Acoustic waves used to determine softness of brain matter

A team of researchers have measured how soft brain matter really is. By recording how fast an acoustic wave travels in the intact brain of a pig, the researchers were able to determine that brain matter is extremely soft, even softer than common gelatine.

The study by researchers from Tsenghua University in Bejing and Professor Michel Destrade, School of Mathematics, Statistics and Applied Mathematics at NUI Galway, Ireland appears in *Biomechanics and Modelling in Mechanobiology*.

The experiment was carried out by generating "acoustic beams" on the surface of the brain, and focusing the beams to interact at a location inside the brain. The interaction amplified the magnitude of the beams and eventually a sound wave was launched in the bulk of a brain.

The sound wave was then observed in an ultrafast image through an ultrasound scanner, similar to those used in obstetrics. The speed of the wave was measured, and then related to stiffness of the brain matter through mathematical equations, like the pitch of a plucked string can be related to its tension. The connection between wave speed and stiffness was made through advanced modelling and simulations, which were mainly carried out at NUI Galway.

Professor Destrade said: "Previously I had compared the brain to glue by testing cubic samples of the brain. During this study the brain was fully intact and compared to a very, very soft gelatine gel, basically a wobbly liquid."

Results from the experiments showed that brain matter is at least three times softer than a gelatine gel. This extreme softness helps explain why brain matter is so susceptible to impacts and rapid accelerations of the head, such as those occurring in violent sports, car accidents or following a bomb blast.

The research has promising results for neurosurgery, if it can be used to measure the stiffness of healthy tissue compared to that of brain tumours. At the moment neurosurgeons have to rely on crude estimates to determine the extent of a brain tumour, as it is visually undistinguishable from the surrounding healthy tissue.

First they remove a part of the skull to access to the brain. Then they use finger palpation to estimate how soft or hard a region is, before deciding which part to remove, a procedure which has barely improved in the last 100 years.

Infrasound detection can improve early warning of tornadoes

A new tornado early warning system based on infrasound detection could result from research at the University of Alabama (UAH) being conducted with the help of General Atomics Electromagnetic Systems (GA-EMS).

Dale Strong, Chairman of Madison County Commission which is supporting the project with $50,000 in funding, said: "Any early prediction or warning to residents is critical in saving lives and property.

"It's not about if we're going to have another natural disaster – it's when."

The seed funding will be used to develop the necessary infrastructure and start the research on the relationships between infrasound and tornadoes and other severe storms, said UAH atmospheric scientist Dr Kevin Knupp.

Infrasound is generally defined as sound waves with a frequency less than 20 Hz – the lowest range of human hearing. Unlike higher frequency sound in the audible range (20-20,000 Hz), infrasound with a frequency around 1 Hz can travel hundreds of miles under typical atmospheric conditions without significant atmospheric attenuation.

Natural sources of infrasound include volcanoes, earthquakes, avalanches, large ocean waves, meteors, and meteorological sources such as turbulence, thunderstorms and tornadoes.

"I have had a long-standing interest in infrasound, and that interest was heightened after I was contacted by Hank Rinehart of GA-EMS, who leads an infrasound group at the company," said Dr Knupp. "They had some infrasound detectors operational during the April 27, 2011 super tornado outbreak, which accurately detected and tracked the Hackleburg (EF-5) and Cullman (EF-4) tornadoes."

Mr Rinehart, GA-EMS business area director of Sensors and Surveillance Systems, said an internally funded analysis of GA-EMS infrasound sensors that were operational on April 27, 2011 demonstrated further evidence of persistent and high-coherence infrasound emissions during the lifecycle of multiple tornadoes.

Dr Knupp said: "Infrasound detection offers a capability to economically fill in gaps in radar coverage. If the public understands that direct detection has a very high level of accuracy, then we believe that complacency can be reduced through public education."

A relationship between infrasound and tornadoes was suggested in the 1960s and 1970s, and further established by National Oceanic and Atmospheric Administration (NOAA) scientists who conducted research that has correlated infrasound sources with verified tornadoes. However, the manner in which infrasound is generated by tornadoes is not completely understood.

Infrasound sensors may help in tornado detection