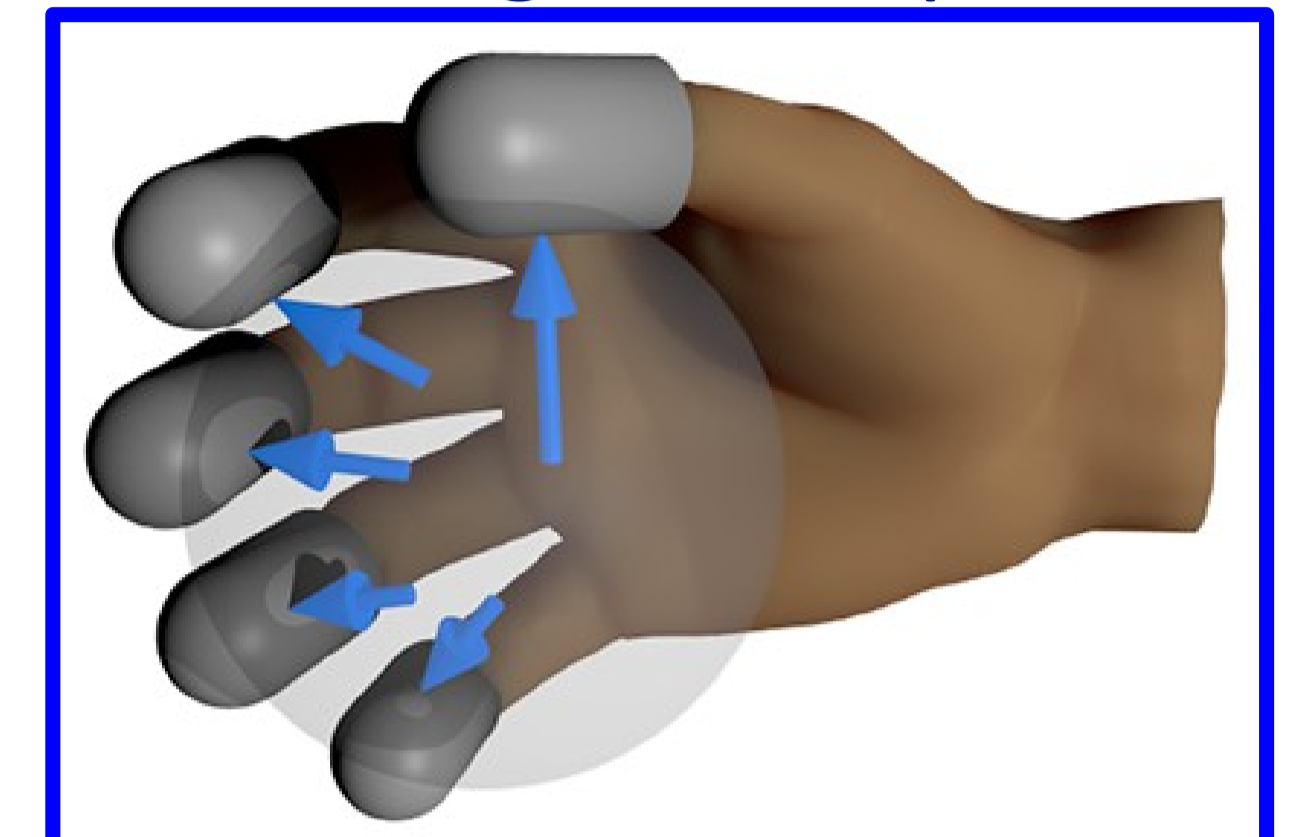


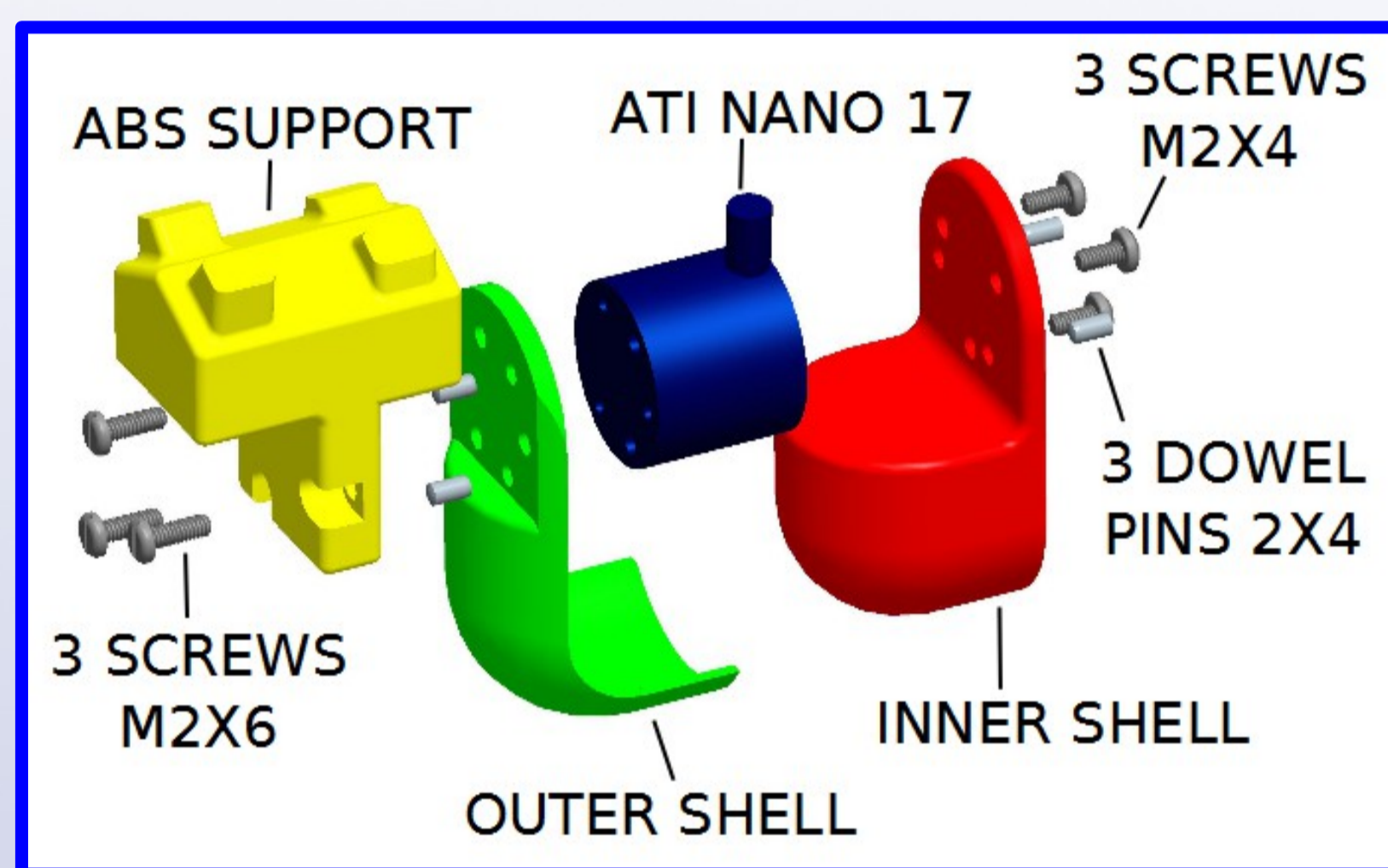
System Description

We present *ThimbleSense*, a design for a wearable sensor system which gives **force and torque** measurements from each finger, allowing reconstruction of **contact point** positions. This is achieved by combining a commercial six axis force/torque sensor with a pair of support shells. Integration with a marker-based motion capture system provides position and orientation of the system.

