Generating a Point Cloud from a Crowdsourced Photographic Survey

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1 Introduction

The use of point cloud data – a set of vertices in a three-dimensional coordinate system – is becoming more and more widespread. It’s in particular a quick way of capturing and representing complex environments where measuring each little detail with traditional tools is impractical. Generally, point clouds are captured using sophisticated and expensive 3D laser scanners resulting in very accurate and extremely detailed results. LIDAR data for instance is a common example, already widely in use.

The aim of this paper is to show an alternative way to create a point cloud, based on a free-to-use photogrammetric tool. The entire process from capturing the input photos, to turning them into usable point cloud data for use in AutoCAD or other programs is discussed here.

As a way to illustrate this method, the archaeological site of Sillyum in Antalya (Turkey) was chosen as a case study. One of the sites that was visited during the Le:Notre Landscape Forum, that took place in Turkey previous spring (18th – 21st of April 2012).

2 Sillyum as a Case Study

Different working groups were set up for the Le:Notre Landscape Forum in Antalya, focussing on various themes. I took part of the heritage working group supervised by my college Harlind Libbrecht (University College Ghent) and assisted by specialists Graham Fairclough (English Heritage), Karsten Jørgensen (Norwegian University of Life Sciences) and Diedrich Bruns (Kassel University).

Each of the working groups went on a different excursion related to their theme, we visited the archaeological site of Sillyum. Contrary to similar sites in the area like the overcrowded Pamphylian or Perge, Sillyum is barely known and far less documented. Combined with the distinct topography and the impressive ruins, some say it’s more attractive than the better-known places (BEAN, 1968). Sillyum – like other heritage sites – is in many ways an interesting case study as point clouds are particularly useful for representing such complex environments.
After a thorough introduction to the site by the experts (Fig. 1), we split up along our particular interests. I took charge of a small group consisting of six people concentrating on documenting through photography. The idea was to get the most out of the hundreds of pictures that would be taken anyway. For this, we used the application Photosynth, developed and made freely available by Microsoft Labs (MICROSOFT, 2012). It maps photos relative to each other, resulting in a very user friendly and intuitive way of browsing a set of images. People unfamiliar with a certain site get a better impression as they can see the relation between each of the photos. It allows even further ways of use, since a point cloud can be derived quite easily from this data.

Our final aim was to generate a basic point cloud, solely based on photos taken collaborative with standard digital photo cameras. Our time on the Sillyum site was limited as we only had 3 hours, nonetheless we managed to apply this method on two smaller areas within this archaeological site and still found time to visit other parts of the site. We chose to focus on a palace close to the entry (Q) and the tower (D) (Fig. 2).
2 Method and Results

2.1 Capturing the photographs

For Photosynth to allow to recognize the relative position of each photo, the following guidelines are important (PHOTOSYNTH TEAM, 2008):

- Panorama first, then move around: Start by taking a panorama of your scene, then move around and take more photos from different angles and positions. If you just do a panorama you won't end up with a good 3-D experience.
- Have enough overlap when shooting panoramas: Try for at least 50% overlap between photos.
- Shoot wide shots: Wide angle shots (photos taken from farther away, or with your camera's lens zoomed all the way out) reconstruct more reliably than closer shots. It's good to have close-ups, too, but you'll want to have good coverage of your subject with lots of nice overlapping wide shots.
- Move around the object capturing the object from all possible sides

In order to make sure that all of the photos taken by the participants of this experiment would be recognised, I made sure to cover the general landscape by taking numerous wide angle photos at various positions.

In total, P. Diehl, W. Dutch, I. Fasching, M. Kremmel, S. Rulinha and myself ended up taking 589 pictures of the palace area (Q), and 359 pictures in and around the tower (D).
Fig. 3: Palace area

Fig. 4: Tower
2.2 Processing the photos

A folder with +400 photos can quickly be more than one gigabyte in size, so a fast and stable broadband connection is needed to make this uploading process more bearable. It is also advised to reduce the number of pixels of the photos prior to feeding them in Photosynth. This may on the other hand result in Photosynth having more difficulty in matching all of the photos. So keep in mind not to reduce the file size too much. Somewhere between 2 – 4 megapixels seems most appropriate. This can be done prior to taking the photos by adjusting the resolution setting in the camera, or be done afterwards in a wide range of programs (e.a. Adobe Lightroom, Adobe Photoshop, Picasa …).

