New method for the early detection of emerging problems in industrial processes

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A statistics-based method for the early detection of emerging problems in industrial processes such as oil refining could improve industrial safety and productivity. Credit: Paul Marshall, Alamy Stock Photo

Modern automated industrial processes rely heavily on the precise control of process conditions, making it critical to detect emerging deviations. A KAUST-led research team has now developed a highly sensitive incipient anomaly detection method with the potential to

dramatically improve industrial productivity, quality and safety.

From oil and gas refining to water treatment and product manufacturing, precise process control has become an integral, but largely hidden, part of modern industry. However, keeping an automated process running smoothly and safely, and producing the desired results, remains a major challenge in many sectors. Even small deviations in process parameters can result in lost time, and catastrophic failure can bring devastating health, safety and financial consequences. It is little wonder then that engineers keep tweaking and improving the reliability of their processes, watching carefully for signs of anomalies that could lead to disaster.

"The detection of incipient anomalies is crucial to maintain the normal operation of a system by providing an early warning," says Ying Sun from the Environmental Statistics group at KAUST. "The problem is that incipient anomalies are often too weak to be detected by conventional monitoring methods."

Conventional methods for detecting process variations rely on the statistical identification of trends in the constant stream of monitoring data from key points in the process. To avoid false alerts, however, many observations are needed before a warning is triggered, so when an anomaly is detected it is often too late to avert a major problem, demanding a process shutdown..

"Our method incorporates information from the entire process history, rather than just the most recent observations, so that the detection indicator is more sensitive to small changes," explains Sun.

The team's statistics-based approach involves construction of memory chart of multiple monitoring parameters using a statistical technique known as principle component analysis. The test statistics for new measurements are then compared with a control limit set using 'healthy'

historical process data for anomaly detection and decision-making.

"Another advantage of our scheme is that it can be easily implemented in real time because of its low computational cost," says Sun.

Using their incipient anomaly detection scheme, the team was able to detect very weak emerging anomalies in an air flow heating system that could not be detected by conventional methods.

"Statistical quality control methods have a wide range of applications," says Sun. "At KAUST we are also developing incipient anomaly detection methods to monitor wastewater treatment plants and water desalination plants."

More information: Fouzi Harrou et al. Improved detection of incipient anomalies via multivariate memory monitoring charts: Application to an air flow heating system, *Applied Thermal Engineering* (2016). DOI: 10.1016/j.applthermaleng.2016.08.047

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