3DInMed

Digital stereoscopy in medical and industrial applications

The significance of digital stereoscopy for medical technology, such as surgical microscopy and endoscopy, has been increasing over the last few years. Stereoscopic systems offer entirely new possibilities to extract and visualize additional information resulting in significantly improved conditions for surgery. Furthermore, digital stereoscopy improves related work processes by reducing surgery duration and risks. For this purpose Fraunhofer HHI has developed image-based algorithms which analyze and optimize the complete 3D processing chain from video recording to playback.

Challenges

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

Benefits

- Measuring of distances and areas without additional hardware
- Shorter surgery duration 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 visualisation of the operating field on a glasses-free SeeFront 3D stereoscopic display

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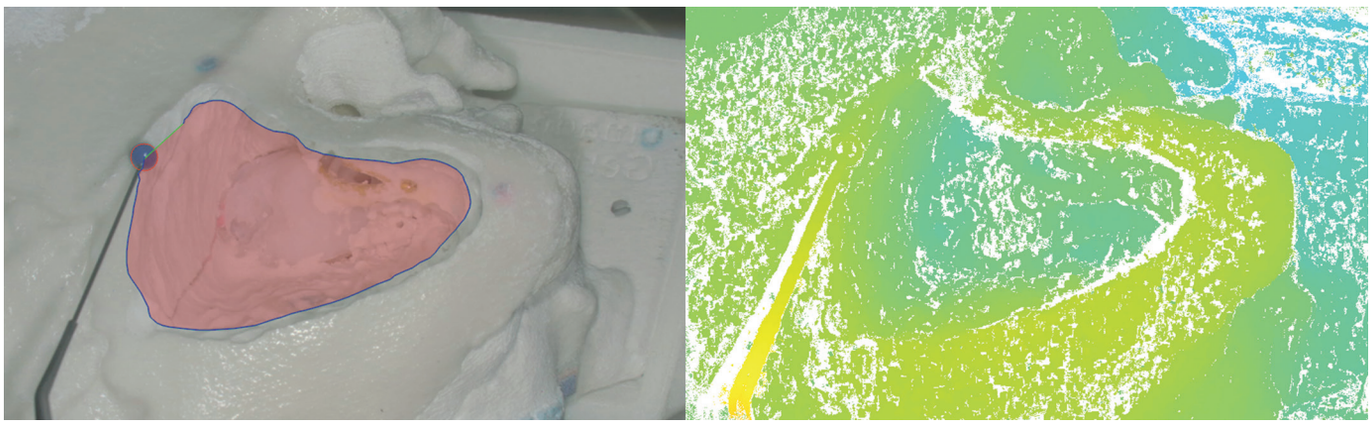

(a) Real-time tracking result of instrument tip

(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 between the optics are corrected digitally in real-time by detecting unique feature points. The algorithm allows to determine 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 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 called 3DInMed. Our 3DInMed 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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