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Reflectional Symmetry Detection In 3D Models Changing In Time

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Computer science and its specializations
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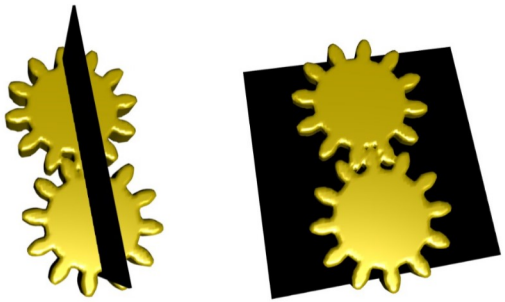

Figure 1: Detected symmetry planes for rotating gears without maintaining coherence.

Method

Three types of methods for symmetry detection in sequences were developed. For symmetry plane detection the method bassed on the differentiate symmetry measure described by Hruda et al. (2022) was used. This method is called ***SD*** in following text.

- **Starting SD for each frame from the sequence without coherence maintainance.** The simple method as the base for the comparison with following methods.
- **Starting SD for each frame with coherence maintainance.** Changing of the symmetry measures in the output of the SD. Multiplication using weights or choosing the most suitable plane in the sense of coherence.
- **Starting SD in chosen key frames and computing approximate planes between key frames.** Using interpolation or the plane fitting between centroids of two clusters created in key frames generated uniformely or error-based.

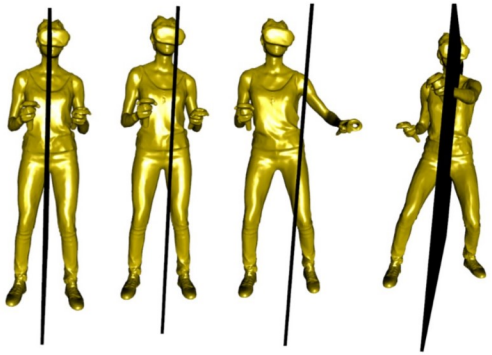

Figure 3: Detected symmetry planes for a person in VR using the interpolation method.

Introduction

Symmetry is the important feature of geometric objects. It can be defined as a geometric transformation against which is an object invariant. This master thesis focuses on symmetry detection in 3D objects changing in time. These objects are defined as the sequence of triangle meshes. For each frame from the sequence, the number of vertices and their positions are changed a little. Symmetry in these objects is detected in the sense of coherence, so the change of resulting symmetry planes between frames should be smooth despite lower quality in the mathematical sense.

Results

All the methods were tested on the set of 28 sequences with people or simple geometric shapes. The first method without maintaining coherence gave the worst results. If the symmetry measures in the output are changed (the second method), results are significantly better. The best results in the lowest time were gained for the third method with the estimation of planes between the planes computed in key frames, but these results have lower quality in mathematical sense. Examples of results can be seen in Figs. 1-3.

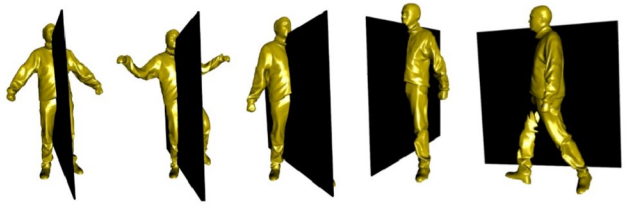

Figure 2: Detected symmetry planes for a walking person with maintaining coherence.

Conclusion

Within this master thesis, three types of methods for the symmetry plane detection in sequences were developed. The best results in the sense of coherence were produced by the methods that compute symmetry plane only in key frames, such as interpolation or plane fitting between centroids. These methods were also faster than others.

References

HRUDA, Lukáš; KOLINGEROVÁ, Ivana; VÁŠA, Libor. Robust, fast and flexible symmetry plane detection based on differentiable symmetry measure. The Visual Computer. 2022, vol. 38. DOI: 10.1007/s00371-020-02034-w.