Probeless Illumination for Mobile Augmented Reality

Augmented Reality (AR) is a user interface paradigm to seamlessly integrate virtual information into the real world view, whereby both the virtual and the real are spatially registered in 3D [1]. Besides geometric registration, high-quality AR also calls for photometric registration, which is the concept of illuminating virtual objects, optimally done in the same way as the real counterparts. While earlier works measure the physical illumination conditions by light probes using additional equipment [2, 3], more recent approaches aim for using a light-weight technical setup and uses the scene geometry as a light probe [4, 5]. If we assume a single moving camera setup, this requires prior monocular dense reconstruction [6]. Based on the reconstructed scene, a radiance transfer function needs to be computed and applied [7]. The objective of this work is to robustly estimate the radiance transfer for photorealistic mobile AR with dynamically changing scene geometry.

Literature Project (LP): *Photorealistic Rendering in AR*	- identify and briefly describe the related keywords and requirements (e.g., AR, photometric registration, illumination, etc.) - review and describe existing approaches for photorealistic rendering in AR [2, 3]
Software Project (SP): *Monocular 3D Dense Reconstruction*	- implement the dense reconstruction approach of Pizzoli et al. [6] - evaluate your implementation based on comparison with a ground truth dense map
Master Thesis (MA): *Probeless Illumination for Mobile AR*	- implement the light estimation approach of Gruber et al. [7] - use the SP implementation for dense reconstruction - evaluate the resulted performance and light estimation quality - discuss the constraints, disadvantages and advantages of your light estimation approach

Qualifications:

- Good programming skills (C++, Unity)
- Interested in computer vision and computer graphics
- Ability to work independently

Literature:

[1] Azuma, R.T. (1997) A survey of augmented reality. *Presence, Teleoperators and Virtual Environments*, 6(4), pp. 355-385.

[2] Jacobs, K., and Loscos, C. (2004) Classification of illumination methods for mixed reality. *Computer Graphics Forum 25*, 1, 29– 51.

[3] Kronander, J., Banterle, F., Gardner, A., Miandji, E. and Unger, J. (2015) Photorealistic rendering of mixed reality scenes. *Computer Graphics Forum 34*, 2, pp. 643-665.

[4] Pilet, J., Geiger, A., Lagger, P., Lepetit, V. and Fua, P. (2006) An all-in-one solution to geometric and photometric calibration. Proc. of *IEEE/ACM International Symposium on Mixed and Augmented Reality, 2006 (ISMAR'06)*, pp. 69–78.

[5] Gruber, L., Trummer, T. & Schmalstieg, D. (2012) Real-Time Photometric Registration from Arbitrary Geometry. *Proc. of International Symposium on Mixed and Augmented Reality (ISMAR'12)*, pp. 119-128.

[6] Pizzoli, M., Forster, C. and Scaramuzza, D. (2014) REMODE: Probabilistic, Monocular Dense Reconstruction in Real Time. Proc. of *IEEE International Conference on Robotics and Automation (ICRA)*, Hong Kong.

[7] Gruber, L., Langlotz, T., Sen, P., Höllerer, T. & Schmalstieg, D. (2014) Efficient and Robust Radiance Transfer for Probeless Photorealistic Augmented Reality. Proc. of *IEEE Virtual Reality (VR'14)*, pp. 15-20.

Book: Schmalstieg, D. & Höllerer, T. (2016) Augmented Reality: Principles and Practice. *Addison Wesley*.

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