Towards a predictive tool to assist the planning of LASIK refractive surgery

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Abstract

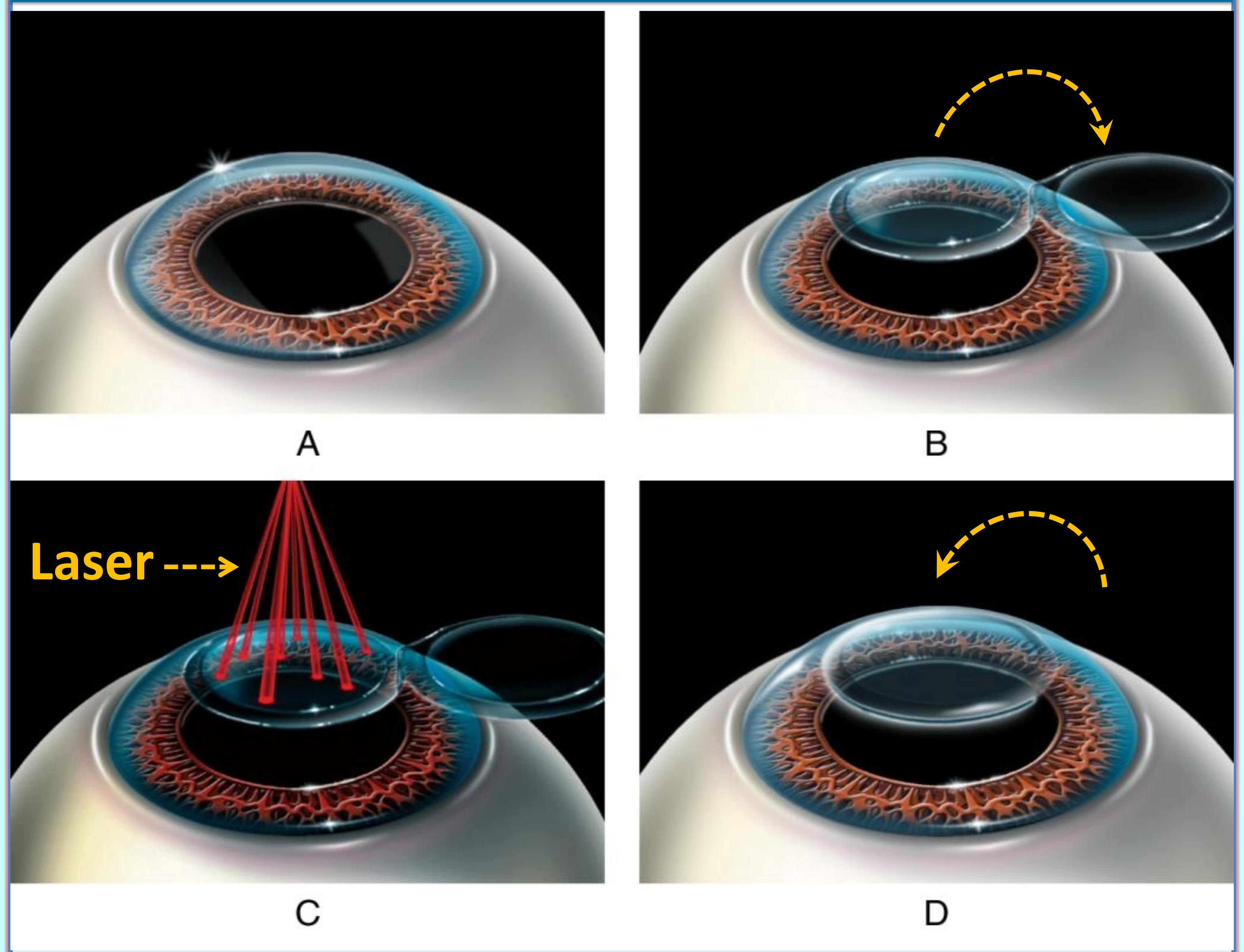
Refractive surgery has been developed to improve the refractive state of the eye in myopia, hyperopia and astigmatism, and decrease or eliminate dependency on glasses and contact lenses. The most common and successful form of refractive surgery is LASIK [1]. In spite of the growing worldwide popularity of LASIK, the procedure is still in need of optimisation, Loads of uncertainties lead to undesirable post-surgery corneal shape [2]. A predictive tool to assist the LASIK plan is to be achieved, following the steps presented here. (You might look at the first figure and come back)

Introduction

Patient-specified numerical eye model is a perfect choice to simulate the LASIK procedure and understand the level of uncertainty and identify the biomechanical parameters with possible large effect on the procedure's outcome and therefore assist the surgery plan. The information of the cornea is vital for the modelling because it is what LASIK applied to.

