

TRIMBLE: 3D Digitalization of large objects or scenes with a time of flight 3D Scanner

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1 Introduction

Since a long time ago, Computer Vision community has been concerned to find new methods or techniques to model objects, scenes or shapes from the real world. This field is known as 3D modelling and it plays an important role in a wide range of applications such as video games, industrial design, orthotics and prosthetics, reverse engineering and prototyping, quality control/inspection, etc.

There are a large variety of techniques that allow one to create a model from sample and one of the most crucial aims consist in preserving the object's integrity i.e. to employ a non-destructive measurement approach. The idea passes through retrieving the object/scene by visualizing it.

During the 3DD course we have seen a wide number of techniques that allows to estimate the 3D position of a given set of points by using 2D information. These are known as passive techniques because they do not emit any kind radiation to recover the 3D scene. Usually, they do not need a specific hardware but simple digital cameras.

Active techniques becomes in another alter-

native to reconstruct a 3D scene. Opposite to passive, in active techniques there is a device that emits some kind of radiation or light and detects its reflection to obtain the desired 3D information directly from the real world.

This lab focuses in the later techniques and more precisely in the one that is introduced in section 2.1 which is known as Time-of-flight.

2 Used technology

In this lab session we have taken use of different technologies from which the TRIMBLE GS 101 3D Scanner is the most basic one. This scanner fall into the previously introduced active techniques and more precisely follows the principle of the Time-of-flight. In this section we will introduce this principle, then we will give the main characteristics of the scanner and a mention to the used software.

2.1 Time-of-flight

The time-of-flight is a technique that consist into sending a pulse of laser light from a source (in our case the Trimble scanner) to the object/scene that we want to model and waits for it to return to a sensor. The distance of the surface is found as follows. A laser is used to emit

a pulse of light and the amount of time before the reflected seen by the sensor is timed. Since the speed of the light c is known, the round-trip time determines the travel distance of the light, which is twice the distance between the scanner and the surface. Considering t as the round-trip time, then the distance $d = (c \cdot t)/2$.

The accuracy of the reconstruction depends on how precisely we can measure the time t . On its side, time-of-flight 3D scanners have some advantages. They are portable devices simply to use and allow to make large measurements. As a drawback, they are sensible to variations of environmental light and the interferences with other scanners working at the same time.

2.2 TRIMBLE Family

During the lab session, we have used the TRIMBLE GS 101 3D Scanner. Among its characteristics we can emphasise on the following ones:

1. Motorized indoor and outdoor scanning through 360° horizontal and 60° vertical field of view.
2. Optimized performance up to 200 m (recommended a maximum of 100m).
3. Acquisition of real-time true-color images.
4. Maximum scanning speed of 5000 points per second.
5. Video acquisition snapshots up to 9 megapixels max. resolution.
6. Compact and lightweight with fast set-up that allows one-person operation.
7. Possibility of being connected via WiFi using Trimble ReconTM.

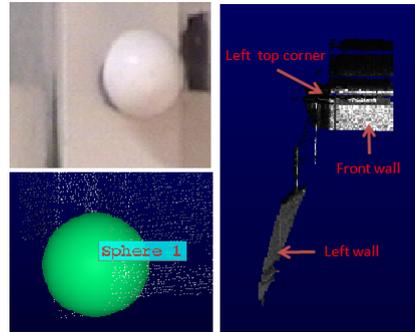


Figure 1: First sphere (left top), 3d surface of the detected sphere (left bottom) and the scene from the first point of view (right).

We have also used two software tools: the PointScapeTM, and the RealWorks surveyTM. The former has been used to acquire the 3D data. The later is used to merge/register the data obtained with the PointScapeTM and built the virtual 3D model.

3 Experiments

The objective of this experiment is to register the 3D points obtained from two point of views and to triangulate them into a 3D mesh. Since point correspondence between the views is unknown, we have to estimate the extrinsic camera parameters by some other means. The extrinsic parameters (i.e rotation and the translation) of the second view with respect to the first one are estimated based on the position of three spheres located at three different places. The steps are followed as per the instruction provided in the manual. Figure 1 shows the first sphere, its surface detected based on acquired 3D points and the scene from the first point of view.

The camera is then moved to another place by unknown translation and rotation. The 3D points of the scene and all the three spheres are captured from the second point of view as well. Here, the first scenes are top-left and



Figure 2: Both scenes and all spheres form two views before registration. Red boxes show the spheres from the first view.

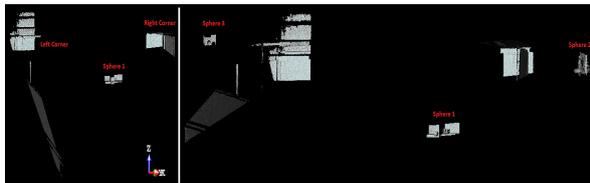


Figure 3: Two views of Registered and triangulated scene 3D mesh.

top-right corner of the laboratory respectively. Both scenes and all the spheres before registration are shown in Figure 2.

After the acquisition, point clouds are registered using target-based registration technique. Subsequently, the station-based projection method for triangulation is used to obtain 3D mesh from the registered point cloud. 3D mesh is analysed with and without enforcing the triangulation algorithm to remove the triangles around surface discontinuities. The 3D mesh obtained after triangulation is shown in figure 3.

Problem faced: During the acquisition we found that there is some problem with the setup. The larger projected region/area in the scene is shifted towards a right position with respect to the region of interest selected in the software. In Figure 4 the larger projected region includes the sphere opposite to the selected region of interest, which does not include it. Every time we acquired the data, we selected our region of interest towards a little left position from the real one that contains the sphere. Doing so, we overcame this problem.

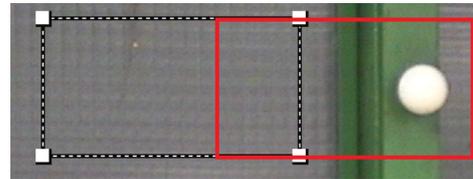


Figure 4: Region of interest selected by the software (left box) and corresponding 3D scene image (right box).

4 Alternative techniques

There are many other techniques that are widely used for 3D reconstruction of large object or scene. Some of them are listed below:

1. Multiple views
2. Structured light
3. Contact sensors
4. 3D from polarization

5 Conclusions

Trimble 3D scanning is accurate for 3D point and true color acquisition. It is easy to use and suitable for both indoor and outdoor performance through 360 degree. Advanced scanning functionality and various post processing options offered to analyse the captured point cloud data make it very useful in many applications. On the contrary, it is expensive and not fast enough for some applications.

Trimble 3D scanning can widely be used in several applications such as civil survey and infrastructure, architectural and building mining and quarrying etc. In fact, almost anywhere we need large amounts of data. Industrial surveying (especially hot objects), cultural preservation, forensics are some more application of Trimble 3D scanning .