SIEMENS

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Autonomous Systems

How to Give Industry a Hand

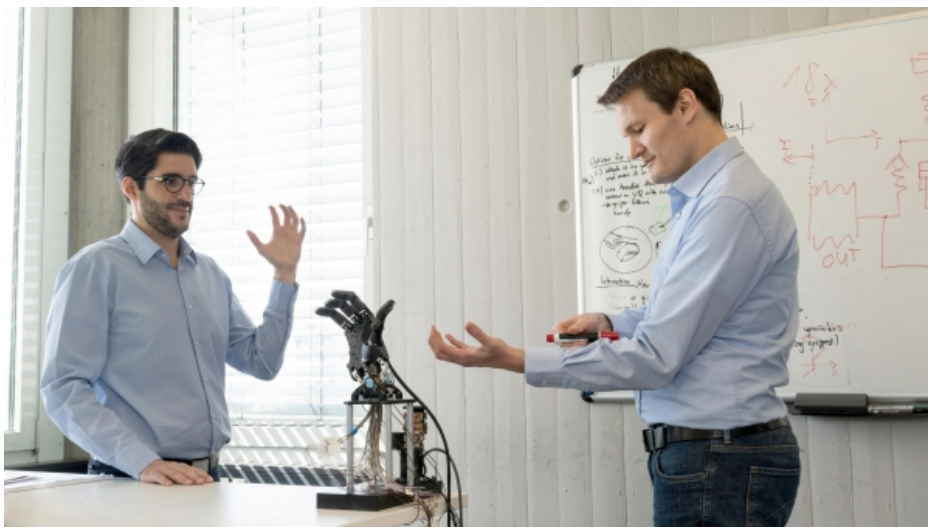
An international team of researchers has developed a prototype robotic hand that mimics the human hand in terms of its range of movements, flexibility and sensitivity. Thanks to a combination of piezomechanics and hydraulics, the hand has the potential for applications requiring everything from great sensitivity to surprising strength.

The human hand is a truly remarkable system — an anatomical structure whose ligaments, tendons, and muscles connect 27 bones and enable it to perform a wide variety of movements. Hands can grip small items such as tweezers with just the right amount of sensitivity and flexibility, as well as applying great force in order to move heavy objects. The hand's incredibly wide range of capabilities also includes high-precision grasping, which makes very special movements such as writing possible.

With a view to duplicating this range of capabilities, a research team at Siemens Corporate Technology in Munich is now working with London-based Shadow Robot Company, which specializes in the development of anthropomorphic robot hands and related systems.

Four Fingers

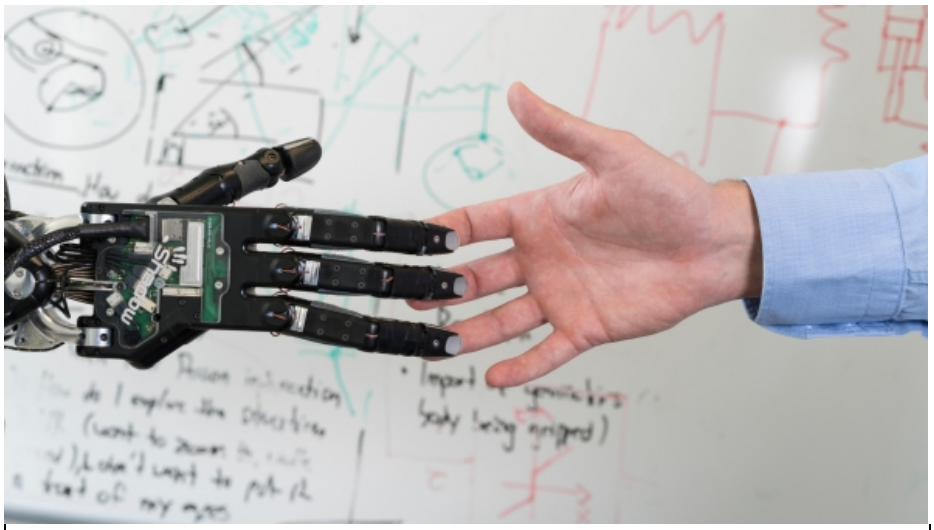
The researchers have developed a technology that brings robotic hands much closer than ever before to achieving human-like sensitivity and flexibility. Key to this is a new wire-based linear actuator system.



