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Background

Breast-conserving surgery followed by radiotherapy is a standard treatment for various breast cancers. However these procedures often alter breast size, shape, and symmetry, affecting appearance and quality of life. Current evaluation methods include automatic 2D tools that cannot provide volumetric data, 3D approaches based on MRI or CT that are costly and rarely acquired for cosmetic follow-up, and commercial 3D systems that require proprietary hardware and expensive licenses, limiting accessibility and transparency. As a result, reliable volumetric assessment remains out of reach for most patients and clinicians, despite its clear clinical relevance. There is, therefore, a need for an automatic, accurate, and open-access pipeline for volumetric breast assessment.

Methods

We present a pipeline that can work with 3D meshes, obtained from surface scans using consumer-level devices. The core of this pipeline is a breast landmark detection model (YOLO-v8/v11), which is currently being trained on more than 8,000 annotated images from the REQUITE dataset (www.requite.eu). This breast landmark detector is embedded within processing pipeline of the 3D mesh, which segments breast regions based on multiple renders of the mesh. Additional details about this pipeline are provided in Figure 1.

Results

The YOLO-v8 model, retrained on the REQUITE Dataset using identical training settings, performs better than its v11 counterpart, as presented in Figures 2 and 3. This difference may be explained by the lower training stability observed for YOLO-v11 compared with YOLO-v8. Hence, the v8 model was selected to facilitate the segmentation process in the breast volume assessment pipeline. As shown in Figure 1, this pipeline can automatically select the breast region of the 3D mesh, although, human oversight is still required to ensure the segmentation accuracy. In addition, multiple tests (Figure 4) have shown that the texture of the mesh plays a substantial role in maintaining detection accuracy, as the textures play crucial role in bridging the gap between photographs of real subjects and renders of 3D meshes.

Conclusions

This pipeline is a first step toward objective, accessible breast volumetry. Further work is needed to fully automate the assessment process, and access to 3D scans of real patients could accelerate development of future software versions.

Lay Summary

Treating breast cancer can change the size and shape of the breast in the long-term. Currently, many patients cannot obtain accurate measurements of their breast volume in the clinic due to technical and financial limitations. In this work, we introduce a new software that can measure breast volume to help solve these issues. The software uses artificial intelligence (AI) trained on hundreds of 2D photos to calculate the surface area of breast regions in 3D meshes. These 3D meshes can come from different sources, including everyday devices like iPhones. The new software already works well, but at the moment still needs a human to check its results. With access to 3D scans from real patients, we could improve this system, speed up the development of a fully automatic version, and create even better tools for measuring breast volume.

