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Slither in to spot engine trouble

Robot snakes may one day be set loose in jet engines to diagnose faults

Paul Marks

JUST sometimes, snakes on a plane can be a good thing. Snake-like robots wielding UV lasers may soon slither deep inside aircraft engines to seek out and repair damage, according to the British jet engine maker Rolls-Royce. Once it is up and running, the technology should help airlines deal with potential engine problems on the spot to keep planes in the air and avoid delays for passengers.

The idea for the snake robot stems partly from the fact that engine makers like Rolls-Royce and General Electric in the US routinely use intelligent algorithms to monitor the health of plane engines in flight. The software analyses data sent from around 100 pressure, temperature and vibration sensors embedded in each engine. These algorithms flag up trouble spots. But taking a plane out of service to strip down the engine can cost an airline millions of dollars – so technologies that can quickly inspect them are needed.

Right now, such checks are performed using a fibre-optic instrument called a borescope, a heavy-duty version of a medical endoscope. It is inserted in one of many 10 millimetre-wide ports dotted around a jet engine, allowing an engineer to look for, say, bird-strike damage to a fan or compressor blade. The trouble is, with Rolls-Royce monitoring 14,000 of its engines, flown by 500 airlines on 4000 aircraft worldwide, there are not enough borescope experts at all the airports the planes visit to do this diagnostic work.

> "The snake robot would wriggle into the engine and feed back images of any damage"

"We don't have enough specialists to go around so we need to automate this capability," says Rolls-Royce senior vice-president Pat Emmott. The firm's answer is to develop a robot that a relatively unskilled engineer can bolt on to an engine and leave to do its job. The snake robot would then go into the engine and feed images back to an expert who controls it remotely, a bit like telesurgery, he says. An engineer could then fix any problem.

Rolls-Royce is developing the technology as part of a €4 million European research project dubbed Miror, alongside industrial partners, who also need robots that can wriggle into small spaces. The snake robot prototype should be completed by July 2014. Miror project engineer Salvador Cobos Guzman of the University of Nottingham, UK, told a conference on mechatronics in Linz, Austria, on 19 September.

Big engines need big diagnostics

While Rolls-Royce's snake-like mechanism is under wraps – pending patent filings – its aim is to have the robot carry far more than a camera. A UV laser would make the edges of blade fractures fluoresce, and a miniature grinding tool could sand down a compressor blade damaged by bird corpse debris or stones sucked into an engine, for example. The main challenge is beating gravity, says Rob Buckingham, managing director of OC Robotics in Filton, UK, a pioneer in industrial snake-like robots. The longer the snake, he says, the more likely it is to become droopy and hard to control at its far end.

The thinnest snake robot that OC robotics have developed is just 12.5 millimetres wide – pretty close to what Rolls-Royce is aiming for – but it is only 60 centimetres long. Buckingham doubts that kind of length will be of great utility in a jet engine. "The more joints you add, the more difficult it becomes to maintain the curviness," he says.

Rolls-Royce is also developing robust camera chips that can be installed around the engine's 2000 °C core. The idea is that on engine shutdown, certain of the cameras in this interior CCTV network can be activated remotely by staff at Rolls-Royce's operations centre to give an instant picture if algorithms have suggested damage – before even the snake robot gets a look in.

"These cameras won't have to operate at engine temperatures – just survive them," says Emmott." So we're going to need some interesting ways to keep them cool." ■

Jazz-singing robot could shed light on consciousness

ROBOTS and humans will soon be living in harmony. A singing robot is being taught to improvise jazz duets with a human in a project that researchers hope will shed light on the nature of consciousness.

Antonio Chella at the University of Palermo, Italy, is working with a Teleno id robot, developed by the Hiroshi Ishiguro Laboratory in Japan. To start with, the Teleno id will be trained to mimic the movements and simple sounds made by a human singer, as well as associate parts of music with different emotional states. Chella then plans to see if the robot can use these associations to improvise – choosing movements and vocalisations that complement its human duet partner.

Intelligence is often defined as the ability to find connections between existing entities – understanding that a key goes in a lock, for instance. But Chella suggests that a conscious organism should be able to go a step further and introduce novel connections – between, say, musical phrases – that result in the creation of something new. That, in essence, is the idea behind improvisation.

Jazz musicians impressed by Chella talked of having a mental library of musical phrases that they were able to combine in new ways when prompted by other musicians. Importantly, however, this combination happens in a state that is "similar in a sense to dreaming", he says. "Not really conscious, but not unconscious." Chella wants to replicate these states in a machine. "Consciousness could be linked to these moments of combination," he says.

Chella presented the idea this month at the International Conference on Artificial Neural Networks in Lausanne, Switzerland.

"[This work] raises interesting questions about the link between consciousness and music making," says musician and computer scientist Philippe Pasquier at Simon Fraser University in Vancouver, Canada. But he is sceptical about whether a robot musician needs a physical body, citing examples of AI composers that exist only in software.

Instead, Pasquier argues that automated musicianship boils down to two challenges: composition and interpretation. Software has already been developed that can imitate Bach, he says. Interpretation, on the other hand, involves the specifically human traits of taste and aesthetic judgement. "What made The Beatles famous was not so much their compositions, but the fact that the interpretations of the compositions were brilliant," he says.

It is not yet clear how an artificial musician would go about interpreting music in a novel way. But by mimicking humans and then learning to sing, Chella's robot could provide clues.

What does seem to be important is that human composers often listen to hours of music made by others. "Humans don't tend to do things in a vacuum," says Pasquier. Chella's robot better get listening to those jazz standards. Douglas Heaven ■

ONE PER CENT

Solar concentrator gets alpine workout

On a sunny rooftop at its lab in Zurich, Switzerland, last week, IBM proved a chip powered by concentrated solar energy that's cooled to peak efficiency by water. Bruno Michel and his team demonstrated a 1.5-metre mirrored dish that concentrates the sun's energy by 150 times onto a prototype water-cooled photovoltaic chip (see picture). The how zor will be used to drive desalination systems in arid areas. Current efficiency is 16 per cent, but the team hopes to scale that up to 40 per cent. Similar water-cooled microchips already power an IBM supercomputer in Munich – the heat the water carries away warms nearby buildings.

Cartoon virtuoso plays by ear

Watch a professional pianist play and you'll be struck by how effortlessly their hands skip across the keys. Making an animated character do the same is much harder, but now Yuanfeng Zhou from the University of California, Davis, has built an algorithm that generates realistic 3D animation of piano-playing hands on the basis of music it is given. The software calculates finger positions for every chord in a piece of music and the motion of each hand throughout the piece (Computer Animation and Virtual Worlds, doi.org/jdw). The animated hands play the music as efficiently as possible – just like human players. See the video at bit.ly/pianobot.

When parking information is power

If you've ever driven around a city desperately in search of a parking place, here's how you need: a way to buy and sell information about free spaces. The software, developed by Baik Hoh of the Nokia Research Center in Palo Alto, California, is called TruCentive and counts a marker for parking spaces. The value of parking data is graded according to demand, and users get a bonus if their information enables someone to park, giving them credits to buy future information about parking spots. The work was presented at a transport conference in Anchorage, Alaska, this week.

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