Scientist creates AI algorithm to monitor machinery health

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Dr. Rodrigo Teixeira's patented algorithm adds artificial intelligence to machinery vibration analysis. Credit: Topher Simon Photography

An artificial intelligence algorithm created by University of Alabama in Huntsville (UAH) principal research scientist Dr. Rodrigo Teixeira greatly increases accuracy in diagnosing the health of complex mechanical systems.

"The ability to extract dependable and actionable information from the vibration of machines will allow businesses to keep their assets running for longer while spending far less in maintenance. Also, the investment to get there will be just software," says Dr. Teixeira, who is the technical lead for the Health and Usage Monitoring Systems (HUMS) analytics project at UAH's Reliability and Failure Analysis Laboratory (RFAL).

In blind tests using data coming from highly unpredictable and real-life situations, the algorithm consistently achieves over 90 percent accuracy, says Dr. Teixeira.

"This technology is in the trial stage. We are seeing how it performs in the field. If the results so far hold, we will build credibility and hopefully gain acceptance with our Dept. of Defense partners," he says. "At the same time, we are expanding our client base to include the private sector. There, we believe we will have an even larger impact in the way they do business."

Typical vibration analysis searches for anomalies in the vibration of machinery such as engines and gearboxes. These changes in vibration can signal wear and future maintenance needs long before the machinery fails.

"Any machine shakes and vibrates, and it will vibrate a little differently when there is something wrong, like a fault," says Dr. Teixeira. "If you can detect a fault before it becomes serious, then you can plan ahead and reduce the time machinery spends idle in the shop. As we all know, time is money."

The difficulty in extracting useful information from machinery vibration is the amount of random noise that exists in normal operating environments. Finding that useful information has been a "needle-in-a-haystack" problem. Current monitoring algorithms assume that

vibrations are static and that signal and noise can be differentiated by frequency.

"The problem is that those assumptions never hold true in real life," Dr. Teixeira says. "Instead, what we have done is to take an artificial intelligence algorithm and 'teach' it the basic principles of physics that govern faults in a vibrating environment."

Dr. Teixeira's approach has provided the U.S. Army with a new way of producing actionable information from helicopter HUMS data, says Chris Sautter, RFAL director for reliability.

"His approach, using machine learning, permits the analysis to look at the history of the data output rather than just a single flight. We train the algorithm much like you train your cell phone to understand your voice," Sautter says. "When the particular component we are monitoring sees vibration signatures that no longer reflect the normal performance of a component, an alert is passed to the maintenance team."

The RFAL algorithm fits easily into the Condition Based Maintenance paradigm that has been adopted across the Dept. of Defense and the commercial aviation sector, Sautter says. "Having this capability and the ability to enhance the maintenance policy of large fleet operators has presented UAH and the Reliability Lab with a host of new clients for our research capabilities."

Provided by University of Alabama in Huntsville