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Subjective Visual Quality Assessment of Immersive 3D Media Compressed by Open-Source Static 3D Mesh Codecs

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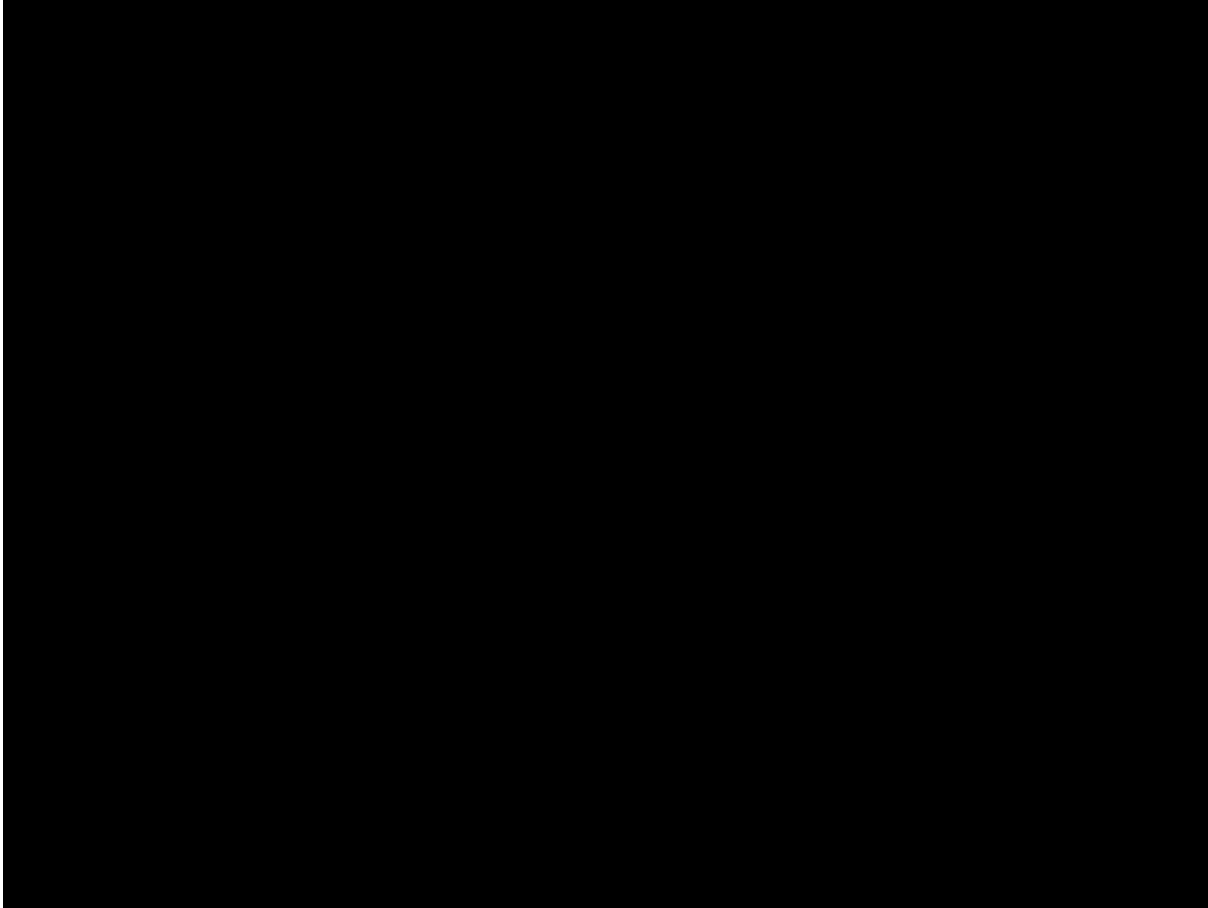


VRTogether

Introduction (1/2)

- New applications and tele-immersive platforms based on virtual and mixed reality.
- Increased user engagement by embedding 3D re-constructed human representations in virtual environments
- Usually take the form of 3D meshes, collections of vertices and faces that define the surface of an object in 3 dimensions.

