

Electronic supplementary materials

For <https://doi.org/10.1631/jzus.A2400540>

A dual-focal-plane augmented reality head-up display optical system adapted for heavy-haul locomotives

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Section S1 The extension and parameter relationship of Zernike polynomial equation

The expansion form of Zernike polynomial is shown in Eq. (S1).

$$\sum_{i=1}^N A_i E_i(x, y) = A_1 x^1 y^0 + A_2 x^0 y^1 + A_3 x^2 y^0 + A_4 x^1 y^1 + A_5 x^0 y^2 + \cdots + A_N x^{j-k} y^k. \quad (\text{S1})$$

The parameter relationship of the Zernike polynomial expansion is shown in Eq. (S2).

$$N = \frac{1}{2} j(j+1) + k. \quad (\text{S2})$$

Section S2 Virtual image size calculation

The virtual image size with projection distances of 10m and 3m can be calculated according to Eq. (S3) and Eq. (S4).

$$H = V(\tan F_{v\max} - \tan F_{v\min}). \quad (\text{S3})$$

$$W = 2 \times V \times \tan\left(\frac{F_H}{2}\right). \quad (\text{S4})$$

Where H represents the height of the virtual image, W represents the width of the virtual image, V represents the distance to the virtual image, $F_{v\max}$ represents the maximum value of the longitudinal FOV, $F_{v\min}$ represents the minimum value of the longitudinal FOV, and F_H represents the size of the transverse FOV.