Report on the Low Cost 3D Workshop, December 2014

Dr Petra Helmholz and Dr David Belton

Department of Spatial Sciences, Curtin University, Perth, WA.
Researchers: CRCSI Project P2.01 - Multimodal data acquisition and feature extraction from multi-sensor terrestrial mobile mapping systems

Overview

The workshop "Low Cost 3D" was held at the Technical University of Berlin, 02. – 03. December 2014 and jointly organised by the Department of Geodesy and Geoinformation Science of the TU Berlin, under the direction of Frank Neitzel, and the Department of Computer Science, Computer Vision of the Humboldt University Berlin, under the direction of Ralf Reulke.

The workshop (see program at end of the report) was a platform to present operations and application examples of different low-cost-3D mapping systems and reconstruction methods. Topics included were current sensor developments and sensor operation, calibration and accuracy assessment as well as an overview and the application of state-of-the-art algorithms used for 3D reconstruction, together with a high number of application driving presentations. The target audience included researchers, developers and users of low-cost 3D mapping systems and reconstruction methods. The workshop provided a wonderful opportunity to discuss both recent and future developments in the area of Low-Cost 3D.

In total, 53 participants were registered from eleven countries and four continents (Europe, North America and Australia). The workshop included one keynote speaker, 19 oral presentations, six interactive presentations and two live demonstrations. As there was no parallel program offered during the interactive (poster and demonstration) session, and dinner was provided for participants, it was well attended and offered a great opportunity for intense discussions with the authors (see Figure 1, left image).

The workshop was officially opened by Frank Neitzel and included a welcome address. The following keynote speech was given by Thomas Kersten from HCU Hamburg about "Potential and limitations of Low Cost 3D Systems". The talk started with a comparison over time of how prominent both common methods (range finding and Photogrammetry) are and which are most often used for 3D surface reconstruction. During the talk it was worked out that, especially in the last decade, there is a clear trend to low cost sensors mainly based on new introduced technologies and also algorithms. For instance, new technologies are the development of smart devices ("Smartphonegrammetry") and UAVs but also algorithms such as "Structure from Motion" (SfM), "Simultaneous Localization and Mapping" (SLAM) and "Scale Invariant Feature Transform" (SIFT). The new algorithms especially allow a highly automatic workflow for 3D reconstruction, whereas precise measurements still require manual interaction with the user. Furthermore, the number of software products available to process large image datasets increased rapidly and is still increasing ranging from free program solutions (e.g. VisualSFM and 123D Catch) over medium range (e.g. Photoscan and Pix4D) to professional solutions (e.g. LPS and Australis). However, there are also clear limitations when using highly automatic software solutions especially if a geometric accurate 3D reconstruction is required. For instance, a number of products do not allow the introduction of Ground Control Points (GCO)

leading to scale and merging problems. Also, automation needs very short baselines that introduce accuracy issues. Hence, highly automated low cost and medium cost solutions often suffer from reliability and repeatability. While low cost solutions offer an alternative to high-end products, it is important to apply an optimise workflow so accuracy and precision can be secured. It is necessary to benchmark the results and to follow the best practise rules. This requires a full understanding of the performance and specification of each sensor as well as a deep understanding of the potential parameters of the used algorithms. It is not recommended to use sensors and software as black boxes. While automation is important, it should not be in conflict with the final accuracy and quality of the result.

Beside the invited talk there were two technical sessions on the first day and four technical sessions on the second day.

Technical Sessions

The first technical sessions focused on Surveying and Mapping and showed how low cost sensors are used in industry and industrial applications. The session included a case study of using the new Trimble V10 image rover (J. Markiewicz), an automatic 360 degree reflector for high accuracy kinematic application (F. Keller) and the development of an indoor mapping system (T.P. Kersten). All presenters had a research background.

The following technical session presented talks about Aerial Platforms and showed the great range of possible low cost airborne systems. While the first talk about challenges and limitations of UAV systems was given by an industry partner (S. Fick), the other two talks were given by researchers. B. Lonneville talked about a helium balloon for photogrammetric applications, and P. Westfeld (presented by D. Mader) introduced his work about UAV-based acquisition of TIS-attributed 3D point clouds in building energy evaluation.

The workshop on the second day was opened with the technical session on Low Cost Systems. The presented systems included an interactive 3D visualisation platform using a mobile phone for stereoscopic viewing (F. Tschirschwitz). This system was also presented during the live demonstration on the previous day. The other talks presented a low cost tracking system with great success for medical and audiological applications (J. Pilinski) and the comparison of radial distortion parameters of low cost cameras (A. Masiero) followed by interesting discussions.

After the coffee break the attention of the audience were drawn to one of the main areas of low cost systems – Cultural Heritage and Archaeology. The presenters from Belgium (C. Stal), Italy (L. Pecchioli and A. Alamouri) and Poland (M. Kowalczyk) showed their work which included the data collection, the processing of the data and their access/visualisation by online platforms. The session showed the level of interdisciplinary activity around photogrammetry but also showed how important it is to communicate not only the potential of photogrammetry but also the fundamentals of the discipline.

The third session of day two focused on RBGD-Sensors (colour and depth) with the Microsoft Kinect being the most prominent sensor. While J. Schoening introduced the audience to an overview of 3D sensors, M. Romaszewski and R. Ravanelli presented their work with the Microsoft Kinect sensor. The first talk focused on tensor decomposition of dynamic 3D face models; and the second talk

compared the accuracy of the first and second generation Kinect sensors. The last talk in this session presented a fast depth map fusion method using OpenCL (S. Zagoruyko).

