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Concerning: BSc evaluation of Mr. Mahmoud Mohamed Bahaa

Dear Professor Abdennadher,

It was a great honor to host your student, Mahmoud Mohamed Bahaa in my research group *Fachgebiet Augmented Reality (FAR)* at the Technische Universität München. It was a pleasure to work with Mr. Bahaa. During his stay from April until August 2010, he wrote his Bachelor thesis with the title "Integration of Markerless Tracking into Global Reference Frames", under the supervision of my Ph.D. student Peter Keitler. Furthermore, he was fully integrated in a team embedded in the German BMBF research project AVILUS.

Garching, Dec. 6, 2010

The assignment to Mr. Bahaa consisted of the development and testing of registration methods that allow for quickly integrating the position and orientation (pose) measurements of an optical natural feature tracker into the natural coordinate frame associated with the environment. Pose tracking is a basic prerequisite for Augmented Reality. There is a high potential for Augmented Reality in industry where digital CAD models shall be integrated into the worker's view to support working processes during production, maintenance, or quality control. The rendering of the model is thereby adapted in real-time, depending on the worker's viewing perspective as determined by the tracker. The efficient registration of the arbitrary coordinate frame of the feature tracker with the given model coordinate frame is not solved in general yet. Mr. Bahaa implemented and tested two alternative registration methods:

- Automatic registration method (marker-based): A square marker has to be available in the scene and its position and orientation has to be known in advance. From the square-marker, the position of the camera can be determined in world coordinates. Together with the corresponding position of the camera in the coordinate frame of the map of natural features, a transformation between this map and the world can be computed, based on 3D-3D pose estimation.
- Manual registration method (based on CAD model): The 3D positions of salient feature points are extracted directly from the CAD model. By manually clicking the highlighted feature points in the camera view, correspondences between feature map and CAD model are established. Having at least 3 point correspondences, the transformation can be estimated. This approach is useful if square markers are not allowed for reference.

Different registration and tracking methods were evaluated in the AVILUS *Tracking Contest* (August 18-26, 2010). FAR participated successfully in this contest, Mr. Bahaa's work being one of the key components of our contest system. Besides this scientific contribution, Mr. Bahaa was also fully committed to the preparation of and the participation in the contest. We highly appreciated his generous help.

In his bachelor's thesis, Mr. Bahaa has impressed with sharp problem seizing skills. He is fully committed to his work and follows an intuitive approach towards problem solving. Inquisitive mind and willingness to learn typify his character. He has maintained an extremely pleasant relationship with his colleagues. It was a pleasure to work with him.

I can fully attest that Mr. Bahaa has produced an excellent bachelor's thesis and would like to honor the thesis with our highest grade

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Kindest regards,

(Prof. Gudrun Klinker, Ph.D.)