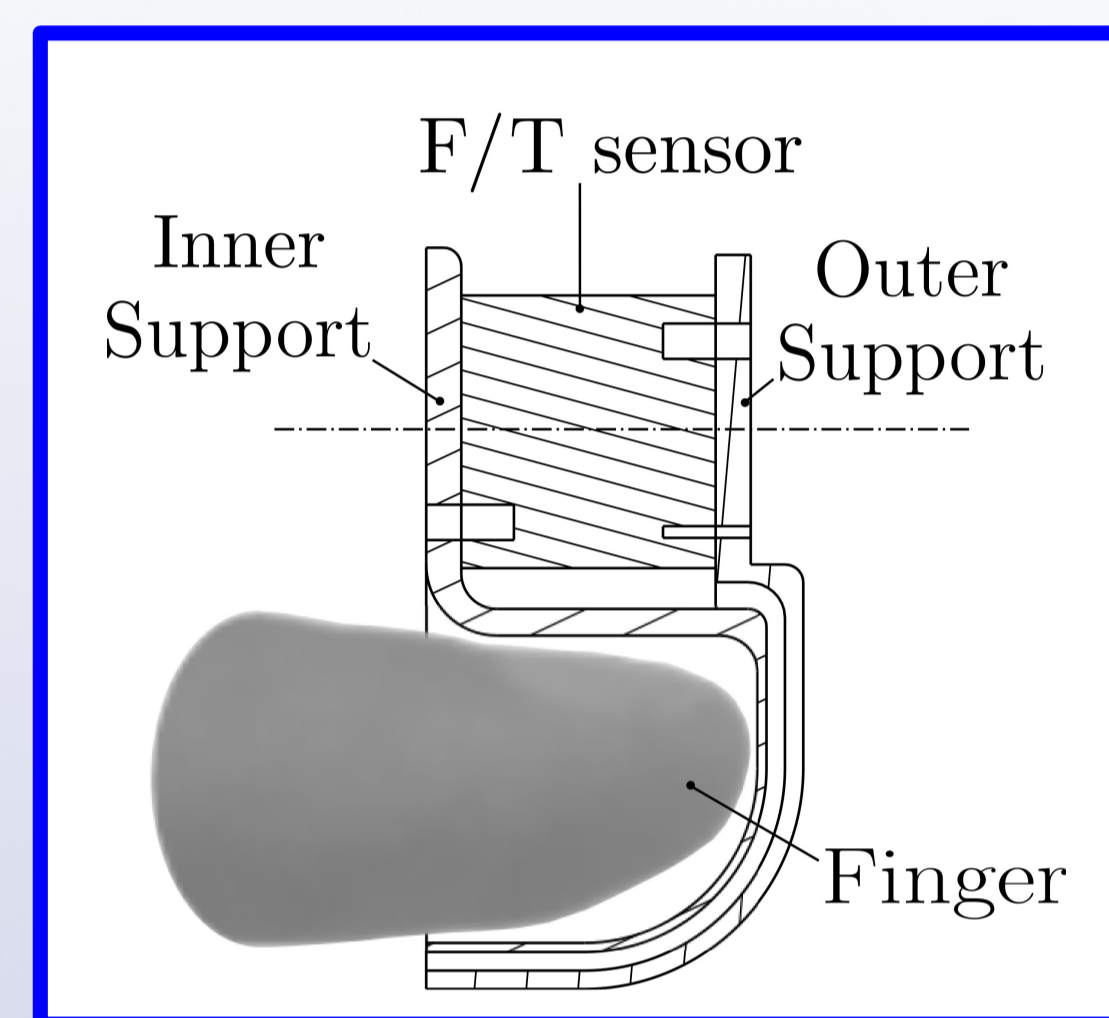
Design concept



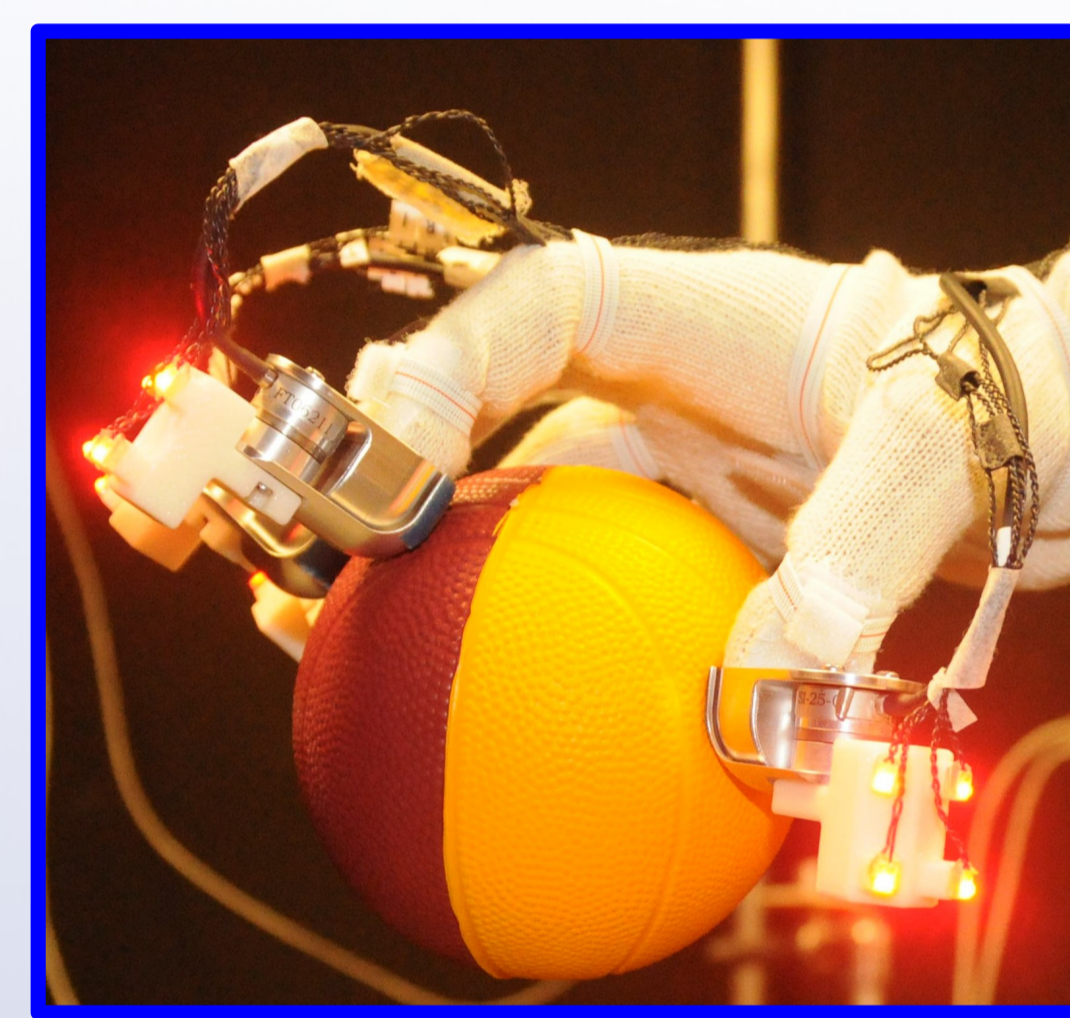
Exploded view of CAD model



Section



Prototype implementation



App. to the DLR Hand II



Experiment I: Reconstruction of contacts

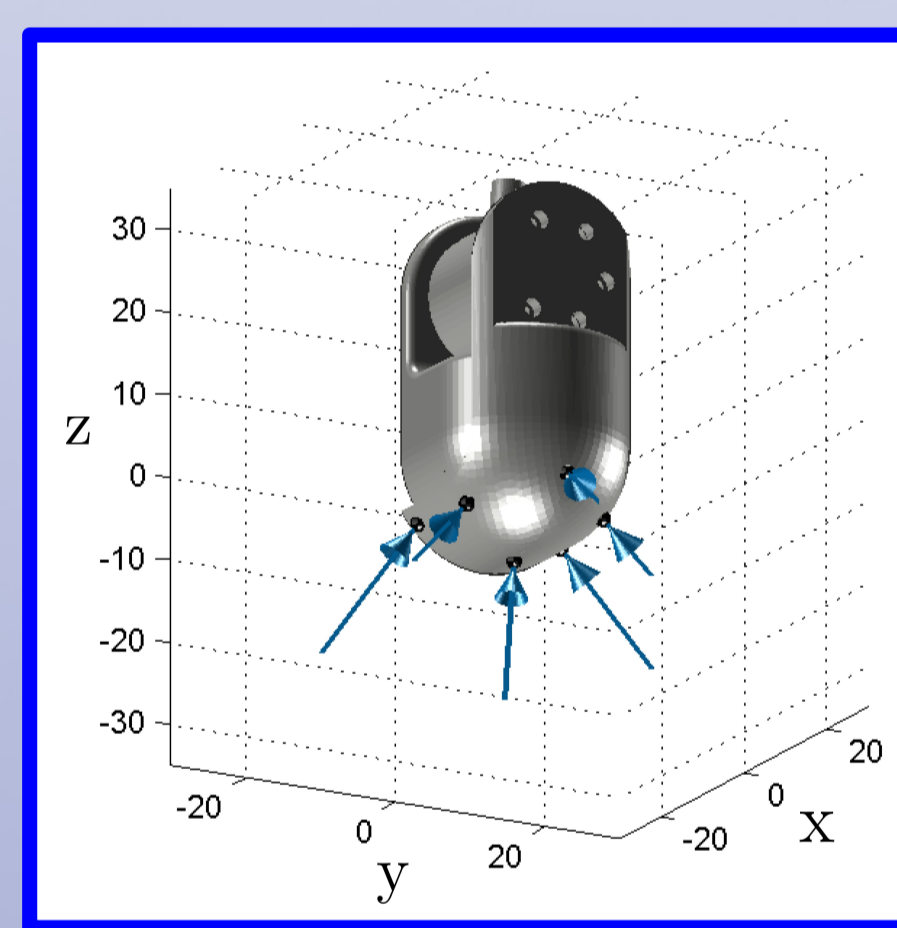
Target points



