Corrigendum: Data-Driven Digital Twins in Surgery utilizing Augmented Reality and Machine Learning

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***Abstract*—In the following corrigendum to our paper "Data-Driven Digital Twins in Surgery utilizing Augmented Reality and Machine Learning" [1], we give additional references to the context of the work, namely to results of our research partners, as well as collaborative results of the ARAILIS project group. We apologize for the omissions.**

First of all, our paper [1] reflected work in progress, the distributed software architecture of the project ARAILIS, as well as a preliminary and intermediate case study of the project, and we refer to the final project results in the publications [3], [4], and [5], which describe the achieved prototype more conclusively.

Figure references and descriptions. Unfortunately, in our paper [1] the following references and incorrect captions were omitted:

- Figures 1, 3, 4 are courtesy to the partner NCT (National Center for Tumor Diseases, Prof. Stefanie Speidel, Dr. Sebastian Bodenstedt, Reuben Docea).
- Figure 2 is courtesy to [2], also by NCT.
- The caption of Figure 4 has to be changed to "ORB-SLAM [citation] detects features (left) which are used to localise the camera and build a sparse map (right) [7]."
- Figure 5 is courtesy to discussions in the entire project, in particular also with partner MT (Chair of Multimedia Technology, TU Dresden, Prof. Raimund Dachselt, Dr. Annett Mitschick, Katja Krug)
- The caption of Figure 5 has to be changed to "Overall architecture of the system: blue: core modules, yellow: user interface, green: camera image processing/calibration", as the architecture describes a reflection of a digital twin prototype.
- Figure 6 and 7 contain intermediate results of the ARAILIS group, in particular of the partners ETIT (Chair of Fundamentals of Electrical Engineering, TU Dresden, Prof. Ronald Tetzlaff, Dr. Jan Müller). and IPF (Chair of Photogrammetry, TU Dresden, Prof. Hans-Gerd Maas, Matthias Hardner).
- Caption of Figure 6 need to be changed to: "Problem setting of disparity/depth estimation from stereo images using an artificial neural network. The '3D feature map' is a surfel cloud created using the ElasticFusion SLAM system [8]."

The Figure 6 outlines the problem setting at the beginning of the project, concerning the production of 3D point clouds of the scene (symbolised by a point cloud rendering overlaid by feature points). Previously, the resolution had to be reduced to a quarter, to achieve an "acceptable" frame rate of 15 Hz, whereas at full resolution only 2 Hz would be accomplished. However, at the time of publication of this article, this part of the processing pipeline including point cloud generation was running at full speed (30 Hz) at full resolution (2 x 1920 x 1080 px) of the input stream. The correct and more detailed information can be found in [4].

Text Corrections. In Section 2, we need to credit the work of our project partner MT clarifying the sentence: "To gather the medical requirements, we evaluated the general surgeons' challenges during laparoscopic liver surgeries via personal interviews and transposed them to technical requirements.". Together with partner MT, we did several surveys with surgeons and collected the data. Afterwards, our partner evaluated the data and provided the results to the project group. Hence, the mentioned sentences should be changed to "Personal interviews were conducted and afterwards, by the project partner MT, evaluated to gather the surgeons' requirements during laparoscopic liver surgeries and transposed to technical requirements."

In Section 2.1, we have to correct the reference to the endoscope. As mentioned in the paper of our project partners [6], instead of the STORZ endoscope, the Einstein Vision 3.0 endoscope was used.

Also we need to clarify in Section 2.2 that the base of our software architecture is a prototype provided by the NCT group.

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References

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