Part II - Scanning Procedure

The required steps to get an optimal scan output is generally common to every scan procedure and it is strictly connected to the technology used by the 3D scanner. What can vary from case to case is the elaboration of the obtained data using IDEA the Software, which is dependent from the work goal. For example the 3D model editing will be different whether the output is used for 3D printing, where it is very important to have a lightweight data, or if the same 3D model is meant to be used with a third-part 3D modeling software. Furthermore, the work set-up can be adapted to the user comfort and preference. The purpose of this guide is to give an ordered set of steps to follow during the scanning process to obtain a useful 3D model, in a raw format and information rich, ready to be exported.

Considered to be satisfied the recommendation given in the first part of the guide about how to create an ideal scenario for the scanner usage, the scanning procedure has been divided in five key steps:

1. Acquisition;
2. Alignment;
3. Mesh Generation;
4. Post Processing;
5. Simplification.

1. Acquisition

Scan in a Box, using the structured light technology, digitize the object by a combination of single acquisitions (called range images or depth image).

The acquisition is the first fundamental step in which the acquired image is created in the software as a set of points. This points define a 3D representation of the part of the object that has been framed and hit by the light pattern generated by the projector.

For this reason, it is advised to proceed with the acquisition of a wide part of the object first, postponing the acquisition of details and missing parts in a following moment.

It would be ideal to start with an initial scan that frames the wider part of the surface of the object (ref. fig. 31).
Once decided where to start the acquisition, the scan strategy will be very easy. It is advised to build a 360° panning shot of the object, taking the second acquisition after having rotated the object 25° about its vertical axis or after moving the scanner, using the LIVE view available in the software as reference (ref. fig. 32).

![Figure 31: example of 3D Scan framing the central part of the object.](image1)

The scan can be continued using the same view selection method, taking care to ensure a certain sequentiality, such that a given acquisition partially overlap other previously acquired object parts (ref. fig. 33).

![Figure 32: a sequence of 3D Scans, captured by rotating the object horizontally.](image2)
Once a rough 3D reconstruction has been obtained, the scan can be improved by adding more views that correspond to some missing parts that can be due to undercuts, dark surfaces or parts of the object not framed previously.

It is advised to add every scan you may need in order to have a complete 3D model of the object (ref. fig. 34).

**TIP!** It is possible to verify the area framed by the scanner at every moment, just by activating the LIVE command on the IDEA the Software. This command will show the scene framed by the two cameras in two different windows that will appear into the software interface. In order to make the scanning process easier, a crosshair is placed in the middle of each window (ref. fig. 35).
The crosshair is constituted by a green and blue square in the middle of the image and by a black line projected on the object. When the black line lays on the yellow cross in the middle of the green and blue square, the point beneath the yellow cross is exactly at the middle of the scan range (ref. fig. 36).

If the object is moved away from the scanner, the black line will move toward the external part of the cross-hair, the blue one (ref. fig. 37); if the object is moved closer to the object, the black line will move toward the inner part of the cross-hair, the green one (ref. fig. 38).

In this way, by observing the color of the box that is crossed by the black line is possible to set the wanted work distance: if the line is in the blue it means that the object is farther from the range image center, if it is in the green it means that the object is closer from the range image center.

Figure 35: a screenshot of IDEA the Software in live mode.

Figure 36: the 3D Scanner positioned at the right working distance and corresponding live view showing that the black vertical line lays under the yellow cross (middle of the scan range).
PRO TIP! A wide and very detailed object can be scanned by exploiting Scan in a box versatility, by setting up two different field of work! The part of bigger dimension of the object can be digitized with a wider field of work. After that, it is possible to set the scanner for a smaller field of work. In this way you can scan the smaller object feature with a higher resolution (ref. fig. 39).

Acquisitions of the same object made with different field of work does not prevent to align the Range Images (ref. fig. 40).

Figure 37: object distanced from the 3D Scanner and corresponding live view, showing that the black vertical line lays on the blue side of the crosshair (beyond the middle of the scan range).

