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Digital Image Correlation: Metrological Characterization in Mechanical Analysis

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The Digital Image Correlation (DIC) is a newly developed optical technique that is spreading in all engineering sectors because it allows the non-destructive estimation of the entire surface deformation without any contact with the component under analysis. These characteristics make the DIC very appealing in all the cases the global deformation state is to be known without using strain gages, which are the most used measuring device.
The DIC is applicable to any material subjected to distortion caused by either thermal or mechanical load, allowing to obtain high-definition mapping of displacements and deformations. That is why in the civil and the transportation industry, DIC is very useful for studying the behavior of metallic materials as well as of composite materials. DIC is also used in the medical field for the characterization of the local strain field of the vascular tissues surface subjected to uniaxial tensile loading.
DIC can be carried out in the two dimension mode (2D DIC) if a single camera is used or in a three dimension mode (3D DIC) if two cameras are involved. Each point of the test surface framed by the cameras can be associated with a specific pixel of the image and the coordinates of each point are calculated knowing the relative distance between the two cameras together with their orientation. In both arrangements, when a component is subjected to a load, several images related to different deformation states can be are acquired through the cameras. A specific software analyzes the images via the mutual correlation between the reference image (obtained without any applied load) and those acquired during the deformation giving the relative displacements.
In this paper, a Metrological Characterization of the Digital Image Correlation is performed on aluminum and composite targets both in static and dynamic loading conditions by comparison between DIC and strain gauges measures. In the static test, interesting results have been obtained thanks to an excellent agreement between the two measuring techniques. In addition, the deformation detected by the DIC is compliant with the result of a FEM simulation
In the dynamic test the DIC was able to follow with a good accuracy the periodic deformation of the specimen giving results coherent with the ones given by FEM simulation.
In both situations, it was seen that the DIC measurement accuracy depends on several parameters such as the optical focusing, the parameters chosen to perform the mutual correlation between the images and, finally, the reference points on image to be analyzed. In the future the influence of these parameters will be studied and a method to increase the accuracy of the measurements will be developed in accordance with the requirements of the industries especially of the aerospace one.