Sensor mimics bats to detect dangerous structural cracks

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An ultrasound sensor for detecting dangerous cracks in structures such as aircraft engines, oil and gas pipelines and nuclear plants has been developed by researchers at the University of Strathclyde – with inspiration from the natural world.

The device, known as a transducer, identifies structural defects with varying ultrasonic frequencies and overcomes the limits of other, similar devices, which are based on rigid structures and have narrow ranges. It is thought to be the first device of its kind in the world.

The transducer developed at Strathclyde has a more flexible structure, based on a natural phenomenon known in mathematics as fractals. These are irregular shapes which recur repeatedly to form objects such as snowflakes, ferns and cauliflowers, making their structure appear more complex than it often actually is. The same concept also lies behind the hearing system of animals including bats, dolphins, cockroaches and moths.

Dr Tony Mulholland, a Reader in Strathclyde's Department of Mathematics and Statistics and co-researcher on the project, said: "Fractal shapes and soundwaves are characterised by having geometrical features on a range of length scales. However, man-made transducers tend to have a very regular geometry, similar to a chess board, and this restricts our ability to use this technology in finding cracks and flaws in structures where safety is critical.

"The reason transducers are still made this way is mostly historical; they were usually made by an engineer cutting with a saw and their design was traditionally done by manufacturing but now, with 3D printing, computer manufacturing and more laser technology, the transducer we have designed is increasingly viable.

"We know if we can send out soundwaves that are complicated and have different frequencies, we can work towards simulating what nature does. If there are defects in a nuclear plant or an oil pipeline, we would be able to detect cracks that have a range of sizes and do so at an early stage.

"This device could not only improve safety but also save a great deal of money, as early detection means inspections don't have to be carried out as often. This is something industry is telling us it needs and we are responding to that need."

More information: "A finite element approach to modelling fractal ultrasonic transducers," *IMA Journal of Applied Mathematics* DOI: 10.1093/imamat/hxv012

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