When 3D geometrical face analysis meets maxillofacial surgery-a methodology for patients affected by dental malocclusion

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When 3D geometrical face analysis meets maxillofacial surgery – a methodology for patients affected by dental malocclusion

A PhD thesis in collaboration with the Maxillofacial Unit of A.O.U. Città della Salute e della Scienza - Ospedale Molinette

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Abstract

The principal purpose of the work that will be presented was the development of a novel 3D methodology for the prediction of the facial soft tissue displacements after corrective maxillofacial surgery. Despite the existence of several commercial solutions, both bi- and three-dimensional, none of these seem to be adequate to the involvement in the clinical routine, as the produced results are not sufficiently reliable, or quite accurate but just for not complex interventions. These considerations were drawn both from the analysis of the state-of-the-art and from the direct experience of maxillofacial practitioners that collaborated to the development of this new methodology. Our proposal finds place in the 3D systems panorama and is based not on the mechanical modelling of soft tissue behaviour, as the majority of the available solutions, but on the collection of the soft tissue responses in terms of displacements in the 3D space of facial points of patients already operated. The collection of already treated patients is not aimed to the construction of a mean model of the occurred modifications after specific surgeries, as other studies proposed, but it is aimed to the computation of a displacements vectorial map of a specific treated patient; this patient is chosen by means of a similarity analysis and represents the most similar patient to the one whose prediction is to be carried out. The concept of similarity is a delicate theme; here we consider the similarity as the lower difference between two subjects in terms of facial proportions and measurements. Even if we faced with a paucity of data and despite the good results obtained in the validation stage, the prediction methodology would be more robust with a large data set of patients among who the similarity should be searched; thus, the secondary purpose of this work was the development of a human- assisted methodology for the generation of three-dimensional models in form of 3D depth maps (as will be described in detail) of quality comparable to that of the 3D models produced with appropriate software. The whole work is completed by an in-depth study on the changes occurred in the malar regions of patients underwent malar valgization for

both hard and soft tissue and by a multifaceted study on the relationship between soft tissue thickness, corrective surgeries, body mass index and sex. Moreover, two studies employing facial features of the same type of those involved in our main path are reported, respectively in the domain of face recognition and in the domain of face expression recognition.

As we will present, the obtained results were quantitatively and qualitatively accurate, as they were assessed by the comparison with a real post-operative soft tissue outcome and were validated by expert surgeons. Moreover, the potentiality of this method stands also in the fact that even if it was coded in an environment not freely licensed, it could be translated in a free language, freeing the user from costly annual licences.