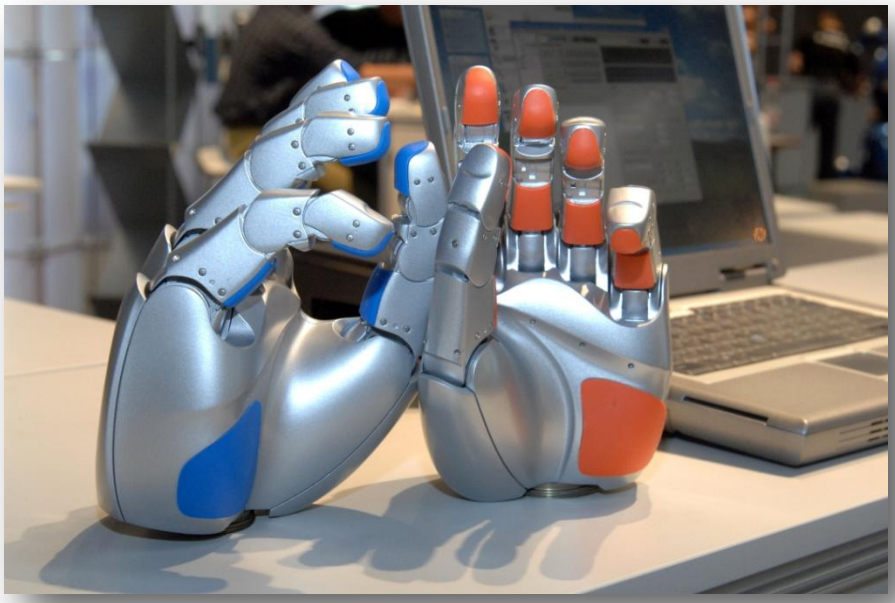
Humanoid Robotic Hand Moves

The human hand is undoubtedly one of the most universal and complex tools of nature. Researchers have been studying the characteristics and special features of this evolutionary design for years. Now the findings of this research are being used and implemented for the robotic hand of the future.

Rapid progress in the development of robotic hands that replicate human movement has progressed to the design of delicate grippers with fingers and thumbs. This accomplishment is no longer a vision but a reality, meaning that multi-fingered hands may soon be available for use in the daily work environment. At the moment only simple, yet robust, two- or three-fingered grippers are being used, leading the charge for the more complex, five-fingered hands that will be able to carry out intricate tasks. Progress in microelectronics and micromechanics allows a multi-fingered hand to be produced with separately controllable fingers and joints that replicate the human hand. The complex mechanics and control electronics required for this can even be constructed, to a certain extent, using standard commercial components.



Five-fingered hand

The German Aerospace Centre (DRL) has developed a robotic hand in conjunction with the Harbin Institute of Technology (HIT). Thanks to micro and precise drive technology and high-performance bus technology, this development is sets new standards for sensitive gripper hands that replicate human ones. Compared with its predecessor, the DRL-HIT-Hand I, the new DLR-HIT Hand II has five fingers, each with four joints and three degrees of freedom. The hand is also smaller and lighter. Four fingers are required for clasping conical parts, and a thumb is used as an outer support. The mechanical range of movement must be properly controlled and monitored to enable the hand to be used fully. High-performance information channels are essential.

The motors in the DRL-HIT Hand II fit directly into the fingers. Particular attention has been paid to the control processor’s information with respect to positioning and operating data. This allows the discrete drive to show its strengths in situ. Every finger joint is fitted with a self-developed non-contacting angle sensor and a torque sensor. Due to the application, both sensors must resolve very quickly.

A high-speed bus transmits the data flow. Rapid feedback — comparing target and actual value is crucial for the function of the controller, particularly in precise and delicate applications. Besides data

volume, speed of transfer is also vital, which is why an internal real-time 25 Mbps high-speed bus, based on FGPAs (Field Programmable Gate Arrays), was developed for the application. Only three leads are required for the external serial connection of hand and control processor. The actual controls — a signal processor on a PCI insert card — is integrated into a standard PC. The user-friendly interface provides a way for the hand to be controlled at the PC, with all sensor data displayed on the screen.

EC flat motor designed and manufactured by maxon precision motors.

Each finger needs several drives, and each of those must be controlled separately. In this instance, 15 brushless DC motors with Hall sensors are used for each hand. Maxon motor's EC 20 flat drives were designed in because they are inexpensive, commercially available, products offering a high power density in a compact size. The motors, including Hall sensors, create a unit that is only 10.4 mm long with an outer diameter of 21.2 mm. Each motor weighs 15 g. The motors are mounted with harmonic drive gears from the HDUC 05 range, which have the same diameter as the motor. The three-watt motors are available in a 12 or 24 V version and provide maximum torque of 8.04 mNm. Good dynamic behaviour and preloaded ball bearings ensure precise response behaviour of control commands, including changing the direction of rotation. The digital Hall sensors always report the actual position to the controller accurately. The motors idle at 9,300 rpm. Thanks to compact drive technology with feedback and rapid data transfer per bus technology, the new DLR-HIT Hand II can be controlled very sensitively and precisely. Micromechanics and microelectronics complement each other, which allows for standard components to be used to produce well-designed products that would have been previously unimaginable, even with expensive special developments.

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