Introduction (2/2)



The problem

- Applications like 'Spacewars' require real time time interaction and low latency.
- 3D meshes have to be transmitted in real-time to remote parties
- Compression needed to transmit through the network
- Objective metrics often used to measure the degradation on 3D mesh quality (Hausdorff distance)
- Subjectives studies required to examine the effect of compression on 3D mesh quality

Experiment (1/2)

- Examine distortions by 3 codecs on watertight meshes of reconstructed human models
- Two datasets used to consider the possible effects of the mesh production process on the subject's opinion
 - **Application specific:** human 3D meshes by a real-time 3D reconstruction algorithm
 - **Generic:** samples from open repository, high quality meshes of precisely 3D scanned real world objects

Experiment (2/2)

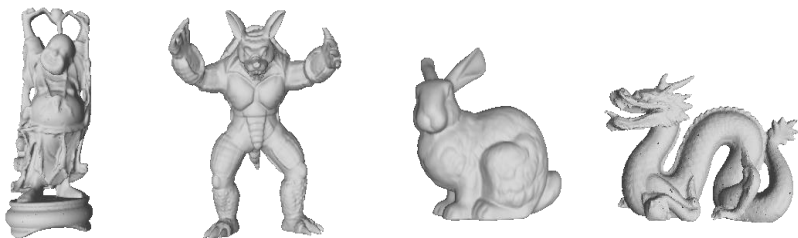
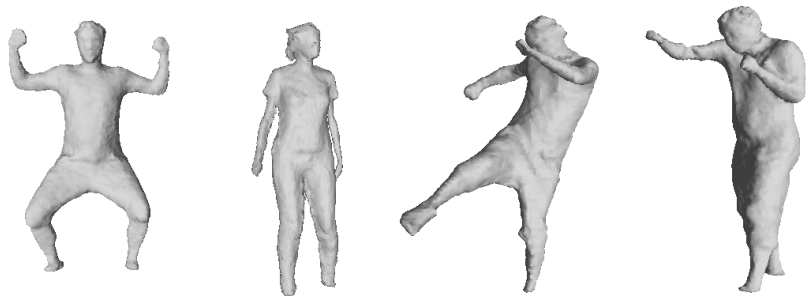
- Display medium: **VR headset** instead of 2D monitor
 - 3D models can be observed in real-life sizes
 - Well aligned with the envisaged applications
- Result: Ranking of the compared conditions in a continuous scale for 2 datasets
- Aim: capture the subjective preference on the compression algorithm and the various distortion levels

Evaluation Methodology

Pairwise comparison methodology with existing reference

- To evaluate the fidelity of the various conditions to the reference undistorted 3D mesh
- Superiority over MOS (mean opinion score) methods, less demanding for the subjects, appropriate for non experts
- Number of required comparisons can quickly get prohibitively large as number of compared conditions increases

Datasets



Model Group #1

3D reconstructed human meshes

- Real-time 3D reconstruction algorithm in a mixed-reality platform
- Reconstruction artifacts
- Noise

Model Group #2

Stanford 3D scanning repository

- Higher accuracy 3D scans of real objects
- No noise

Compared Conditions

- Four available open source 3D mesh codecs , Draco, Corto, ~~OpenDGC~~
~~,OpenCTM~~
- Three quantization bits: 10,11 and 12
- Comparisons limited among codecs and neighboring quantization levels

