MOBILE IMAGE OVERLAY SYSTEM (MIOS) FOR IMAGE-GUIDED INTERVENTIONS

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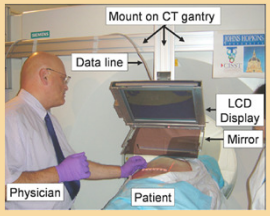
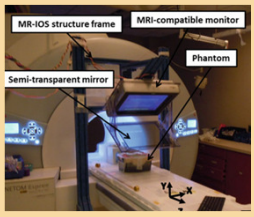
Introduction

Previous work:

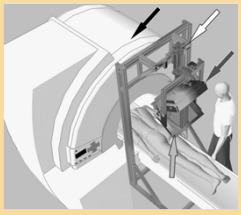
- Static image overlay proposed to aid needle placement [1,2]
- Excellent results with pre-clinical trials on cadaver and phantom [3, 4]
- Three generations of static image overlay system developed:



1st generation – image overlay mounted on CT



2nd generation – image overlay on floor mount



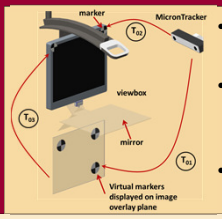
3rd generation - image overlay with tilt and rotation function

Limitations of static image overlay:

- System either fixed to the CT/MR imaging system or on a floor-mounted frame over the patient table
- Limited access to the patient and excluded clinically relevant ranges of motions of the tool and the physician
- Required careful calibration before each procedure
- Prone to misalignments due to structural deformation or unintended physical contact with the device

Solution: dynamically tracked mobile image overlay system (MIOS).

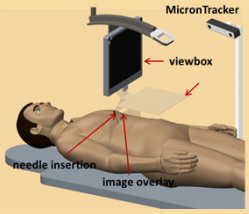
Calibration method



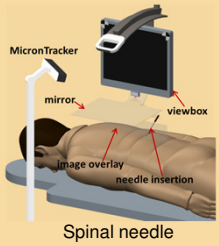
- Direct registration of virtual image overlay plane in the patient with the image re-slicing plane in the software
- Virtual markers in the image overlay plane and markers on the monitor tracked by MicronTracker to determine the pose of the Image overlay plane w.r.t monitor
- Calibration can be done away from the patient space without calibration phantom

Clinical applications

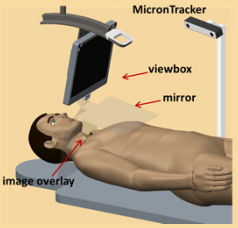
- By exploration of the image volume by a moving image slice overlaid on the patient the physician identifies plane of insertion and target
- Software displays the correct image in real time corresponding to the actual position tracked by MicronTracker (Claron Technology, Inc.)



Percutaneous access to blood vessel



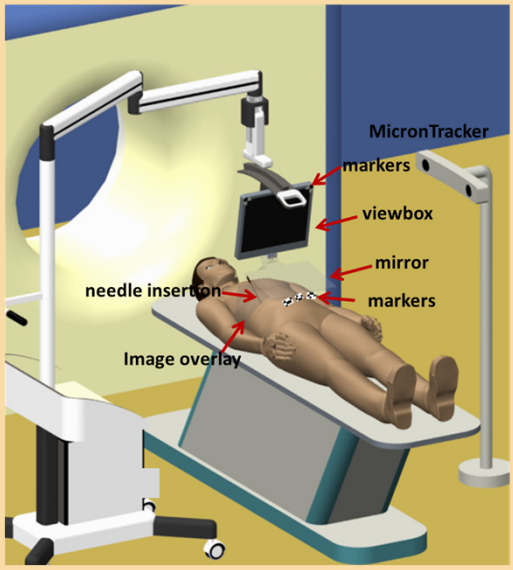
Spinal needle injections



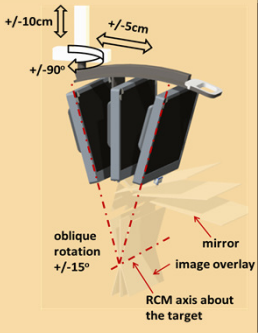
Parathyroidectomy

System design

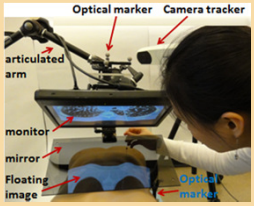
2D image overlay attached to floor mounted four degrees-of-freedom articulated and counter-balanced arm:



Conceptual view of the MIOS system



Motion ranges of the MIOS



MIOS prototype

- New mirror-monitor (viewbox) configuration (90° instead of previous 60°) resulting in increased user viewing angle
- Remote center of rotation (RCM) for oblique rotation of image overlay plane about the target

Discussion and Future work

- Based on successful pre-clinical testing of the static image overlay system [3,4], MIOS promises to become an even more useful tool for image-guided surgical interventions.
- The mechanical design of the system needs to be worked further for precise movement of viewbox along longitudinal and patient vertical axes and enable the rotation of viewbox to view oblique images up to +/- 15°.
- Phantom and cadaver studies need to be performed to evaluate the accuracy of direct calibration method and to refine the clinical workflow.

References

[1] Fichtinger *et al.* "Image overlay guidance for needle insertion in CT scanner," IEEE Transactions on Biomedical Engineering, (52:8), 2005, pp. 1415-1424.
[2] Fischer *et al.* "MRI image overlay: Application to arthrography needle insertion," Computer Aided Surgery (12:1), 2007, pp. 2-14.
[3] Fritz *et al* ."Augmented Reality Visualization with Use of Image Overlay Technology for MR Imaging-guided Interventions: Assessment of Performance in Cadaveric Shoulder and Hip Arthrography at 1.5 T," Radiology (265:1), 2012, pp. 254-259.
[4] Fritz *et al.* "Augmented reality visualization using an image overlay system for MR-guided interventions: technical performance of spine injection procedures in human cavers at 1.5 Tesla," European Radiology (23), 2013, pp. 235-245.

Acknowledgements

This work was jointly funded by the NIH grant number R01 CA118371, USA. The Discovery Grant of NSERC, Canada. National Center for Research Resources and National Institute of Biomedical Imaging and Bioengineering of the NIH USA, through grant numbers P41EB015898 and P41RR019703. Gabor Fichtinger was funded as Cancer Care Ontario Research Chair.