HARVEST4D
HARVESTING DYNAMIC 3D WORLDS FROM COMMODITY SENSOR CLOUDS

Publications for Task 5.4

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Statement of originality

This deliverable, although of public dissemination level, may at the time of delivery still contain original unpublished work (e.g., accepted papers that are not public yet, or papers under revision). Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

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1 EXECUTIVE SUMMARY

1.1 INTRODUCTION

This deliverable describes the publications that resulted from Task 5.4, and how they fit into the work plan of the project.

The objective of Task 5.4 is to explore techniques for separating the incoming data into a new 3-level representation. This representation is composed of a low-rank part, a sparse component and the remaining noise.

There is so far one publication that is mainly attributed to Task 5.4, which can be found in the appendix of this deliverable.

1.2 PUBLICATIONS

The following publication can be found in the appendix:

- Jun Li, Weiwei Xu, Zhiquan Cheng, Kai Xu, and Reinhard Klein
  Lightweight Wrinkle Synthesis for 3D Facial Modeling and Animation
  Computer Aided Design (2014), 58(117-122)

2 DESCRIPTION OF PUBLICATIONS

2.1 OVERVIEW

Almost all of the scene content such as the surface geometries and reflectance properties of objects can be considered as a superposition of a basic coarse-scale representation, an additive sparse representation and an overlaid noise characteristics. Considering e.g. a flat stonewall, the coarse-scale geometry is represented by a plane, the sparse component is characterized by the cement structures between the stones and the noise is represented by the pores in the involved materials. In the scope of this Task, the key objective is therefore represented by the separation of the incoming data into a novel 3-level representation, which is composed of a low-rank part, a sparse component and the remaining noise. We envision applying such a separation of components both for geometry and reflectance data. The key problems to be solved are:

- finding a suitable low-rank representation,
- separating the remaining data (i.e. sparse component and noise component) via subtracting the low-rank part, and

- separating the semantically important sparse parts from superimposed noise.

The separated representation will then be utilized to derive a compact representation in Task 4.3. In addition to compression, we intend to investigate whether it is possible to derive novel distance metrics from this representation. Tasks such as retrieval might benefit from comparing the separate parts with each other independently, since for example noise no longer influences the distance metric on the basic shape. On the other hand, noisy data cannot be compared directly with each other while superimposed over the actual data. However, after the separation, the statistics of the fitted models can be utilized to support suitable metrics.

2.2 EXTRACTION OF LOW-RANK AND SPARSE COMPONENTS FOR 3D GEOMETRY

In the scope of the publication [Li et al. 2014], we approached the problem of separating the incoming geometric data into a novel 3-level representation which is composed of a low-rank part, a sparse component and the remaining noise in RGBD-video-data acquired using a Kinect.

For analyzing the temporally varying surface geometry of faces, the presented technique first consists of an offline personalized wrinkled blendshape construction where user-specific expressions are recorded using the RGB-Depth camera, and the wrinkles are generated through example-based synthesis of geometric details (see Figure 1).

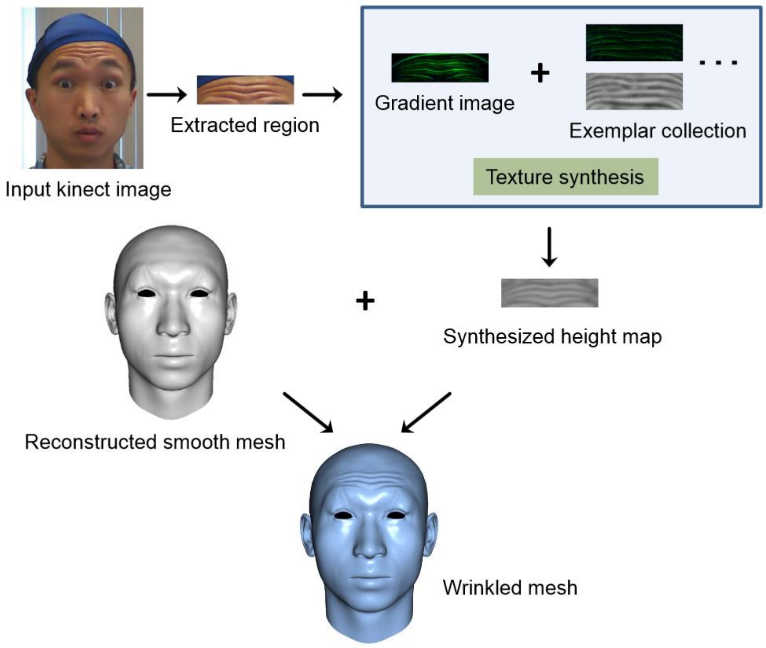

Figure 1: Offline wrinkle synthesis pipeline: From the incoming data, a smooth mesh is reconstructed and the local gradients observed in the image are used to synthesize local heightmaps via texture synthesis. In the latter stage, the heightmap computation is based on considering both gradient image and a database of collected exemplars with registered gradient information and geometry. The superposition of the reconstructed smooth mesh and the synthesized heightmap form the wrinkled mesh. This illustration has been taken from [Li et al. 2014].