Unfortunately, a single corneal measurement from the front has limited coverage of the entire cornea; several peripheral maps are measured when the patient is directed to look to the side [3]. **1.** A technique that could be able to register all the maps to the coordinates system of the central map is required. Following the map combination, **2.** another technique that can fit the map as an explicit equation is further needed because the combined map itself, as a discrete points cloud, is not convenient for model setting-up [4].

So what is LASIK?



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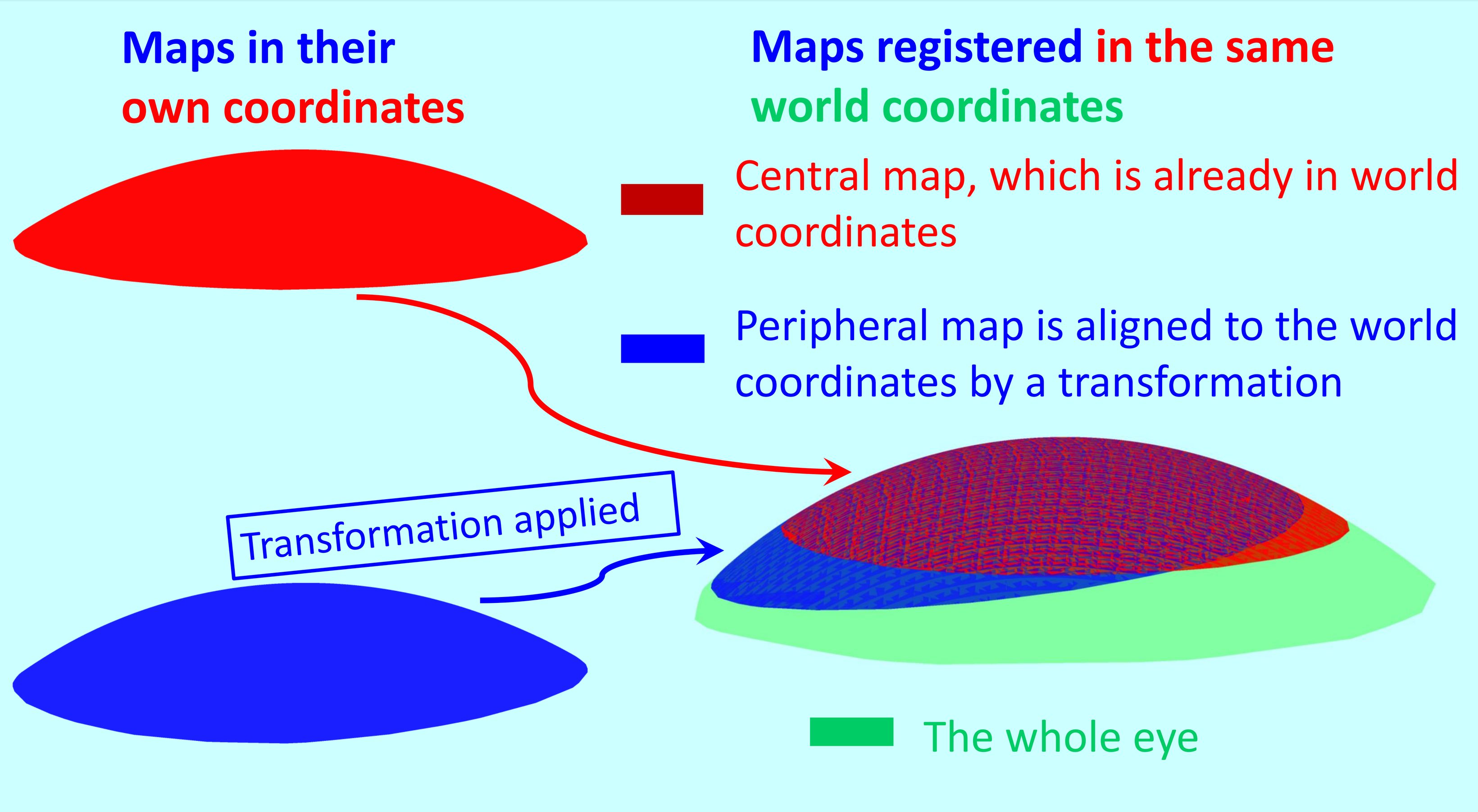
LASIK (laser-assisted in situ keratomileusis), in which (B) a small, hinged flap of tissue from the front of the cornea is cut with a microkeratome followed by (C) tissue ablation using a laser before (D) placing the corneal flap back into place.

