O-30

SHAPING PATIENT SPECIFIC TEMPLATES FOR ARTHROPLASTY TO OBTAIN HIGH DOCKING ROBUSTNESS

Joost Mattheijer,[1,2] Just L. Herder,[1] Gabrielle J.M. Tuijthof,[1] Rob G.H.H. Nelissen,[2] Edward R. Valstar[1,2]

[1] Department of BioMechanical Engineering, Delft University of Technology, Delft, The Netherlands
[2] Department of Orthopedics, Leiden University Medical Center, Leiden, The Netherlands

In arthroplasty, worn out and painful joints are replaced with a prosthesis. Alignment instruments are used to find where bone cuts need to be made, in order to place the prosthesis with the correct alignment. This process can often be problematic and prone for errors, because only a small part of the involved bones – the joint - is exposed. Computer Assisted Surgery (CAS) techniques are being used in arthroplasty, in order to obtain accurate alignment of prosthetic components.

Generally there are two CAS approaches used today: Camera-based CAS and Patient Specific Templates (PST's). Camera-based CAS relies on – time consuming – registration of the actual bone surfaces as exposed during surgery and the virtual bone models resulting from CT or MRI. Bone, instruments and prosthesis using markers are subsequently tracked by a camera. For the PST method, the virtual bone models are used to fabricate plastic templates, representing the negative imprint of the joint surface. During surgery, the templates are supposed to dock in the planned position only, taking away the need for a time-consuming registration process. Holes and slots that are incorporated in the templates are instantly aligned right and will be used to guide cutting instruments. Our research group is developing Configurable PST's: templates that can be customized for every surgery to have a patient specific fit.

As a first topic of research we are investigating the quality of the fit. The shape of the template – the location of bone-template contact and an application surface where the surgeon may push – determines the fit that may be perceived when the template is held in its planned position. The goal is to analyze the effect of the template's shape onto the range of forces that may be applied, i.e. the docking robustness. The bony geometry is hereto used as an input to find suitable locations for bone-template contact and the application surface. The wrench space theory widely used in the related research areas of robotic hands and workpart fixtures is employed to obtain an analytical method. With this method, templates can be fully shaped to obtain high docking robustness with minimal contact.