## View dependent surface watermarks for 3D printed objects

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Digital 3D model watermarking embeds a message on a digital 3D model by manipulating its shape or attributes. In our application scenario, the message carrier is an external surface attribute, such as color or texture, and the retrieval method uses a photo of a 3D printed copy of the model. Here, unlike standard 3D model watermarking, the retrieval process does not have access to the digital 3D model itself, allowing a distinction between two cases. View independent watermarking, where the position of the camera may only affect retrieval accuracy, and view dependent watermarking, where changes in camera position may lead to different watermarks been retrieved.

We formulate the following optimization problem, related to the view dependent case. Find a maximal area surface which is: piecewise  $C^2$ ; bounded by a flat bounding box; and the normal semi-lines inside the half space defined by one of the flat faces of the bounding box do not intersect the surface. The natural interpretation of that formulation is that we maximise the area of the surface, and thus its watermark carrying capacity, while we are still able to see each surface point from far away and directly from above.

We study the equivalent problem for curves, obtaining some results on the properties of the optimal curves, and using them to obtain a good, but not provably optimal solution, in the form of a family of piece-wise circular curves.

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