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A NOVEL FORCE FEEDBACK-BASED TELEOPERATION SYSTEM FOR MEDICAL APPLICATION

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Abstract. *We propose a novel force feedback-based teleoperation system for medical application. Most teleoperation systems are based on the visual feedback from the camera with the occasional use of force feedback. We present the concept and principle of a virtual force feedback in a teleoperation system. The circle tracking experiment was considered using the proposed virtual force feedback. The experimental results showed that the relative tracking error decreased by more than 50% when using the virtual force feedback. We also performed another experiment studying the cutting of a piece of bean curd using the real force feedback. Using real force feedback resulted in a 0.4 N decrease in the contact force of the knife and the object. After further experimentation, the system will be suitable for telesurgical training.*

Keywords: Medical application, Visual feedback, Virtual force feedback, Real force feedback, Telesurgical training

1. **Introduction.** Robotics has been widely used in many industrial fields. In recent years, it has also been applied in the biomedical field, in which robotic operations have been used for stroke rehabilitation, neurological surgical operation, and a variety of other exciting applications. Of particular relevance to this work are the virtual reality-based surgery simulation systems [1,2]. Given the complexity of realistic environments, full autonomy in robotics has yet to be achieved; hence, semiautonomous robotics systems have been established as a major research line (IEEE Robotics & Automation, 1999). The teleoperation robotic system is a kind of semiautonomous system that has been applied in telerehabilitation [3-5] and telesurgical operations [6-10] in addition to other evolving technologies.

Until now, some surgical operation systems are commercially available. For example, both the ZEUS surgical robotic system from Computer Motion (Goleta, CA) [11,12] and the da Vinci surgical system from Intuitive Surgical, Inc. (Mountain View, CA) [13-17] have been used in cardiac surgery to perform coronary artery bypass grafting and mitral valve repair. Despite these successes, many surgeons claim that further progress in this field is limited by an unresolved problem: the lack of haptic (force and tactile) feedback to the user [18].

Incorporating force feedback into teleoperated systems can reduce the magnitude of contact forces, leading to a reduction in the energy consumption, the task completion time,