

Fusion of augmented reality imaging with the endoscopic view for endonasal skull base surgery

a novel application for surgical navigation based on intraoperative cone beam computed tomography and optical tracking

Lai, Marco; Skyrman, Simon; Shan, Caifeng; Babic, Drazenko; Homan, Robert; Edström, Erik; Persson, Oscar; Burström, Gustav; Elmi-Terander, Adrian; Hendriks, Benno H.W.

DOI

[10.1371/journal.pone.0227312](https://doi.org/10.1371/journal.pone.0227312)

Publication date

2020

Document Version

Final published version

Published in

PLoS ONE

Citation (APA)

Lai, M., Skyrman, S., Shan, C., Babic, D., Homan, R., Edström, E., Persson, O., Burström, G., Elmi-Terander, A., Hendriks, B. H. W., & de With, P. H. N. (2020). Fusion of augmented reality imaging with the endoscopic view for endonasal skull base surgery: a novel application for surgical navigation based on intraoperative cone beam computed tomography and optical tracking. *PLoS ONE*, *15*(1), Article e0227312. <https://doi.org/10.1371/journal.pone.0227312>

Important note

To cite this publication, please use the final published version (if applicable). Please check the document version above.

Copyright

Other than for strictly personal use, it is not permitted to download, forward or distribute the text or part of it, without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license such as Creative Commons.

Takedown policy

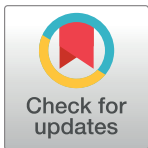
Please contact us and provide details if you believe this document breaches copyrights. We will remove access to the work immediately and investigate your claim.

CORRECTION

Correction: Fusion of augmented reality imaging with the endoscopic view for endonasal skull base surgery; a novel application for surgical navigation based on intraoperative cone beam computed tomography and optical tracking

Marco Lai, Simon Skyрман, Caifeng Shan, Drazenko Babic, Robert Homan, Erik Edström, Oscar Persson, Gustav Burström, Adrian Elmi-Terander, Benno H. W. Hendriks, Peter H. N. de With

The images for Figs 2, 3, 4 and 5 are incorrectly switched. The image that appears as Fig 2 should be Fig 3, the image that appears as Fig 3 should be Fig 4, the image that appears as Fig 4 should be Fig 5, and the image that appears as Fig 5 should be Fig 2. The figure captions appear in the correct order.



OPEN ACCESS

Citation: Lai M, Skyрман S, Shan C, Babic D, Homan R, Edström E, et al. (2020) Correction: Fusion of augmented reality imaging with the endoscopic view for endonasal skull base surgery; a novel application for surgical navigation based on intraoperative cone beam computed tomography and optical tracking. PLoS ONE 15(2): e0229454. <https://doi.org/10.1371/journal.pone.0229454>

Published: February 13, 2020

Copyright: © 2020 Lai et al. This is an open access article distributed under the terms of the [Creative Commons Attribution License](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

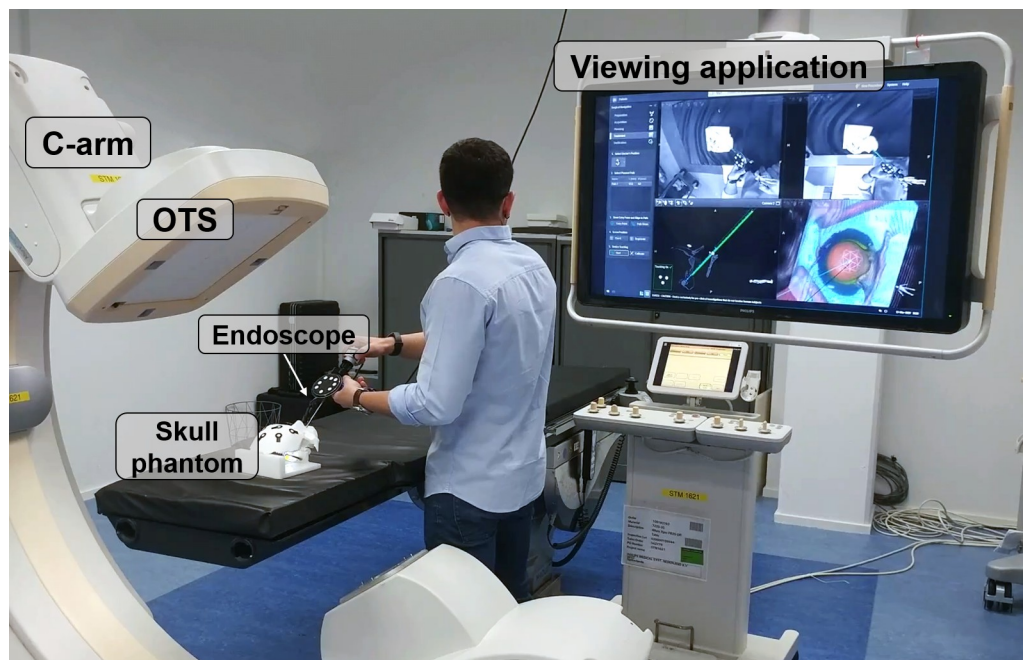


Fig 2. Experimental setup for the study on the skull phantom.

