Scientists develop haptic interface with seven degrees of freedom

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Haptic interfaces allow humans to handle dangerous or delicate materials. From laparoscopic surgery to radioactive waste removal to the simple act of putting a mobile on vibrate, robotics are getting touchy.

Now, researchers from the Chinese Academy of Sciences have developed an even more expansive haptic interface that allows for seven degrees of movement. The most common haptic interfaces typically have three degrees of movement. The research findings were published on the January 10th issue of *IEEE/CAA Journal of Automatica Sinica*, a joint bimonthly publication of the IEEE and the Chinese Association of Automation..

"With the development of human robot interaction technologies, haptic interfaces are widely used for 3-D applications to provide the sense of touch," wrote co-author Zeng-Guang Hou, a professor at the State Key Laboratory of Management and Control for Complex Systems. "These interfaces have been utilized in medical simulation, virtual assembly, and remote manipulation tasks. However, haptic interface design and control are still critical problems to reproduce the highly sensitive touch sense of humans."

Hou and his team designed a haptic interface based on a modified delta mechanism. This mechanism has a static base platform to which three identical chains are connected and lead to a moving platform. The mechanism can use each chain to move in a different direction.

"The main advantage of this architecture is its low inertia, the critical element of haptic device design, because its actuators can be mounted on the fixed platform," Hou wrote, referring to how little effort it takes to make the mechanism move. "In addition, a mechanical wrist can be added to the moving platform to realize the rotational degrees of freedom."

The engineers designed a controller to sense motion and display how much force the operator should exert. The interface is controlled via an algorithm that helps maintain equilibrium.

"Experimental results show the good control performance of this interface," Hou wrote of his team's simulations and prototype tests. "The dynamic model and the haptic controller can be used as references for model based control systems to improve the performance further."

According to Hou, the proposed haptic interface is also appropriate for true haptic interaction, such as the touch sense of a mobile phone's vibration setting, and teleoperation applications, such as surgical procedures.

More information: Jian-Long Hao et al, Development and evaluation of a 7-DOF haptic interface, *IEEE/CAA Journal of Automatica Sinica* (2017). DOI: 10.1109/JAS.2017.7510769

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