Figure 38: object placed near to the 3D Scanner and corresponding live view, showing that the black vertical line lays on the green side of the crosshair (before the middle of the scan range).

Figure 39: 3D Scan using a field of work of 250x200 mm (left) and 3D Scan using a field of work of 100x80mm.
Alignment

Alignment is the work phase where, through an easy tool provided by IDEA the Software, it is possible to bring to the same reference system (align) the Range Images acquired previously (ref. fig. 41-42).

Manual Alignment

The process is manually helped by the identification of three corresponding points between the two acquisitions taken into account (ref. fig. 43). The alignment can be done any time. It is advised to try this tools with only two selected Range Images for the first alignment approaches.

Switching between alignment and scan is useful only when in doubt about the correct object reconstruction. Once taken familiarity with the acquisition process, it will become more natural to acquire all the range images first and then work with the alignment tool on a Range Images sequence.

It will always be possible to complete and align the subsequent scans to a previous data set, for example to fill a missing information with an extra acquisition. It is recommended to use the alignment tool after having cleaned the range images of all the outlier points (ref. fig. 44).
Global Alignment

Beside the manual alignment, that works with the identification of three corresponding points, another alignment tool called ‘global alignment’ is also available. It is advised to run this command after having manually aligned all the range images, in this way the alignment of each acquisition is optimized with respect to the others (ref. fig. 45).

Figure 43: screenshot of the manual alignment tool, before (left) and after (right) the identification of three corresponding points between the two acquisitions.

Figure 44: screenshot of the manual alignment tool, after the fine-tuning obtained by clicking the “Align” push button.
PRO TIP! The global alignment tool can be also used as a diagnostic tool because it allows to automatically underline if one of the Range Image is not correctly aligned to the others. In this case the value of the unaligned range image will be much greater than the others, and it will be easily identified.

3. Mesh Generation

Once a sufficient number of range images has been acquired and aligned in order to create a 3D model as complete as possible, the following step is to generate a triangular Mesh. The Mesh generation converts a set of 3D points (Range Image) (ref. fig. 47) to a data constituted by a set of triangles (Mesh) (ref. fig. 47).
The Mesh is the first useful data that can be elaborated and exported in the available formats. The Mesh generation is an automatic procedure in IDEA The Software: included in this command there are four profiles with different data processing parameters according to the type of the digitized object.

The four profiles include:

**Technical Object** - It is appropriated to maintain a high level of detail with a tolerance of 0.035mm. The profile expect a mesh with maximum triangles in the amount of 500'000. In the case of a mesh with a higher number of triangles, the software will decimate it automatically with a tolerance of 0.010mm. It also automatically applies a smoothing and it closes the smallest holes (with a boundary of less than 100 vertexes) (ref. fig. 48).

**Design Object** - The parameter are the same of “Technical Object” with the difference that it applies a stronger smoothing with a higher tolerance (ref. fig. 49).
Small Artistic Object - This profile has a very high detail with a small tolerance (0,010mm). It applies a light smoothing and it automatically fills the smallest holes. It has no limits in the triangles number, so the automatic decimation is not applied. In this way it is possible to achieve the higher detail level and precision on the mesh (ref. fig. 50).

Sculpture - This Mesh generation profile has a tolerance of 0,025mm, but always keeping the high details. The default settings does not apply an automatic mesh decimation (ref. fig. 51).
TIP! The parameters of the default profiles can be modified upon customer's need by expanding the Mesh Generation panel with the advance settings. Applying some filters during the mesh generation such as smoothing, detail tolerance, decimation and hole filling can make the following operation easier and speed up the following mesh post processing. These commands can be applied individually in the post processing procedures that follows the Mesh generation.

4. Post Processing

Post Processing is every operation that involves the enhancement and finishing of a mesh. Its purpose is to prepare a complete and flawless 3D model ready to be exported. These operations should be chosen depending on the result to be achieved and they can affect more or less the 3d model (ref. fig. 52).

