

Detailed Eye Region Capture and Animation

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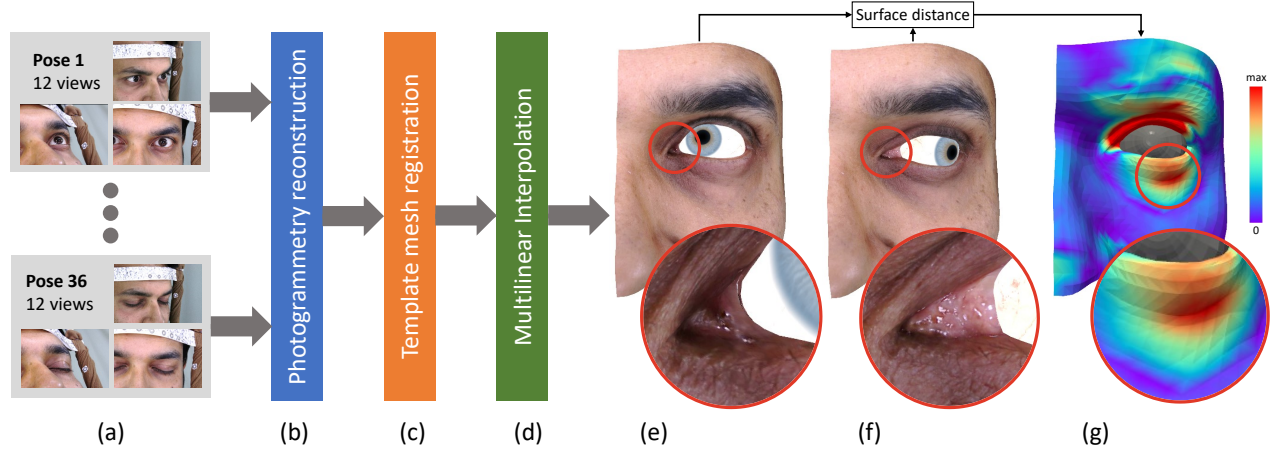


Figure 1: Summary of our approach for capturing and animating detailed eye regions: (a) eye capture, (b) mesh reconstruction, (c) mesh registration and (d) multi-linear interpolation. Through this pipeline, we are able to produce detailed eye region animation by accurately reproducing specific details such as (e, f) eye inner corner tissues and g) bulging effect caused by eyeball orientation.

ABSTRACT

We propose a data-driven approach for capturing and modeling the correlation between gaze direction, eyelids aperture and eyelids shape. Subtle features such as inner eye corner stretching, local skin bulging and closed eyelid deformations are incorporated in a personalized trilinear animation rig. This work has led to a publication [5].

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1 MOTIVATION

Human face modeling has received a great amount of attention from the research community [4]. Among the human face features, eyes stand out by being the most salient and descriptive region while being crucial to convey emotions, mental state or non-verbal communication [1]. The need of faithful reconstruction of the eye region is therefore a key challenge of human face animation. Here, we focus on the detailed capture, reconstruction and animation of

the eye region using a data-driven approach. We refer to eye region as the soft tissues surrounding the eyeball, but not the eyeball itself. Our goal is to capture how these tissues behave when the gaze direction and the eye aperture vary.

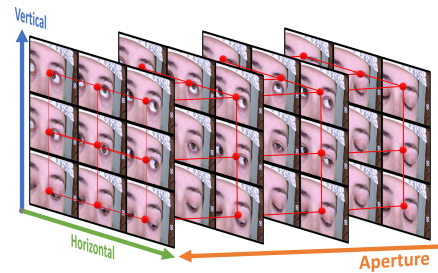


Figure 2: The eye pose space is discretized in 36 poses, as the cartesian product of 3 levels for horizontal gaze angle ("right", "center" and "left"), 3 levels for vertical gaze angle ("down", "center" and "up") and 4 levels for eye aperture ("wide open", "open", "half-closed" and "closed"). The red spheres represent the data nodes used for the interpolation process of the animation).

