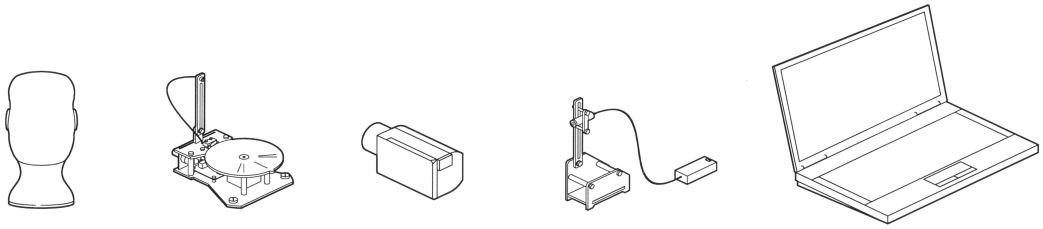
TriAngles™

3D Builder

V1 R2



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TriAngles 3D Builder Version 1 Release 2 SOFTWARE
TriAngles 3D Circumference Scanner Version 1 Release 1 SOFTWARE
TriAngles rsdEditor Version 1 Release 1 SOFTWARE
TriAngles Turn Table, Laser Support Stand DESIGN
TriAngles 3D Circumference Scanner; Operations Manual Version 1 PUBLICATION
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TriAngles 3D Circumference Scanner, Version 1 IntriCAD
TriAngles; 3D Scanner, 3D Builder and 3D Viewer rsdEditor IntriCAD

DO NOT LOOK INTO LASER BEAM

3 Worlds
now exist; the real world as we know it, the world of our imagination and the world that we have created within our computers.

While each world offers almost endless possibilities their collective limitation resides in the ability to efficiently and effectively
interact.

Introduction

Drawing a 3D cube in your favorite graphics program is an easy task by today's standard. But try drawing something more intrinsic like a face or a car or some other complicated shape. Chances are that this will be a difficult task to complete. Fortunately there are other ways to accomplish this. Probably one of the most impressive solutions is to use a 3D scanner.

3D scanning offers the means to take a tangible object and automatically convert it into a 3D computer model through some or other technique. The basic idea would be to have an apparatus detect enough points of an object in 3 dimensions and convert this into information that would allow a computer to display the object as a 3D model. Once it's in the computer you can modify it in almost anyway.

However, unlike 2D scanning, entering the third dimension is somewhat of an art. 3D scanning is not a trivial task to perform as many factors contribute to the integrity of the scanning process. It is important to clearly understand how these factors can influence the scan process and how they should be adjusted accordingly in order to permit the best scanning conditions possible. This product provides the platform to get started. Naturally, your most important tools will be your attention and patience.

There are many kinds of 3D-scanner technologies in existence. The technology developed here includes a non-contact, circumference type 3D scanner. Non-contact meaning that the object is not touched during scanning as the scan technique is based on a visual acquisition process. Circumference means that it scans around an object. Apart from the supplied hardware, the basic setup requires things that must of us already have such as a video camera, tripod and a computer with a video interface.

The chosen design concept is based on various criteria. One of which is to bypass the economical constraints and electrical/mechanical complexities usually coupled with an apparatus of this type while providing high quality scanning capability. An added feature is that this scanner not only scans objects but also an object's texture. The result is a 3D-scanner package that can approach the accuracy of mid range scanners and will permit scans to be made with texture in less than 2 minutes! Better yet it does not cost thousands of Dollars. In fact this is probably one of the best cost to performance scanners on the market today.

IntriCAD Amsterdam 2007


TriAngles
3D Scanner
Object
Scan
Build
Export
DXF STL VRML OBJ
Texture
Surface
Points

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Getting started

This sectioned provides a quick overview on how to use TriAngles 3D Builder to process the Raw Scan Data file from the 3D Scanner and build the 3D model. While you may have already made a scan using the 3D scanner this manual will use the included sample files to support explanations. Once familiarized with the application you will have an enhanced idea on how to best process your scans.

The next section titled "Maximizing the Build Process" provides a more in depth and detail overview of TriAngles 3D Builder.

1. Product Overview

TriAngles 3D Builder is an application that was designed to build 3D models of scans using the Raw Scan Data file that was produced with the 3D scanner. The application includes some sophisticated elements to achieve this:

- **Data Enhancement Functions**. Smoothing, Patching, Softening and Texture Mapping
- **Graphics**. Hardware Rendered Graphics, Display 3D Models at Real Time Rates
- **Editing**. Mesh Data Editing
- **Export**. Popular File Format Export such as DXF, STL, VRML* and OBJ*

*** with texture**

The design incentive behind TriAngles 3D Builder is to build, display and export 3D scanned models. 3D Builder is not a CAD or graphics editing program. There are plenty of very powerful applications on the market which will do an excellent job in the post processing of the exported 3D models. In fact, especially for graphic designers, there is a good chance that most users will want to perform editing in applications they are most familiar with and which include more specific levels of functionality. The various export formats that 3D Builder provides will easily permit 3D models to be imported into almost any 3D CAD or graphics application.

As with TriAngles 3D Scanner, 3D Builder requires a high performance PC to build 3D models. Please consult the Absolute Base Requirements section for details.

2. Process Overview

The rsd file produced by the scanner is a basic text file which includes a set of structured, but unassembled, 2D coordinate maps of the scanned object. Before building the 3D model based on the raw data we will first need to determine its integrity, make corrections if needed and enhance it before it can be exported. The basic process includes:

Data Processing

- **Optimizing.** Cleans the data and permits the patching of lost data as well as smoothing of the scan lines.
- **Building** Assembling the 2D data maps based on camera angle and alignment settings into the 3D model point cloud.
- **Triangulating** Connects the points to form surfaces (triangles) and permits a smoothing procedure to be implemented on the data.
- **Editing** Removing unwanted mesh segments from the model.

