A set of parallel lines is parallel to the ray connecting the optical center and their vanishing point. If the vanishing point appears at pixels (x, y) on the image with optical center (x_c, y_c), then the ray is characterized by the homogenous coordinates

$$\begin{bmatrix} x - x_c \\ y - y_c \\ f \end{bmatrix}$$

(assuming aspect ratio of 1). We also know that two rays may be orthogonal in 3D space is the lines parallel to each of them are orthogonal. Thus, let $(x_1, y_1), (x_2, y_2)$ be the vanishing points of two orthogonal set of parallel lines, we have

$$\begin{aligned} (x_1 - x_c, y_1 - y_c, f) \cdot (x_2 - x_c, y_2 - y_c, f) = 0 \Leftrightarrow \\ f^2 = -(x_1 - x_c)(x_2 - x_c) - (y_1 - y_c)(y_2 - y_c) \end{aligned}$$