Description of Breast Morphology through Bag of Normals Representation

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19th International Conference on Image Analysis and Processing
11—15 September 2017
Catania — Italy

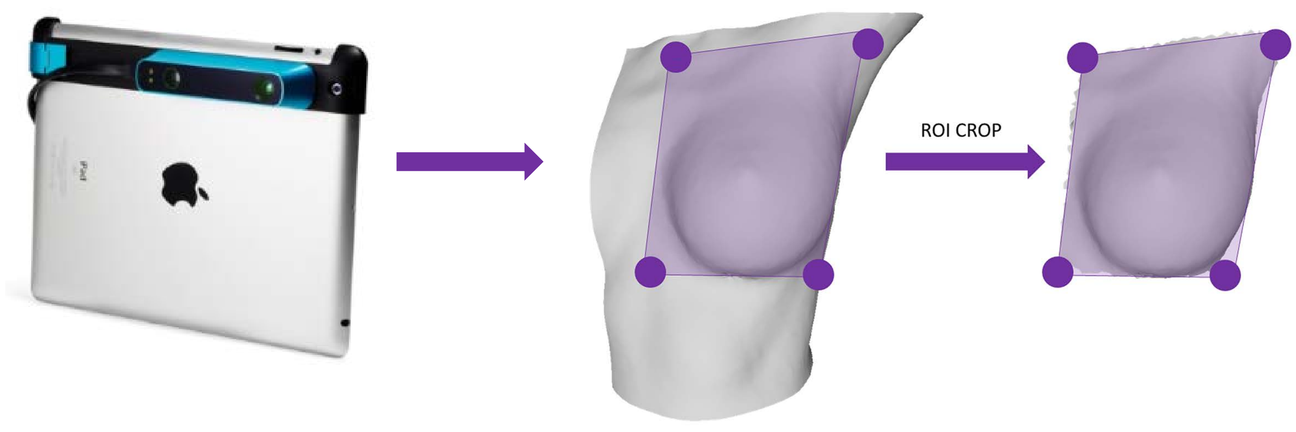
Abstract

In this work we focus on digital shape analysis of breast models to assist breast surgeon for medical and surgical purposes. A clinical procedure for female breast digital scan is proposed. After a manual ROI definition through cropping, the meshes are automatically processed. The breasts are represented exploiting “bag of normals" representation, resulting in a 64-d descriptor. PCA is computed and the obtained first 2 principal components are used to plot the breasts shape into a 2D space.
We show how the breasts subject to a surgery change their representation in this space and provide a cue about the error in this estimation. We believe that the proposed procedure represents a valid solution to evaluate the results of surgeries, since one of the most important goal of the specialists is to symmetrically reconstruct breasts and an objective tool to measure the result is currently missing.

Proposed algorithm

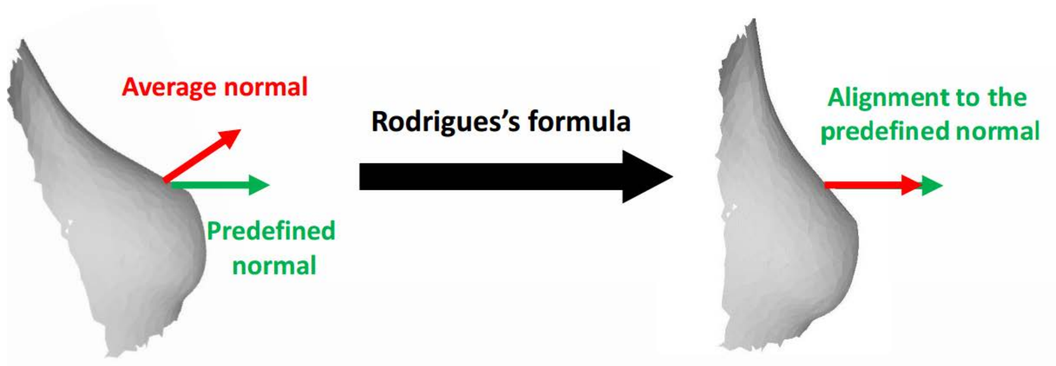
1. Acquisition of 3D models
2. Crop of the ROI using 4 landmarks
3. Model registration
4. Computing bag of normals
5. PCA

