Design and implementation of a maxillofacial surgery rehearsal environment with haptic interaction for bone fragment and plate alignment

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Repair of maxillofacial fractures involves aligning fragments of bone with accuracy so that aesthetics and function are restored, as well as selecting and adjusting plates intraoperatively.

We are presenting a conceptual and functional prototype of a haptics-enabled maxillofacial surgery rehearsal environment that aims at providing a direct



Left: The user can move bone segments in free space using a 3D haptic feedback device and feel contact

high-fidelity immersive experience for the surgeon with little training.

The ability to shift important surgical decisions to a preoperative planning stage would decrease the length of surgery and improve confidence in the accuracy of repair.

With novel computational algorithms and interaction design of 6-DOF haptic technology, we aim to establish a direct and tangible interaction equivalent and beyond the experience of working with conventional plaster models.



Below: A typical scenario for fracture repair involves repositioning bone fragments, choice of appropriate plate, and bending it to fit the specific patient.









Example of conventional surgery planning software (Simplant OMS, Materialise Dental, Leuven, Belgium). The user is restricted to positioning the jaw segments along one translational or rotational axis at a time using the mouse. In addition, no real-time collision detection is provided.

Plaster-based planning, which is common for certain procedures, provides a bi-manual tactile experience for the surgeon. Results of very small movements, such as setting for occlusion, can be felt concurrently with visual inspection from arbitrary angles. Real-time collision detection combined with a novel 6-DOF haptic rendering algorithm developed in our lab enables surgeons to move bone segments in space and feel resistance when colliding. Future work in this on-going research project involves FEM simulation of plate bending and improved collision algorithm resolution.

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