Appearance Enhancement

- **Softening.** Softens the way light reflects on the model by manipulation of triangle normals.
- **Colors.** RGBA changes can be made to the model.
- **Texture.** The application, blending and positioning of a circumferential 2D texture onto the model.

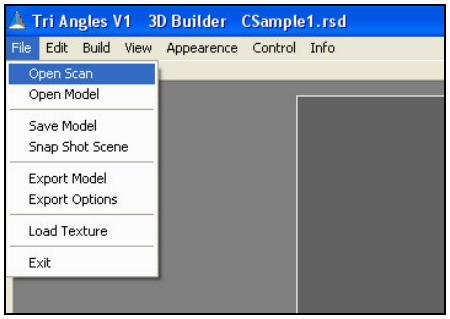
3. Data Processing

The basic building blocks for all computer generated surfaced 3D models are triangles. The raw scanned data must first go through several processing stages before these can be used to display the 3D scanned model.

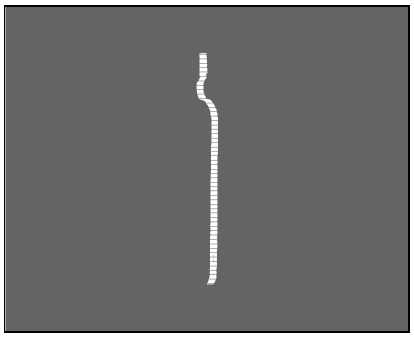
To give you a quick preview about what this will look like run TriAngles 3D Builder, click on File in the applications main menu and then click Open Model. Select the sample TXS file called CSample1.txs. Depending on your computers performance this may take a moment or two to open. Once the model is opened take a look **around** it using your left mouse button to drag it around. The following explanations will demonstrate how this model was built.

3.1 Optimizing the Data

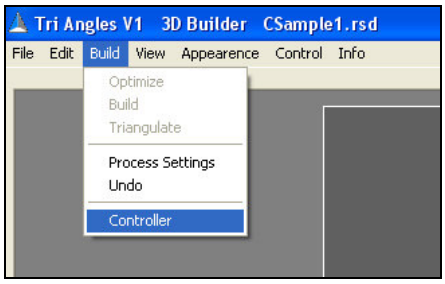
This first stage of processing automatically filters artifacts from the data that may have made their way through the scanner procedure. In addition, 3D Builder allows you to select if you want to fill any gaps found in the data as well as apply some preliminary smoothing of the data.

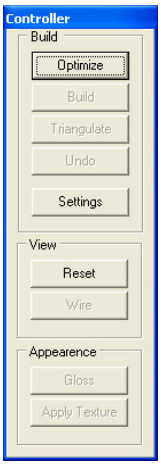


Click on File in the applications main menu and select Open Scan. At the Open Scan dialog choose the rsd file name CSample1.rsd. The first thing that you will notice after the file is displayed is a thin profile area in the view port. This is actually all of the unassembled scan lines bunched up together in 2D space.

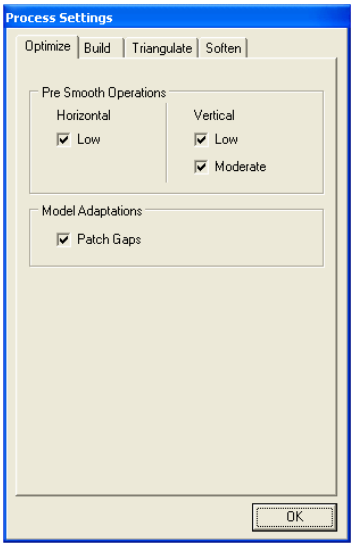


Click on Build and choose Controller. This will bring up a new dialog which includes some of the most frequently used functions.





Press the Settings button in the Build group box of the Controller dialog.



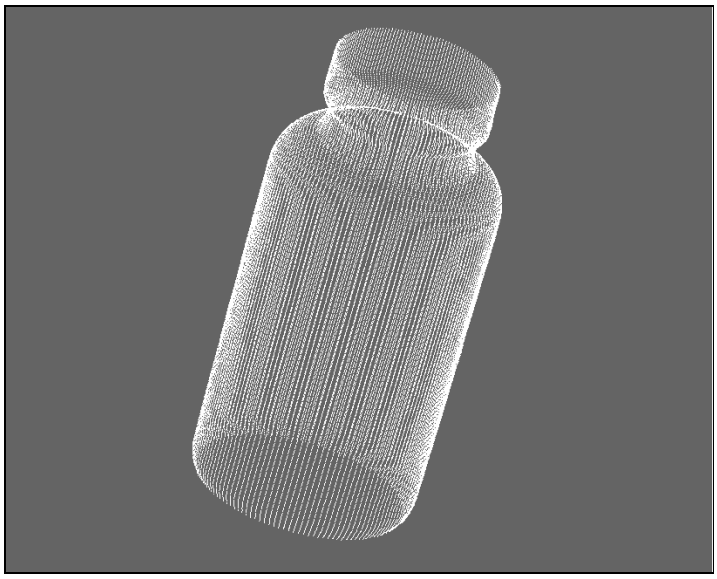
Choose the Optimize tab in the Process Settings dialog. The options here include smoothing and patching of the data. Choose all settings and press the OK button. On the Controller dialog press the Optimize button.

Not much seems to have happened when looking at the viewport after the optimization process was completed. Actually the data has undergone some changes but it still resides in 2D space. The affects will be revealed in the subsequent stages of processing.

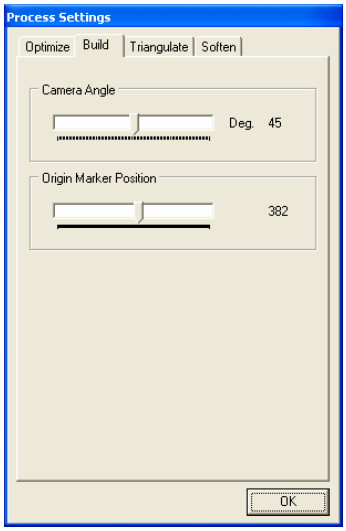
3.2 Building the Data

The next stage includes the building of the data to form a 3D point cloud. The point cloud is nothing more than the display of the acquired 3D positions of the scanned object set in virtual 3D space.

