

3DInMed

Digital stereoscopy in medical and industrial applications

The significance of digital stereoscopy for medical applications, such as surgical microscopy or diagnostic and interventional endoscopy has been increasing over the last few years. Stereoscopic systems offer entirely new possibilities to extract and visualize additional information resulting in significantly enhanced conditions for diagnostics and surgical interventions. Furthermore, digital stereoscopy improves clinical workflows by reducing both, surgery duration and risks. For this purpose Fraunhofer HHI has developed image-based algorithms able to support the analysis and optimization of the complete 3D processing chain from acquisition to playback.

Challenges

- Guarantee of highest stereo image quality by avoiding symptoms of visual fatigue
 - Objective stereo characteristics (e.g. geometric alignment of stereo images)
 - Subjective stereo characteristics (e.g. stereoscopic comfort zone)
- Visual matching of stereo recording and playback unit
- Precise calibration of optical system
- Providing enhanced information in real time
 - Distance measurements
 - Contour measurements
 - Volume measurements
 - Tracking of spots of interest
- Retain established workflows

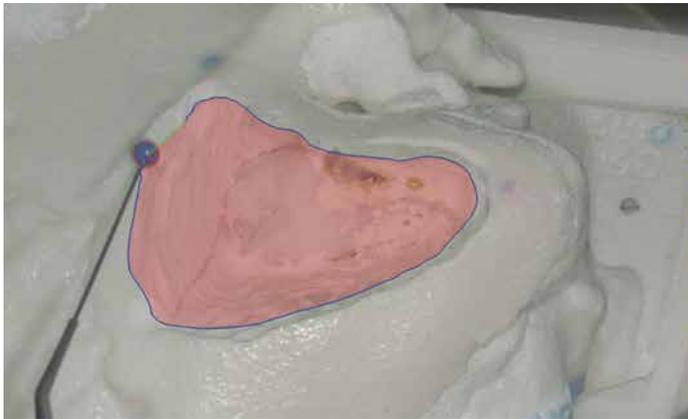
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Benefits

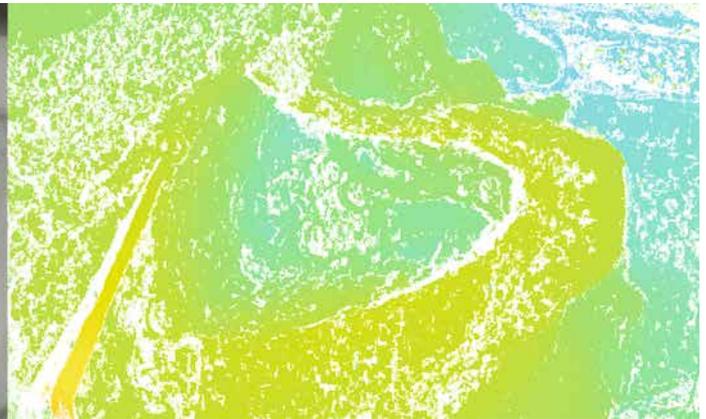
- Measurement of distances and areas without additional hardware
- Shorter durations of surgical interventions due to uninterrupted workflow
- Additional and enhanced visual information to facilitate intraoperative decisions
- Reduced symptoms of visual fatigue and exhaustion by optimizing the stereo signal in real-time
- Cost reduction due to increased efficiency
- Seamless integration in established workflows



Immersive 3D visualization of the operating field on a glasses-free SeeFront 3D stereoscopic display



(a) Real-time tracking result of instrument tip



(b) Related result of real-time depth map estimation

Technical background

Digital stereoscopic systems introduce a wide variety of new possibilities in medical applications. However, such systems also require a properly configured setup. Therefore a streamlined design is needed to match the stereoscopic recording unit and stereoscopic display. Geometric misalignments are corrected digitally in real-time by detecting robust feature point correspondences. The algorithm ensures compliance with the so-called stereoscopic comfort zone for video playback. Colorimetric inconsistencies are corrected by real-time capable advanced histogram analysis.

Furthermore, well calibrated stereoscopic imaging systems allow metric measurements of critical points by triangulation. In this context surgical instruments can be used as tactile measuring devices by using innovative and advanced tracking algorithms. The core tracking algorithm is based on a hybrid approach of color- and depth-based image segmentation.

The targeted technologies are also more and more used in other application areas, such as planning, production or inspection processes in construction, trade and industry. Especially endoscopic stereo systems are enabling touchless inspection and measurement processes of inaccessible tubular parts or cavities.

Project background

The described procedures are developed by members of the „3IT – Innovation Center for Immersive Imaging Technologies“ in the project “3DInMed“. The project partners are ARRI Medical, C.R.S. iiMotion GmbH, Fraunhofer HHI, Fraunhofer IIS, SCHÖLLY FIBEROPTIC GmbH, SeeFront GmbH and Solectrix GmbH. The project is funded by the German Federal Ministry for Economic Affairs and Energy on the basis of a decision by the German Bundestag.

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