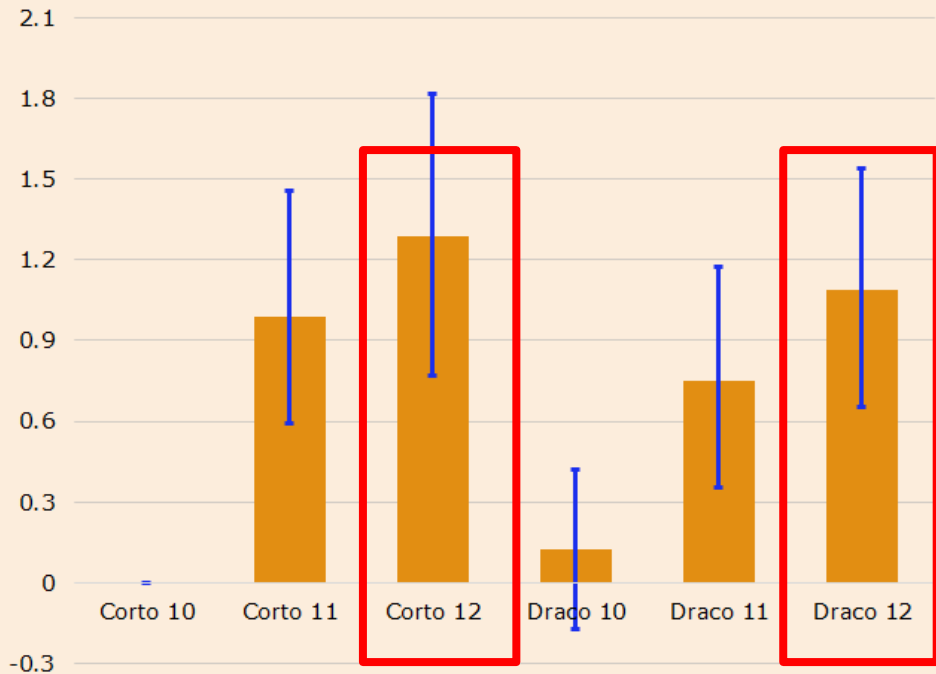
VR survey



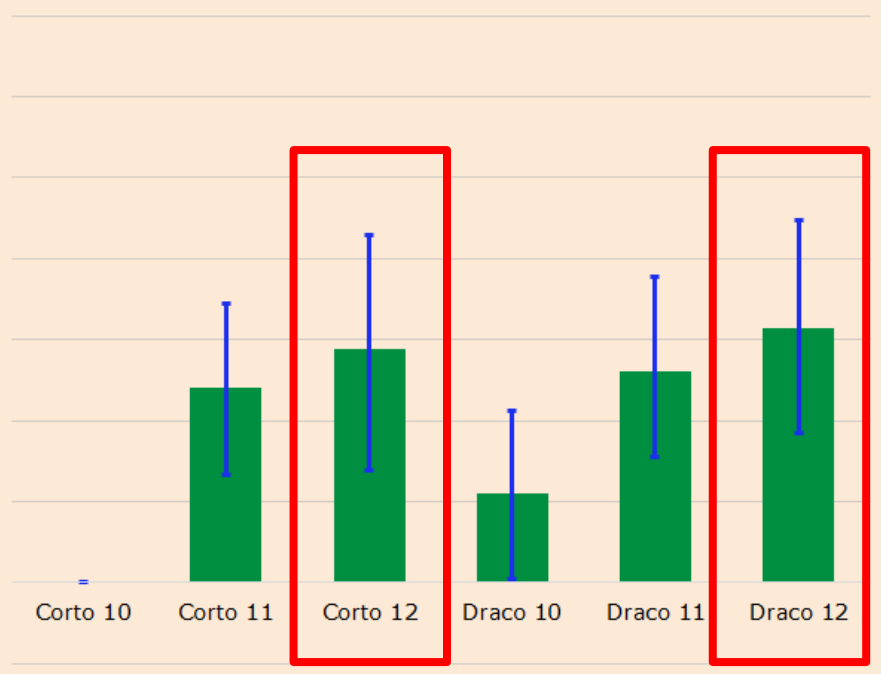
- Immersive VR application (HMD)
- Reference model in the middle, distorted models on left and right side.
- Free view point, model rotation with HMD controllers.
- Subjects' task: Vote for the least distorted mesh