Models acquisition

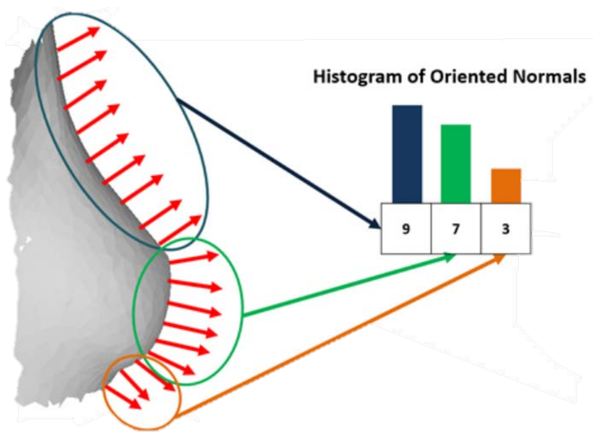


Registration

Move vertices’ average in the origin and then:



Computing bags of normals

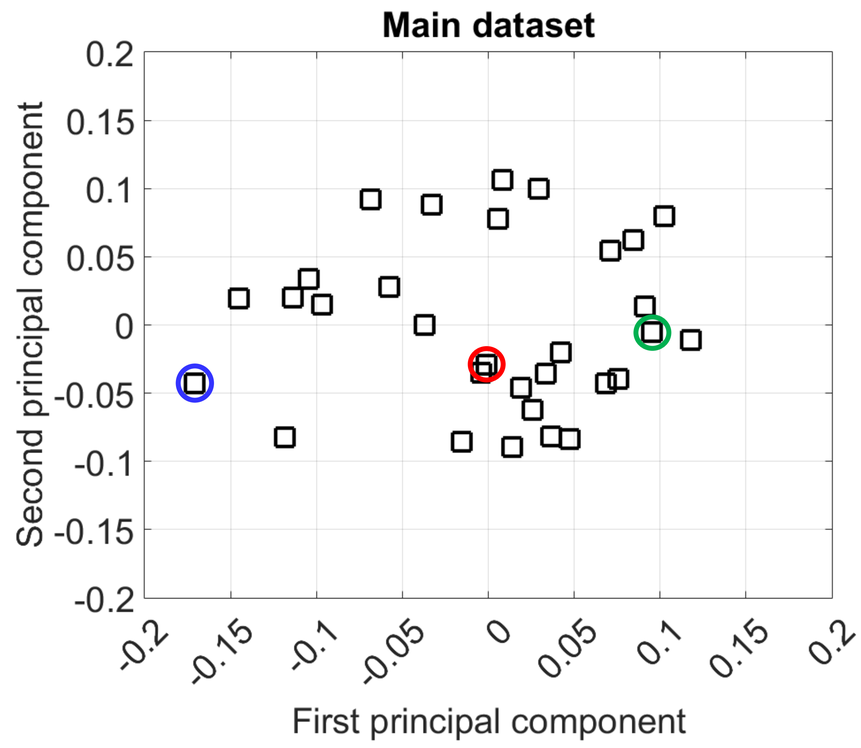


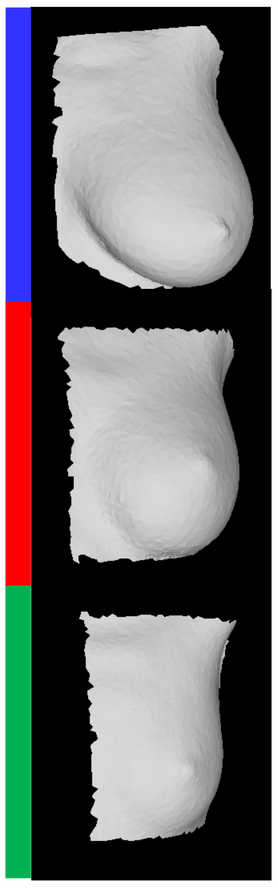
To compute the bag of normal we linearly quantize the space of each component into 4 levels, in order to obtain 4 × 4 × 4 = 64 different cluster. Then, each mesh is represented by counting the occurrences in each cluster.

