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Orthonormal vector polynomials in a general pupil

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In optical wavefront analysis of telescope images acquired utilising circular mirrors, such as the Large Zenith Telescope, it is sometimes necessary to represent the phase in terms of its gradient in a unit circle. A suitable infinite discrete orthonormal vector circle (OVC) polynomial set spanning a circular mirror can be used to uniquely represent the phase gradient for analytical purposes. We present a novel approach in which we use matrices to derive the OVC polynomials and accordingly deduce a matrix relationship between OVC expansion coefficients and Zernike circle coefficients. We use a matrix similarity transformation to extend the model to general noncircular mirrors such as the hexagon, the shape of the Southern African Large Telescope mirror. This model may be applied to the analysis of measurements from microlens-based wavefront sensors in other applications, such as light beam analysis, and may be used to characterise radiation from any part of the electromagnetic spectrum.

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