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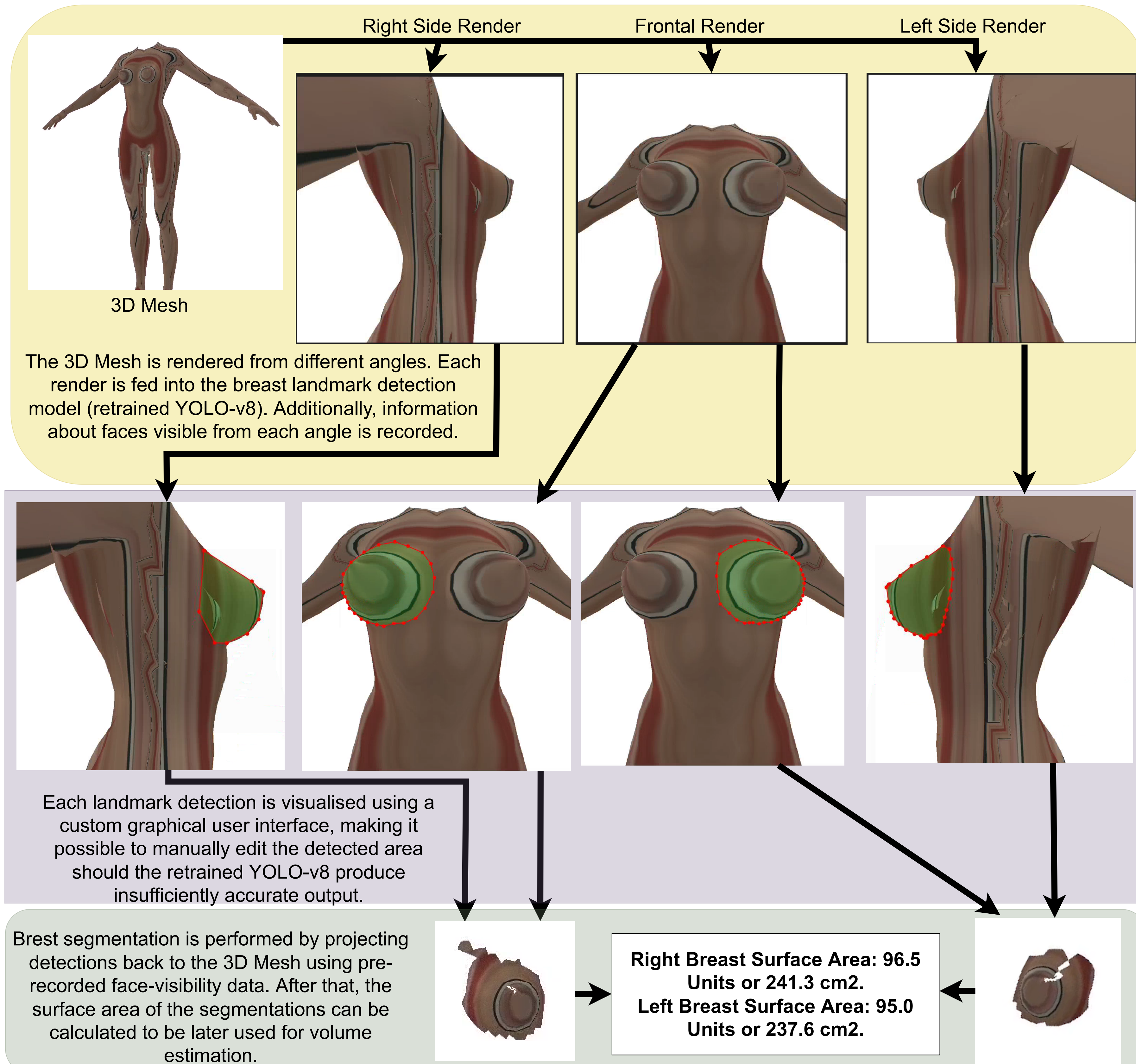
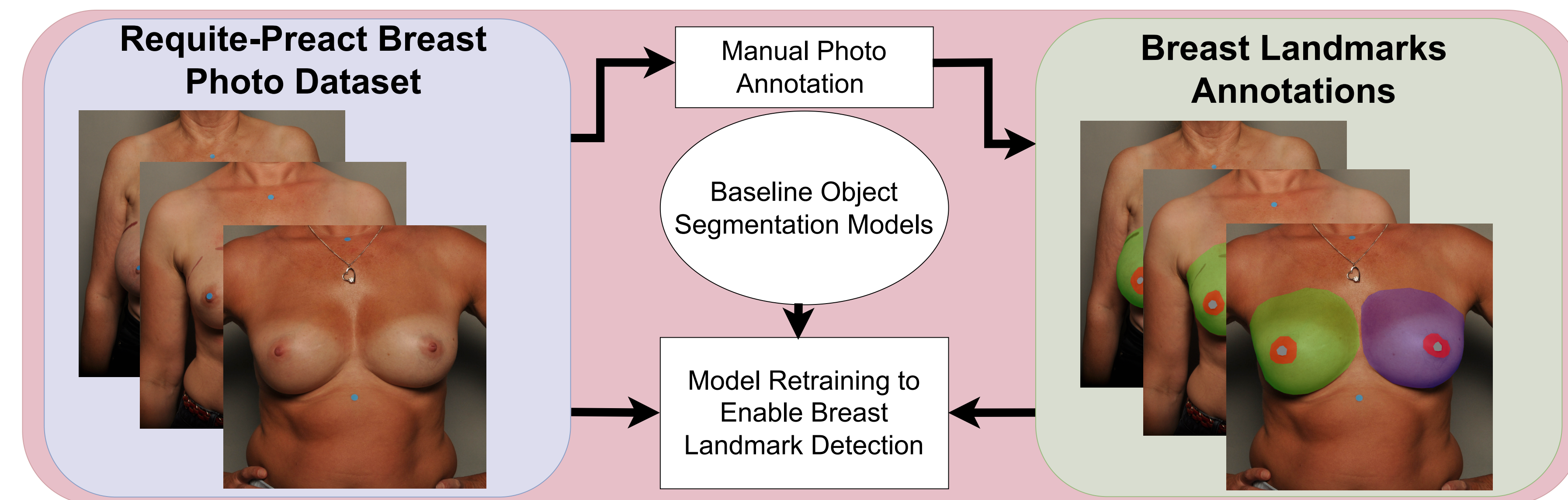


