Modification of Commercial Force Feedback Hardware for Needle Insertion Simulation

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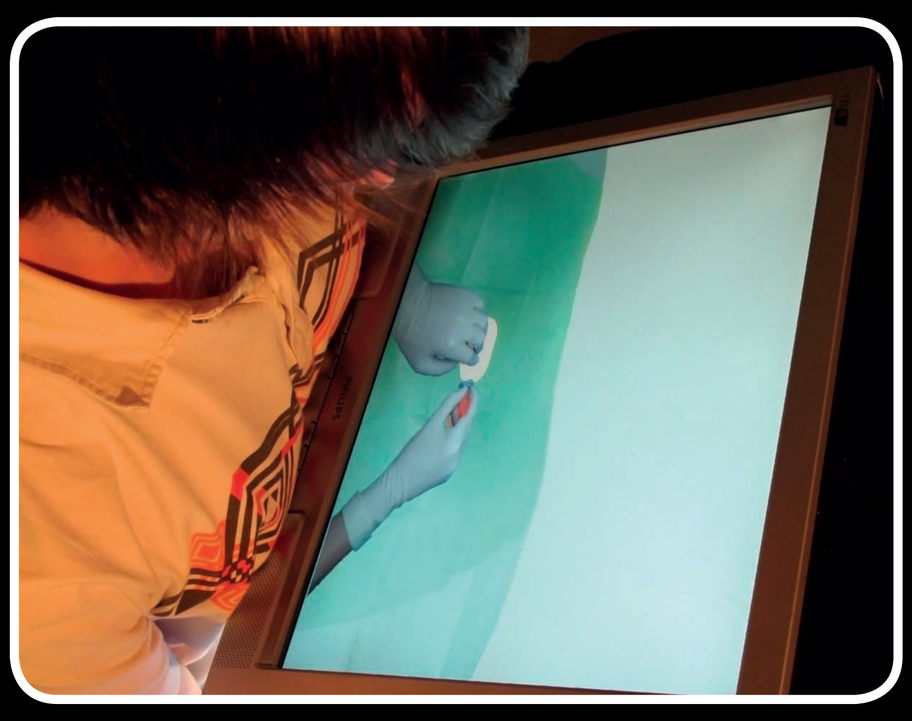
Motivation: To increase the face validity of haptic enabled needle insertion simulations



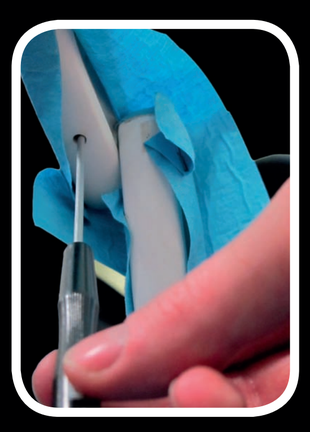
PalpSim [1] augmented reality palpation and needle insertion training simulation. Omni held in users in right hand.

A real interventional radiology needle hub can be grasped.

SensAble's Omni is modified by removing its 3 DOF wrist and stylus and replacing it with a U shaped wrist that holds a needle.

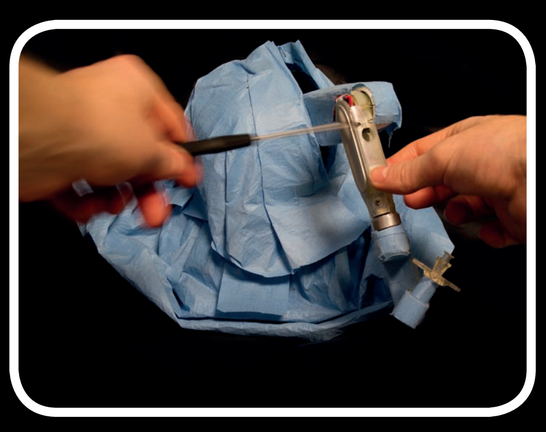
A SensAble Omni force feedback device has been modified to increase the face validity of an augmented reality needle insertion simulation called PalpSim [1][2]. The new end effector uses a real needle hub and shortened needle shaft in place of the Omni's pre-fitted pen shaped end effector. This modification facilitates correct procedural training through the simulation of collocated visual and haptic cues in an augmented reality (AR) approach to simulation. Initial results from a face and content validation study of PalpSim [1] indicate the interface provides high fidelity visual and haptic feedback as the user grasps the hub and provides sufficient force feedback for effective simulation.

Modification Process



Remove arm casing. Screw under arm.

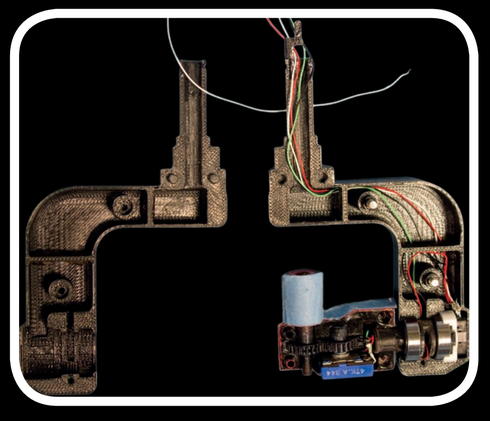
Top and bottom plasitc cases can now be uncliped from arm.



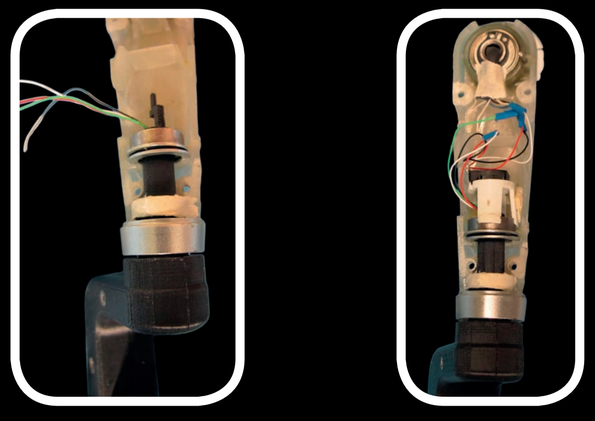
Four screws and bolts are now removed to detatch second cover.

Wires entering the armature must be cut.

The Y shaped wirst can now be slid out with force.



The new wrist, manufactured on a 3D plastic printer, uses one original potentiometer and a second (blue) off-the-shelf device.



The new wrist is closed with three screws and slid back through the two bearings. The corresponding cables are re-connected and the third potentiometer repositioned.

The arms two covers can now be re-attached, replacing the five screws and bolts. The arm is then covered in fenestrated drape for AR visualisation.

The user can grasp the real needle hub between their fingers whilst feeling the correct tactile cues and force feedback. Real hub can be seen in AR environment.

[1] T.R. Coles, D.A. Gould, N.W. John and D.G. Caldwell, "Integrating Haptics with Augmented Reality in a Femoral Palpation and Needle Insertion Training Simulation", IEEE Transactions on Haptics, Conditional Acceptance. [2] T.R. Coles, D.A. Gould, N.W. John and D.G. Caldwell, "Virtual Femoral Palpation Simulation for Interventional Radiology Training" EG UK Theory and Practice of Computer Graphics, 2010, Pp. 123 -126.