OCRobotics

www.ocrobotics.com

Steerable string

It could soon be the year of the snake, at least in robotics terms, according to ROB BUCKINGHAM, managing director of OCRobotics

Historically, robots have been designed to operate on the outside of objects or to work in an environment where there are very few constraints. But there are situations when working on the inside is essential. Examples include inspection of nuclear facilities or industrial equipment or a submarine where the hazards or costs prohibit disassembly. That's where snake-arm robots come in. Many dangerous, time-consuming and otherwise impossible tasks can be simplified by these machines, which can reach the heart of a particular application without touching or damaging any components on the way.

A snake robot doesn't have wheels or legs, but moves by flexing its joints. By using its own body as scaffolding, the robot acquires an extensive motion range, including the vertical direction. Since a snake robot is composed of a number of of similar cooperating cells, where each cell is an independent unit, it becomes easy to manufacture, inexpensive and easy to maintain. In principle, a snake robot can climb by wriggling up a pole, and climb vertical steps by using its own body as scaffolding.

Snake robots are examples of hyper-redundant robots, or robots with a large number of degrees of freedom. Interestingly, such robots borrow inspiration from animals, in this case from jellyfish, worms and colonies of one-cell animals such as amoebas and volvox. From a robotics point of view, these life forms have many interesting features. They consist of many small parts, which are not complicated, but which combined have advanced properties.

The snake is basically a robotic arm, comprising a number of individual segments, with a drive unit controlling one or more of them. Taken to its ultimate, each individual segment can be controlled independently and has its own specific motors. A typical five segment machine would be powered by 15 motors. OCRobotics is using Maxon Motor A-max or EC models with planetary gearheads and encoders. For a really flexible 20 segment machine, as many as 60 motors would be used, all computer controlled and working in synchronised motion.

One of the prime target applications is servicing jet engines. The snake-arm robot travels down the air path to inspect inaccessible components, removing the need for manual access or dismantling. Importantly, the snake-arm robot can enter the engine and travel through the fan blades while components are still hot, reducing downtime and improving turnaround.

Wider applications

Other applications planned include operating TV cameras, searching vessels and vehicles for drugs, working in boilers or ovens and drilling underground. In the medical world, the snake arm robot may be used in keyhole surgery – again, the key advantage over current procedures is that the whole device may be controlled, not just the tip.

These snakes need to be long and flexible – ideally like a piece of steerable string. OCRobotics is considering arms as long as 15m with a diameter of only 80mm. These are seriously flexible devices which need support from their environment, but they would be ideal for exploring a collapsed building or exploring the drains. In effect these devices take the advantages of endoscopes and combine them with the motion control of a robot creating a device that is both flexible and can be controlled to follow a path.

Another key area for snake-arm robots is for shorter devices that need to carry a significant payload – let's say an

SNAKE-ARM FAQ

Q: Is the arm self-supporting?
A: Yes. We can also build longer thinner arms when such an arm can be supported at points along its length.

Q: What repeatability can be achieved?
A: Our definition of repeatability is the range of deviation in tip position when returning to a pre-defined position using the same path. For a 3m arm the repeatability will be approximately 5mm. In nearly all applications of snake-arm robots there is no requirement for any absolute accuracy since the operator controls the device relative to the environment. However, the computer can calculate where any part of the arm is to within a few millimetres.

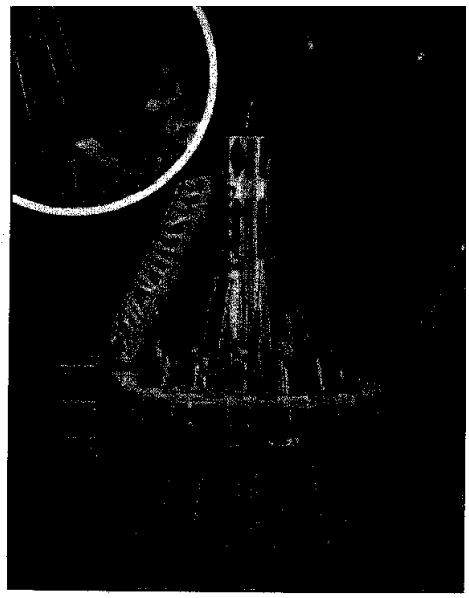
Q: What about soft contact?
A: We have designs to incorporate sensors into the skin of the device. This will mean that we are able to control contact with the environment. This is particularly important where there is interaction with people or fragile components.

Q: What are the size and weight constraints on sensors and tools?
A: This depends on the diameter and length of the arm. The payload can vary from 10g to 100kg. In fact some applications require a payload of 500kg.

Q: What is the size and weight of the drive unit?
A: A cylinder of diameter 500mm and height 500mm, and weighing approximately 50kg.

Industrial Technology
November 2002

OCRobotics
5 Fallodon Way, Henleaze
Bristol BS9 4HR, UK
Tel: +44 (0)117 909 5187
Fax: +44 (0)117 983 4397
Email: info@ocrobotics.com
URL: www.ocrobotics.com



arm with a reach of 3m and a payload of 20kg. Such an arm is ideal when the working environment is not benign or static.

One things that is difficult to get across is just how straightforward it is to control these things. Basically, the operator sees where the snake-arm is going using a tip-mounted camera and changes direction using a joystick – like flying an aircraft. The clever bit is the software that keeps track of where the rest of the device is and makes sure that it keeps as close as required to the path the camera has traced. This means it can avoid obstacles and makes it possible to interactively explore a structure – going forwards then backing up creating a tree of paths. Of course if the path is known offline then motion control becomes much more straightforward.

OCRobotics is based in Bristol and has close links with the aerospace industry and with local universities. Formed five years ago, the company has recently won two Smart Award from the DTI. It launched the snake arm technology in January of this year.

This is a new technology. Converting a piece of string into a piece of steerable string is not simple but we have cracked the key technical challenges. Recent work at OCRobotics has focused on developing a product family by concentrating on new actuators and a quick release mechanism. The aim is to be able to present a family of arms that can be manufactured in volume and sold at a very competitive price.

We are looking for partners in the UK, Europe, the US and Japan – companies who have particular requirements for working in difficult to reach places such as inspecting and maintaining aircraft wings or aero-engines. We would also be interested in talking to companies who make robots for endoscopes. We are also interested in talking to investors who have a vision for developing robots for human environments, from surgery to vacuum cleaning. But not ironing – ironing really is very tricky!

For more details on **snake-arm robots** from OCRobotics, please use the free information service

More information: Write in **565** on the card or email it enquiry@ilmagazine.co.uk.com

Industrial Technology
November 2002

OCRobotics

www.ocrobotics.com