Press the Build button on the Controller menu. After this has completed you will noticed the 3D point cloud. Use the mouse wheel to zoom in and the left mouse button to drag the model around.



The Process Settings dialog includes a Build tab. Under this tab you find options to change the camera angle as well as change the center of rotation point.

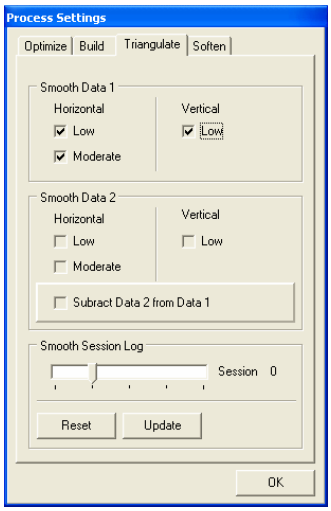


Keep the set positions as they are. These settings were included in the rsd file and do not need to be set unless the model needs to be modified.

3.3 Triangulation

The last stage of the build process creates the surface triangles based on the 3D points. The points of the point cloud are connected in a structured manner to form triangles. This is much like connecting dots.

Choose the Triangulate Tab in the Process Settings dialog.



The options presented include smoothing operations. While the effect is similar to the smoothing operations performed during the Optimize process the fashion in which this is done is different here. Press the Reset button and then check all boxes in the Smooth Data 1 group box. Press the Update button to save the choices made. Slide the Smooth Session Log slider one point to the right. Again check all boxes in the Smooth Data 1 group box, press the Update button and then press OK.

On the Controller dialog press the Triangulate button. The data will now undergo the programmed smoothing operations and then be triangulated to form the surface triangles which will produce the 3D model.

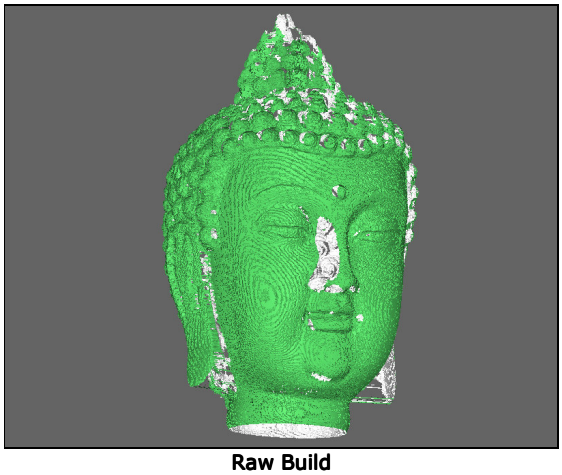
Maximizing the Build Process

The previous section provided a quick overview about what's involved in building the raw scan data to produce the 3D model. This section will go more in depth on the use of several functions that were mentioned in the previous explanations as well as some others. These functions modify the data and can enhance the appearance of the 3D Model.

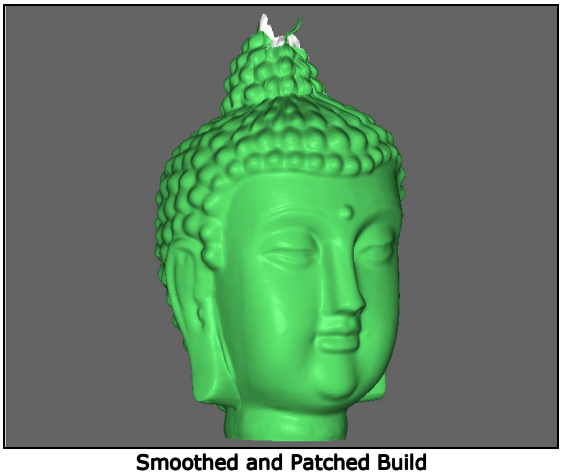
4. Build Options

TriAngles 3D Builder includes patching, smoothing and editing options. Getting a better idea on how they do their work will give you a handle on how best to choose settings.

The previous example displayed the model after going through certain patching and smoothing operations. Let's see what happens when we just build the raw data without performing these modifications. Press the Settings button in the Build group box of the Controller dialog. On the Optimize menu uncheck all the boxes. Press the Triangulate tab, press Reset and then press Update. Press OK to close the dialog. Open the sample scan called CSample2.rsd. Go through the Optimize, Build and Triangulate Stages as before.



Raw Build



Smoothed and Patched Build

The result of the raw build is a model with a highly pixilated, stepped appearance that also contains holes. However, when applied correctly, this same model can look like the right illustration while still retaining most of its shape accuracy.

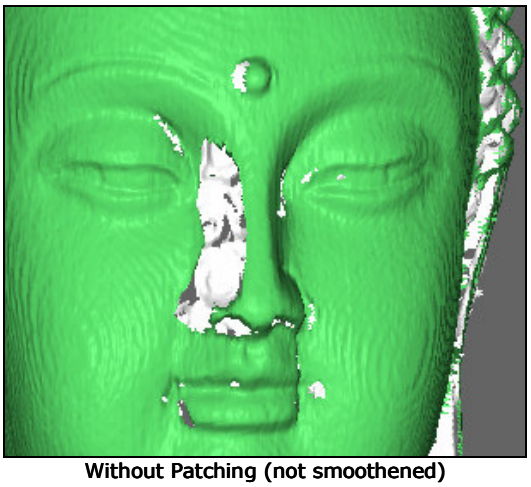
The pixilated appearance in the raw build is actually the discrete jumps from one pixel to the other on the camcorder CCD array. This pixilated result can be reduced by choosing a larger camera angle to improve shape accuracy. But this would also result in more occluded areas such as around the nose of the object. Typically, occluded areas are unavoidable for certain object geometry. In these cases TriAngles 3D Builder can offer several solutions.

