Supplementary Video S1. Demonstration of the geometric variations associated with the first five *Eigeneyes* ($\mathbf{e}_1$–$\mathbf{e}_5$). For each *Eigeneye*, the corresponding coefficient a_k is varied across the range $[-3\sigma_k, ..., 3\sigma_k]$, where σ_k denotes the standard deviation of the projection coefficients in the dataset. The resulting full-eye geometry generated from the linear combination of the **Eigeneye** basis is displayed in real time.

Supplementary Figure S1. Distribution of crystalline lens tilt in synthetic eyes generated from the statistical eye model conditioned on laterality. 2000 eyes where generated, 1000 right eyes (OD) and 1000 left eyes (OS). Figure a) shows tilt magnitude and direction in polar coordinates, whereas Figure b) shows the corresponding cartesian components (Tilt X and Tilt Y).

Supplementary Video S2. Demonstration of the conditional eye generation application. The video shows the user interface, including the input variables used for conditioning the statistical model (age, axial length, sex, and eye laterality), the biometric parameters predicted by the model, and the corresponding generated full-eye geometry.

Supplementary Figure S2. Representation of the first six *Eigeneyes* obtained from full-eye models restricted to the central 3-mm pupil region. For each coefficient a_k, three values were evaluated: $-3\sigma_k$ (blue), 0 (black), and $+3\sigma_k$ (orange), where σ_k denotes the standard deviation of the coefficients associated with *Eigeneye* k across the full dataset. The mean eye shape ($a_k = 0$) is shown in black in all subfigures. For each color-coded eye, the different ocular surfaces are displayed (i.e., from top to bottom, anterior corneal surface, posterior corneal surface, anterior crystalline lens surface, posterior crystalline lens surface, and retina). In this analysis, the crystalline lens surfaces were not extrapolated and were described including the spherical aberration Zernike coefficient.