Paper 2

Marker-free opposing two-view perspective projection and projective distortion correction

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Abstract

From opposing two-view photos taken while walking the common areas on site (corridors, stairs, elevator halls, etc.) with a smartphone (two photos facing each other from both ends of a corridor; private spaces are never entered), we back-calculate corridor widths, corners, door heights, ceiling heights and effective clearance under beams. Pages of paper as-built drawings photographed at an angle are corrected to orthographic drawings by projective transformation and overlaid on the floor plan obtained from the Block Puzzle (an optional step when a more detailed floor plan is wanted).

1. Projective distortion correction (as-built drawing data)

A 3×3 homography H is estimated by the direct linear transform from the four paper corners x_i and their orthographic positions y_i, and the whole page is corrected.

$$y \simeq H\,x, \quad H = \operatorname{argmin} \Sigma_{i=1}^{4} \parallel y_i \times H\,x_i \parallel^2 \qquad (1)$$

2. Dimensions from opposing two views

For two photos facing each other from both ends of a corridor, real dimensions follow from the corridor length $L = Z_1 + Z_2$ obtained from the walking track, image width p and height q, and focal length f.

$$W = p \cdot Z / f, \quad H_c = q \cdot Z / f, \quad Z_1 + Z_2 = L \qquad (2)$$

$$h_{\mathrm{eff}} = \min(\text{ ceiling height, clearance under beams, door height }) \qquad (3)$$

3. Overlaying as-built drawing data

The corrected as-built drawing is aligned to the Block Puzzle floor plan by a least-squares similarity transform (scale s, rotation R, translation t).

$$(s, R, t) = \operatorname{argmin} \Sigma_i \parallel s\,R\,u_i + t - v_i \parallel^2 \qquad (4)$$

4. Results

The spatial data on corridor widths, corners, door heights, ceiling heights and clearance under beams is used directly in the carry-in/out clearance check by 3D Minkowski difference in the 3rd Paper.

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