4.1 Patching

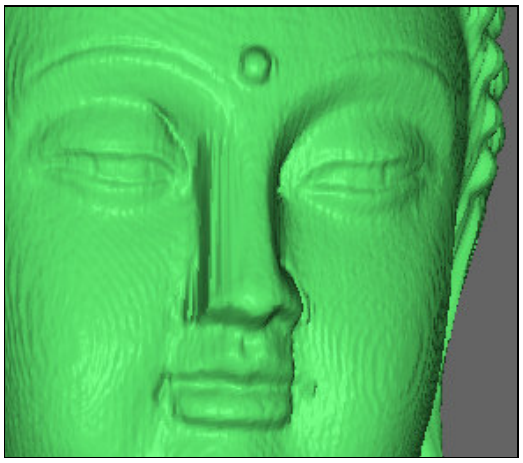
TriAngles 3D Builder includes a quick patching function to fill holes in the data. The incentive is to get most of the data fixed without having to apply a great deal of time and effort to achieve this. The process is automatic.

Holes are due to areas that are not illuminated by the projected scan line during scanning. This is typically the result of occlusion and shadowed areas that lead to missed data.

The patching algorithm is designed to search only for closed holes in the data. When a hole is found it interpolates the best fit positions and inserts the necessary points. Usually this leads to the correct result but in some cases, with complex profiles, the positions may not entirely match with the real object. To minimize this, the patching precedes the pre smoothing of the data.



Without Patching (not smoothened)



With Patching (not smoothened)

The illustrations demonstrate the effectiveness of the auto patching function on the data. Most all holes have been correctly patched. The area around the nose however is complex and the patching has not been able to recover all the data in the correct shape. Fortunately the subsequent smoothing functions will offer some solution to this.

The patching algorithm will only patch closed areas (holes). Areas not visible by the camera during scanning, which reside around the top and bottom sections of the model are also not patched. The reason is that patching these areas would frequently lead to wrong geometry.

The patch checkbox can be found on the Optimize tab of the Settings dialog.

4.2 Smoothing

Smoothing operations are probably the most important functions. They offer the ability to correct the curvature of the scan lines to best approximate the actual shape of the scanned model. It's analogous to sanding a rough surface into a smooth or even polished one.

However smoothing operations generally suffer from one deficiency; smoothing not only reduces the roughness of the scan line is but also the actual shape and detail. Tri Angles 3D Builder includes ways to:

- Set the level of smoothing
- Choose the directions of smoothing
- Best preserve the actual shape of the object under high levels of smoothing.

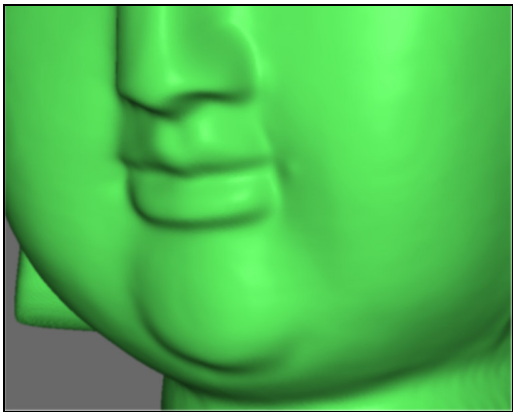
TriAngles 3D Builder offers 2 types of smoothing; pre and post build smoothing. In both cases they offer the ability to select smoothing direction and the level of smoothing

Selecting smoothing direction pertains to smoothing either along the scan lines (vertical) or around the scan lines (horizontal). This can be useful as the vertical and circumferential resolutions differ. In most cases the amount of smoothing required around the model will be less than for the vertical.

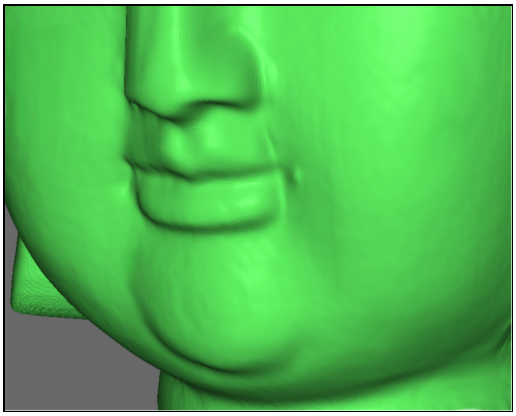
Pre smoothing can be selected during the optimize stage. It provides a high quality level of smoothing that retains the shape accuracy of the scanned very well. Models will look much less pixilated. However pre smoothing can also reduce object details.

Post smoothing occurs after the build stage. It offers a much wider selection as well as permits multiple cycles of smoothing to be performed. It also provides an extra function to retain the shape accuracy of the object.

In the Controller dialog choose Settings and press the Triangulate tab. This will display the Post Smooth settings menu. You will notice that there are two sets of smoothing groups namely; Data 1 and Data 2. There is also a checkbox labeled Subtract Data. High levels of smoothing may sometimes be desired. But this will lead to a loss in the shape accuracy of the model. The shape flattens. However the affect can be made less pronounced by subtracting the data. This involves making a copy of the 3D model (data 1) called data 2. Both data 1 and 2 undergo smoothing, but data 2 much less than data 1. Data 1 is now very smooth but its shape accuracy has suffered. Data 2, on the other hand, is not as smooth it has still retained much of its original shape. Checking the Subtract Data check box will then recombine the two models into a new model. This new model contains a highly smoothened surface while it has still retained much of its shape accuracy.