Pressing with a pen



Reconstruction



Experiment II: Grasping Objects

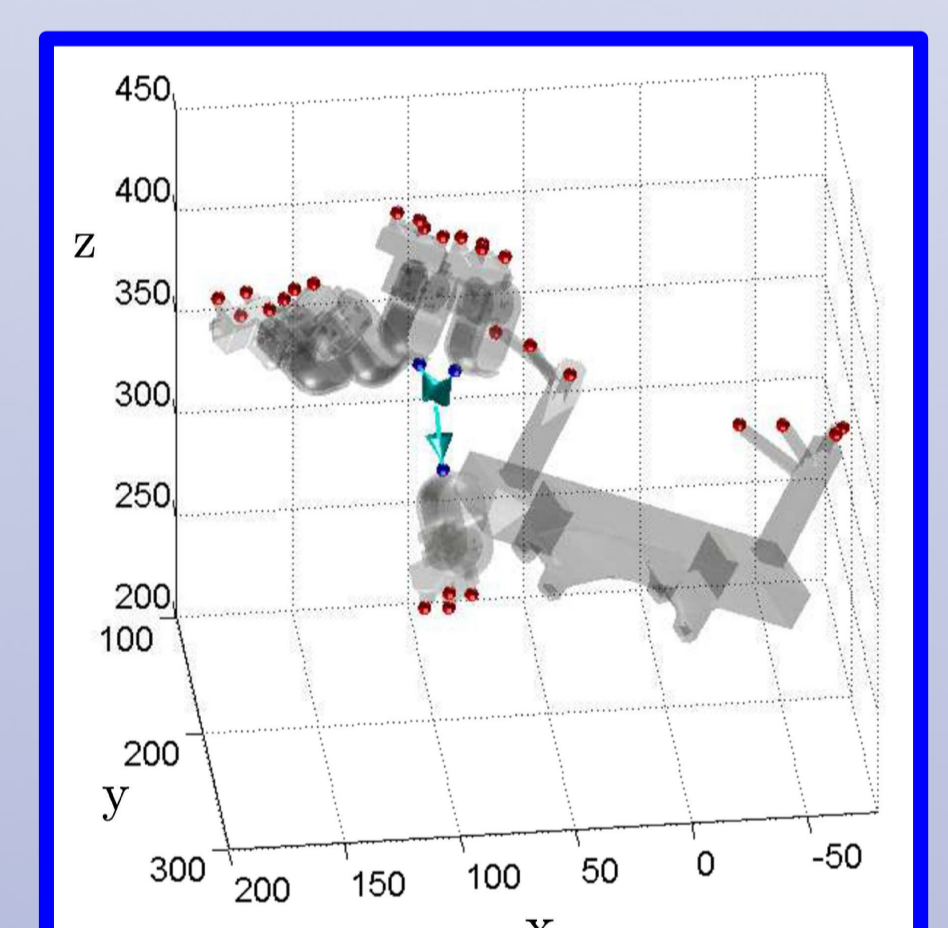
Several objects with different shapes

Full-fledged force and posture reconstruction

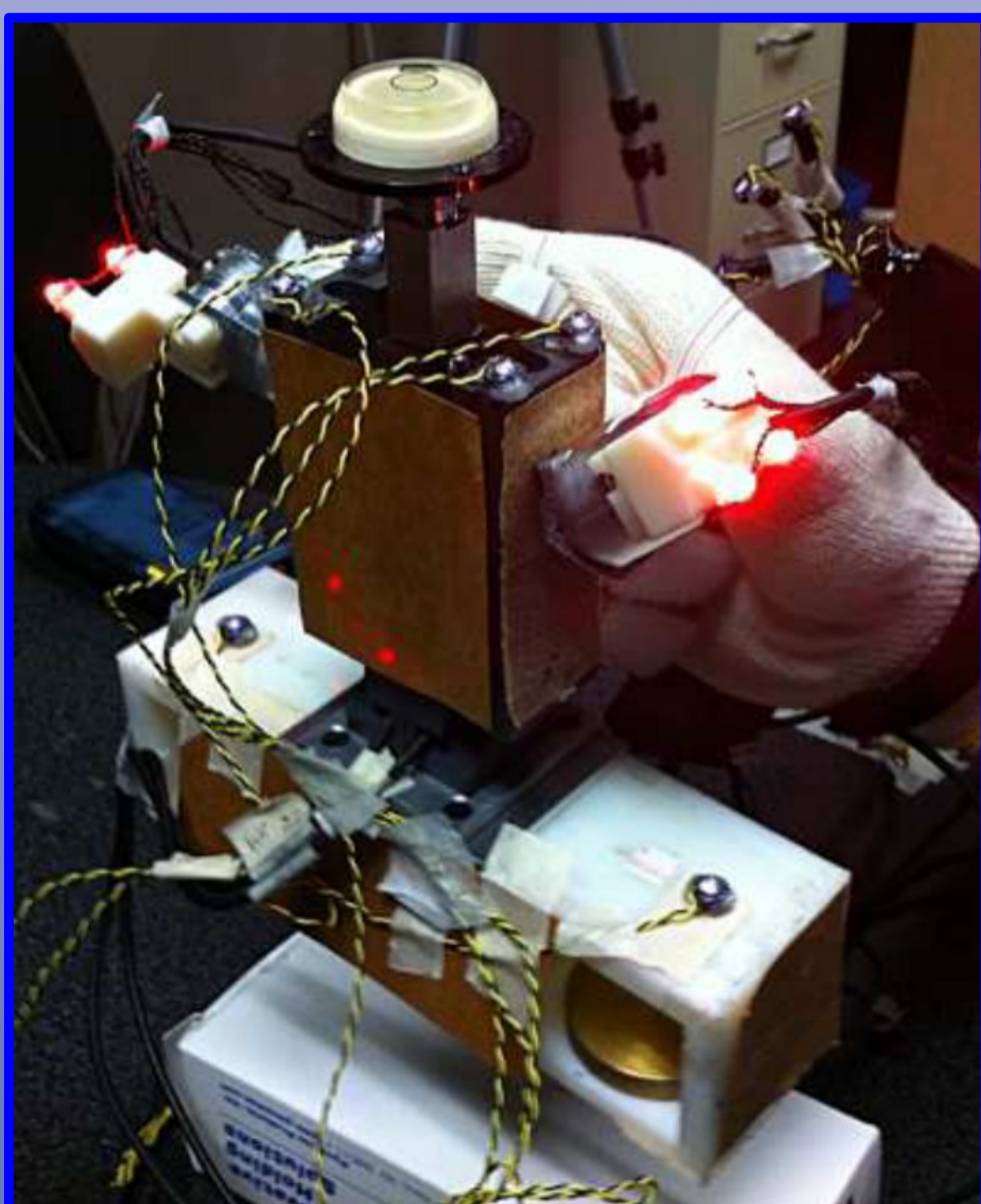
Grasping an egg



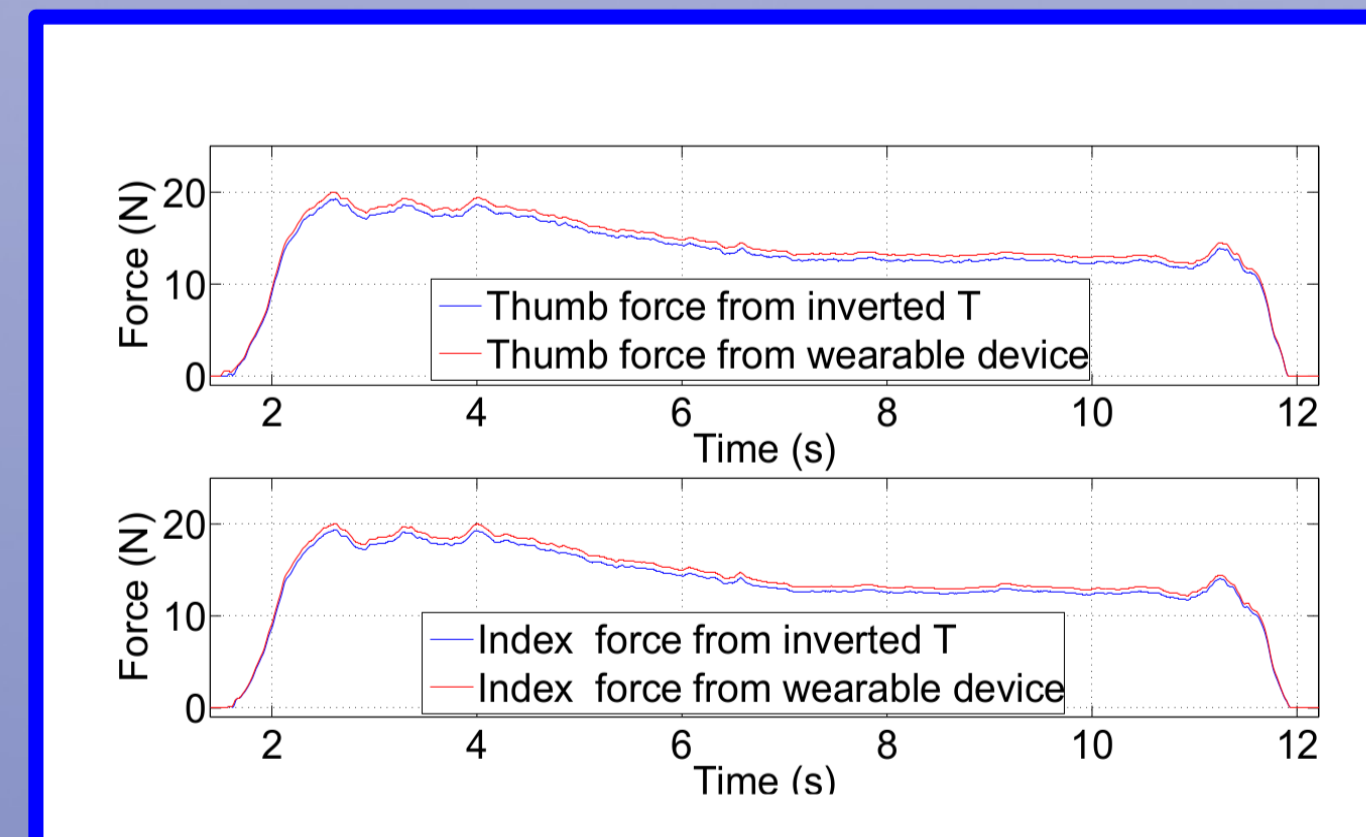