In the second phase, the reconstructed blendshape models can be directly used in real-time performance-driven facial animation. The overall procedure consists of two steps: rigid motion tracking to compute the global rigid transformation of the head and non-rigid motion tracking to reconstruct the local deformations at each expression. The purpose of non-rigid tracking is to determine the weights of the blendshape models and reconstruct the user expressions in each image frame.

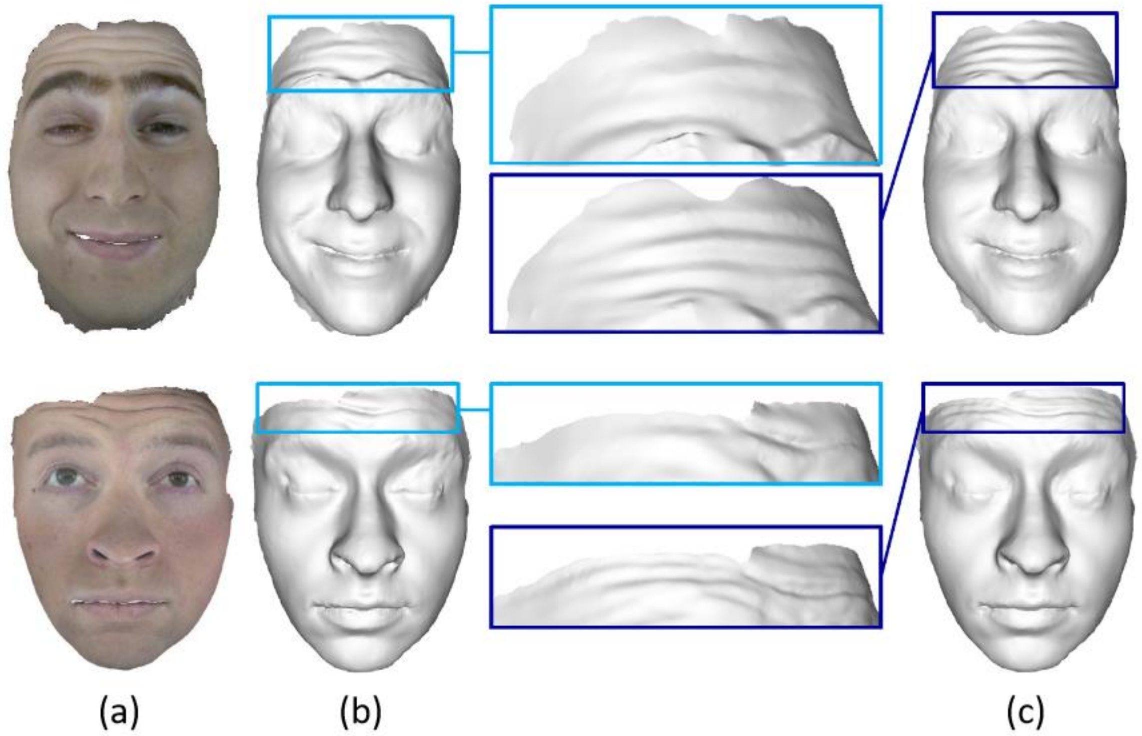

Figure 2: Performance comparison: For the input data shown in a) the result of the method in [Bradley et al., High resolution passive facial performance capture,TOG2010] is shown in b). Our developed algorithm is capable of significantly better separating the sparse component. This illustration has been taken from [Li et al. 2014].

At first sight, considering animated faces might seem to be a rather special application scenario. However, there are several reasons to work on this data. First of all, the technique can be generalized to other objects in the scene by replacing the smooth mesh of the face with some basic geometric primitives as used for point cloud compression in Task 4.3 [Golla et al. 2014]. Secondly, the data is highly challenging because of the rapidly varying face expressions, which can still be reliably handled by our proposed method. In further work, we intend to investigate storing the separated noise component via its noise characteristics to increase the compression rates for Task 4.3. Additionally, we plan to focus on developing suitable algorithms for decomposing reflectance data as well in a similar scheme.

3 APPENDIX

The following pages contain all the publications listed in Section 1.3 that are directly associated with this deliverable. Other publications referenced in this deliverable can be found in the public Harvest4D webpage.