Results

Model Group #1 - Reconstructed Humans

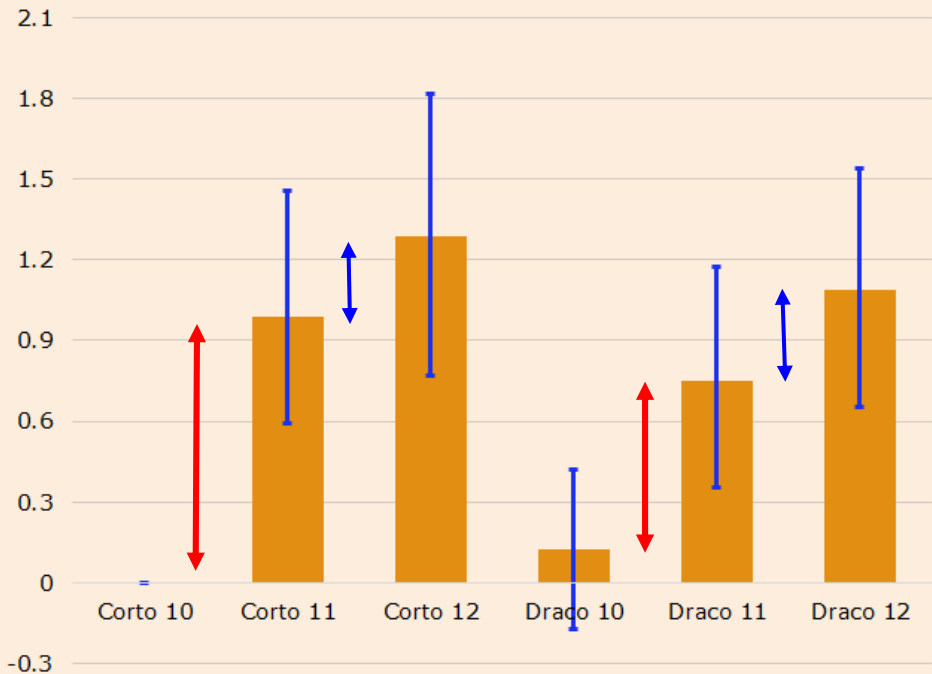


Model Group #2 - Scanned Objects

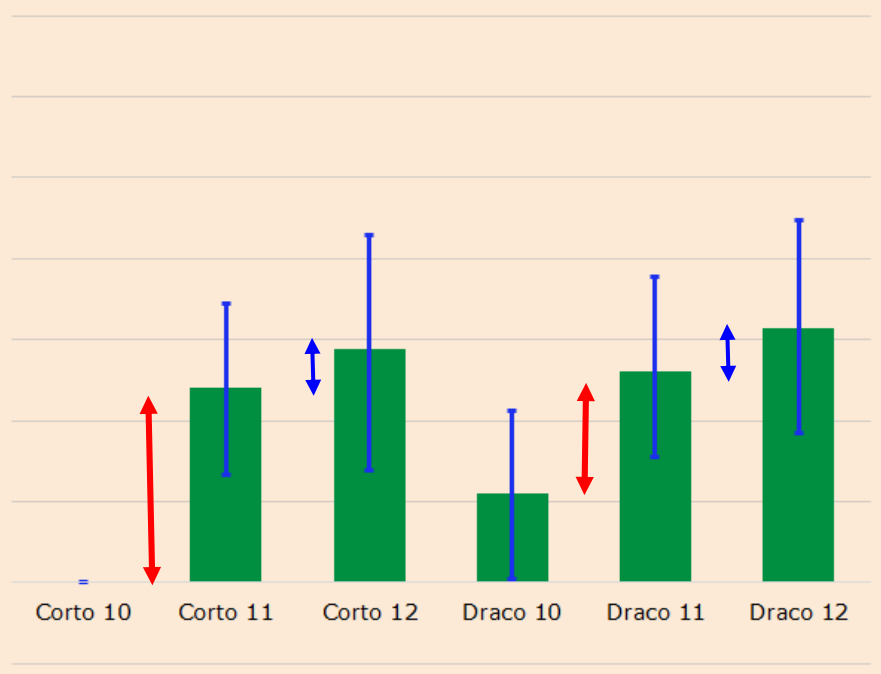


Results

Model Group #1 - Reconstructed Humans

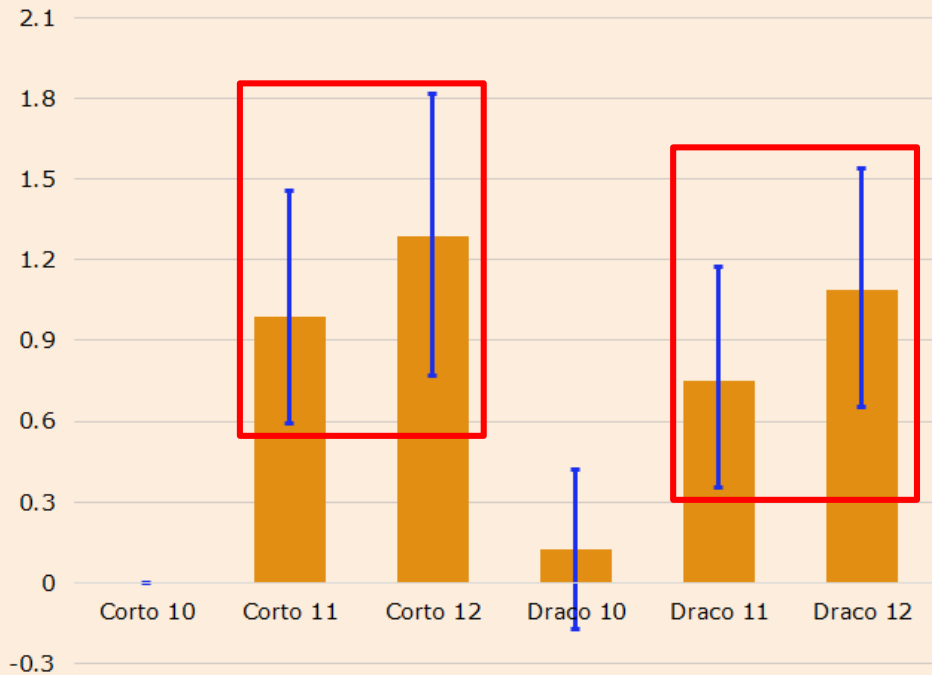


Model Group #2 - Scanned Objects

