Investigations on Google Tango Development Kit for Personal Indoor Mapping

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Abstract

The paper summarizes first experiments with the Google-Tango Development Kit. The idea is to use this device for a personal indoor mapping application with reduced accuracy requirements but fast and economic acquisition of 3D spatial data to compete with high level surveying instruments as tachymeters or terrestrial laser scanners or close-range photogrammetric cameras. The investigations concern the quality of the sensors used in navigation and mapping in combination with applications available for 3D geometric reconstruction using different sensor combinations. The experiences show, that a critical part is the motion tracking, as well as the influences of the depth sensing caused by lighting conditions and object material as well as on the object distance due to the fixed base length of the depth sensing.
Keywords: Structure-from-Motion, Depth-Sensing

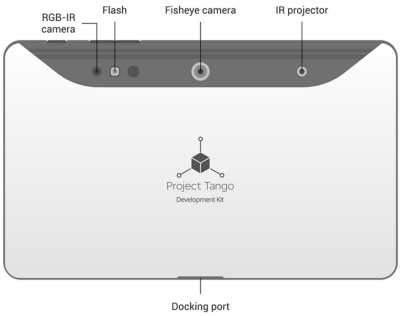
1 Introduction

The Google-Tango Development Kit [2] is available for developers in Europe since August 2015. There are numerous sensors integrated combined with a very advanced computational architecture. Several sensors allow the acquisition of image and spatial information for a wide range of applications like e.g. personal indoor mapping. The investigations performed concern the quality of the sensors for navigation and mapping which are used in different combinations in some available applications for 3D geometric reconstruction. The paper summarizes our first experimental studies ([1], [3].

2 Google-Tango Development Kit

The Google-Tango Development Kit is shown in Figure 1. The device is operated like a tablet computer, when taking pictures.

Figure 1: Google-Tango Development Kit - Back



Source: https://developers.google.com/project-tango/hardware/tablet

2.1 Sensors and features of Project Tango Tablet Development Kit.

Several cameras in combination with motion tracking and 3D depth sensing allow the acquisition of image and spatial information using also a great variety of communication tools. A wide range of currently available apps do exist from Google Play-Store or other sources. Some few have been tested here:

- Project Tango Constructor
- Project Tango MeasureIt
- Project Tango ADF Inspector

3 Evaluation of Google-Tango Apps for 3D indoor mapping

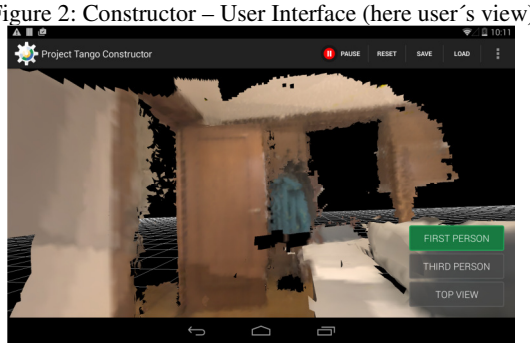
3.1 Project Tango Constructor

The app allows to record and view 3D models of the surroundings. The app starts recording immediately after launching it. A view of the User Interface is shown in Figure 2. The user can move around by keeping the tablet in both hands as steady as possible. As export formats the .ply (Polygon File Format) and the .obj (Wavefront Objekt File Format) are available.

The first tests concerned the mapping of an office room in different lighting conditions using the room lights, and no extra light sources like e.g. spot lights. The model in Figure 3a was taken with proper lighting conditions. It shows the walls and furniture in rather good detail and quality. The example in Figure 3b with insufficient light conditions clearly reveals the much reduced geometric and radiometric quality of the model.

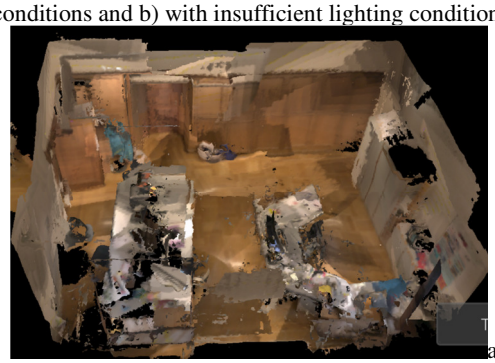
Another important application area is the 3D-modeling of staircases. This is extremely more time consuming with terrestrial laser-scanners or tachymeters due to the difficulties for sufficient and good stand points in the staircase.

Figure 2: Constructor – User Interface (here user´s view)

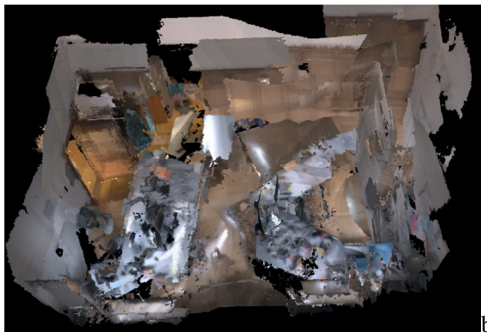


Source: Shohrab Uddin

Figure 3: Office room modeled with a) proper lighting conditions and b) with insufficient lighting conditions.