The commands menu will be accessible after selecting a mesh.

In order to make the workflow faster and easier, the post processing commands are organized in the following order, although every command can be applied freely and they can also be repeated.

Make Manifold

The first command that is advised to be used after the mesh generation is “Make Manifold”. This tool automatically solves the possible topological issues that can be attributed to the presence of triangle edges shared by more than two faces. This tool will also remove automatically all the small connected components of a Mesh that are disconnected from the main body of the object and that are so considered as separated entities. This tool is mandatory in order to make the model ready to be 3d printed. It is advised to apply this command every time an operation of triangles removing and hole filling is applied on the mesh (ref. fig. 53).
Detect and repair intersection

The second step is to apply the “Detect and repair intersection” command. This function, as the previous command, resolve some possible topological issue, in this case the ones attributed to the triangles that intersect other triangles of the mesh surface (ref. fig. 54).

By starting the tool, the command panel will open. Here you can chose which kind of operation apply on the Mesh: the simple selection of the intersecting triangles, that will highlight the intersecting triangles with red colour; the selection and cut of the intersecting triangles, that will create new holes; the selection with cut and hole filling of intersecting triangles, that will automatically close the holes created with an automatic fill. In order to have a quicker post processing procedure, it is advised to chose the third option. Otherwise it is possible to cut the intersecting triangles with the second option and then close the resulting holes in a following moment.

Fill Holes

The third tool to be used is “Fill Holes”, a tool that detects missing parts on the mesh surface and allows to fix them. It automatically fills the missing data with a surface composed of triangles that propagates the nearby shape and texture information. This command runs a sophisticated algorithm (is underneath) that allows the resultant 3d model to be as close as possible to the physical object. After the activation of this tool, a window with a list of all the mesh holes will open (ref. fig. 55).
In order to have a quicker post processing elaboration, it is advised to select all the holes of the mesh by clicking “Select all” and then to proceed with the automatic holes filling with the command “Fill” (ref. fig. 56).

Otherwise it is possible to select a single hole or a group of holes by clicking on the voices on the list. If the options “Centre selected boundaries” or “Frame selected boundaries” are selected, it will be easier to locate the holes on the Mesh (ref. fig. 57).

It is possible to fill automatically the hole by browsing with the mouse the 3d model and by clicking on the hole border (ref. fig. 58).
Following these steps, a closed 3D model without imperfections is obtained. This data is already a really good solution and it can be exported in one of this available extensions: .stl, .obj, .ply, .off.

5. Simplification

Under this process called “Simplification” are gathered all the steps made on the mesh that (tend to) simplify the data.

Reduce noise on mesh

When the generated 3d model presents some surface imperfection, such as roughness or orange peel effect, a filter commonly defined as reduce noise, can be applied to smooth the surface. This is an operation that looks like a digital sandpaper; in IDEA there are three surface smoothing profiles. The user can experiment what he thinks that is more useful to the specific object that has been digitized (ref. fig. 59).

**TIP!** By selecting an area on the mesh surface, the noise reduction command will be applied only on the selected area (ref. fig. 60).
IDEA has a tool that allows to reduce smartly the mesh triangles number; the operation can be done forcing a tolerance that guarantees that the decimated 3d model does not differ more than this value from the original model.

It is advised to use the decimation command in order to have a more manageable file that is quicker to elaborate with the post processing tools, and of smaller dimension, thus easier to share on the internet and with less occupancy on the hard disk, without loosing the 3d model details (ref. fig. 61).

**TIP!** Simplification procedures are not supposed to be applied only after the post processing procedure. It can be strategically useful to make this simplification operations before completing and closing a mesh, bearing in mind the final purpose of the file that you’re generating and modelling. For example a decimation that is done since the beginning of the work flow, with the knowledge of a maximum triangles number, can make the work quicker and reduce the computing time of the hole filling and other post processing procedure.

Figure 61: example of a mesh decimation.