Newsroom
Calendar
Funding Opportunities
Calls for Proposals
Calls for Tender
Press Packs
Press Releases
Library
Audiovisual
Speeches
Search Newsroom
Register & Subscribe
Login
Services for the Press

Research Result ::

Handy technologies for dextrous robots

(05/07/2012) A team of EU-funded researchers has developed the world's first human-sized, five-fingered robotic hand that can learn to grasp and manipulate a range of delicate and oddly shaped objects just as humans do.

© DEXMART project

According to Bill Gates a time is soon coming when there will be a robot in every home. And it does seem like we are at the dawn of robotics - intelligent and cognitive systems are popping up all over the place. The camera and infrared sensor on new video game consoles hint at a future when we can control devices just by speaking or hand gestures. There are even vacuum cleaners that navigate around your house and clean it up while you are out at work.

But one big problem that the robotics community has struggled to solve is that of manipulation. 'We are not talking about grippers, ' insists Professor Bruno Siciliano from the Second University of Naples, Italy (Università degli Studi di Napoli Federico II). 'Industry robots are pretty good at picking things up and putting them down. If robots are to really transform life and work alongside humans then they must be able to handle items just as humans can with their hands. Manipulation is a complex task that robots must learn to master.'

As coordinator of the **Dexmart** (1) project, Prof Siciliano has led a collaborative team of robotics researchers which has built an anthropomorphic five-fingered robotic hand that can handle eggs, pick up and turn around a credit card or take a pen from another person.

'We used the human hand as our model,' explains Professor Claudio Melchiorri from University of Bologna, Italy, where the hand prototype was constructed, 'as this provides the ultimate example of dextrous manipulation.'

The project wanted to build a hand that looked and moved as much as possible like its human equivalent. So far, however, no robotics lab has been able to build human hands of the correct size.

'We came up with a simple, yet extremely effective idea: using strings that are twisted by small, high-speed motors, we are able to exert high tensile forces within a compact space,' says mechatronics researcher Chris May from the University of Saarland, Germany. The robotic hand is able to touch diverse objects, grasp and lift them and place them gently in a new position. This new actuation solution was demonstrated on the Dexmart Hand, which could handle a delicate Easter egg and a heavy glass bottle.

The twisted strings are made of a strong polymer and enable the prototype hand to lift a five kilogram load by 30 mm within a split second, making use of small electric motors that are located in the forearm rather than the joints, which helps to give the hand the correct dimensions. 'Each robotic finger, which is like a human finger with three segments, can be controlled precisely by means of the individual tendons,' says researcher Gianluca Palli from the Bologna team 'The capability of the robotic hand is so near to that of humans that the vision of robots as personal assistants in the household, in the operating room as well as in industrial settings is becoming ever more realistic. We presume that the combination of small electric motors with twisted string is interesting for other applications as well.'

A handy brain

This hand has a brain too. 'One of the goals of robotics, especially for companion and helper robots in society, is their ability to behave autonomously,' says Prof Siciliano. 'Robots must respond to situations in appropriate and ways which are not pre-programmed. They should decide on an action and also work out the based motion to achieve it.'

But what is the best way to endow robots with this cognitive power? Prof Siciliano believes that robots, just like humans, need to learn through observation. A team of researchers from Karlsruhe University, Germany, Second University of Naples, Italy and the UK technology firm OMG, used advanced image processing technology to study the fine details of human hand movements. They stuck visual markers on a special sensorised glove worn on their hands and asked to perform various manipulation tasks that were captured on video. The image processing algorithms could track the movements on each marker and use this data to create rules on how the robotic hand should handle and manipulate similar objects.

Efficient, safe and adaptive control mechanisms are essential for complex robotic manipulation. But trying to coordinate the movements of five fingers, each with four joints, is incredibly challenging. 'If you look at each joint and what each motor would have to do individually you are dealing with 20 degrees of freedom and that is too complex,' explains Prof Siciliano. His research group in the University of Naples took its inspiration from biology to simplify the problem. 'Research into human hand control and coordination has shown that we don't control each joint separately; our brain controls all the joints at the same time in a coordinated fashion. Neuroscientists have demonstrated that human hand positions and movements can actually be simplified to just three so called "postural synergies". These three synergies can describe about 80 % of all possible grasping actions and positions,' says researcher Fanny Ficuciello from the Naples team.

The Naples team developed a control system which would take input from the optoelectronic sensors on the hand (which measure the grasp pressure), work out the synergies and actuate the finger movements. The grip precision that these three synergies can create is quite remarkable and permits extremely refined manipulations.

The optoelectronic sensors are another major innovation which the Dexmart partners integrated into their

hand. Several sensors have been developed to measure joint angles, tendon forces and tactile interactions with objects. Within the tactile sensor, advanced computational analysis of the captured light intensity inside a number of sensitive elements makes it possible to calculate the forces exerted on the object by the fingers and also whether the object is slipping out of the grasp. Professors Giuseppe De Maria and Ciro Natale, together with researcher Salvatore Pirozzi from Second University of Naples, who developed the sensor, have filed a European patent for the technology.

'The success of the Dexmart hand is based on the integration of all these novel technologies and concepts - the sensors, the actuators, the control and learning mechanisms,' says Prof Siciliano. 'Our demonstration hand has proven its capabilities and we are now receiving enquires and interest from research groups from many countries. Despite all this new technology the cost of one of these hands is significantly lower than anything you could currently buy, and which would have much less dexterity.'

A prototype hand and two fully sensorised fingers ran without error for four days last December at the RobotVille and successfully took a range of objects out of visitors' hands. The consortium is now exploring the commercial viability of producing fully functional hands initially for the academic community for robotics studies.

The Dexmart project received EUR 6.3 million (of total EUR 8.1 million project budget) in research funding under the EU's Seventh Framework Programme, ICT specific programme.

(1) 'Dexterous and autonomous dual-arm/hand robotic manipulation with smart sensory-motor skills: A bridge from natural to artificial cognition'.

Useful Links:

- **'Dexterous and autonomous dual-arm/hand robotic manipulation with smart sensory-motor skills: A bridge from natural to artificial cognition' website**
- **Dexmart project factsheet on CORDIS**

Related Videos:
- **http://wwwiaim.ira.uka.de/users/jaekel/share/Dexmart_FZI_Video.mov**
- **http://www.dexmart.eu/fileadmin/dexmart/public_website/downloads/attentional-CNRS-UNINA_JAN-2012.mpg**
- **http://www.dexmart.eu/fileadmin/dexmart/public_website/downloads/BeerRobot.wmv**
- **http://www.dexmart.eu/fileadmin/dexmart/public_website/downloads/tactile_new.wmv**
- **http://wpage.unina.it/lvillani/ftp/Dexmart/video_unibo_unina.mp4**
- **http://www.dexmart.eu/fileadmin/dexmart/public_website/downloads/00013-HandsUp.MTS**

Related Articles:
- **Feature Stories - Inspired by challenge - our robotic future**

Information Source: Bruno Siciliano, Università degli Studi di Napoli Federico II, Italy