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# HOLOGRAPHIC TECHNIQUES APPLIED IN DENTISTRY STUDIES

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## ABSTRACT

In this work we present de development and implementation of two experimental devices based in holographic techniques for the measurement of surface deformation applied to dentistry studies. The proposed systems, an ESPI (Electronic Speckle Pattern Interferometry) system and a DH (Digital Holography) system, both present all the advantages associated with these techniques such as: high resolution, full field, non contact and the possibility of post processing the obtained numerical data. However when compared to each other they present advantages and disadvantages.

The two techniques were applied in some studies in the orofacial biomechanics and material characterization. The advantages and disadvantages in their use are discussed. The potential development of each these techniques are also discussed.

***Keywords:*** holographic, ESPI, digital holography, dentistry.

## INTRODUCTION

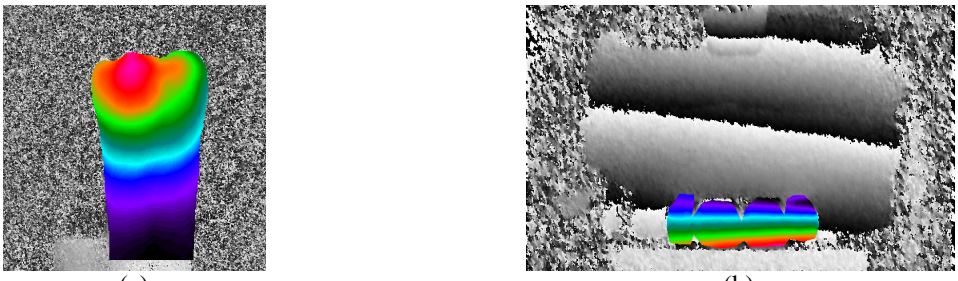
Holographic techniques are nowadays well established with proven results in different areas. They present several advantages when compared with conventional ones, since they are full field, high resolution and non contact techniques. Electronic Speckle Pattern Interferometry (ESPI) and Digital Holohgraphy (DH) use the same principle, but in DH no lens or other imaging device is used between the object and the video sensor. In DH holograms are digitally sampled, information of optically interfering waves is stored in the form of matrices. Numerical processing is used to simulate the optical processes of interferometry, spatial filtering, etc. This way is possible to calculate the interference phase directly from the holograms, without generation of an interference pattern. In ESPI the results are obtained in real time but in DH due to the numerical reconstruction of the holograms all the process is slower and the results are not obtained in real time.

The application of these techniques to dentistry studies has been done during the last years in the characterization of the mechanical behaviour of dental structures. Currently dentists have available an extensive set of methodologies, components and materials to perform dental rehabilitation. The application of new materials in dentistry like composites, adhesives and ceramics, used in association with metallic implants has increased in the last years. To improve the clinics it is important to understand the limitations of the materials and techniques used because the success of most procedures is highly dependent on the understanding of the Biomechanics associated. Holographic techniques are well adapted for this purpose due to their high resolution field measurements which can be performed with no

contact. Recent works proved the advantages of the application of using DH (Monteiro, 2010) and ESPI (Cássia, 2012) in the assessment of the mechanical behaviour of dental structures.

## RESULTS AND CONCLUSIONS

In this work is shown the application of two holographic techniques, ESPI and DH, in the assessment of displacements in dental structures. The experimental measurements performed with these two techniques are described, their differences highlighted as well as the relevance of the obtained results. In Figure 1 are presented some results obtained with these techniques. In Figure 1(a) is shown the shrinking of dental filling resins loaded with Nano particles, using DH recordings of the dental surface. This study could be used to select the composition with less contraction during light-induced polymerization. In Figure 1(b) is presented one of the obtained results with ESPI technique of the mechanical behaviour of an implanted supported maxilla anterior dental bridge, this study was done to investigate how the position of the implants influence its stiffness.



(a) (b)

Fig. 1 - (a) Tooth shrinkage due to cure reactions of a composite filling material using DH, (b) results obtained with ESPI in a Maxilla prototyped model with implant supported rehabilitation of 4 teeth.

Both ESPI and HD present great potential since they offer new non-destructive possibilities for bridging the gap between in vitro and in vivo measurements in dentistry, and thus increase the possibility of achieving more accurate and more objective diagnosis and therapy.

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