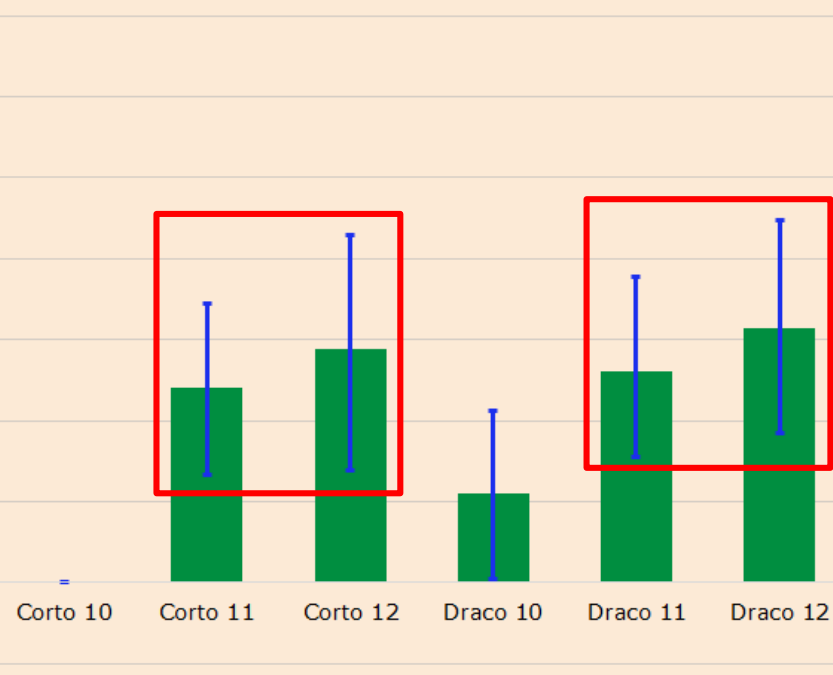


Results

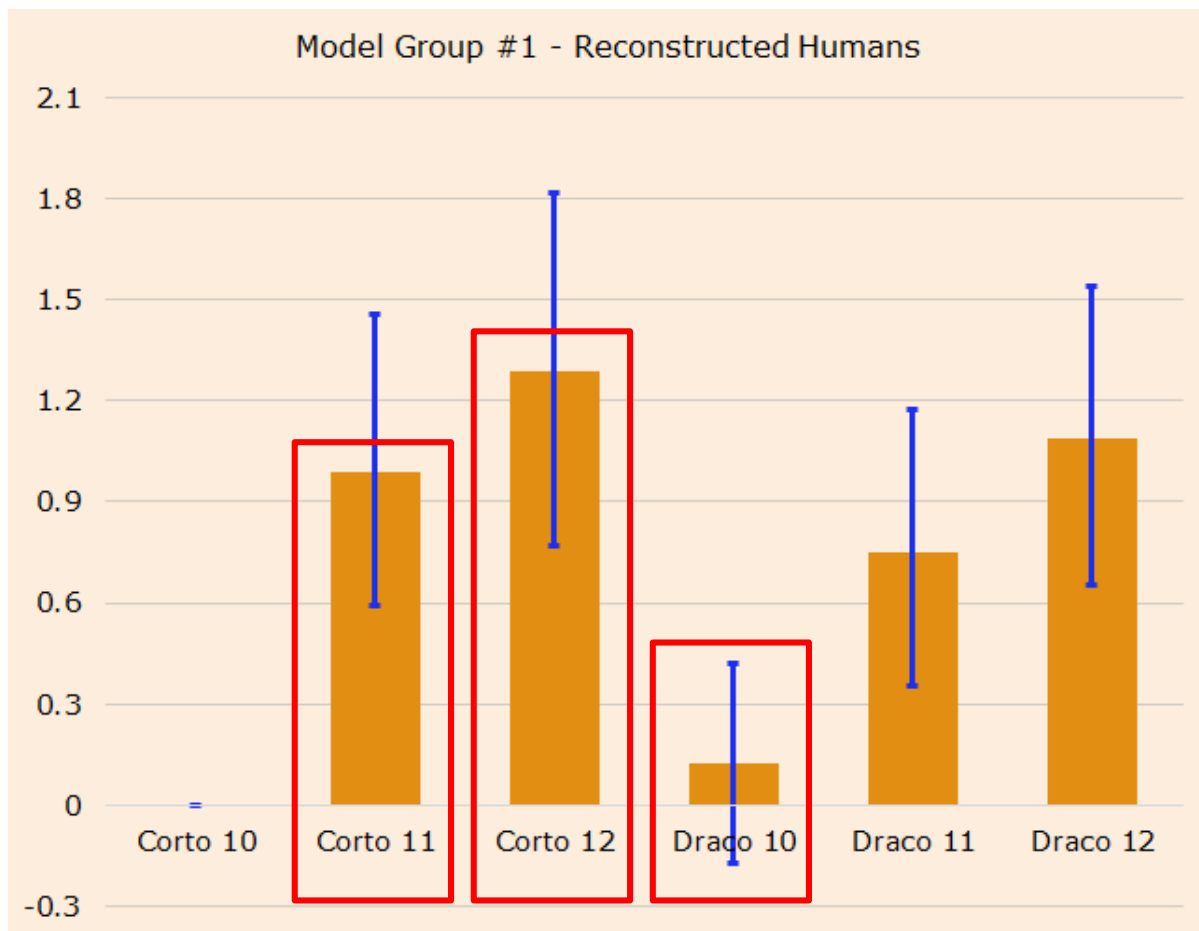
Model Group #1 - Reconstructed Humans



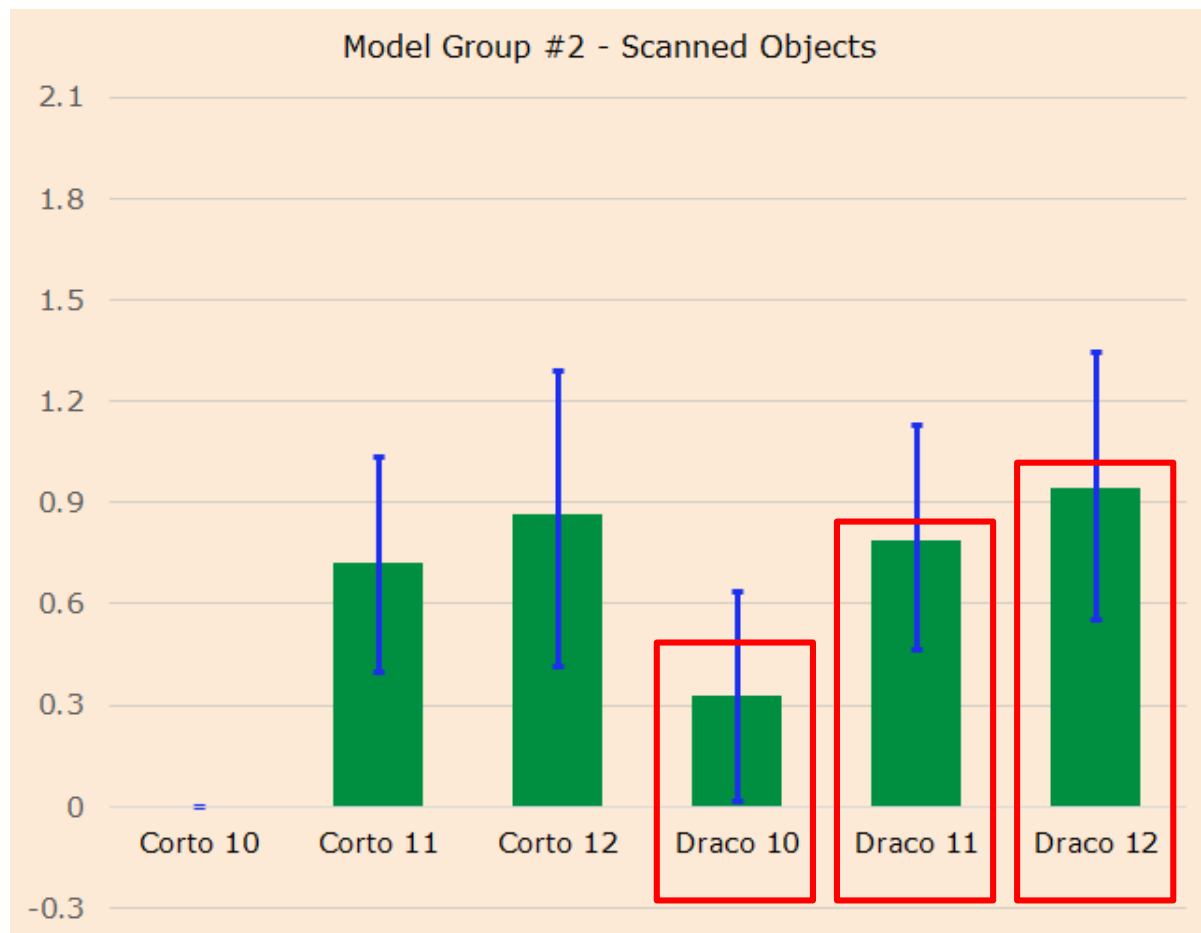
Model Group #2 - Scanned Objects



Results

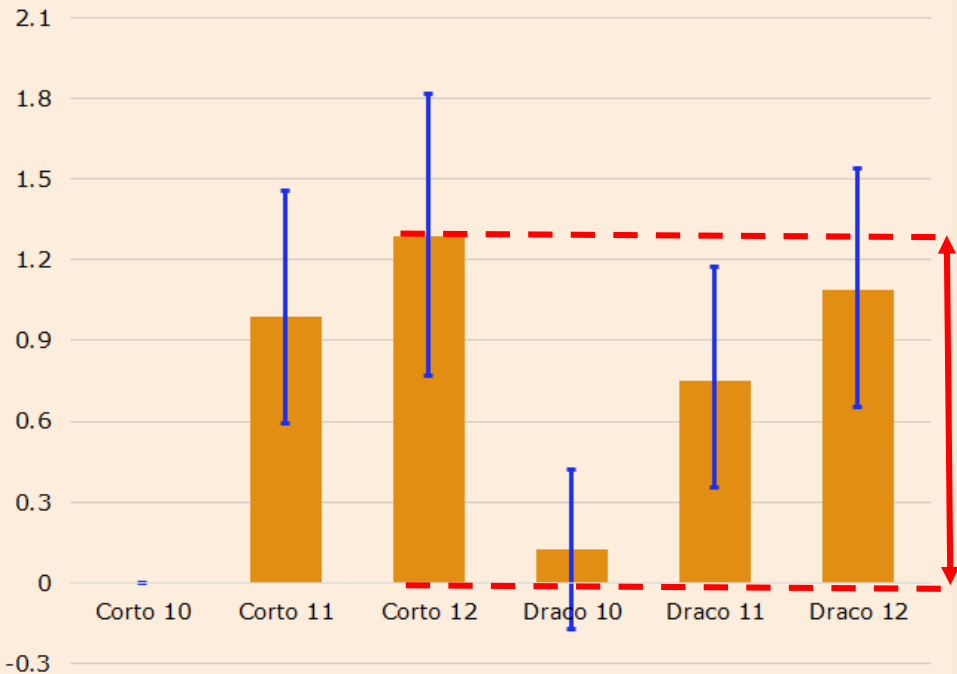


Results

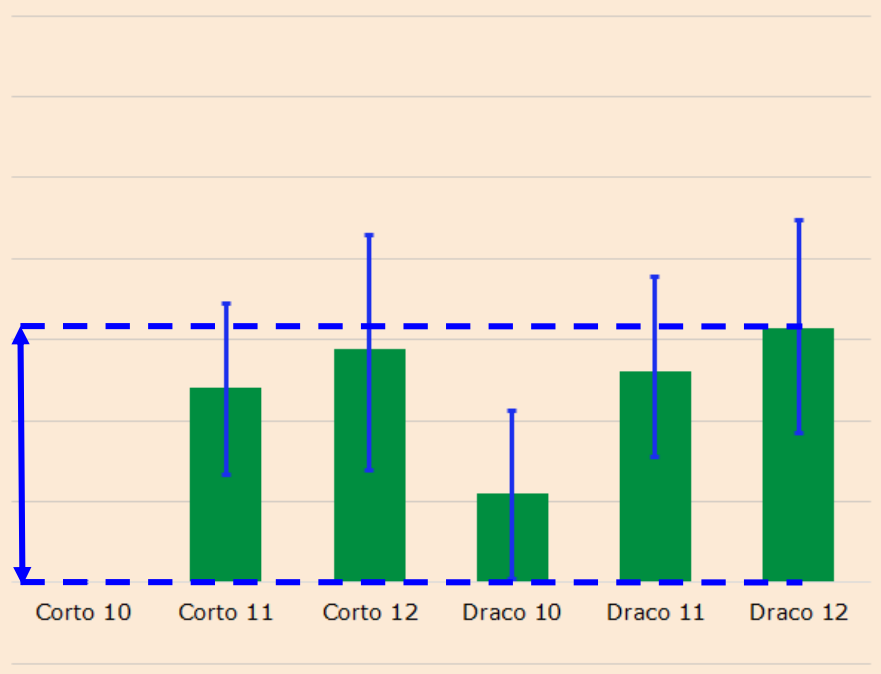


Results

Model Group #1 - Reconstructed Humans



Model Group #2 - Scanned Objects



Correlation of scores with objective metrics

Not consistent in the two model sets.

- Scanned objects group : strong correlation with Hausdorff distance. Draco has smaller Hausdorff distance for the same quantization bits.
- Human meshes group: Scores do not correlate well with the objective metrics.
- Codec choice matters for subjective visual quality, depending on the production process of the 3D meshes.

Summary

- Survey on the effects of compression on the subjectively perceived quality of 3D meshes
- Use of VR headset
- Two codecs and three different distortion levels
- The choice of the codec depends on the generation process of the produced 3D mesh
- For higher values of the quantization parameter the differences in subjective visual quality are less apparent