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Technical report : Greyc 3D colored mesh database

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ABSTRACT

We present in this report a 3D colored mesh database established within the GREYC laboratory.¹ 15 real objects with different colors, geometries and textures were acquired using the NextEngine 3D color laser scanner.² On the 3D original colored meshes, we have applied several distortions according to different strengths and situations (on rough or smooth areas), leading to a corpus containing a total of 425.

The provided 3D meshes are in the .PLY format. Each vertex of a mesh is represented by 3 coordinates that describe its position and 3 others that reflect its colors (RGB values). The whole database can be downloaded from:

<https://nouri.users.greyc.fr/coloredMeshDatabase/Colored3DmeshDatabase.zip>.

The reference 3D meshes (free distorted) can be downloaded from:

<https://nouri.users.greyc.fr/coloredMeshDatabase/FreeDistortedColored3DmeshDatabase.zip> .

Keywords: 3D colored meshes, database.

1. 3D SCANNER

The Scanner NextEngine 3D Laser Desktop HD (figure 1) was used for the scan of the 17 3D objects. This latter permits the acquisition of both geometric and colorimetric properties. Its principal features are:

- Laser triangulation
- Image sensor 3 megapixels for the texture acquisition
- Rotating plate
- Acquisition field: Macro mode and Large mode
- Density of Points: 160K points/in² (macro) and 22.5K points/in² (large)
- Image texture dentiste: 400 DPI (macro) and 150 DPI (large)
- Acquisition speed: 50 000 points/sec
- Precision: $\pm 0.005''$ (macro) and $\pm 0.015''$ (large)
- Website: <http://nextengine.com>

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Figure 1. NextEngine 3D Laser Desktop HD

2. ACQUISITION PROCESS AND PRE-TREATMENT

Before beginning the scan, it was necessary to put some white powder on some regions of the objects that were dark, glassy or reflective. Then, since the size of the objects wasn't important, we choose the Macro mode for scanning the objects. These were placed on the rotating plate at a distance of 17cm to the scanner in a enlightened environment to permit a good capture of the textures. Two parameters were specified in the Studio Scan HD software that pilots the 3D scanner: 1) Points density. This influences the precision and the scan duration. A high quality level will produce a file of consequent size. However this choice doesn't affect the texture precision. 2) The Rotation step of the rotating plate (between 4 and 16) so that the object makes a complete turn. This parameter will influence the global duration of the scan and will facilitate the alignment by reducing the number of non scanned areas. When the object to be scanned is complex, we privilege an important step number.

For all the objects, two scan phases were necessary to scan the occulted regions : 1) Scan with a placement of the object in a normal position. 2) Scan with a placement of the object in an elongated position.

When the scans are done, we align and merge them. We then delete undesirable elements (like the rotating table..), fill the holes and optimize the 3D mesh.

The obtained 3D meshes are exported in the .OBJ format. We found that these ones could be more optimized and we choose the Geomagic 3D System software³ for this. The final 3D meshes were exported in the .PLY format.

3. DISTORSIONS

We have enriched the database by applying several distortions to the reference 3D meshes. The aim is to construct a corpus that reflects as much as possible the effects occurring in common 3D mesh processing algorithms. These distortions were applied according to 3 strengths (weak, medium and high). The strengths correspond to a number of iterations for smoothing, and a value of maximum deviation for noise addition and a desired number of vertices for simplification. The distortions considered in this database are the following:

- Geometric Noise addition uniformly on the surface mesh : we modify the coordinates of the vertices of the mesh, according to a randomly chosen offset between 0 and a maximum deviation.
- Geometric Noise addition on rough regions.

- Geometric noise addition on smooth regions.
- Simplification (Quadric Edge Collapse decimation algorithm).
- Noise addition on colors (RGB values).
- Geometric Smoothing uniformly on the surface mesh: Isotropic smoothing.
- Geometric Smoothing on rough regions: Isotropic smoothing.
- Colorimetric Smoothing: Isotropic smoothing on colors.

In order to take into account the visual masking effect that may occur on some regions depending on their geometry or texture, the distortions were applied according to three situations: 1) Uniformly on the surface mesh. 2) On rough areas. 3) On smooth areas. To distinguish the rough areas from the smooth ones, we implemented the approach of Wang et al.⁴ that provides a rugosity map and associates a real value of roughness to each vertex of the 3D mesh. To apply a distortion to a rough or a smooth region on the surface mesh, it's necessary to modify the geometrical (or colorimetric) coordinates of its vertices v_i . For this, we represent a mesh M by a non oriented graph $G = (V, E, w)$ where V represents the set of vertices, $E \subset V \times V$ the set of edges, and $w(v_i, v_j)$ the weight of the edge $e(v_i, v_j) \in E$. To each vertex v_i are associated its 3D coordinates $\vec{v}_i = (x_i, y_i, z_i)^T$ and its RGB color values $\vec{c}_i = (r, g, b)^T$.

In the case of adding a geometric noise to rough or smooth regions, we use the roughness map as follow:

$$\left\{ \begin{array}{ll} \vec{v}_i = \vec{v}_i + \text{noise} \times \text{rugosity}(v_i) & \text{distorsion of rough regions} \\ \vec{v}_i = \vec{v}_i + \text{noise} \times (1 - \text{rugosity}(v_i)) & \text{distorsion of smooth regions} \end{array} \right\}$$

The same process is followed for distorting colors of vertices belonging to rough or smooth areas. Hence, the constructed colored database contains a total of 425 colored mesh (17 reference meshes + 17 x 3 strengths x 8 distortions).

4. COPYRIGHT

- Permission to use, copy, modify, and distribute the database and its documentation for any purpose, without fee, and without a written agreement is hereby granted as long as this work is cited (see section Citing the database).
- In no event shall the GREYC laboratory be liable to any party for direct, indirect, special, incidental, or consequential damages, including lost profits, arising out of the use of this database and its documentation.

5. CITING THE DATABASE

Anass Nouri, Christophe Charrier, Olivier L  zoray - Greyc 3D Colored Mesh Database, Technical report, 2017. <https://nouri.users.greyc.fr/ColoredMeshDatabase.html>.

6. ACKNOWLEDGEMENTS

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