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<b>ViHAP3D</b>	<b>VIRTUAL HERITAGE: HIGH QUALITY ACQUISITION AND PRESENTATION 3D</b>	
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# MeshSimplify 1.0

## USER MANUAL

### *Abstract*

Post-processing tools are the software instruments needed to transform the raw data produced by 3D scanners (basically, a set of range maps) into optimized and application-oriented representations, which should integrate geometry and appearance and run smoothly in distributed environments.

This document, **Deliverable 4.4.1** describes the features and usage of the MeshSimplify tool.

Deliverable **4.4, First Release of Representation Tools** is composed by

- **4.4.1** Simplification Tool: MeshSimplify v.1 with User Manual
- **4.4.2** PLY fileformat description



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# ViHAP3D

Virtual Heritage: High Quality 3D Acquisition and Presentation

## MESHSIMPLIFY *User Manual*

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# 1. Introduction

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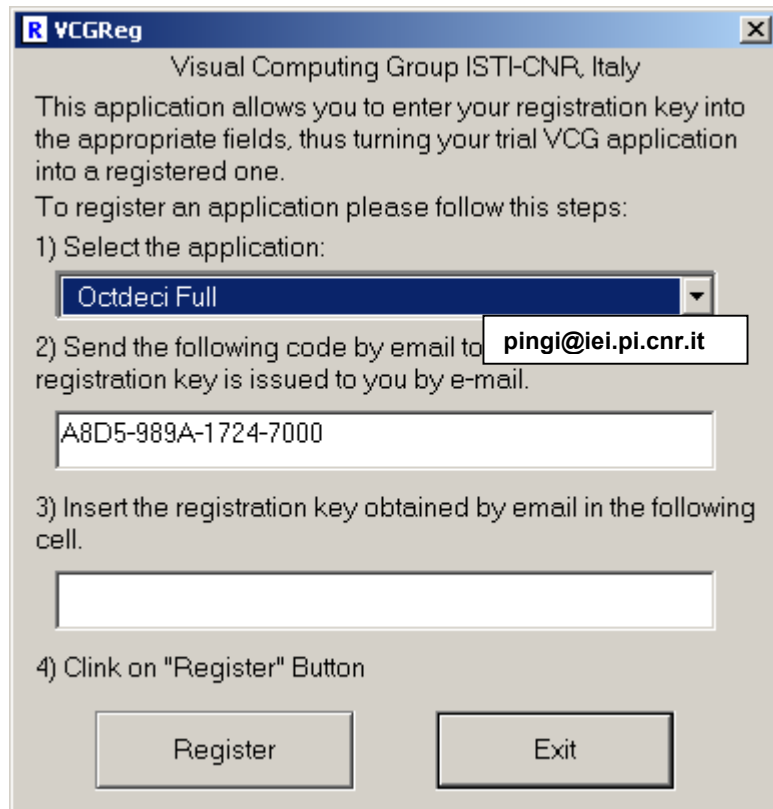
All the software is command line (no graphical interface) and can run in a MSDOS command shell. Installation means just copying the executables in a directory included in the system path would be enough.

There are two separate packages:

- **PlyDeci** : simplification of models that could be completely loaded in RAM memory
- **PlyMerge, OctBuild, Raw2Ind, OctDeci** : tools for out of core simplification of very large models.

## 2. Registration

After software installation it is necessary to register your copy of our simplification software using the **VcgRegister.exe** program (see next figure):



The screenshot shows a Windows-style dialog box titled "VCGReg" with a standard Windows icon in the title bar. The text inside the dialog reads: "Visual Computing Group ISTI-CNR, Italy". Below this, it says: "This application allows you to enter your registration key into the appropriate fields, thus turning your trial VCG application into a registered one." and "To register an application please follow this steps:". The steps are listed as follows: 1) Select the application: A dropdown menu is shown with "Octdeci Full" selected. 2) Send the following code by email to ping@iei.pi.cnr.it registration key is issued to you by e-mail. A text box contains the code "A8D5-989A-1724-7000". 3) Insert the registration key obtained by email in the following cell. An empty text box is provided. 4) Click on "Register" Button. At the bottom, there are two buttons: "Register" and "Exit".

Select the application OctDeci Full from the menu and follow the instructions.

## 3. PlyDeci

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### 3.1. System requirements

- **OS platform:** Windows 95/98/NT/2000/XP
- **Hard disk:** space necessary for the original mesh plus the decimated one
- **Main memory:** minimum 256 MB, recommended 512 MB
- **CPU:** Intel Pentium III 1000 Mhz or more

### 3.2. Software installation

Just copy the executables in a directory included in your path.

All software is comman-line and can be executed in any MS-DOS window shell.

### 3.3. Memory occupation

Plydeci is usable only on mesh that can be completely loaded in main memory.