Reconstruction



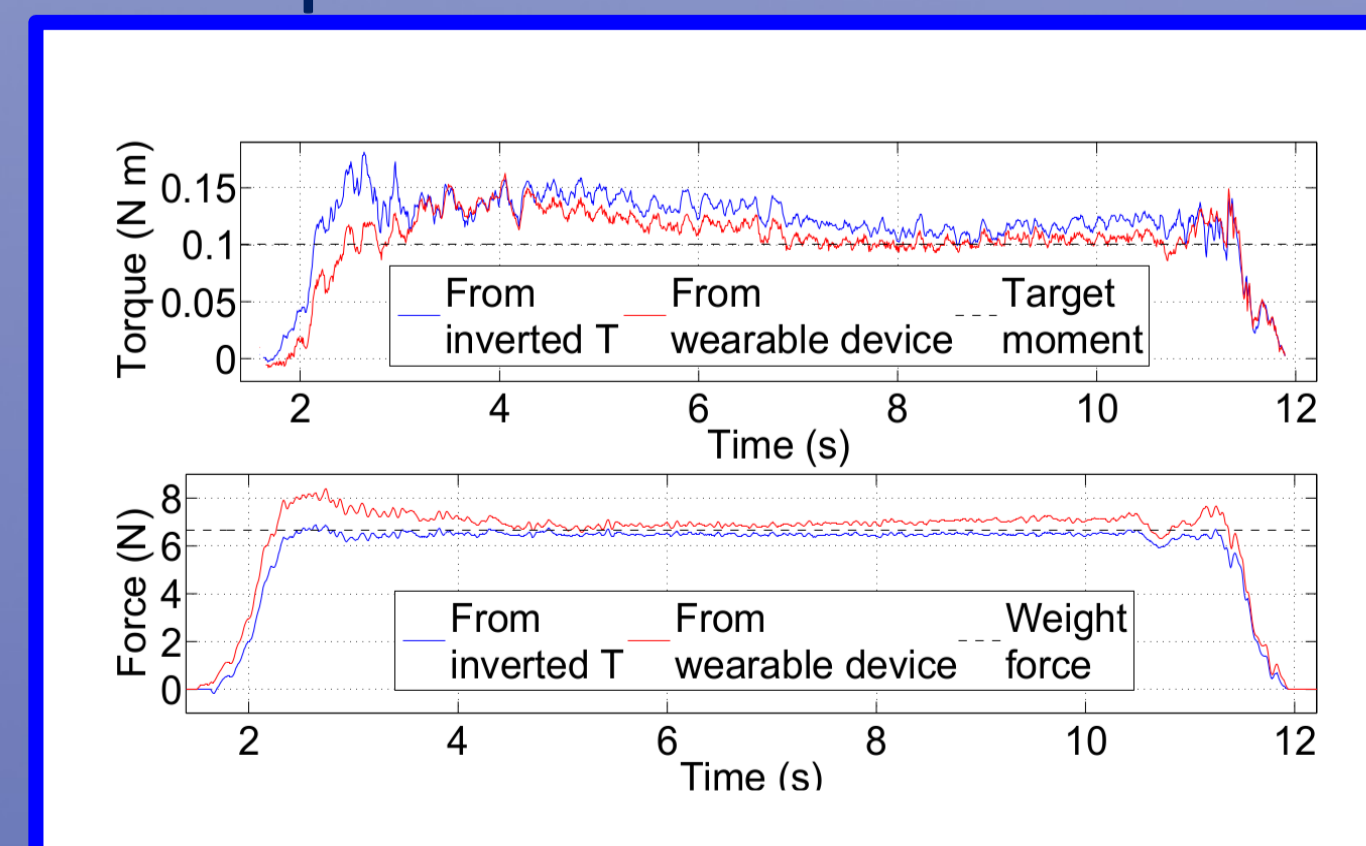
Experiment III: Invert T Comparison



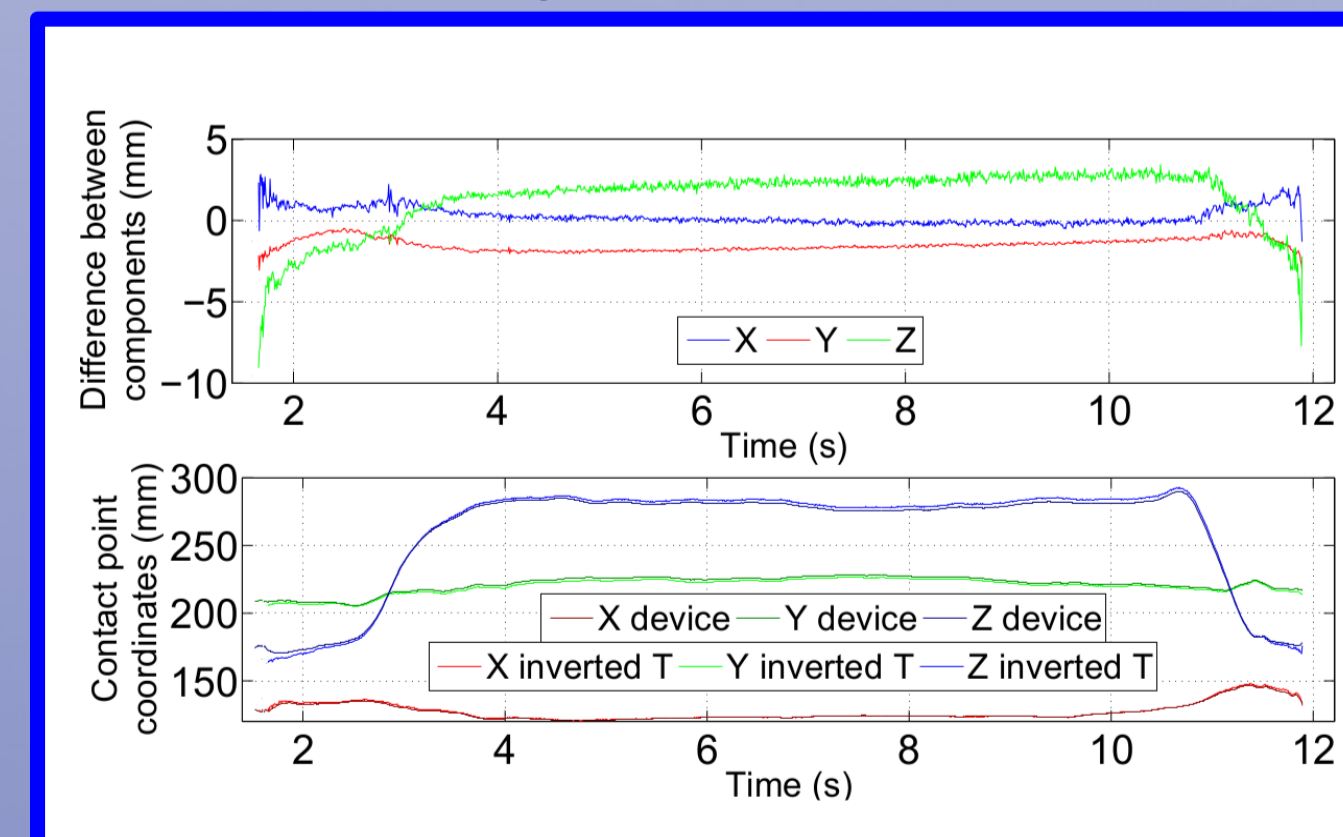
Normal forces



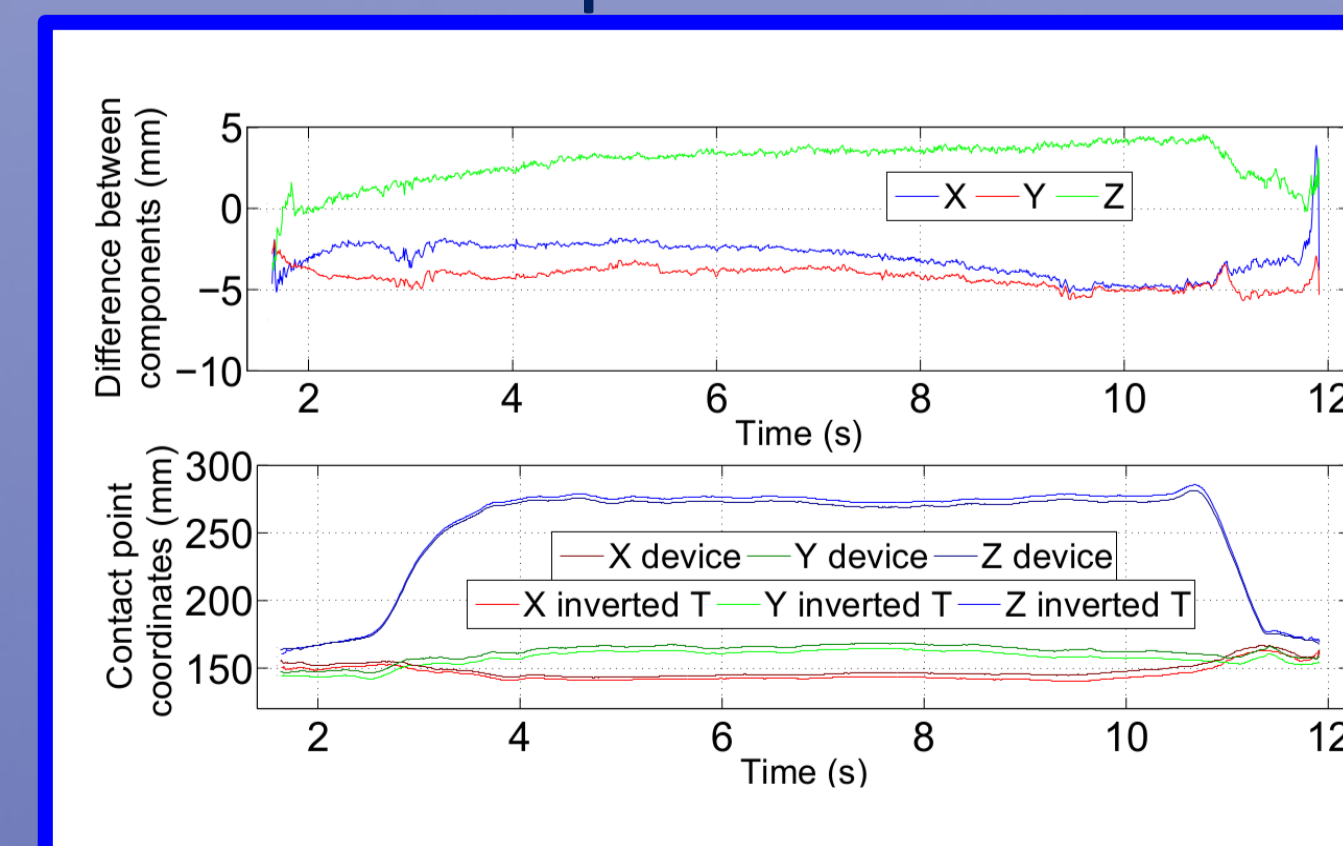
Comp. moment & lift force



Contact point on thumb



Contact point on index



Conclusions

Qualitative experimental validations show accuracy in estimating contact points (I) and position and orientation of fingertips (II).

A quantitative validation (III), performed by comparison with a reliable reference, shows some small differences, which can be ascribed to the glove setup. Future work will involve performing a more thorough validation, and designing a more stable setup.

References:

- [1] E. Battaglia, G. Grioli, M. G. Catalano, M. Santello, A. Bicchi, "ThimbleSense: an individual-digit wearable tactile sensor for experimental grasp studies", accepted by 2014 IEEE International Conference on Robotics and Automation.
- [2] W. Zhang, A. M. Gordon, Q. Fu, and M. Santello, "Manipulation after object rotation reveals independent sensorimotor memory representations of digit positions and forces," *The Journal of Neurophysiology*, vol. 103, no. 6, pp. 2953 – 2964, 1998.