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Mobile Markerless Augmented Reality and its Application in Forensic Medicine

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This thesis addresses two major tasks of forensic medicine:

(1) Differentiation between natural and non-natural causes of death in cases of unknown cause and (2) documentation and translation of findings to a language that is understandable for judicial persons and for medical laymen.

Although 3D medical imaging data, such as computed tomography (CT) data, could greatly support forensic pathologists from damaging evidence by allowing to associate, for example, external wounds to internal injuries, such data is rarely used. One possible reason for this is the lack of appropriate visualization methods. In particular, there is no system for augmented reality support during autopsy and no system combines intuitive visualization and surface documentation at low cost. To address these issues, the first mobile markerless solution for intuitive visualization and documentation of multi-modal forensic data was proposed. The key is a range camera, which is mounted on a tablet computer to form a new device. The camera pose is continuously estimated based on surface registration of CT and depth data to allow for augmented reality visualization of the internal anatomy directly on the tablet. Additionally, projection of color information onto the CT surface is implemented for 3D textured surface documentation and presentation in court.

A prototype of the visualization concept was validated in both a phantom and a post-mortem pilot study using fiducials attached to the skin for quantification of a mean target registration error of 4.2 ± 0.6 millimeters (mm) for a phantom and 4.4 ± 1.3 mm for a human corpse. Additionally, an underlying service-oriented architecture was implemented to quickly integrate new range imaging devices without having to modify the open-source code.

The concept is mobile, markerless, intuitive and real-time capable with sufficient accuracy for visualization. Despite its preliminary prototype status, it has high potential for forensic applications and other fields like surgery or education, due to its low price, simplicity and generic concept.