PFG 2012 / 6, 0677 – 0678
Stuttgart, December 2012

Editorial

3D Reconstruction of Real World Scenes with Low-Cost Hard- and Software

Stereo visualisation and 3D reconstruction of objects together with their environments is an important topic of research but also of interest for entertainment with applications in many areas such as gaming, virtual museums and architecture.

In the last few years 3D cameras and 3D visualisation has progressed enormously. For the first time, the loop from digital stereo image acquisition to visualisation of commercial, scientific and private applications is closed. Besides this, comparatively inexpensive stereo screens and 3D printers are available for everybody.

3D capturing hardware and processing software has been available for several decades. However, their acquisition costs were exorbitantly high. Hence, the use of these systems and methods was limited to larger production companies and a few academic institutions and research institutes.

This situation has changed dramatically in recent years. Today free software is available that allows 3D reconstruction based on uncalibrated consumer-grade sensor systems. An example is Bundler, a 3D software tool based on structure-from-motion (SfM) algorithms where a large number of unordered images can be processed. Previous projects have shown the capabilities of this software where it has been applied on city-scale photo collections, e.g. the Rome in a Day project.

Beside this, digital stereo cameras can now be used for 3D capturing and visualisation. In addition to passive optical systems, some inexpensive active systems, e.g. light measurement and David laser scanner, exist. The Kinect sensor which Microsoft originally provides for the Xbox 360, applies a completely different approach. Measurements can be carried out by comparative analysis with a reference pattern using a speckle pattern depth approach. KinectFusion is another research topic that is gaining interest of the scientific community as the system focuses on real-time 3D reconstruction of indoor scenes by using a moving depth camera.

A new trend is the implementation of 3D reconstruction on a variety of web-based 3D reconstruction services, e.g. 123D Catch, available also on iPhone and iPad.

All the above-mentioned trends are within the scope of the LC3D conference. The department for Geodesy and Geoinformation Techniques at the Technical University of Berlin (TU) as well as the Department of Computer Science (Computer Vision) of Humboldt University (HU) hosted the first "Low-Cost 3D: Sensors, Algorithms, Applications" workshop which was held on December 6 to 7, 2011 at the TU Berlin. The workshop featured live demonstrations of various systems in the afternoon and continued with a conference at the next day including 13 presentations.

The workshop was organized by Prof. Dr.-Ing. Frank Neitzel (TU Berlin) and Prof. Dr. rer. nat. Ralf Reulke (HU Berlin) supported by their respective staff members. Joint organisers of the workshop were the German Aerospace Center (DLR Berlin-Adlershof), the Fraunhofer Heinrich-Hertz Institute as well as the International Society for Photogrammetry and Remote Sensing (ISPRS) represented by the Image Sensor Technology working group. The Low-Cost 3D workshop has been the first one of its kind that exclusively focused on Low-Cost 3D reconstruction while covering the entire spectrum of facets. The event attracted researchers, developers and users that are interested in various fields of application and the intrinsic potential of such techniques. In spite of the short announcement 80 participants from Germany and abroad attended the workshop which reflects the current interest in this hot topic. About two thirds of the participants were affiliated to Universities or other research facilities, 28% worked in free enterprises while a minority of 5% came from ad-

www.schweizerbart.de
DOI: 10.1127/1432-8364/2012/0147
1432-8364/12/0147 $ 0.50

ministrative or public authorities, e.g. working in archaeology and forestry management.

Live demonstrations of 13 presenters took place at TU Berlin's Geodätenstand, a geodetic observation platform on the university's roof, and proofed that 3D data acquisition can be cheap. The combination of the icebreaker party and live demos went well, accompanied by a picturesque view at dusk over Berlin. Staff of TU Berlin presented how one can reconstruct geometry by applying Bundler and PMVS2 software, Ruhr-University Bochum showed their low-cost navigation system based on a PMD camera, the TU Clausthal-Zellerfeld demonstrated impressively their implementation of a visualisation of cave systems, Fiagon GmbH, displayed a novel navigation system for dentistry while GFaI tech ltd. presented their new laser scanner FinalScan LR-50.

At the following day 13 talks were held in five session covering aspects from data acquisition, algorithms, geometric considerations and various applications. The spectrum of the presentations was large.

Frank Neitzel (TU Berlin) presented a low-cost UAV system, an octocopter equipped with Canon IXUS 100 IS, for mobile mapping purposes. Subsequently, Konrad Wenzel (University of Stuttgart) presented a multi camera system consisting of panchromatic and near infrared cameras, while a Kinect projector was used to ensure sufficient contrast on the object's surface. Yuan Xu (Humboldt-University Berlin) used a Kinect sensor for motion detection within a soccer playing robot. Jan Böhm (University College London) presented results of his accuracy analysis that he conducted on various natural user interface sensors (Kinect, PrimeSense and Asus). Fabio Remondino (FBK Trento, Italy) showed, apart from results of accuracy analysis, effects of multi view stereo software (Photosynth, Agisoft, Apero/MicMac) for automatic generation of 3D point clouds. Sebastian Vetter (fokus GmbH, Leipzig) demonstrated the versatility of their metigo 3D software on various tasks for object documentation based on image bundles. Afterwards Günter Pomaska (University of Applied Sciences Bielefeld) presented a solution which combined Microsoft's Photosynth with SketchUp 3D for modelling buildings. Nesrine Grati (i3mainz) demonstrated a strategy for improving 3D reconstruction within point clouds of urban scenes by deploying 2D imagery. An optimised work and data flow has been revealed by Mohammed Abdel-Wahab (University of Stuttgart). Wilhelm Hannemann (TU Clausthal-Zellerfeld) took the audience underground while presenting their interactive WebGL visualisation of a spacious cave system that has been reconstructed via Bundler and PMVS2. Thomas Kersten (HCU Hamburg) revealed the potential of multi view stereo software, namely Bundler / PMVS2, Photofly / 123D Catch and Microsoft Photosynth, with examples from architecture, cultural heritage and archaeology, and compared the results with point clouds from terrestrial laser scanning as ground truth. Two final talks from commercial organisations grasped the idea of low-cost from a different perspective. Dirk Kowalewski (navXperience GmbH, Berlin) raised the question "What is the real accuracy of a GNSS antenna?". Andreas Rose (fiagon GmbH, Berlin) presented an optical navigation system for dentistry.

The contributions of Abdel-Wahab et al., Hannemann et al., and Kersten & Lindstaedt are published in this issue of the PFG.

To conclude, every participant experienced the enormous potential of the image based data acquisition techniques for numerous fields of application. While the development of the techniques is at its beginning, first commercial steps are currently undertaken. We believe that these methods will gain a wide distribution. However, aspects of accuracy, embedded quality measures and reliability are yet not suitably solved for commercial applications and have still be investigated thoroughly.

We hope that again fascinating talks on the subject can be heard at the second workshop at the end of 2012 in Berlin-Adlershof.

Frank Neitzel and Ralf Reulke, Berlin