Figure 1. Breast Volume Assessment Pipeline. The 3D mesh was imported as an .obj file. Textures of the mesh were imported as a plain .png file. The PyGlet engine (<https://pyglet.org/>) was used for image rendering and scene visualisation. All manipulations with the 3D Mesh are facilitated by the Trimesh library (<https://trimesh.org/>).



model	precision(M)	recall(M)	mAP50(M)	mAP50-95(M)
YOLO-v8	0.96202	0.94492	0.96226	0.67561
YOLO-v11	0.95643	0.94187	0.96005	0.66843

Figure 2. Examples of photos from the REQUITE Dataset and their manually outlined annotations used for retraining of two baseline object detection models: YOLO-v8 and YOLO-v11. The table below includes performance metrics after 150 training epochs for each of these models. Both models achieve high performance metrics. However, YOLO-v8 slightly outperforms its v11 variant.

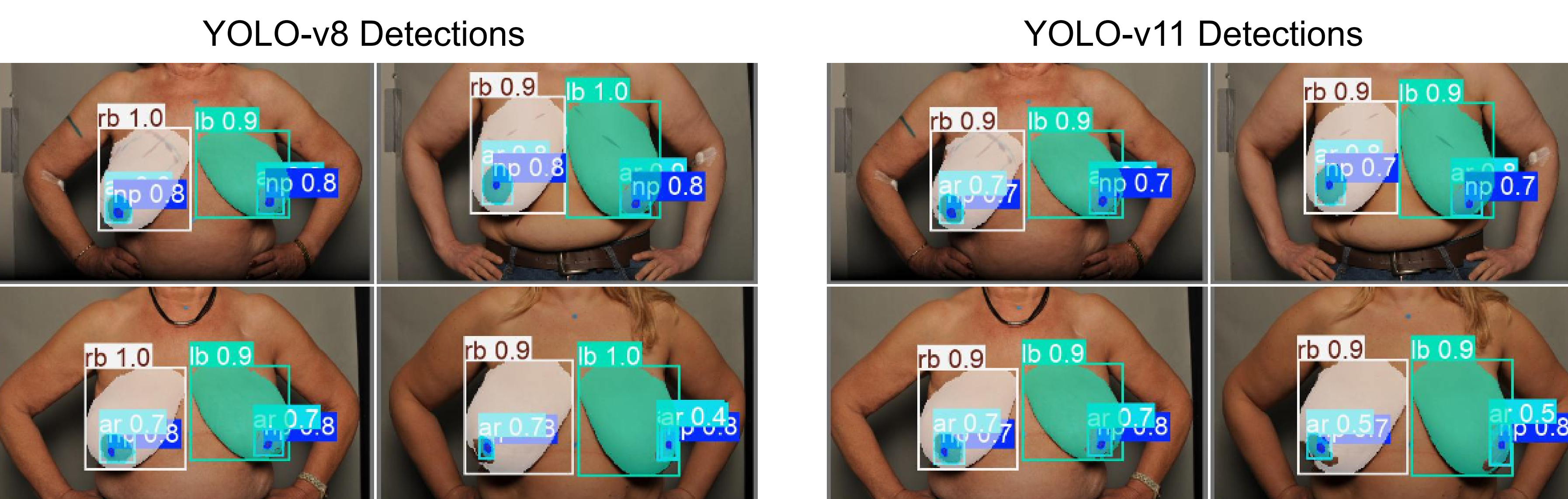


Figure 3. Examples of breast landmark detections with YOLO-v8 and YOLO-v11 models on the same images. Abbreviations: rb - right breast, lb - left breast, ar - areola, np - nipple. The number next to the annotation represents the confidence score.

