Robotic hand nearly identical to a human one (w/ Video)

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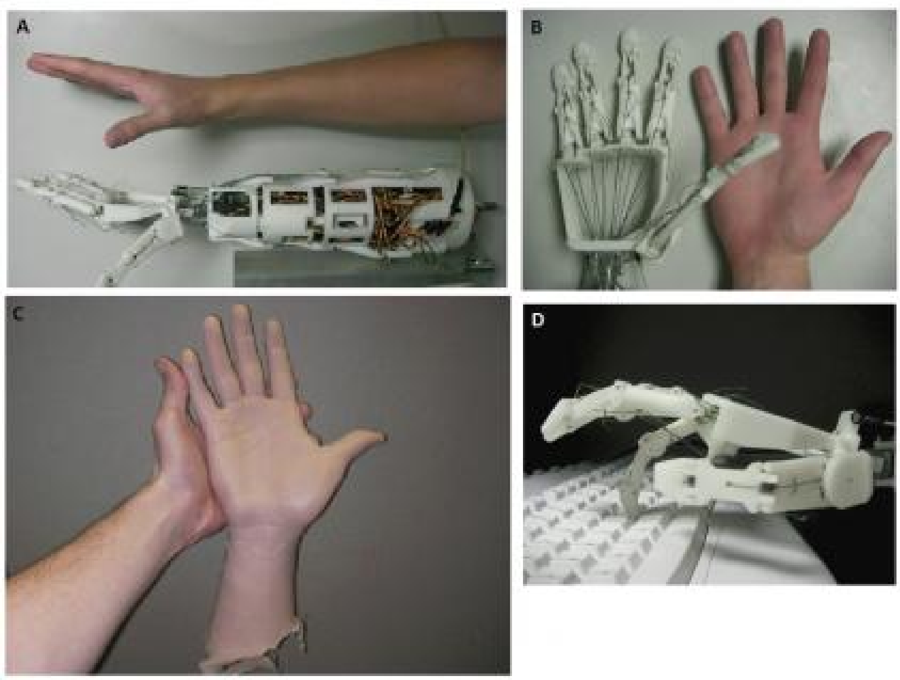

(A) and (B) show the DART hand in comparison to a human hand. (C) shows the silicone skin covering the mechanical components. (D) shows the DART hand typing the letter 'L' at a computer keyboard. Image credit: Thayer, et al. ©2011 IOP Publishing Ltd.

(PhysOrg.com) -- When it comes to finding the single best tool for building, digging, grasping, drawing, writing, and many other tasks, nothing beats the human hand. Human hands have evolved over millions of years into four fingers and a thumb that can precisely manipulate a wide variety of objects. In a recent study, researchers have attempted to recreate the human hand by building a biomimetic robotic hand that they have optimized to achieve near-human appearance and performance.

The researchers, Nicholas Thayer and Shashank Priya from Virginia Tech in Blacksburg, Virginia, have published their study on the robotic hand in a recent issue of *Smart Materials and Structures.*

The researchers call the hand a dexterous anthropomorphic robotic typing hand, or DART hand, as the main objective was to demonstrate that the hand could type on a computer keyboard. They showed that a single DART hand could type at a rate of 20 words per minute, compared to the average human typing speed of 33 words per minute with two hands. The researchers predict that two DART hands could type at least 30 words per minute. Ultimately, the DART hand could be integrated into a humanoid robot for assisting the elderly or disabled people, performing tasks such as typing, reaching objects, and opening doors.

To design the DART hand, the researchers began by investigating the physiology of the human hand, including its musculoskeletal structure, range of motion, and grasp force. The human hand has about 40 muscles that provide 23 degrees of freedom in the hand and wrist. To replicate these muscles, the researchers used servo motors and wires extending throughout the robotic hand, wrist, and forearm. The robotic hand encompassed a total of 19 motors and achieved 19 degrees of freedom.

"[The greatest significance of our work is the] optimization of the hand design to reduce the number of motors in order to achieve a similar degree of freedom and range of motion as the human hand," Priya told *PhysOrg.com*. "This also allowed us to achieve dimensions that are on par with the human hand. We were also able to program the hand in such a manner that a high typing efficiency can be obtained."

One small difference between the DART hand and the human hand is that each finger in the robotic hand is controlled independently. In the human hand, muscles are sometimes connected at the tendons so they can move joints in more than one finger (which is particularly noticeable with the ring and pinky fingers).

The robotic hand can be controlled by input text, which comes from either a keyboard or a voice recognition program. When typing, a finger receives a command to position itself above the correct letter on the keyboard. The finger presses the key with a specific force, and the letter is checked for accuracy; if there is a typo, the hand presses the delete key. By moving the forearm and wrist, a single DART hand can type any key on the main part of a keyboard.

The DART hand isn't the first robotic hand to be designed. During the past several years, robotic hands with varying numbers of fingers have been developed for a variety of purposes, from prosthetics to manufacturing. But as far as the researchers know, no robotic hand can accurately type at a keyboard at human speed. When the researchers compared the functional potential of the DART hand to other robotic hands, the DART hand had an overall functional advantage. In addition, the researchers used rapid prototyping to fabricate all the components, significantly reducing the cost, weight, and fabrication time.

In the future, the researchers plan to make further improvements to the robotic hand, including covering the mechanical hand in a silicone skin, as well as adding temperature sensors, tactile sensors, and tension sensors for improved force-feedback control. These improvements should give the robotic hand the ability to perform more diverse tasks.

"We have already experimented with grasping tasks," Priya said. "In the current form it is not optimized for grasping, but in our next version there will be enough sensors to provide feedback for controlling the grasping action."

More information: Nicholas Thayer and Shashank Priya. "Design and implementation of a dexterous anthropomorphic robotic typing (DART) hand." *Smart Mater. Struct.* 20 (2011) 035010 (12pp). DOI:10.1088/0964-1726/20/3/035010