A fast global approach that encodes haptic surface relief detail using an image-based Hybrid Rugosity Mesostructure Atlas (HyRMA) shell is presented. It is based on a depth/normal texture computed from surface differences of the same mesh object at different resolutions (a dense one with thousands/millions of triangles, and a highly decimated version). Per-face local depth differences are warped from volume space into tangent space, and stored in a sorted relief atlas. Next, the atlas is sampled by a vertex/fragment shader pair, unwarped, displacing the pixels at each face of the decimated mesh to render the original mesh detail with quite fewer triangles. We achieve accurate correspondence between visualization of surface detail and perception of its fine features without compromising rendering framerates, with some loss of detail at mesostructure holes.