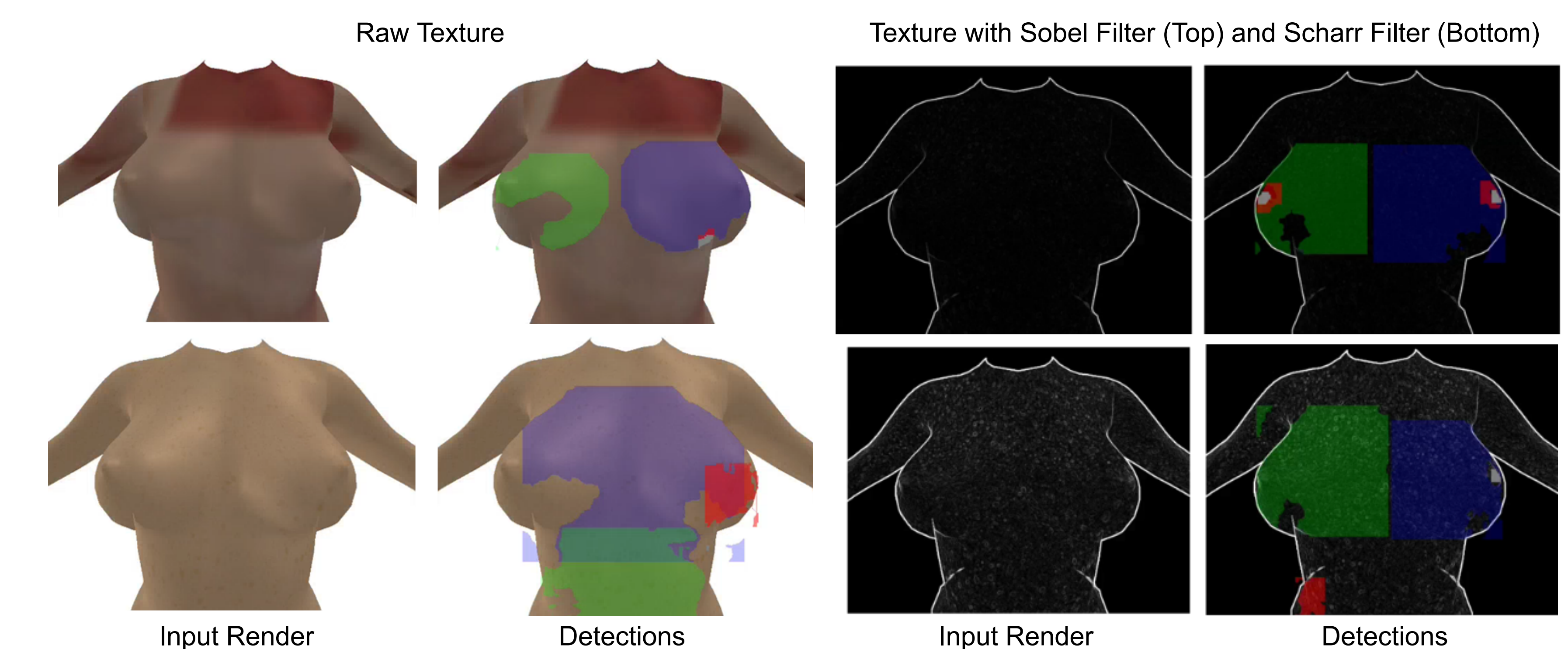


Figure 4. Additional examples of YOLO-v8 detections on frontal renders of the same model but with different textures and filters.