimes that you defined using the principal features to classify the current machine state into the regimes. Based on how close the asset is to operating within a particular regime and on its operating trends over time, you can predict the future operation and health of the asset.

By taking advantage of the industry-leading NI analysis functions and data acquisition platform, the Watchdog Agent Prognostics Toolkit builds on the success of virtual instrumentation to deliver a powerful and flexible prognostics tool.

Watchdog Agent Signal Processing Techniques

The Watchdog Agent Prognostics Toolkit adds the following industry-standard analysis algorithms and techniques to LabVIEW for condition monitoring applications.

Self-Organizing Maps

A self-organizing map helps you visualize the various operating regimes of the asset and their similarities. Each cell represents the similarity of a data or training file and the one next to it. A blue color in the Figure 1 example indicates that the files are very similar while a yellow or red cell indicates a large difference. The map organizes itself, grouping similar files together. The label and hit plot compares the test data you are acquiring to the training data and marks a "hit" in the most similar cells.

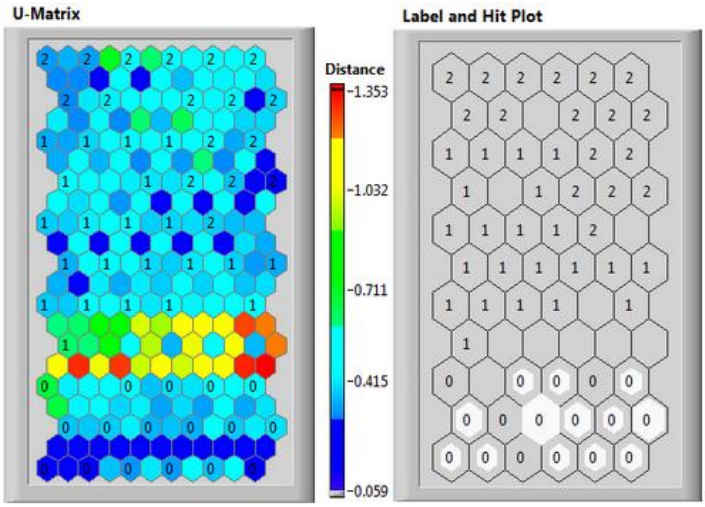

Figure 1. Self-Organizing Map

Health Radar Charts

A health radar chart helps you display the confidence values of an asset's components. A confidence value is generally a number between 0 and 1 that indicates the component's health, with 1 being completely healthy and 0 being failed. Figure 2 shows that the gearbox is the least-healthy component of the machine and is the area where you should focus your maintenance or further investigation.

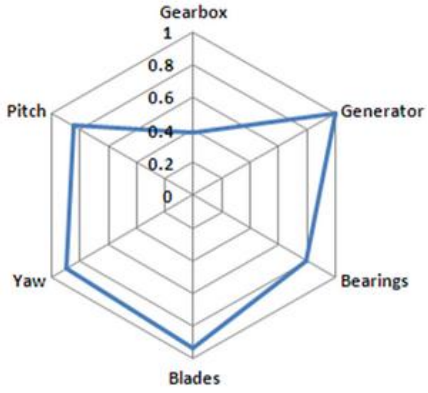

Figure 2. Health Radar Chart

Neural Networks

Artificial neural networks are a powerful tool to help you perform tasks such as pattern recognition using machine learning. Rather than basing applications on the traditional algorithmic approach to solving a problem through a state machine, the system chooses a set of steps to reach the solution based on previous experience and learning. In a neural network, instead of trying to simulate a thought process, applications simulate the architecture of the human brain, a model that runs on a network of neurons that interact with each other to produce optimum results. The Watchdog Agent Prognostics Toolkit uses them to not only produce self-organizing maps but also classify regimes and make long-term predictions with a large amount of training data.

Gaussian Mixture Modeling

Gaussian mixture modeling is another technique you can use to group similar data into multiple regimes based on their calculated features. Once you have grouped the data, you can then use the model to classify new data into the various regimes.

Statistical Pattern Recognition

Statistical pattern recognition is a health assessment tool that uses the data from the healthy component or system for training. It compares the recent feature distribution with the feature distribution from the healthy component or system and calculates the overlap of the two distributions. The amount of overlap is the calculated Confidence Value (CV); the CV value can be considered a health indicator since a degraded component would have much larger deviation from normal than a component that is healthy and has minimal degradation.

Requirements and Compatibility

OS Requirements

Windows 7
Windows Vista
Windows XP

Software Requirements

NI LabVIEW 2011
NI LabVIEW 2011 Advanced Signal Processing Toolkit
NI LabVIEW 2011 MathScript RT Module
NI Sound and Vibration Measurement Suite 2011
Reference Library for Converting Between LabVIEW and XML Data (GXML)

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Support and Services

System Assurance Programs

NI system assurance programs are designed to make it even easier for you to own an NI system. These programs include configuration and deployment services for your NI PXI, CompactRIO, or Compact FieldPoint system. The NI Basic System Assurance Program provides a simple integration test and ensures that your system is delivered completely assembled in one box. When you configure your system with the NI Standard System Assurance Program, you can select from available NI system driver sets and application development environments to create customized, reorderable software configurations. Your system arrives fully assembled and tested in one box with your software preinstalled. When you order your system with the standard program, you also receive system-specific documentation including a bill of materials, an integration test report, a recommended maintenance plan, and frequently asked question documents. Finally, the standard program reduces the total cost of owning an NI system by providing three years of warranty coverage and calibration service. Use the online product advisors at ni.com/advisor to find a system assurance program to meet your needs.

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- **Discussion Forums** - Visit forums.ni.com for a diverse set of discussion boards on topics you care about.
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