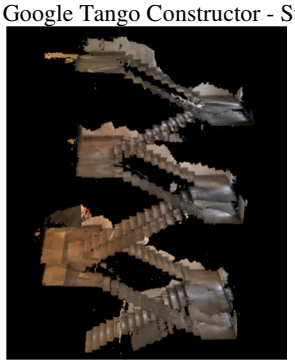
a)



b)

Source: Shohrab Uddin

Figure 4: Test of Google Tango Constructor - Staircase



Source: Shohrab Uddin

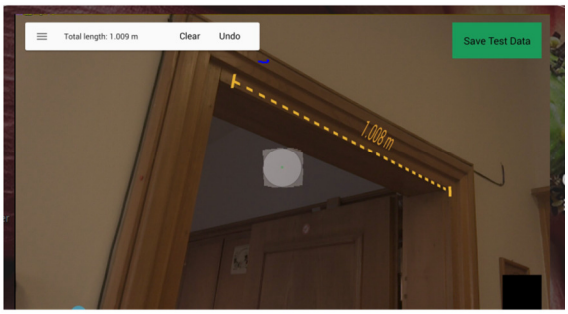
With Google Tango Constructor a quite impressive result (Fig. 4) can be acquired in a rather short time (15 minutes). This opens new application areas for quick monitoring without emphasis on a very high geometric quality, but with low costs and time on site.

The app can be used to generate 3D point clouds of staircases, rooms and floors with a height of some meters. The experiences show, that a critical part is the motion tracking, as well as the influences of the depth sensing due to lighting conditions and object material as well as on the maximal object distance due to the fixed base length of the depth sensing.

3.2 Project Tango MeasureIt

Some first experiments with this app were performed to get information about the quality of the derived 3D-distances. Figure 5 shows the measurement of the width of a door. The app displays the result in an Augmented Reality view which is online updated while pointing the device in this direction. In Table 2 some results, which are representative for the tests conducted, are presented. The quality of some mm by close-range photogrammetry or terrestrial laserscanning cannot be reached, however, the accuracy is sufficient for some applications like a rapid virtual furniture planning or for facility management purposes.

Figure 5: Test of Google Tango App MeasureIT – Door.



Source: Author

Table 2: First experimental results with Project Tango MeasureIt. The ground truth values were derived by using a folding rule with an accuracy of about 2-3mm.

MeasureIt [cm]	Groundtruth [cm]	Difference [cm]	Difference [%]
15,2	13,0	2,2	14,70%
30,5	31,2	-0,7	2,36%
42,7	41,0	1,7	3,91%
63,5	61,0	2,5	3,94%
86,4	91,0	-4,6	5,37%
88,4	85,5	2,9	3,27%
149,9	157,0	-7,1	4,76%

The results show differences between the folding rule and the app measurement on different quality levels. It is possible to reach 2 to 5% error of the measured length, but for smaller objects in close distance the error (in %) can be considerably higher. There is a great influence on the quality of results on how steady the device is moved to measure from the first point to the second point. Objects in more than 10 meter distance cannot be measured. A transparent object like a water bottle cannot be measured either.

3.3 Project Tango Area learning

Project Tango offers possibilities for improved motion tracking and localisation through the so called area learning functionality. It is based on a world map (Area Description File (ADF)). The Tango Tablet can remember the virtual features once acquired and it can identify those features while revisiting an already mapped place.

The app Project Tango ADF Inspector can check an ADF by walking around the area where the ADF was created. It shows where successful localization occurs and where it does not occur (cf. Figure 7), thus indicating the regions, where an ADF should be improved.

Figure 7: ADF Inspector App, Inspecting ADF file.

Source: Shohrab Uddin.

From our experience it is very clear, that there must be sufficient details in the 3D object structure to be able to have a reliable localization performance. The localization result is better within the line of sight. The more one deviates from the line of sight the worse the localization result is produced.

The app is in general not very stable. It freezes and stops every now and then.

A rather strange behavior and alarming side effect is caused by the computational work load and results in an extremely hot temperature of the device, if it is used more than 15 minutes continuously.

4 Conclusions

From our experiments it becomes clear, that there is not yet a sufficient stability of the apps available for Google Tango, certainly affected by the short time since the release of the device to developers. However we can observe short cycles of considerable improvements and new apps appearing on the market. The sensor package is of rather high quality but not yet fully exploited. There is not yet a clear trend for new application areas visible, but new features for location based services in shops and department stores, and support for human machine interaction in industrial environments seem feasible.

Acknowledgments

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References

[1] S. Da. Untersuchungen zur Sensorik und 3D-Punktwolkengenerierung mit Google Project Tango. Bachelor-Thesis HFT Stuttgart, 2016

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[3] S. Uddin. Reports on HFT Tango. HFT Stuttgart, 2016.