2.3 Creating the Photosynth

The Photosynth application is available for free, and can be downloaded from the Photosynth-website (MICROSOFT, 2012). A free Microsoft Live account needs to be created if you don’t have one already. It is strongly advised to close all programs other than Photosynth while processing the photos, as the calculation and creation of the Photosynth is done on your own computer, and is a RAM-intensive process that might fail if the application runs out of memory.

The program is pretty straightforward and needs little explaining as it only consists of pointing the application to the photos that need to be used. Once the Photosynth has been calculated, the final step is an automatic upload of the photos that are part of the synth.

If all went well, you end up with a successful Photosynth tying all of your pictures together accessible on the Photosynth website (MICROSOFT, 2012) pressing the ‘my Photosynths’ button. Please note that this requires an up to date browser and the SilverLight plugin (MICROSOFT, 2013). A variable called ‘synthy’ displays how successful the program was at connecting your photos. The photos can be explored in many ways, the point cloud can also be visualized and navigated within the web browser itself (Fig. 5 and Fig. 6).

Fig. 5: The palace area in the Photosynth browser
2.4 Importing point cloud data into AutoCAD

Most AutoCAD-products can import point cloud data starting from version 2011. AutoCAD uses *.pcg as the default point cloud format, however a few other extensions can be opened.

For importing a Photosynth point cloud we’ve used the ‘BrowsePhotosynth for AutoCAD’ plug-in which is downloadable for free (Walmsley, 2010). Note that this requires having ‘NET Framework 3.5 SP1’ installed (Microsoft, 2008). Once the ‘BrowsePhotosynth’ plugin was installed, entering the command ‘browseps’ in the AutoCAD command line opens a web browser interface of the Photosynth website. Upon navigating to a specific Photosynth, this opens a thumbnail of the photos on the right hand side. Clicking this thumbnails opens the Point Cloud in AutoCAD and stores a local *.PCG file in the Mydocuments/Photosynth Point Clouds folder on the local computer.
Using commands like ‘scale’ or ‘align’ in combination with a given reference length, this point cloud can be put to scale for further analysis and measuring. Using the 3D-orbit tool, the point cloud can be viewed in 3D, and the colour can also be set using height classifications (Fig. 7). In the recently released AutoCAD 2013 there are further tools to clip the point cloud in order to specify which points to display. The REVIT version of AutoCAD 2012 has a downloadable plug-in called ‘point clouds feature extraction’ downloadable for free at (AUTODESK LABS, 2012). Using the release 2011, it’s most easy to store the point cloud as a *.DWG file and insert it in a new AutoCAD file as a XREF. Using the command xclip, the xref can be clipped to only show a specific part of the point cloud (e.g. front, back, side, section …) (Fig. 8 & 9). This allows for more easy measuring or tracing of the features.

Fig. 8: Orthogonal view of the tower and topography

Fig. 9: Two sections derived from the point cloud
If you prefer to use the point cloud in programs other than AutoCAD, a standalone exporter called ‘synthexport’ is also available for download (Hausner, 2010) and allows you to export to formats like *.obj, *.ply, *.vrmI, and *.x3d. Just like the ‘BrowsePhotosynth for AutoCAD’ plug-in, this also requires the ‘NET Framework 3.5 SP1’.

3 Conclusions

The process of generating a point cloud solely based on photos is in most cases fairly simple using Photosynth. Results were achieved fast without much effort, even while the environment was very complex and highly detailed. In addition, it didn’t require expensive (and heavy) equipment.

There are of course some important observations to be made that can limit the usability. For instance, Photosynth has a hard time dealing with repetitive patterns and complex occlusions. The high amount of detail in the heritage site therefor was actually a helpful factor. Making a Photosynth from a contemporary monotonous glass building would have proven much harder to accomplish. Currently the program is Windows-only and absolutely requires having a (fast) internet connection, both of which can be constraining factors.

Most importantly however, it is to be noted that a point cloud created with Photosynth will never have the same amount of detail and preciseness that you would get from a 3D laser scanner.

References


