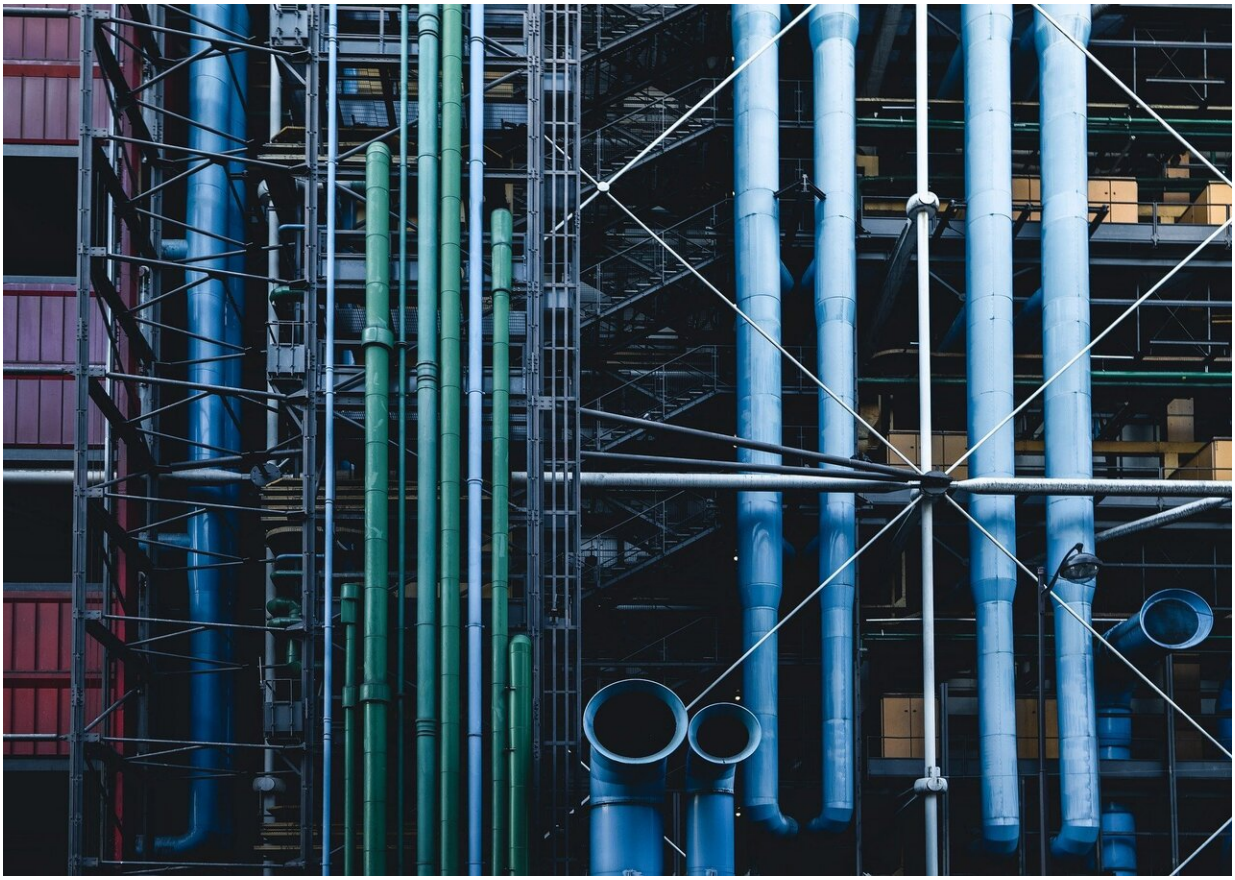
Researchers develop new percussion method to detect pipeline elbow erosion

November 20 2023, by Laurie Fickman



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A University of Houston engineering research team is pioneering a new method, based on percussion, to detect pipeline elbow erosion.

It is no small problem.

Below the surface of Earth, a veritable superhighway of piping carries corrosive liquids and transports substances like carbon dioxide, hydrogen, methanol and others for a variety of industrial needs from oil well cementing to chemical mining. And at each turn, a pipeline elbow is affixed to shepherd the flow in new directions.

Research reveals that due to erosion, the mass loss of the pipeline elbow is around 50 times larger than that of the straight pipe and the wall thickness of the pipeline elbow becomes thinner through continuous operation. This may lead to bursting or piercing of the pipeline elbow, resulting in economic losses, environmental pollution and other safety issues.

Since the 90-degree pipeline elbows are prone to erosion caused by the transported medium, detection of pipeline elbow erosion is critical to the health of the pipeline system. Currently, most of the detection methods of pipeline elbow erosion require the installation of a constant-contact sensor, which are constrained under certain environments.

"We propose a novel detection method for pipeline elbow erosion, combining percussion, variational mode decomposition (VMD) and deep learning," reports Gangbing Song, Moores Professor of Mechanical Engineering, in the journal *Mechanical Systems and Signal Processing*.

"The new method removes the need for the constant-contact sensor and professional operator and shows great applicability in different pipeline elbows with the same structure and dimension and is easy-to-implement, low-cost, and free of the installation of a constant-contact-sensor," continues Song. Jian Chen, a doctoral student, and Lan Cao, a graduated master's student, are the co-authors of the paper.

The method works by using VMD to analyze a sound produced by hitting a surface. VMD also breaks down the sound into seven different components or modes. Then, a machine learning technique called multi-rocket is applied to these modes. Multi-rocket essentially helps identify and select the most significant or representative component from the original sound produced by a single hit. The goal of the process is to enhance the understanding and interpretation of the audio signal.

To verify the effectiveness of the proposed method, the team conducted two case studies on three pipeline elbows with similar structure and dimension.

In the first case study, all the methods performed quite well, with an accuracy of around 100% across six erosion levels. However, in the second case study, the proposed method showed exceptional effectiveness, achieving accuracy greater than 90%. This outperformed other methods, both shallow and deep learning, which had accuracies below 80%. The proposed method showed superior performance compared to the others in accurately classifying data in the second case study.

The article marks the first time a study was conducted of pipeline elbow erosion through the percussion method, machine learning and deep learning. Song and his team have filed a patent on his invention, called "Detecting Elbow Erosion by Percussion Method with Machine Learning."

More information: Jian Chen et al, Detection of the pipeline elbow erosion by percussion and deep learning, *Mechanical Systems and Signal Processing* (2023). DOI: 10.1016/j.ymssp.2023.110546

Provided by University of Houston