DUOADD[§]: a software to detect and export damages of 3D scanned objects

Matteo Perini[*], **Paolo Bosetti**[†]

University of Trento
Department of Industrial Engineering

[*] e-mail: matteo.perini@unitn.it
[†] e-mail: paolo.bosetti@unitn.it

web page: https://www.promfacility.eu/

ABSTRACT

One of the most challenging problems in repairing a damaged object using a hybrid additive machine is to detect the missing material and place it in the precise position in the working area. This work uses octrees to discretize both the original CAD model and the 3D scanned geometry and to compare them in the process of identifying the mismatching volumes. Firstly, the presented software recursively subdivides the bounding box of the nominal solid model into eight octants at every iteration, dividing every edge in two parts, recursively building an octree representation. For each depth level of the octree, the program checks whether the nodes intersect at least one triangle of the scanned model and only in this case the node is marked as part of the model. This process proceeds until the desired resolution is reached. After this first step, the result is a compound of cubes that represents the shell of the scanned model. Secondly, the software deals with the scanned surface, which has to be converted in an octree too. To compute a boolean difference between the two octrees it is necessary that they are fully filled, so the one representing the scan must be expanded into the inside of the component. For this reason, DUOADD uses a ray–triangle intersecting algorithm to classify the leaf nodes of the octrees that are inside the shell and those outside the shell. If the number of intersections between the ray — traced from the node center — and the mesh is odd, then the node belongs to the volume inside the meshed surface. Otherwise, it belongs to the surrounding volume. The data structures of the two octrees need to be consistent — i.e. they must have a coherent number of levels and leaves. An iterative algorithm has been developed in order to uniform the octrees data structures. To perform the boolean comparison, DUOADD scans over the data structure of both octrees at the same time and checks — with a NOR operation — whether the nodes are marked as "inside node" in both the octrees or not. The result of this comparison represents the damaged spots. Once the analysis result is obtained, DUOADD joins all the nodes representing the damage into a single solid body that can be exported in various file format as STEP, IGES or VTK. DUOADD allows to approach the repair problem from a new point of view and provides a powerful tool to obtain a solid model used to add the new material. Authors successfully employed DUOADD to repair die injection molds and there are many other applications that could benefit from the use of this software. Many improvements are expected in the near future such as the binary encoding of the octree structure and the smoothing of the exported solid body shape.

[§] DUOADD = DUOADD Uses Octrees As Damage Detector