No Data Subtraction Applied



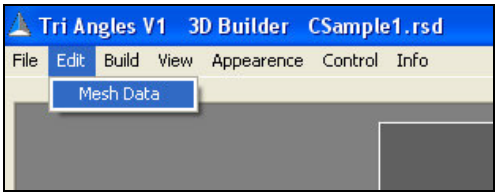
Data Subtraction Applied

4.3 Mesh Editing

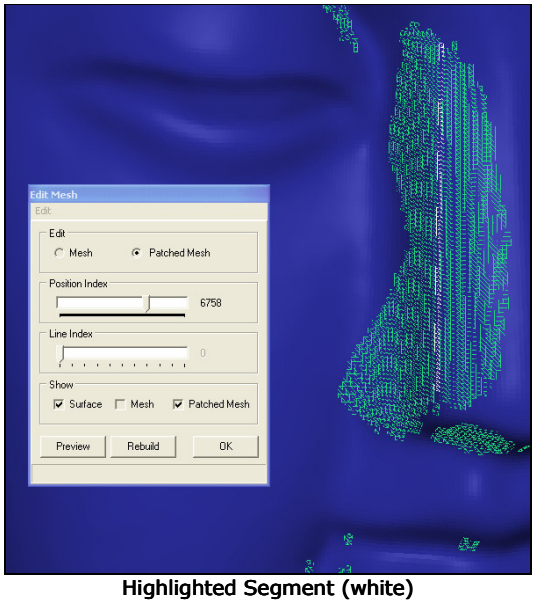
Although 3D Builder is not a 3D graphics or CAD editor it does include some basic editing capability. While most high end 3D graphic applications will offer much more editing functionality and capability, 3D Builder allows some quick and fairly easy editing to be performed.

Unlike many CAD and graphic programs that use the mouse to select and edit data TriAngles use a more systematic approach. Editing 2D data using the mouse is great. 3D data on the other hand can get confusing and require more intensive effort and/or greater software control functions. TriAngles uses a less direct but more structured approach to select and edit the data in 3D.

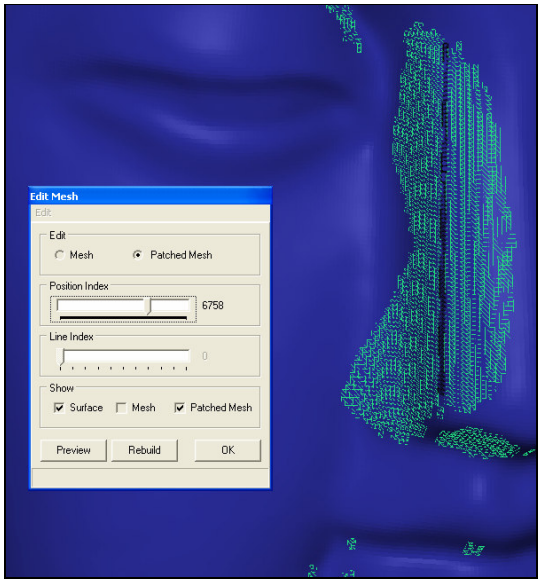
With a fully built model, go to Edit and press Mesh Data. This will bring up the Edit Mesh dialog.



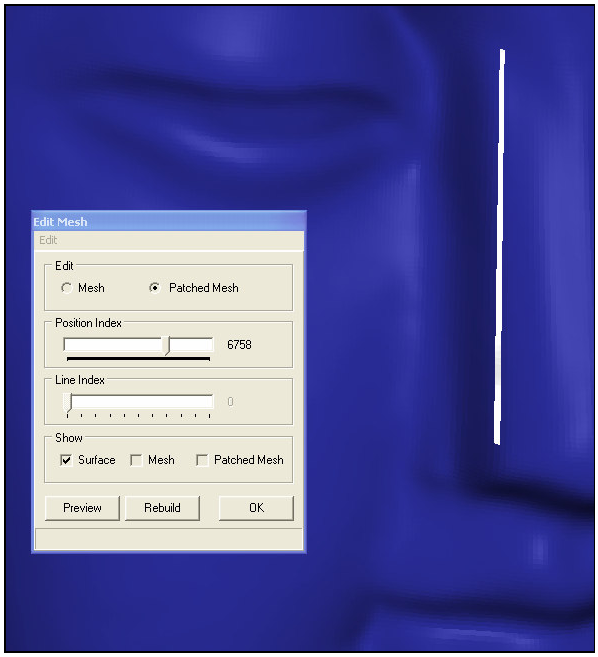
Select the Patched Mesh in the Edit group box of the Edit Mesh dialog. This will focus editing on the Patched Mesh only. In the Show group box check the Patched Mesh check box and uncheck the others. You will now see only the patched areas of the model mesh in the view port. Use the Position Index slider to scroll through the mesh. These positions will be highlighted as you scroll. Use the mouse to pan, rotate and zoom a highlighted mesh segment into view. Press the Del key on your keyboard. You will notice that the segments change color. This means that it has been selected for deletion (if you were to press the Del key again it will unselect this segment). Press the Preview button and then check the Surface check box. The selected segment has been removed from view. Pressing the Rebuild button will delete the segment completely.



Highlighted Segment (white)

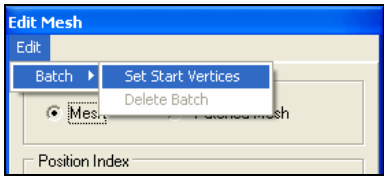


Deletion Selected Segment (black)



Deleted Segment

Editing the model mesh works in a similar way. Check the Mesh check box in the Show group box and uncheck the other 2 check boxes. In the Edit group box choose Mesh. This will allow editing of the model Mesh only. Use the mouse to place the model in view. Slide the Line Index slider. You will notice that entire scan lines are highlighted as you scroll. Using the mouse place a highlighted scan line of the model in view. Slowly slide the Position Index. You will notice that single triangles become highlighted as you scroll. Click on Edit in the main menu of the Edit Mesh dialog. Choose Edit, Batch and select Set Start Vertices.



Scroll a few triangles down using the Position Index slider. Use your mouse scroll wheel to do this. Click Edit, Batch and select Delete Batch. The selected triangles from the first position to the new position will change color. This indicates that they have been selected for deletion. Press the Preview button and then check the Surface check box in the Show group box. The selected triangles are gone. Press the Rebuild button to completely delete these triangles.