Space required in main memory for a mesh (in Megabyte), depends upon number of faces and number of vertices the mesh contains. This space can be calculated with this expression:

$$\frac{\#F \cdot 114 + \#V \cdot 104}{1024^2}$$

#F number of faces

#V number of vertices

A table with some examples of memory occupation is presented here. If the required memory exceed the free memory just for a few megabytes the process can be successful but (since it uses virtual memory and swapping) the decimation time would take much more time.

faces	vertices	memory (RAM)
500.000	250.000	~80 Mb
1.000.000	500.000	~158 Mb
1.500.000	750.000	~237 Mb
2.000.000	1.000.000	~316 Mb
5.000.000	2.500.000	~791 Mb

### 3.4. Parameters

Execution of PlyDeci can be launched from any ms-dos prompt (or command line) using this command:

**plydeci input output target\_faces [options]**

**input** name of the input mesh (PLY FORMAT)

**output** name of the output mesh

**target\_face** number of faces

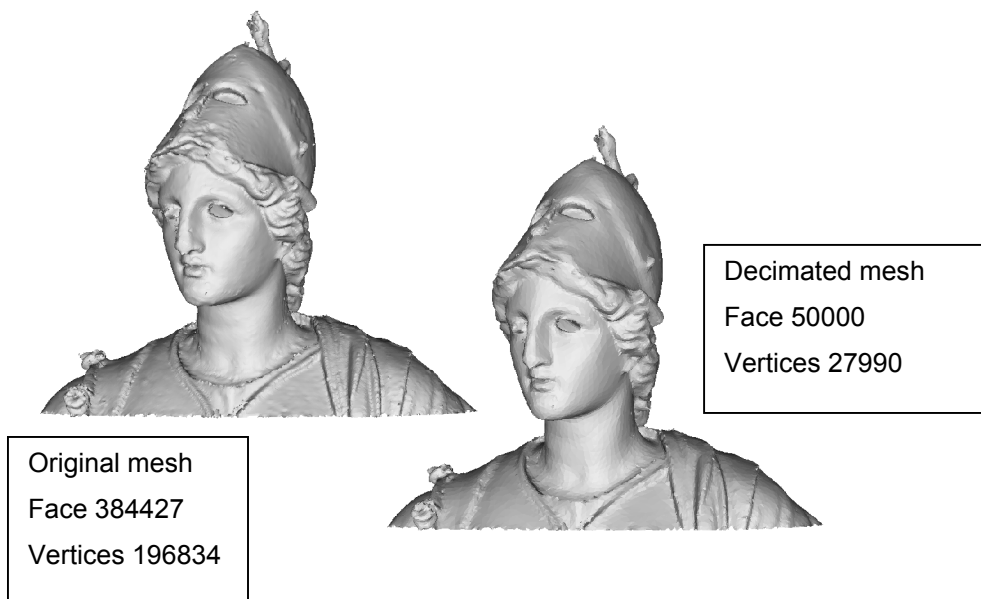
**[options]:**

- **-e#** error threshold; range  $[0, \infty)$  default  $\infty$   
additional stop criterion (with *target\_face*), decimation ends when next collapse would exceed the error threshold. Exponential notation (1e-1, 1e-2, 1e-3) is allowed.
- **-b#** boundary weight; range  $[0, \infty)$  (default 0.5)  
is used to maintain more detail near the object boundary (higher value => more boundary quality).
- **-q#** quality threshold; range  $\left[0, \sqrt{\frac{3}{2}}\right]$  (default 0.1)  
triangles with quality lower than threshold are rarely generated. (higher value => more quality).
- **-n#** normal threshold; from 0 to 180° (default 90°).  
Avoid collapse between triangles with incidence angle higher than threshold (WARNING: VERY SLOW).
- **-E#** minimal error threshold for using the quadrics error evaluation (too small error values can cause numerical problem).
- **Qy** quality threshold is used to control generation of newer triangles (default).
- **Qn** disable previous parameter.

- **Ay** enable size/error tradeoff: smaller triangles are collapsed before bigger ones (default).
- **An** disable previous parameter.
- **Oy** smart vertex placement, new vertex generated during collapse is placed in the position that minimizes the error introduced (default).
- **On** disable previous parameter, position is chosen between the two old vertices (instead of free positioning).
- **Sy** enable quadrics independents from object scale.
- **Sn** disable quadrics independents from object scale.
- **By** enable boundary preservation.
- **Bn** disable boundary preservation (default).
- **Ty** enable topological preservation.
- **Tn** disable topological preservation (default).

### 3.5. Output

Program output of the program is the decimated mesh (in PLY format) and some information printed in the DOS window.



## 4. OctDeci

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### 4.1. System requirements

- **OS platform:** Windows NT/2000/XP
- **Hard disk:** data bound – see *memory occupation* section
- **Main memory:** recommended 256 Mb
- **CPU:** Intel Pentium III 1000 Mhz or more

### 4.2. Software installation

Just copy the executables in a directory included in your system path.

