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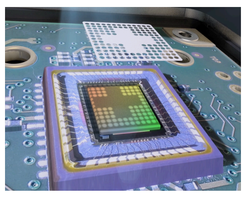
HearRestore RTD 2013

FNSNF

Accuracy studies for nanotracking in image-guided microsurgery



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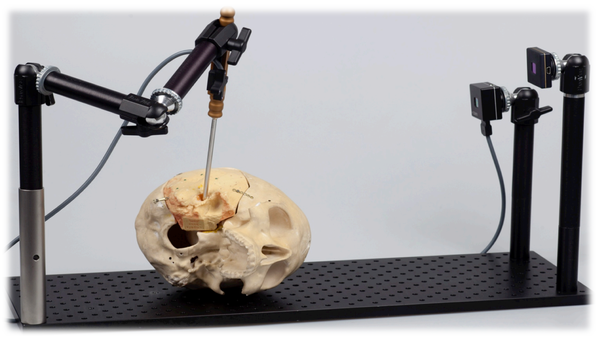
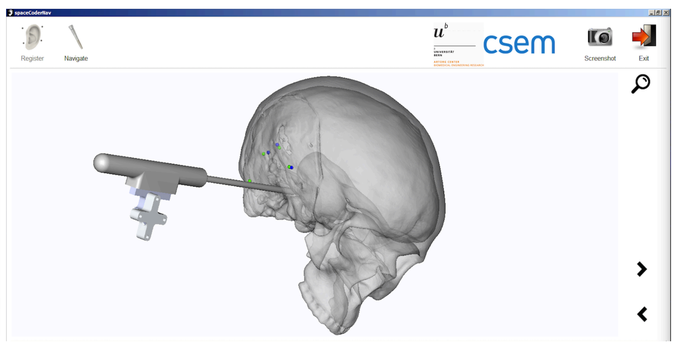
Demonstrator and tracking accuracy

First HearRestore demonstrator

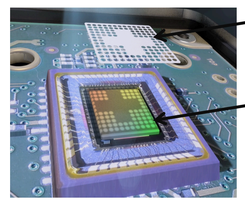
- Consists of a camera, a 6D spaceCoder platform, a 6D tracking algorithm, a 4-LEDs target, and a navigation application
- The 6D spaceCoder drives the target and synchronizes the camera with the LEDs
- The navigation system shows in real time the 6Dposition of the instrument w.r.t to the patient





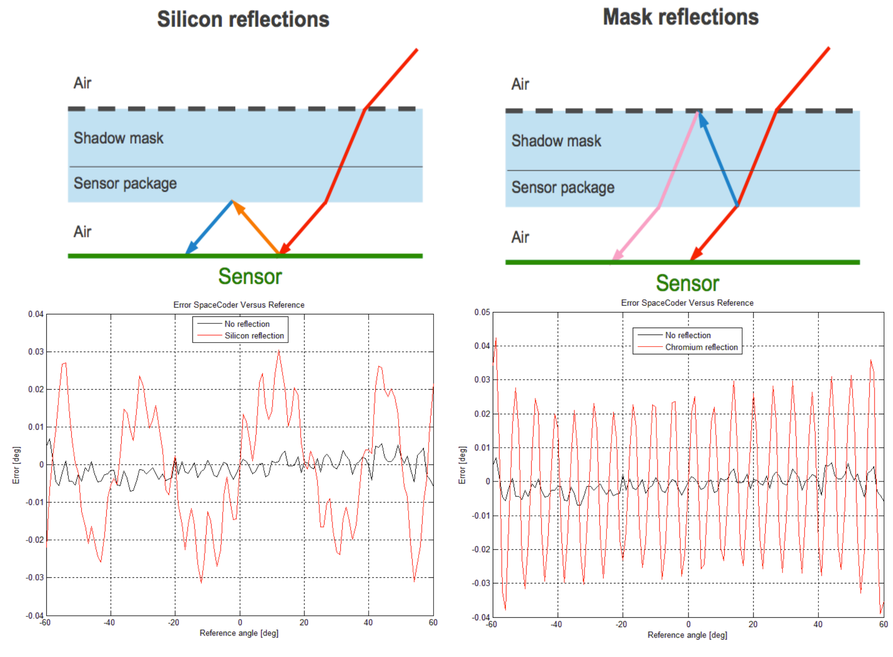
The spaceCoder tracking technology

- Consists of optical sensor coupled with a shadow mask and a 2D pattern ⟶ Create a shadow image
- Detect position of a light source by computing phase of shadow image



Accuracy analysis

- Tracking systems with high accuracy and precision are crucial in CAS surgeries
- Match theory with simulations and measurements
- For computing accuracy, we need to derive appropriate calibration methods
  - We need to understand the sources of errors: how/when/why do they occur
- Assuming a fixed spaceCoder setup, and a light source moving
- Main identified error sources: reflections, refractions and frequency mismatch



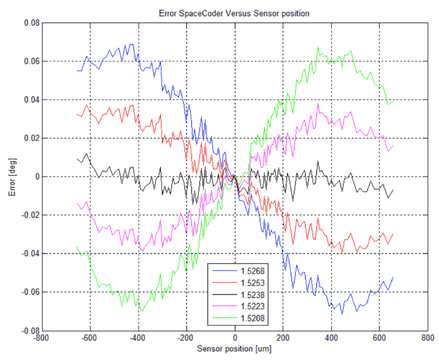
Effect of reflections

- Setup: fixed spaceCoder in front of which a light source moves in a circular manner from -60° to + 60°
- Two types of reflections: Those from sensor's Silicon + mask's Chromium
- Errors can be as high as 40 mdeg

Accuracy studies

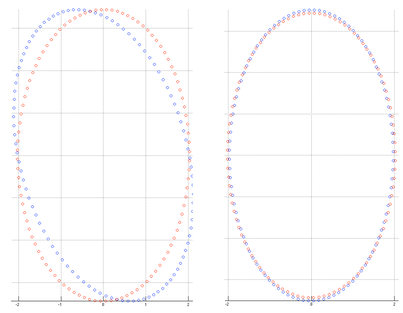
Effect of refraction

- Simulate the effect of the refraction index of the shadow mask (glass) of reflections
- Depending on the angle of incidence (or sensor position), a slight change in the index can lead to large errors in the computed position.
- Solution
  - Carefully choose the material composing the mask
  - Estimate the refraction index instead of using the theoretical one for the chosen material



What's next

- Accuracy and precision benchmark lab experiments
- Derive corrective measures for each source of error
- Redesign target for a larger baseline and add a light source non-planar with the others to lift position ambiguity in the 6D optimization
- Embedd the computation of the (x,y) to increase frame rate and the apparent rigidity of the target
- Correct errors due to frequency mismatch
  - Find suitable interpolation method to reduce effect of mismatch + discretization (both ellipses should overlap perfectly)



Patents

- 6D positioning system using a shadow sensor", US application number 14597434, filed 15-Jan-2015

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