The patching function will do a good job closing up holes in the geometry. Yet in some cases it may not always produce the desired result. A scan of a tea cup, for instance, may result in the inner geometry of the cup's ear being patched to the cup's base since the geometry is seen as a hole by the patching algorithm. Editing will be required here.

Another area that may require editing is around the center of rotation area of the scanned object. You may have noticed that the scanned Buddha model presented in this manual shows a small twist at the top. This twisting of the 3D mesh is located around the center of rotation of the Turn Table. Exact alignment of the laser, reducing disc wobble as well as choosing the exact center of rotation of the Turn Table where the object is scanned on is almost not possible. The result is that here the coordinates twist around this area. One way to reduce this twisting is to choose a different Center Marker position and, to a limited degree, changing the Camera Angle. You can find these settings on the Build tab of the Process Settings dialog. Still editing may be required.

5. Appearance Enhancement

The previous chapters dealt with the building and the modification of the scanned data. The objective was to produce an accurate 3D model of the scanned object. However in many cases the way the model appears is equally if not more important than accuracy. Otherwise stated, how accurate the model *appears* is most significant.

TriAngles 3D Builder includes several ways to enhance the appearance of the 3D model. When applied correctly, these enhancements can produce an almost magically realistic view of the 3D model.

5.1 Softening

Softening is a function which modifies the way the 3D model surface reflects light by manipulating triangles normals. It distributes the light more evenly over the surface of the model creating, hence, a softened appearance. It is a very CPU intensive operation which can take some time to process. But it can lead to producing a more realistic impression when combined with texture mapping (discussed later in this manual).

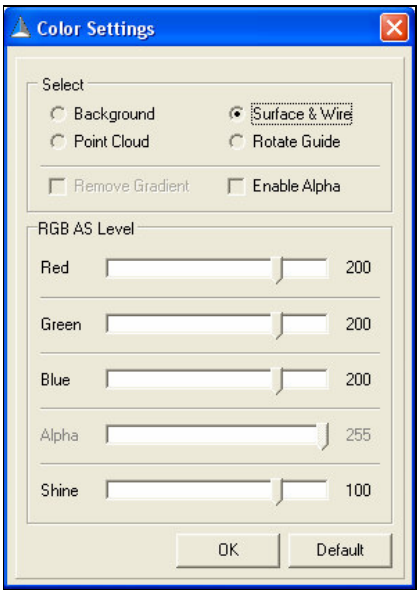
Go to File in the applications main menu and choose Open Scan. Open the CSample1.rsd sample and then Build the model. Use pre and post smoothing operations to create a smooth model surface. Click on Appearance in the main menu and choose

Soften. A message will appear stating that the process may take a few minutes to complete. Press the Yes button. When the operation is completed press the Gloss button on the Controller dialog in the Appearance group box. The model will appear to have a gloss appearance. This is actually the appearance with no softening applied. You will need to set the soften functions in the Process Settings dialog at the Soften tab. Check all boxes except the Subtract Data check box. Click on Appearance in the main menu and perform the soften operation as before. The glossy appearance is now much less on the model. However the surface of the model reflects light more evenly.

5.2 Color Setting

Probably the most basic way to effect the appearance of the model is through the use of coloring. TriAngles allows you to change the model color using RGBA and Shine settings which equals out to more than 16 million different possible color settings, 256 levels of transparency and 128 levels of shine. The model can be made to look like gold, silver, bronze and most any other color you can think of. In combination with a blended texture map, coloring and shine adjustment can significantly enhance the way the model looks.

To change the colors of the model click on Appearance in the main menu and choose Color Settings. Select the entity you want to change the color of in the Select group box and use the Red, Green, Blue Alpha and Shine sliders to change color settings.

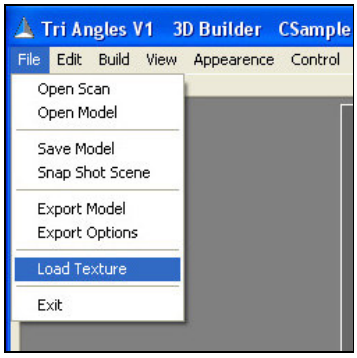


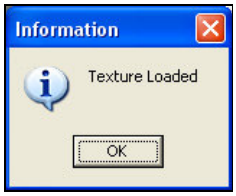
5.3 Texture Mapping

Texture mapping is probably the most powerful and effective way to add realism to a 3D model. In addition, the technique can offer certain important solutions such as significantly reducing model file sizes while retaining most of the appearance quality and surface detail.

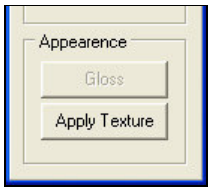
Texture maps created with TriAngles are 2D circumferential bitmaps. Since it's a bitmap you can use most any photo editor to enhance or make changes the bitmap.

Open the CSample1.rsd scan and build it. Use patching and smoothing operations. In the main menu click File and select Load Texture. Choose the bmp file called CSample1.bmp.

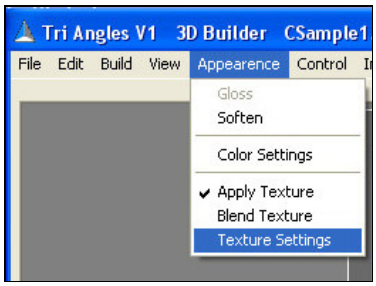




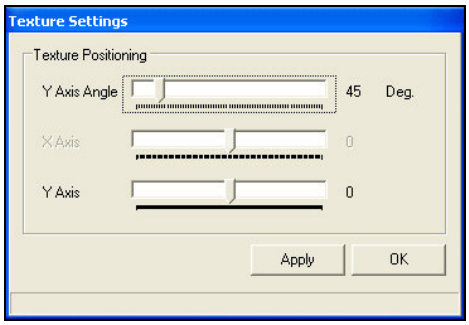
A message will appear if this was successful or not (if not, then your graphics card may not have enough memory to support the default texture palette required). Press the Apply Texture button on the Controller dialog.



