

# An Amputation Simulator With Bone Sawing Haptic Interaction

謝銘勳

Hsieh;M;S;;Tsai;M;D;;Yeh;Y;D;;;

摘要

## Abstract

This paper describes a haptic device equipped surgical simulator that provides visual and haptic responses for amputation surgery. This simulator, based on our reported volume (constituted from CT slices) manipulation algorithms, can compute and demonstrate bone changes for the procedures in various orthopedic surgeries. The system is equipped with a haptic device. The position and attitude the haptic device are transformed into the volume to simulate and render the oscillating virtual saw together with the virtual bones. The system then judges if every saw tooth immersing in (cutting) any bone. The load for removing the bone chip in a cutting tooth is calculated according to the feed rate, oscillating speed, saw geometry and bone type. The loads on all the saw teeth are then summed into the three positional forces that the haptic device generates and thus the user feels. The system provides real-time visual and haptic refresh speeds for the sawing procedures. A simulation example of amputation surgery demonstrates the sawing haptic and visual feelings of the sawing procedure are consistent and the simulated sawing force resembles the real force. Therefore, this prototype simulator demonstrates the effectiveness as a surgical simulator to rehearsal the surgical procedures, confirm surgical plans and train interns and students.