All software is command-line and can be executed in any MS-DOS window shell.

### 4.3. Out-of-Core decimation pipeline

#### 4.3.1.1 PlyMerge

Plymerge program is used to construct a RAW file from one or more input PLY files. If the input is a single PLY file, that mesh is simply converted. If there are more input files, they are merged in a single mesh and then converted to a RAW file

The typical situation is building a single file from multiple PLY files; this case is when a very large range map fusion has occurred and the process has been splinted in sub-parts to reduce memory occupation and calculation complexity.

Command line can be one of the following:

**PlyMerge [opt] file0.ply [file1.ply ]....**

**PlyMerge [opt] conffile.conf**

Meshes files can be specified one after another or grouped in a file called **conffile.conf** (simply the list of files).

[opt] :

- **-q** vertex quality is stored also, to be used as a decimation criterion during simplification.
- **-c** vertex color is stored also, during collapse color is interpolated linearly .
- **-x minx miny minz maxx maxy maxz** in the raw file are imported only faces inside bounding box defined by coordinates *minx miny minz maxx maxy maxz*.

Output file is saved with the name **mesh.raw**.

#### 4.3.1.2 OctBuild

OctBuild is used to transform the unstructured RAW file in a structured octree for the subsequent simplification.

Command line:

**4.3.1.2.1.1.1.1 OctBuild basename.raw**

Output files are **basename.roct** (octree structure) and **basename.roctb** (data)

#### 4.3.1.3 Raw2Ind

Command line:

**Raw2Ind basename.roct**

This program gets in input the file **basename.roct** generated in the prtevious phase and builds:

<b>basename.oct</b>	octree structure
<b>basename.voct</b>	mesh vertices
<b>basename.toct</b>	mesh triangles
<b>basename.bm</b>	secondary memory status

the OCT file is the main one but it rely upon the data contained in the other files.

#### 4.3.1.4 OctDeci

the OctDeci program performs the out-of-core simplification on the Octree data structure.

This program gets in input an OCT file and a **target\_error**.

Command line:

#### 4.3.1.4.1.1.1.1 OctDeci dataset.oct target\_error [opt]

**target\_error** is the most important parameter since it defines the error threshold for the simplification, evaluating the error is very difficult and it's under development a graphical front-end to better understand which parameter is the optimal.

It's important to say that OctDeci does not produce output with new files but MODIFY the current dataset. For this reason it's a good idea to have a backup of the octree dataset if we are not sure about the decimation process to be performed; this backup can be done using a parameter of the OctDeci program.

**[opt]:**

Decimation parameters, same as PlyDeci with:

- **-Cy** use vertex quality for the decimation
- **-Cn** don't use vertex quality (default)

General parameters:

- **-t#** maximum number of triangles loadable in memory (RAM),. Each triangle is 84 byte, this number can be estimated with this formula (WARNING: optimal value is half the maximum)

$$\frac{1}{2} \frac{RAM \cdot 1024^2}{84}$$

RAM: Mb of free memory

RAM (MB)	# of faces loadable in memory
128	800.000
256	1.600.000
512	3.200.000

- **-s filename** save a file in PLY format at the end of decimation called filename.ply.
- **-d basename** make a backup of the input data structures, new files are saved with the new name *basename*.
- **-kd** no decimation, just scanning and integrity check (and saving if specified with **-d** parameter).
- **-kt** no decimation and no scanning (to be used for saving with **-d** parameter)

- **-o basename** split the dataset in multiple ply files each one with maximum number of faces equal to number specified by **<-t#>** parameter.

#### 4.4. Memory occupation

Secondary memory (disk) occupation is determined by the size of the intermediate files (RAW, ROCT, ROCTB, ecc.) which is proportional to the initial dataset and can be evaluated using formulas in the following table. It is important to note that, before using OctDeci to perform the simplification, the files RAW, ROCT e ROCTB can be deleted to save space.

File Ext	RAW	ROCT	ROCTB	OCT	VOCT	TOCT	BM
sizein Mbyte	$\frac{\#F \cdot 36}{1024^2}$	*	$\frac{1}{10} \cdot \frac{\#F \cdot 36}{1024^2}$	*	$\frac{\#V \cdot 28}{1024^2}$	$\frac{\#F \cdot 36}{1024^2}$	*

#F number of faces

#V number of vertices

\* very small file.

Main memory occupation (RAM) is determined with the **-t** parameter of OctDeci used to specify the maximum of faces loadable in main memory (**#F**). Space used can be calculated using:

$$\frac{\#F \cdot 114 + \#V \cdot 104}{1024^2}$$

where it's safe to assume  $\#V \approx \frac{1}{2} \#F$ .