On the main menu click Appearance and choose Texture Settings.



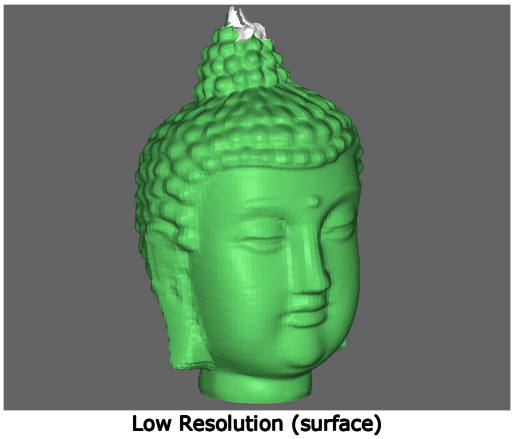
This will bring up the Texture Settings dialog. On this dialog press the Apply button. After this operation has been processed the texture should appear on the model. The texture may require positioning. Use the sliders on the Texture Settings dialog to perform this and then press the Apply button.



You can also choose to blend the texture with the material colors of the models. This can produce the highest level of realism since the lighting changes as you move the model. To do this, click on Appearance in the main menu and choose Blend Texture. Use

the Color Settings dialog to change the Red, Green and Blue material colors to a setting of about 200.

As mentioned, texture mapping can permit low resolution 3D models to retain their appearance quality. The result is reduced file sizes that still look almost perfect when a texture is mapped over. Reducing the file size of a 3D model involves increasing the Grab Rate setting (grab fewer frames) during the scan capture processing. This consequentially reduces the total number of scan lines that will make up the eventual 3D model. The texture scan is set to the lowest possible setting (grab as many frames as possible).



Low Resolution (surface)

Low Resolution (texture)

6. Data Saving and Export

Unlike 2D pictures, 3D models produce very large file sizes. 70-150 MB file sizes and even larger are not uncommon. In addition, opening and saving these large files typically requires a lot of processing time.

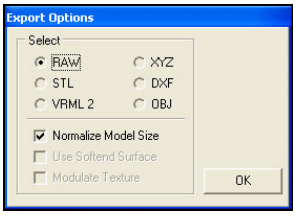
6.1 The TXS Native File Format

3D Builder includes a native file (.txs) format which includes the 3D model data as well as the texture map and color settings in a single file. Moreover the file is compressed and its configuration allows for relatively quick opening and saving. For instance, a 70MB 3D model can be reduced to file size of about 3MB.

The TriAngles package also includes the 3D Viewer which is an application that you can distribute freely (license applies). In other words you can now easily send txs 3D models and the 3D Viewer to others as an email attachment. Recipients can then view the files as well as export them using 3D Viewer.

6.2 Supported Export Formats

3D Builder includes several export formats to choose from as well as provide export options. Click on File in the main menu and choose Export Options. The Export Options dialog allows you to normalize the size of models, selected softened appearance for certain files as well set the texture to blend with model colors or not (TXS, VRML and OBJ only).



Here is a list of the support export file formats with a brief description:

- XYZ This file format contains a point cloud of all of the scanned points. The file structure includes the xyz coordinates of a point per line. Many 3D applications can open this type of file although file structure may differ as well as the extension.

- RAW This file format is similar to the .xyz format but instead of points it contains the coordinates of the triangles that make up the 3D model mesh.

- STL This is the most popular format for rapid prototyping use. It is very widely accepted and supported. The file structure includes the triangles of the mesh as well as the normals for each triangle. The file also contains labels for each triangle vertex and triangle normal. This leads to larger file sizes than the raw type and prolonged opening and saving.

- DXF This is the industry standard when it comes to 2D and 3D technical drawings. Most every 2D and 3D application supports it.

- VRML The extension for this file format is .wrl. This file format showed great promise during the late 90's but it receded in popularity later. Today it is still supported by many graphics programs and it appears to be making a comeback with a revised format called X3D. The VRML format is highly versatile as it can contain multiple objects, texture coordinates, material properties (colors, lighting) as well as viewing and animation properties. The texture map is linked as separate file.

- OBJ For 3D graphics this file format is one of the most widely supported. It also saves texture coordinates and material properties (colors, lighting). The texture map is linked as separate file.

7. Post Processing and VRMesh

While the TriAngles 3D Circumference Scanner captures most of an object in one go, post processing is usually a necessity. This is true for most all 3D scanners available today. In many cases the included patching, smoothing and texturing features of 3D Builder will be sufficient to finalize the model. Yet for more demanding and specific applications it may be required to import the model into a preferred graphics program and take the 3D data to the next level.

The wide range of export formats supported by 3D Builder provides you with an arsenal of graphic programs to choose from. VirtualGrid's VRMesh Studio is one such application and its functionality is in direct alignment with TriAngles. It creates a complete package, in particular, when it comes to efficiently and effectively handling very dense mesh data. If you have purchased the TriAngles/VRMesh bundle then you now have probably the most cost effective 3D scan package on the market today. No other package offers this level of performance and functionality at this price.

