Appendix

Zero-calibration function
We calibrated the system for each patient because of variations in the features of individual subjects. At first, a trained ophthalmologist manually rotated a subject's head to a neutral and unbiased head posture by visual estimation, which was verified against the CROM as the zero value along all axes. By stroking a predefined key on the keyboard of the personal computer, the zero position was designated as a reference posture; the rotation angles along all three axes were zero. Then, the subject's head was rotated to the targeted posture, guided based on the CROM. The KHT values of angle rotations were calculated and represented on the basis of the aforementioned reference posture and real-time angles of head posture. In this calculation, a specific sequence of rotations (i.e., head-turn, chin up/down, and head-tilt) was used, for instance, a leftward head-turn rotation and a chin-down rotation about the new head axes, followed by a rightward head-tilt rotation about the new head axes.

Correction of KHT output using a linear model
We use a linear model as a function of the value of CROM and KHT with the following equation:

$$y = a \times x \qquad \qquad (1),$$

where a represents a slope. Here, y denotes the value of KHT and x represents the value of CROM. The difference between the value of KHT and CROM is obtained as follows:

$$\mathrm{Diff}(x, y) = y - x = (a - 1) \times x = a' \times x \qquad (2),$$

where a' represents $(a - 1)$. The value of a' is calculated using the weighted least squares regression method. We set the weight value that corresponds to the value of KHT to be proportional to inverse of the magnitude of the value of $\mathrm{Diff}(x, y)$ because the larger the magnitude of the value of KHT is more imprecise. As a result, we obtained the values of a with 95% intervals for all eight directions (Table). In addition, we can calculate the corrected KHT value using the following equation:

$$\widetilde{y} = \frac{y}{a} = \frac{y}{a' + 1} \qquad \qquad (3),$$

where $\tilde{y}$ denotes the corrected KHT value.

Table. Values obtained from weighted least squares regression from equation (1) for each direction and rotation.

	Head turn	Chin up/down	Head tilt
Q1-R	0.91(0.88,0.93)	0.94(0.92,0.95)	0.91(0.88,0.93)
Q1-L	1.27(1.24,1.3)	0.95(0.93,0.97)	0.82(0.79,0.85)
Q2-R	1.25(1.22,1.28)	0.88(0.85,0.9)	0.76(0.74,0.78)
Q2-L	0.92(0.89,0.94)	0.90(0.88,0.92)	0.92(0.9,0.95)
Q3-R	1.26(1.22,1.3)	0.86(0.84,0.89)	0.89(0.85,0.93)
Q3-L	0.87(0.84,0.9)	0.83(0.81,0.85)	1.02(0.98,1.05)
Q4-R	0.88(0.85,0.91)	0.80(0.78,0.83)	1.08(1.04,1.12)
Q4-L	1.28(1.24,1.33)	0.89(0.85,0.92)	0.83(0.79,0.87)

These values were used for correcting the KHT value and plotting the graph shown in Figure 8. Q1: Quadrant 1; Q2: Quadrant 2, Q3: Quadrant 3, Q4: Quadrant 4; R: Right tilt; L: Left tilt.