Related work includes extremely accurate eyeball [2] and eyelid reconstruction [3] as well as real-time eyelid tracking [9]. Gaze-eyelid correlation have been explored by Neog *et al.* [7] but only for eyelid aperture variations, and the gaze-eyelid interaction was not modeled in depth. Wood *et al.* [10] built a 3DMM of the eye region featuring a generic rotation-based eyelid rigging. However, they do

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not simulate different eyelid aperture and the eyelid rigging is not extracted from data. More recently, Li *et al.* [6] proposed a dedicated neural radiance field eye capture method. While displaying great regazing results, their solution is not suited for eyelid aperture variation simulation. In summary, no previous work addressed the animation of the eye region from high quality data that correlates gaze direction and eye aperture.

In this paper, we propose to address these limitations by introducing a data-driven approach for capturing and animating detailed eye regions. Our contributions are the following :

- A detailed protocol for capturing the eye region and the correlation between eyelids shape, gaze direction and eye aperture.
- An anatomically coherent multilinear animation model of the eye region.

2 APPROACH

Data Acquisition. First, we define the eye pose space which corresponds to the eye poses achievable with all the activation combinations of the muscles that orient the eyeball and the muscle that opens the eyelid. We discretize the eye pose space in 36 poses (see Figure 2) that participants performed by looking at 9 physical targets in a capture setup with 12 cameras. Scans are obtained by photogrammetry with Metashape ¹.

Registration. To achieve dense correspondence across all the scans, we employ non rigid registration [8] with a template mesh. For visualization purposes, we also fit an eyeball to the registered template using sphere fitting, pupil detection and Iterative Closest Point algorithm. This fitting procedure is performed under the constraint that the eyeball has the same radius for each pose.

Results. The registered 36 poses are blended in a trilinear interpolation scheme. This allows for exploring the eye pose space in a robust and safe manner. For example, Figure 3 shows that unlike blendshapes (a), our approach successfully simulates both a downward gaze direction and a closed eye. Moreover, subtle details arising with some combinations of gaze directions and eyelid apertures can be synthesized.

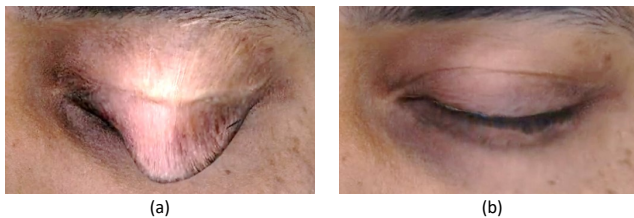


Figure 3: Interpolated pose with both downward gaze and closed eye : (a) blendshapes-driven equivalent of our method, (b) our trilinear interpolation.

The eye inner corner tissues tend to stretch considerably with outward gaze directions as depicted in Figure 1 (e, f). As the eyeball pushes the flesh and lymph under the skin, unexpected bulges may appear (g) which is also exemplified in Figure 4 (a, b). Additionally,

¹Agisoft Metashape software, <http://www.agisoft.com>

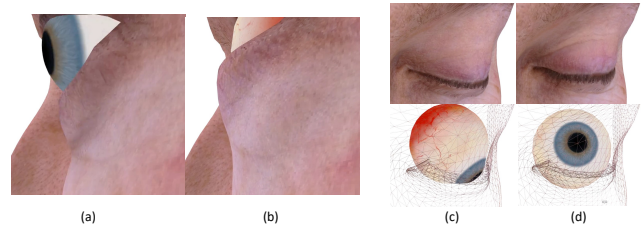


Figure 4: (a, b) Skin bulge appearing with an upward gaze. (c, d) Eyelid deformation with closed eye and a varying gaze direction.

our method is able to recreate the eyelid bumps that occur when the eye is closed and the globe orientation changes (c, d).