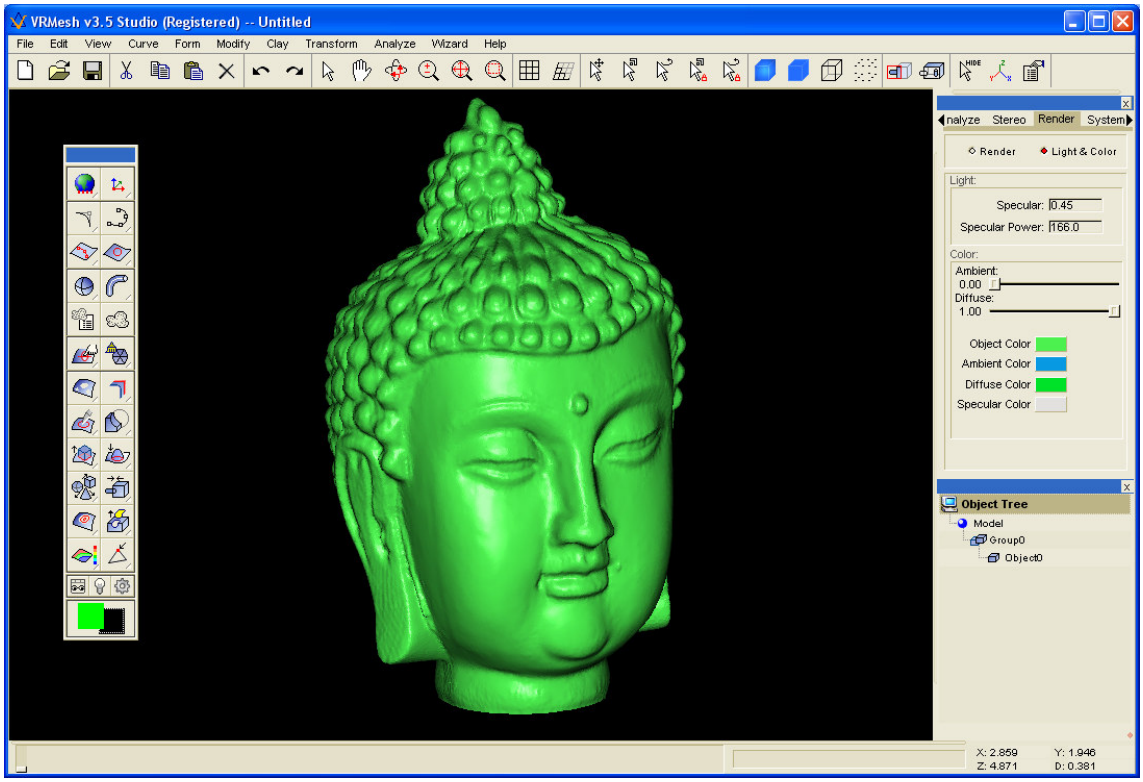
7.1 VRMesh Overview

The VRMesh manuals will best guide you through the process of finalizing your 3D scan data. Still, a very brief overview about common practices is provided here.

The most frequent aspects of 3D scan post processing deal with areas of a scan that have been occluded or left open due to shadows or reside around the polar region of the model. These need to be Patched and Sculpted into the correct shape. In some cases it may be necessary to make two scans of an object from opposite sides and then merge

the scans together. This would mean scanning with the laser positioned on one side and then making another scan with the laser on the other side of the Turn Table.

Another common area of post processing is Decimation of the data. This is a very powerful feature. The data from 3D Scanner is based on scan lines; it's usually very dense and highly structured, in particular around areas that reside more close to the rotation center of the scan. For capturing fine detail this is a necessity but for more consistent low detailed areas it is unnecessary. 3D Builder allows you to export in the XYZ format, which is simply the point cloud data. This data can then be imported into VRMesh. Decimation reduces the number of triangles of the 3D data, and forms a good approximation to the original geometry. The merit here is that you can significantly reduce file size while retaining much of the objects detail. It also means that you can more easily sculpt the data.



The above screen shot displays the modifications made to a scanned model. The data was decimated and the side of the nose (occluded area) and polar region were sculpted into shape. Local smoothing and sharpening was also applied. The modifications were made in about 5 minutes (including the CPU time for processing). Further processing could be performed but at this state the model is already water tight and could, for instance, be exported to the STL format for rapid prototyping a tangible version of the model.

8. Absolute Base Requirements

As mentioned throughout the manual, 3D scanning, as well as the post processing of the acquired data, sets a heavy load on a computers CPU, GPU and memory. Certain processes are also time dependant and will fail unless the employed PC offers the required performance. The following chart includes the absolute base requirements needed to run and use TriAngles.

PC

Unit	Absolute Minimum	Advised
CPU	1 GHz	3 GHz
System Memory	1024 MB	4 GB
Hard Drive	35 GB (high speed)	160 GB (7200 RPM), SATA 2
Free Drive Space	3 GB	25 GB
Graphics Card	64 MB (not Shared), OpenGL Compliant	256 MB (not Shared), OpenGL Compliant
Operating System	Windows 2000, XP (Vista not Tested)	Same
Video Interface	USB, FireWire, Composite In	Same
Pointing Device	3-button, scroll-wheel mouse	Same
Other	DirectX 8 and Above	Same

Camcorder

Unit	Absolute Minimum	Advised
Focus	Auto/Manual	Auto/Manual
Iris	Auto	Auto/Manual
Picture Stabilization	-	Yes
Digital	Analog/Digital	Digital
Tape/HDD/DVD	Tape/Hard drive	Tape
Remote	-	Yes
FireWire	USB, FireWire, Composite Out	FireWire

Note: HD 1080i type camcorder resolutions have not been tested. However provided that the required codec's are available on the PC that is processing the video then this should permit the use of Tri Angles. High end PC will be required as the processing load will be 4 times greater than using standard video.

9. TriAngles 3D Scanner Specifications

Scan Type	3D Non-Contact Circumference Scanner
Scan Technique	Point Triangulation
Scan Method	Deformation of projected pattern (stripe) over the 3D object/scene (laser, projection) to indicate depth points
Scan Sensor	CCD type visual array, video camera (recommended)
Scan Range	Depends on scan set up and optics
Scanning Speed	Typically less than 60 seconds at full video resolution per rotation pass
Scanner Accuracy	Factor 100-200 times less than height of object
Scanable Materials	Most opaque surfaces. (Mat white surfaces are best)
Texture Scanning	Yes
Hardware Footprint	Desk top
PC-less scanning	Yes
Hardware control	Manual (Motorized turn table)
Software Features	Auto interface to CCD video (Composite, USB, FireWire), DirectX AVI recorder, Pre scan filters and process control, device interface control, post process transformations (patching, smoothing etc.), hardware rendered graphics, export to popular formats: STL,DXF,RAW,XYZ,VRML,OBJ and a compressed native format TXS