At the heart of CT's work is the link between the sensors located in the fingers of a robotic hand and a line of Siemens actuators in its forearm. These actuators are what make a variety of movements possible.

The system has made it possible to develop a robotic hand that has four fingers, a wrist, and 20 degrees of freedom, which collectively mimic all of the grasping motions of a human hand – a major step forward compared to traditional two-fingered robotic "gripper" hands. Project researchers are using a piezohydraulic principle developed by Siemens Corporate Technology (CT) to imitate the wide variety of movements of the human hand. "To enable mechanical hands to be used in a wide variety of applications, an appropriate amount of force and speed are needed. Not until this is achieved will a robot be able to take on tasks that require fine motor skills," says Dr. Georg Bachmaier. Together with his colleagues Dr. Iason Vittorias and Dr. Wolfgang Zöls, Bachmaier is, among other things, responsible for autonomous systems hardware within the Mechatronics Systems research group at Siemens CT.

The new actuator can set its mechanical impedance in such a way that it operates quickly but gently, and thus safely. This enables the robotic hand to perform extremely fine movements with great sensitivity. During such movements, sensors from Shadow Robot transmit the position of every joint as well as the pressure exerted at the finger tips to actuators throughout the hand. Here, the key element is the connection between the sensors in the fingers and a wire-operated Siemens actuator strand in the system's lower arm. Information about the robotic hand's position and the pressure being exerted on the fingers enables the system to perform the desired task. This means that the actuators enable the fingers to carry out the appropriate movement with precisely the right amount of pressure. However, they can also apply substantial force, as a modification of the system's controls can quickly change the hand's behavior, making the actuators stiffen and thus transmitting much more force.



CT technology has given an anthropomorphic hand movement and response capabilities similar to those of its human counterpart.

The hand is equipped with sensing and movement technologies that allow it to pick up a flower without causing damage.

A semi-autonomous anthropomorphic robotic hand could open up new paths in industry.

Endless Applications

Behind this development is a combination of piezomechanics and hydraulics. A given voltage causes a piezoelectric crystal to be deflected by minute amounts. A hydraulic system then expands these tiny movements to a total stroke of 20 mm. Another advantage of the actuator is its metallic enclosure, which ensures that all of the hydraulic fluid is contained within the system so that it only has to be supplied with electricity, but not with fluid. In addition, the enclosure protects the actuator against environmental elements such as dust, moisture or chemicals.

Thanks to developments in sensor technologies, robots equipped with human-like hands are likely to be able to work side-by-side with people.

With its potential for extremely fine movements and pressure levels, a human-like robotic hand would open up many new possibilities for industry, especially in combination with autonomous systems. For example, robotic systems equipped with such hands could be used in areas where human beings are “disruptive” or potentially at risk, yet currently still indispensable due to their manual skills. Such environments include the clean rooms of the microchip and semiconductor industry, labs in the pharmaceutical, medical, and food industries, as well as potentially unhealthy environments in the chemical industry.

But the most far-reaching area of application for such robotic hands might be in manufacturing, where robots have traditionally been segregated from humans by protective cages. Thanks to developments in sensor technologies, the latest robots are more agile, and are able to detect human beings and avoid harming them. As they evolve, robots will gradually make steps toward autonomy. Once equipped with human-like hands, they are likely to be able to work side-by-side with human beings.

“The piezoelectric hand achieves a level of efficiency and flexibility that was previously associated only with the human hand,” says Vittorias. This innovation literally puts human-robot collaboration in industrial environments within reach. The researchers expect to present a demonstration version of their robotic hand in late 2016.

Susanne Gold

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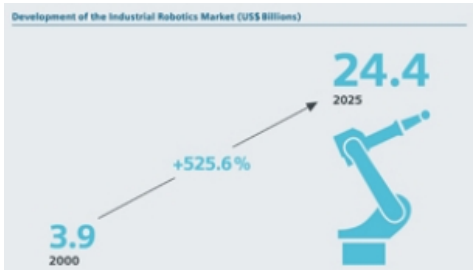

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