COLLISION AND DEFORMATION OF SURGICAL PLATES

Jonas Forsslund

Reconstructive craniofacial surgery involves realigning bone fragments and attach implant plates. Currently selection of plate and its shape is decided intraoperatively, where a malleable template plate is pressed against the bone fragments to acquire the shape for the titanium plate, that is thereafter (still in operating room) bent and affixed to the bone.

In this project, a virtual plate bending mechanism has been implemented. The purpose is for a craniofacial surgeon to be able to affix a plate to a voxel-based bone derived from Computed Tomography, by slowly push one other side of the plate make it follow the shape of the bone and finally stop bending as the end side is in collision with the bone (figure 1 and 2).

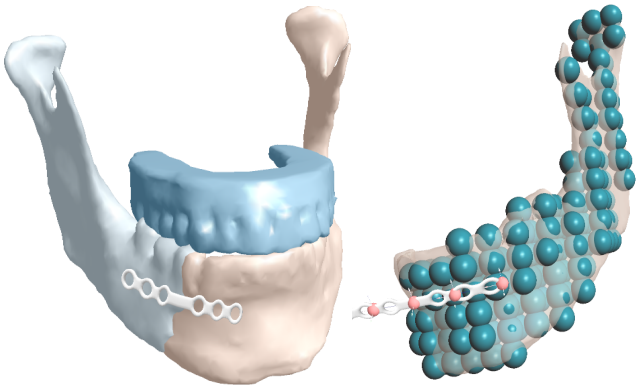

Fig 1. Plate attached (left), spherical voxel represntation of bone and spring-mass reprsentation of plate (right).

The bone is represented by a segmented binary voxel model. The plate is modeled as a five elements, each linked to the next one in a spring-mass structure. For simplification, each element consist of a sphere, that is used for collision detection with the voxel model, that is also represented by spheres.

The plate is implemented using the GEL module in Chai3D. A plate node is set to a fix state when collision is detected with any sphere in any model in global space, which allows for stretching the plate between models.

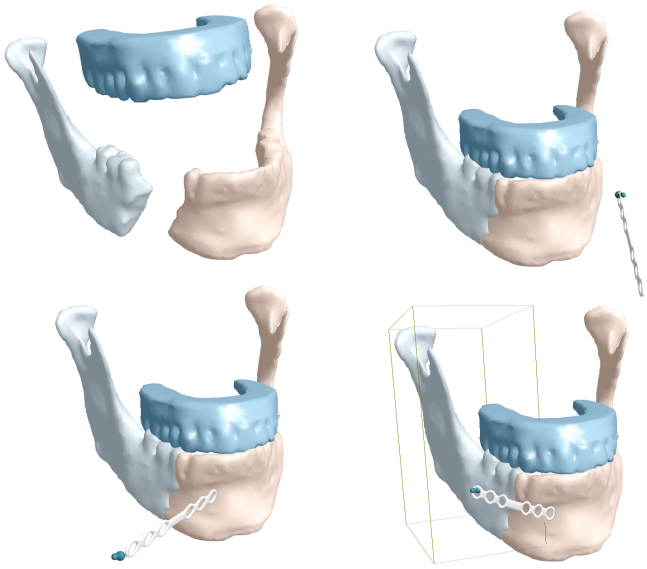

Fig 2. Steps of procedure.

The purpose of the plate tool is planning of positioning and shape, which not necessarily require high realism of metal bending. Current spring-mass based implementation might however provide a too gel-like experience, which might be suboptimal. Future work will include exploring non-time integration techniques, or representing the plate by rigid (non-spring) links.

In addition, when moving the bone fragments in space, forces are felt with magnitude proportional to the calculated volume intersection (using sphere-sphere intersections) in the direction of the weighted sum of intersecting positions.

The bone-bone haptic rendering has been developed together with Sonny Chan, who also created the plate 3D model. This material is based upon work supported by the US Department of Veterans Affairs, Veterans Health Administration, Office of Research and Development, Rehabilitation Research and Development Service

jofo@stanford.edu