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New approach to predictive maintenance in process plants

When Machines Learn From Plant Experts

The author:
Armin Scheuermann, editor in chief of CHEMIE TECHNIK magazine

Data analysis is one of the hot topics of our time. But without a process engineering context, big data is useless to the process industry. This is why the Israeli start-up software company Visual Process uses modern machine learning methods as well as expert know-how for its predictive maintenance and plant diagnostics tool. The company was acquired by SAMSON in June and the valve specialist has great plans for the Precognize software tool.

Predictive maintenance is one of the first business models in the IIoT environment that everybody is talking about. So far, predictive maintenance in process industry was mainly limited to the online monitoring of individual machines and plant components. Systematically monitoring entire plants for predictive maintenance made it necessary to create complex models, which took into account the current operating data as well as process engineering relations. If at all, such tasks were carried out by installing additional sensors and special prediction systems.

Predictive maintenance in entire plants

Many field units (or tags) must be monitored to implement predictive maintenance across an entire plant. Deviations can be detected by comparing current data with historical data. This may sound simple but is no easy task to fulfill. After all, deviations may result from scheduled plant shutdowns or intentional changes to the process itself or how it is run. And false alarms undermine the acceptance of diagnostic systems in real-life operation.

The question now is how expert know-how and a plant's process engineering environment can be taken into account in predictive maintenance? For this purpose, Precognize, the SAMSON tool, combines machine learning and asset and process models with data on the cause-and-effect relations between variables. In this context, 'machine learning' refers to an artificial intelligence (AI) system that learns from examples and is capable of generalizing these examples after a phase of learning. "Our goal is to provide plant operators with a few truly actionable alerts," says Mr. Chen Linchevski, CEO of Visual Process: "Because every small problem that is solved in good time can prevent a bigger problem from occurring later." The art lies in separating important information from unimportant information. The key task of the tool is to differentiate between normal and abnormal data points. This is done based on the analysis and machine learning of the operating data recorded over one year. The result is the baseline: a statistical model that serves as the basis for future analyses of new data in real time. Whether changes to a measured value or tag are normal deviations or the result of an imminent malfunction is determined by the multivariate system based on the relation to the values at other tags. To prevent false alarms, the tool uses a second model, which represents the knowledge gathered by the statistical model as cause-and-effect relations.

Plant description without any modeling know-how

The tool's drag-and-drop interface makes it possible for the plant operator's experts to describe their plant without having any modeling expertise. By doing so, the relations between the plant components' properties and the process variables are identified and the physical relations are recreated. "The on-site team has the greatest influence on the quality of the model," explains Mr. Linchevski. Depending on the number of tags, the software tool creates a fully fledged model of the plant based on the data collected over a few days or weeks. This model is implemented in the form of graphs. Abnormal data points are compared based on graph analyses to pinpoint the cause of a problem. The result is a deviation graded by relevance for which the software specifies a possible main cause and suggests recommended action. Every deviation detected makes the tool's alerts more accurate, for example if users subsequently enter the actual cause of the problem into the system.

According to user experience, pattern recognition helps trigger an extensive exchange among staff about the cause-and-effect relations and the plant's behavior in everyday operations. As a result, discussions among the operator teams improve in quality.

Pattern recognition to prevent costly plant failures

The software tool has already proven itself in real-life plant operation: In a gas plant with roughly 2,500 sensors for example, pattern recognition detected a leaking heat exchanger and thus prevented a costly failure. Problem analysis is based on the relation between small changes in temperature at pipe inlets and outlets and the position of certain valves. In a different petrochemical plant, the tool detected that the condition of a reactor valve gradually deteriorated over time.

The valve could be replaced without having to shut down the plant. A failure of the valve would have made it necessary to flare large amounts of raw gas.

"Operators of plants monitored by Precognize receive alerts on defective sensors, leakages and plant component failures at an early stage," says Mr. Linchevski. According to him, five to ten sensor faults per month are detected in well-serviced plants that would have gone unnoticed otherwise. On top of that, the analyses detect the imminent failure of five to ten additional plant components 1 to 14 days before they actually fail. Depending on the type of plant, very expensive plant failures or shutdowns can be prevented this way.

The software tool is considered to have huge potential. In June, Visual Process received the award as a Technology Pioneer by the World Economic Forum. The award committee lauded that Precognize's technology combined disciplines which were not connected otherwise: sophisticated machine learning, graph analysis algorithms, and system engineering conceptual design techniques.

From valve manufacturer to provider of process intelligence

At the valve manufacturer SAMSON, the software tool functions as the basis for the company's own predictive monitoring and diagnostics system, SAM GUARD. It provides predictive maintenance for several thousand valves and other field units operated in process plants. SAMSON acquired Visual Process in June, but Precognize is to be marketed independently as well. "The acquisition brings us closer to our goal of becoming the market and innovation leader for smart, networked valve engineering in process automation," says Dr. Andreas Widl, CEO of SAMSON.

The monitoring and diagnostics tool is part of the valve manufacturer's digitization strategy, which is marketed under the SAM DIGITAL product line. The acronym SAM stands for SAMSON Asset Management in this context. In these products, the valve manufacturer wants to combine its expertise in processes with new technologies and data, and link it to process automation systems. Dr. Widl: "SAM DIGITAL upgrades our existing product portfolio while we make the transition from a pure manufacturer of valves and controllers to a provider of process intelligence."

INTERVIEW with Dr. Thomas Steckenreiter, SAMSON

"The ability to analyze an entire plant will make it possible to implement planned, predictive maintenance"

CT: What does the acquisition of Visual Process mean for SAMSON's digitization strategy?
Steckenreiter: Thanks to the acquisition of Visual Process, SAMSON will succeed in gain a foothold in the life cycle management of process plants. The ability to analyze an entire plant will make it possible to implement planned, predictive maintenance. This will increase plant efficiency and availability and rule out unexpected events, such as plant failures and undetected outages.

CT: Will the new SAM GUARD monitoring and diagnostic system replace the EXPERT valve diagnostics?
Steckenreiter: There will always be expert diagnostic systems for individual valves and we will continue to develop them further to provide a best-in-class solution. Operators who use SAM GUARD right will be able to deduct valuable information for optimizing their processes by combining valve diagnostics with other process variables. This applies to any type of sensor and other control equipment installed in a plant, by the way.

CT: The use of Precognize in SAM GUARD is aimed primarily at valve diagnostics but the possibilities of pattern recognition are considerably greater. Which other field units and plant components do you plan to monitor with SAM GUARD in the future?
Steckenreiter: This statement is not quite correct. Valve diagnostics are only a subset. Generally speaking, SAM GUARD was developed to monitor entire plants with their sensors, final elements, reactors and other components. If operators only monitor valves, they use merely a tiny portion of the possibilities for plant optimization that SAMSON GUARD has to offer.

CT: Will Precognize still be marketed independently as well?
Steckenreiter: Of course. It is very important for us that Precognize continues to be developed further quickly, regardless of the valve business.

Chen Linchevski, CEO of Visual Process:
"Our goal is to provide plant operators with a few truly actionable alerts."

For plant operators

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