Mobile Augmented Reality

Quellen der Bilder im Uhrzeigersinn von oben links: Augmentedev.com, Microsoft HoloLens, Oculus Rift, Google Cardboard


Bei einigen der angebotenen Themen sind Demos mit Google Cardboard möglich. Dafür sind zwei Einheiten geplant, in denen sich alle Teilnehmer mit der Datenbrille vertraut machen. Die geplanten Vortragsthemen für die Teilnehmer sind:

1. **User Interfaces for Mobile Augmented Reality: Technology, Concepts and Products** (Christoph Bachhuber): Competitive Mobile Augmented Reality requires good user interfaces. User interfaces are on one hand hardware technologies like head-worn displays as Google Glass, handheld displays as smartphones or tablets, or projection displays. The advantages and challenges of the different approaches shall be discussed as well as the perceptual problems, which all the interfaces have in common. These are for example latency, depth perception, fatigue and eye strain. On the other hand, when a hardware interface is given, (photorealistic) rendering is the next challenge. Solutions to this challenge shall be reviewed, too.

   Azuma et al.: *Recent Advances in Augmented Reality*,
   van Krevelen et al.: *A Survey of Augmented Reality Technologies, Applications and Limitations*,

2. **Calibration of Head-Mounted Displays** (Damien Schroeder): In augmented reality, real objects from the user’s surroundings and computer generated graphics have to be properly positioned relative to each other in other to offer a seamless experience to the user. Therefore, the position and
orientation of a head-mounted display needs to be measured accurately before the augmented reality system is geometrically calibrated. The goal of this seminar topic is to get familiar with the general topic of calibration for head-mounted displays in augmented reality applications and to describe the latest research advances in calibration.

Janin et al.: *Calibration of head-mounted displays for augmented reality applications*,
Gilson et al.: *Spatial calibration of an optical see-through head-mounted display*,
Kellner et al.: *Geometric calibration of head-mounted displays and its effects on distance estimation*.

3. **MonoSLAM: Real-Time Single Camera SLAM** (Adrian Garcea): MonoSLAM is the first successful application of the SLAM methodology from mobile robotics to the "pure vision" domain of a single uncontrolled camera, achieving real time but drift-free performance inaccessible to structure from motion approaches. The core of the approach is the online creation of a sparse but persistent map of natural landmarks within a probabilistic framework. The key novel contributions include an active approach to mapping and measurement, the use of a general motion model for smooth camera movement, and solutions for monocular feature initialization and feature orientation estimation. Together, these add up to an extremely efficient and robust algorithm which runs at 30 Hz with standard PC and camera hardware. The applications of MonoSLAM extend to real-time 3D localization and mapping for a high-performance full-size humanoid robot and live augmented reality with a hand-held camera.


4. **Dense Tracking and Mapping in Real-Time** (Dominik van Opdenbosch): Parallel tracking and mapping algorithms form the basis for various applications ranging from autonomous navigation in the field of robotics over the 3D reconstruction of the environment from a single video (Structure from Motion) to various applications in the field of augmented reality. Most of these approaches like PTAM (Parallel Tracking and Mapping) rely on tracking a set of distinctive visual cues from one frame to another. These visual cues, also known as local visual features, can be used to quickly determine correspondences between adjacent frames and estimate the relative motion between two frames. Most of these algorithms build up a map (mapping part), where visual cues are described as feature vectors and unscaled 3D positions (from the tracking step). This representation provides only a very sparse sampling of the environment (at the points, where visual features have been detected). The DTAM (Dense Tracking and Mapping) tries to overcome this limitation using the projection from all pixels from adjacent frames into a reference frame and minimizing the photometric costs. With this approach it is possible to reconstruct a dense 3D model for real-time applications such as augmented reality.

Newcombe et al.: *DTAM: Dense Tracking and Mapping in Real-Time*.

5. **Parallel Tracking and Mapping for Small AR Workspaces** (Adrian Garcea): With the introduction of powerful smartphones and wearable devices (e.g. Google Glass) applications for augmented reality (AR) have moved into the spotlight. An accurate motion tracking approach is needed in order to enable augmented reality applications in an unstructured and non-calibrated environment. Parallel Tracking and Mapping (PTAM) is an approach that solves the challenge of motion tracking for AR using point features from previous video frames.

Klein et al.: *Parallel Tracking and Mapping for Small AR Workspaces*

6. **Outsourcing AR Computations: Video Communication with Ultra-Low End-to-End Delay** (Christoph Bachhuber): Real-time photorealistic rendering can demand high computational power, much more than a current mobile device is able to provide. In case a high-end render is needed on such a device, for example a smartphone, the computational task can be outsourced. This means streaming the video to a computationally powerful server, where it is processed. The server streams the video back to the smartphone. Naturally, the delay between recording the raw video and the final presentation to the user must be very small, ideally below 10 milliseconds. There are three fundamental methods to minimize this latency: first waiving non-causal B-Frames. Second
is optimizing the en- and decoding process. For this optimization, hardware and software have to be considered in the design. Third, and most important is minimization of buffers achieved by rate control algorithms. The latter two approaches are not trivial and shall be presented.

Correa et al.: *Performance and Computational Complexity Assessment of High Efficiency Video Encoders*,

von Lee et al.: *An Intra-Frame Rate Control Algorithm for Ultralow Delay H.264/Advanced Video Coding (AVC)*.

7. **WiFi-based Indoor Localization** (Christoph Bachhuber): The first step to many augmented reality applications is finding out the own position. This can for example be done by analyzing the wireless LAN signals.

   Xiang et al.: *A Wireless LAN-based Indoor Positioning Technology*,

   Liu et al.: *Survey of Wireless Indoor Positioning Techniques and Systems*.

8. **Indoor Positioning Using Magnetic Fields** (Dmytro Bobkov): Magnetic field fluctuations in modern buildings arise from both natural and man-made sources, such as steel and reinforced concrete structures, electric power systems, electric and electronic appliances, and industrial devices. As most of these anomalies are nearly static, they can serve as significant landmarks for indoor positioning. In this seminar topic, an approach to indoor positioning using magnetic field is to be studied in further details.

   Haverinen et al. *A global self-localization technique utilizing local anomalies of the ambient magnetic field*.

9. **Sensor Fusion for Indoor Positioning** (Dmytro Bobkov): To enable ubiquitous location-based services, a reliable positioning and tracking technology for mobile devices is required that works indoors. As no single sensor has a sufficient accuracy and reliability by itself, fusion of multiple information sources is required. In order to combine these sources most accurately according to their properties, one needs to perform a probabilistic sensor fusion. Furthermore, in order to address limited energy resource of a mobile phone, energy-efficient approach is required. In this topic, recent developments in an energy-efficient probabilistic sensor fusion for indoor positioning on a mobile device will be reviewed.

   Hilsenbeck et al. *Graph-based Data Fusion of Pedometer and WiFi Measurements for Mobile Indoor Positioning*.

10. **Backup: Object and Scene Relighting** (Xiao Xu)

11. **Backup: Indexing and Retrieval of Human Motion Data** (Clemens Schuwerk)

12. **Backup: Modeling of Object Fractures** (Jingyi Xu)

13. **Backup: Free Viewpoint Video** (Anas Al-Nuaimi)

Änderung an den Themen vorbehalten.