<https://doi.org/10.1371/journal.pone.0229454.g001>

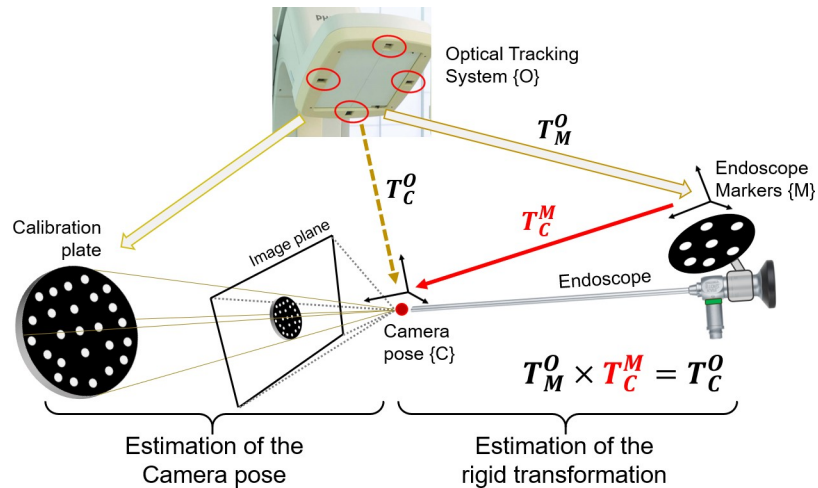


Fig 3. Hand-eye calibration with a moving calibration plate.

<https://doi.org/10.1371/journal.pone.0229454.g002>

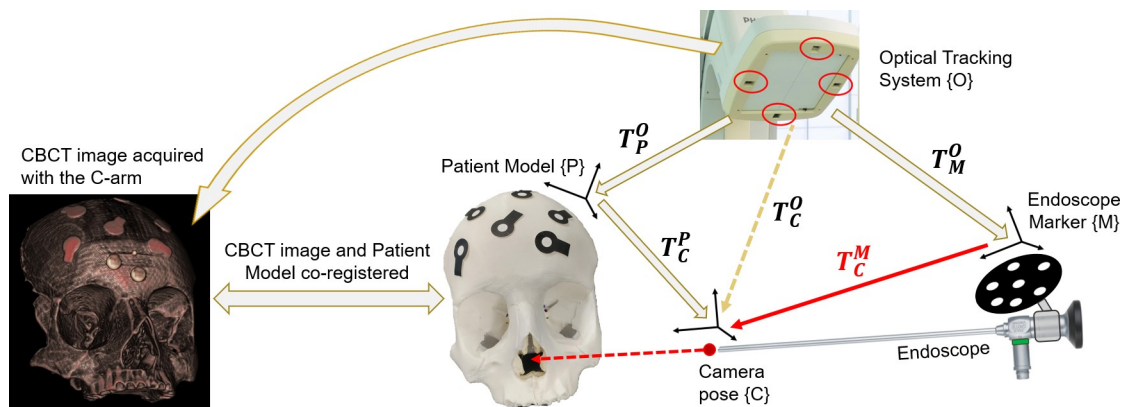


Fig 4. Relationship of the frame transformations.

<https://doi.org/10.1371/journal.pone.0229454.g003>

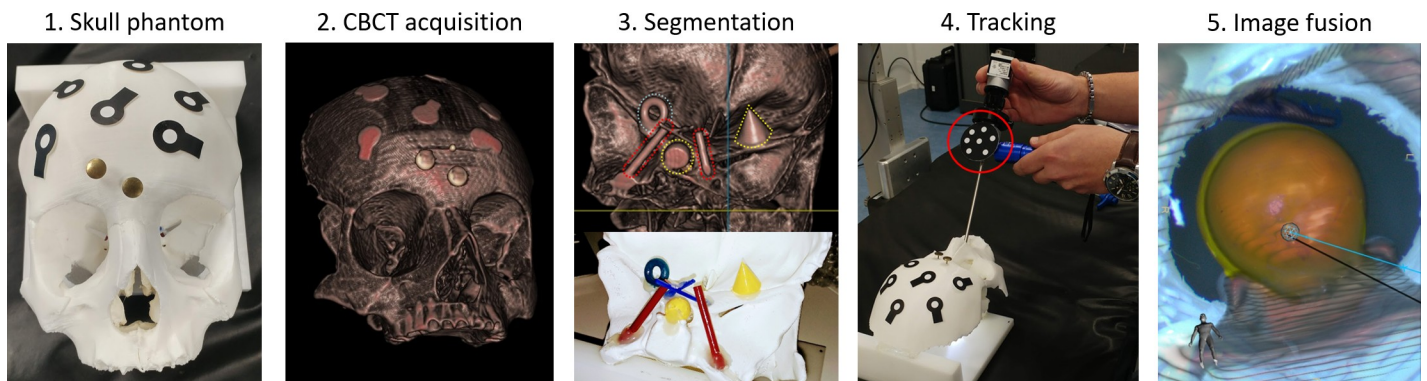


Fig 5. The workflow in a surgical scenario. Overall performances of the image fusion system were evaluated on a plastic skull phantom with a realistic representation of the nasal cavity and adjacent skull base anatomy, including vessels, nerves and the pituitary gland. 1. The skull phantom with optical markers on its surface was positioned on the surgical table. The 3D position of the optical markers was detected by the OTS of the navigation system, to create a VRG for tracking of the phantom's motion. 2. A CBCT image, co-registered with the 3D position of the optical markers (VRG) was acquired. 3. Anatomical structures of interest were manually segmented from the CBCT image. 4. The endoscope, automatically recognized and tracked by the OTS, was placed in the nasal cavity of the phantom. 5. Segmented structures at the base of the skull were augmented onto the live endoscopic image. The augmented endoscopic view, together with anatomical views to guide the surgeon inside the nasal cavity, were displayed.

<https://doi.org/10.1371/journal.pone.0229454.g004>

Reference

1. Lai M, S kyrman S, Shan C, Babic D, Homan R, Edström E, et al. (2020) Fusion of augmented reality imaging with the endoscopic view for endonasal skull base surgery; a novel application for surgical navigation based on intraoperative cone beam computed tomography and optical tracking. PLoS ONE 15 (1): e0227312. <https://doi.org/10.1371/journal.pone.0227312> PMID: 31945082