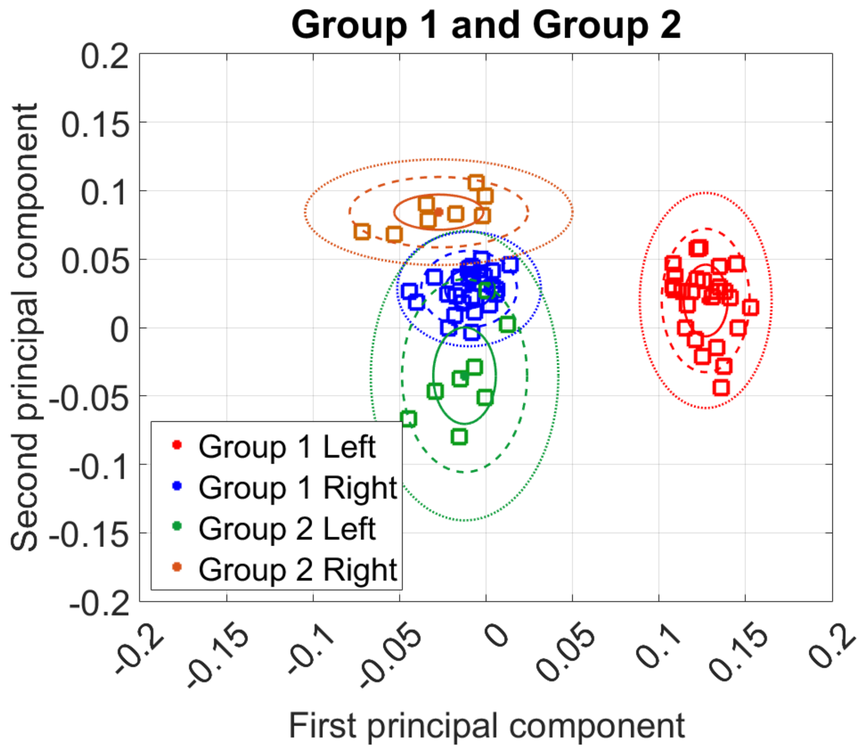
Dataset

- **Main Dataset:** 31 breasts, 17 left and 14 right. (breasts of different size and ptosis)
- **Pre-Op Group 1:** 52 meshes, 26 left and 26 right. (same patient, scanned by two groups of doctors: junior and expert)
- **Post-Op Group 2:** 16 breasts, 8 left and 8 right. (same patient of Group 1 after a surgery on both breasts)

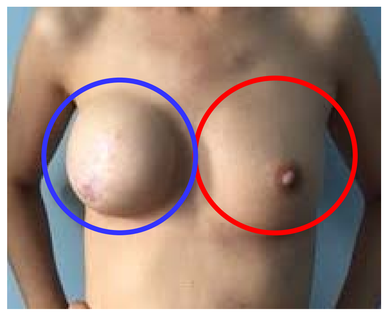
Results



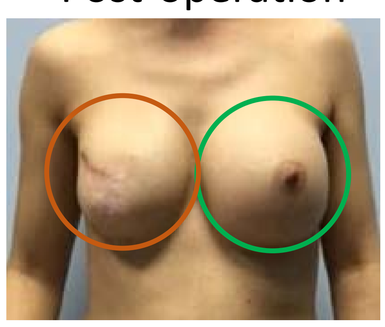




Pre-operation



Post-operation



References

[1] G. Gallo, D. Allegra, Y. G. Atani, G. Catanuto, F. L. M. Milotta, F. Stanco. “Breast shape parametrization through planar projections.” ACIVS, 2016