3 CONCLUSION

We proposed an original data-driven approach for capturing and modeling the subtle deformations of the eye region that come with gaze and eyelid aperture variations. Thanks to our novel capture protocol, we densely capture the eye pose space of a given participant. The 36 resulting poses are mixed in a trilinear interpolation rig that allows for animating the eye region while considering the unique effects that gaze and eyelid aperture have on the surrounding skin. Thanks to the level of detail captured through our setup, our approach paves the way for personalized human eye region modeling and animation.

REFERENCES

- [1] Simon Baron-Cohen, Sally J. Wheelwright, J Hill, Yogini Raste, and I Plumb. 2001. The "Reading the Mind in the Eyes" Test revised version: a study with normal adults, and adults with Asperger syndrome or high-functioning autism. *Journal of child psychology and psychiatry, and allied disciplines* 42 2 (2001), 241–51.
- [2] Pascal Bérard, Derek Bradley, Maurizio Nitti, Thabo Beeler, and Markus Gross. 2014. High-Quality Capture of Eyes. *ACM Trans. Graph.* 33, 6, Article 223 (2014), 12 pages.
- [3] Amit Bermanno, Thabo Beeler, Yera Kozlov, Derek Bradley, Bernd Bickel, and Markus Gross. 2015. Detailed Spatio-Temporal Reconstruction of Eyelids. *ACM Trans. Graph.* 34, 4, Article 44 (2015), 11 pages.
- [4] Bernhard Egger, W. Smith, Ayush Tewari, Stefanie Wuhler, Michael Zollhöfer, Thabo Beeler, Florian Bernard, Timo Bolkart, Adam Kortylewski, Sami Romdhani, Christian Theobalt, Volker Blanz, and Thomas Vetter. 2020. 3D Morphable Face Models—Past, Present, and Future. *ACM Trans. Graph.* 39 (2020), 1 – 38.
- [5] Glenn Kerbiouri, Quentin Avril, Fabien Danieau, and Maud Marchal. 2022. Detailed Eye Region Capture and Animation. *Computer Graphics Forum* 41, 8 (2022), 279–282. <https://doi.org/10.1111/cgf.14642> arXiv:<https://onlinelibrary.wiley.com/doi/pdf/10.1111/cgf.14642>
- [6] Gengyan Li, Abhimitra Meka, Franziska Mueller, Marcel C. Buehler, Otmar Hilliges, and Thabo Beeler. 2022. EyeNeRF: A Hybrid Representation for Photo-realistic Synthesis, Animation and Relighting of Human Eyes. *ACM Trans. Graph.* 41, 4, Article 166 (jul 2022), 16 pages. <https://doi.org/10.1145/3528223.3530130>
- [7] Debanga R. Neog, João L. Cardoso, Anurag Ranjan, and Dinesh K. Pai. 2016. Interactive Gaze Driven Animation of the Eye Region. In *Proc. of the Int. Conf. on Web3D Technology*, 51–59.
- [8] Robert W. Sumner and Jovan Popović. 2004. Deformation Transfer for Triangle Meshes. *ACM Trans. Graph.* 23, 3 (2004), 399–405.
- [9] Quan Wen, Feng Xu, Ming Lu, and Jun-Hai Yong. 2017. Real-Time 3D Eyelids Tracking from Semantic Edges. *ACM Trans. Graph.* 36, 6, Article 193 (2017), 11 pages.
- [10] Erroll Wood, Tadas Baltrušaitis, Louis-Philippe Morency, Peter Robinson, and Andreas Bulling. 2016. Learning an Appearance-Based Gaze Estimator from One Million Synthesised Images. In *Proceedings of the Ninth Biennial ACM Symposium on Eye Tracking Research & Applications (Charleston, South Carolina) (ETRA '16)*. Association for Computing Machinery, New York, NY, USA, 131–138. <https://doi.org/10.1145/2857491.2857492>