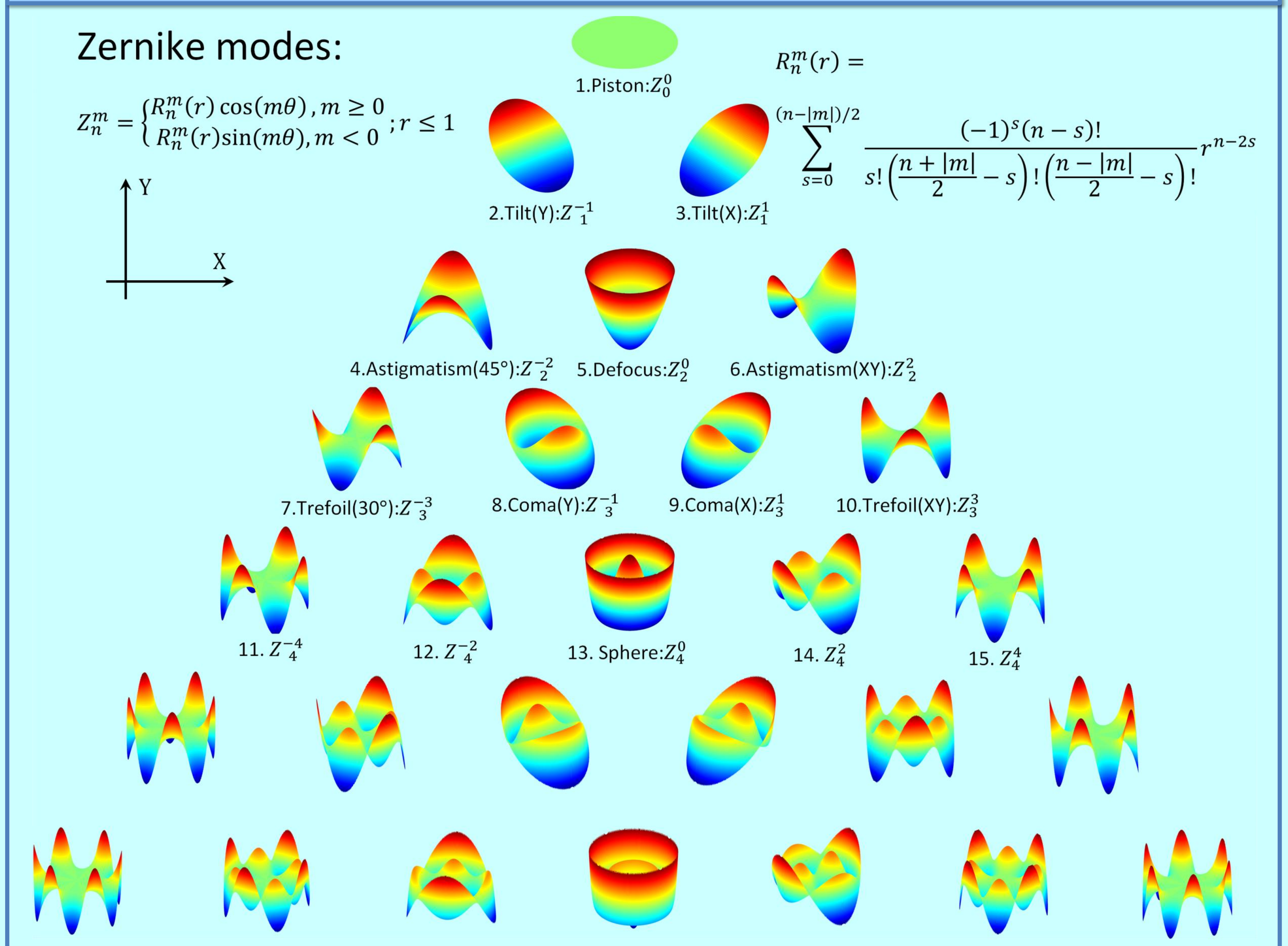
The 1st stage: Maps combination

The idea of maps combination is to find the right overlapping region of central and peripheral maps. Ideally, if the central map and peripheral map are aligned correctly, the difference in the overlapping area should be null or zero. This basically involves in a optimisation problem finding a transformation from peripheral coordinates to the central map coordinates.



The 2nd stage: Maps fitting

The discrete topographic data are usually fitted by certain polynomials for convenient further use. Orthogonal polynomials like Zernike polynomials are widely adapted. Other types of polynomials like Orthogonal Fourier-Mellin (OFM), pseudo-Zernike, Legendre, Tchebichef, Gegenbauer, Gaussian-Hermite and Hahn are also considered in a comparison study. For the corneal topography, the fitting outcomes are very close because the surface is relatively smooth and sphere-like. **Zernike is preferred** in Ocular community because its shapes have close relation with the wave front aberration. However, polynomials like **OFM have superiority fitting irregular cornea** because they also include some local features.



Summary and further works

The aforesaid two stages are vital for numerical model setting-up. Especially, **an efficient map combination technique is finally achieved**, providing a corneal topography as large as possible. Further works will involve building patient-specified eye model which adapts the biomechanical properties known so far, and model updating to converge to the clinical measurement.

References

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[3]. Franklin RJ et al. Eye and Contact Lens. 2006;32:27-32.
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