The final session had two presentations from the area of heritage mapping and magnetic resonance imaging. S. Hendy-Taylor (presented by P. Helmholz) focused in their talk on a case study in the field of heritage mapping using different low cost sensors such as the Trimble V10, the hand held Zebedee line scanner designed by CSIRO and a SLR camera (Figure 1, right image). Afterwards, F. Wetterling introduced a low cost magnetic resonance imaging sensor as an alternative to the traditional 3D scanning approach. This system has great potential due to its size and easy portability of the system compared to other magnetic resonance imaging systems.

Before the conference was closed by Frank Neitzel, the organisers discussed with the audience the scope of the next conference and especially wanted to get feedback about the areas of interest, (e.g. 3D printing) the audience would like included in the next conference.

Figure 1: Live demonstration on the Geodaetnestand (left) and technical presentation (right).

Conclusion

The success of any event, such as this, also rests on the opportunity to socialise with fellow international participants to discuss and exchange ideas as well as to develop new contacts and friendships. On the first night all participants met for the Get Together Party on the top of the local Geodaetnestand (a survey observation platform on the roof of a building on campus) with a great view over Berlin by night.

Thanks go to Frank Neitzel, Ralf Reulke and many others in the background for the excellent organisation of the event. Their efforts included the preparation of the conference, the technical support and the organisation of food and drinks for all participants during the conference.

Let us end with a wish: We are looking forward to seeing you all again 2016 in Berlin.

Agenda LowCost3D

Tuesday 2.12.2014

Session 0	2:45 pm - 3:30 pm
Introductory session	
Keynote speech - "Potential and limitations of Low Cost 3D Systems	Prof. Thomas P. Kersten, HCU Hamburg
Coffee Break	**3:30 pm - 3:45 pm**
Session 1: Surveying and Mapping	**3:45 pm - 5:15 pm**
Development of a New Low-Cost Indoor Mapping System - System Design, System Calibration and First Results	Kersten, T. P.; Stallmann, D.; Tschirschwitz, F.
The Trimble V10 system in registration of cultural heritage - case study	Markiewicz, J.; Kowalczyk, M.
Automatic low-cost 360° reflector for high accuracy in kinematic application	Keller, F.; Kagerah, S.; Sternberg, H.
Coffee Break	**5:15 pm - 5:30 pm**
Session 2: Aerial platforms	**5:30 pm - 7:00 pm**
Challenges and limitations in UAV-Photogrammetry	Fick, S.
UAV-based Acquisition of TIR-attributed 3D Point Clouds for Building Energy Evaluation	Westfeld, P.; Mader, D.; Blaskow, R.; Maas, H.
Helium balloons for 3D modelling: off to a flying start?	Lonneville, B.; Stal, C.; De Roo, B.;
Poster Session and Demos	**7:00 pm - Open End**

Wednesday 3.12.2014

Session 1: Low Cost Systems	9 am- 10:30 am
Interactive 3D Visualisation of Architectural and Archaeological Models Using a Game Engine and Low-Cost-Systems	Tschirschwitz, F.; Kersten, T. P.; Zobel, K.
Development of a real time low-cost tracking system for medical and audiological problems	Pilinski, J.; Luhmann, T.
A comparison of radial distortion calibration methods applied to low cost cameras	Masiero, A.; Fissore, F.; Guarnieri, A.; Pirotti, F.; Vettore, A.
Coffee Break	**10:30 am - 10:45 am**
Session 2: Cultural Heritage and Archaeology	**10:45 am - 12:45 pm**
In-situ image-based 3d modelling for archaeological applications	Stal, C.; Lonneville, B.; De Gelder, K.; De Maeyer, P.; Dierkens, G.
SFM digital survey and modelling for the museum of the sculptures of the Basilica of St. Silvestro, catacombs of Priscilla in Rome	Pecchioli, L.; Verdiani, G.; Pucci, M.
Acquisition of cultural heritage documentation by utilization of popular cameras	Kowalczyk, M.; Markiewicz, J.
ISEE-Based method for information retrieving for historical Baalbek	Alamouri, A.; Pecchioli, L.

Lunch Break	12:45 pm - 2 pm
Session 3: RGBD-Sensors	**2:00 pm- 4:00 pm**
Taxonomy of 3d sensors: A survey of state-of-the-art low cost 3d-reconstruction sensors and their field of application	Schöning, J.; Pardowitz, M.; Heidemann, G.
Tensor decomposition of dynamic 3D face models created using Microsoft Kinect	Romaszewski, M.; Sochan, A.; Skabek, K.
Fast Depth Map Fusion using OpenCL	Zagoruyko, S.; Chernov, V.
Microsoft Kinect first and second generation: sensors comparison and accuracy assessment	Ravanelli, R.; Nascetti, A.; Crespi, M.
Coffee Break	**4 pm - 4:15 pm**
Session 4	**4:15 pm- 5:30 pm**
Comparison of Low Cost 3D sensors for Heritage Mapping – A case study	Taylor, S.H., Helmholz, P., Belton, D.
Low cost magnetic resonance imaging - an alternative 3D scanning approach	Wetterling, F.
Closing Session	