

Index

- 3D reconstruction, 118
- 5+1-point algorithm, 242
- 5-point algorithm, 228
- 7-point algorithm, 223
- 8-point algorithm, 221
- affine transformation, 45
- affine transformation group, 45
- algebraic constraint, 150
- algebraic distance, 32
- algebraic error, 32, 150
- anti-Hermitian matrix, 281
- aperture, 77, 250
- associative operation, 285
- automatic camera calibration, 248
- auxiliary variables, 163, 186, 226, 261
- barrel distortion, 253
- barycentric coordinates, 204
- baseline, 118, 119
- block diagonal matrix, 292
- block matrix, 291
- Brown-Conrady distortion, 255
- bundle adjustment, 267, 268
- C-normalized image coordinates, 81
- calibrated epipolar geometry, 117, 220
- calibration device, 258
- camera calibration, 89, 182, 247
- camera center, 76
- camera centered coordinate systems, 77
- camera matrix, 76
- camera normalized image coordinates, 81
- camera obscura, 77
- camera projection matrix, 76
- camera resectioning, 88
- canonical form, 25, 27, 53, 54, 57, 59
- canonical homogeneous coordinates, 73
- Cardano angles, 112
- Cartesian representation, 17
- Cayley transformation, 107
- central perspective, 75
- central projection, 75
- centroid, 145
- \mathbb{C}^n , 279
- co-linear points, 18
- co-planar points, 20
- collineation, 69
- column compression, 296
- commutative operation, 285
- complex conjugate, 279
- Complex conjugation, 280
- Conjugate transpose, 281
- conjugate transpose, 281
- consensus set, 233
- consistent parameterization, 186
- constraint enforcement, 187, 201, 210, 221
- corner points, 156
- correspondence problem, 164, 165
- corresponding points, 117, 161
- cost function, 144
- cross product matrix, 290
- cross product operator, 290
- cross-correlation, 145
- D-normalization, 28
- data degeneracy, 167
- data error, 157
- data matrix, 149
- decentering distortion, 255
- degenerate configuration, 40
- degrees of freedom, 185
- depth-of-field, 250
- descent direction, 310
- direct linear transformation, 163
- distributive operation, 285
- distortion center, 256
- DL-normalization, 59
- DLT, 163
- double embedding of $SO(3)$, 109
- dual homogeneous coordinates, 27, 55
- dual line normalization, 28, 59
- dual Plücker coordinates, 37, 58
- dual transformation, 49
- duality mapping, 58
- duality principle, 37
- Eckart-Young (-Mirsky) theorem, 299
- ego-motion estimation, 267
- energy function, 144
- epipolar constraint, 122
- epipolar homographies, 121

epipolar line, 119, 123
 epipolar plane, 120
 epipolar points, 119
 epipoles, 119
 equation of the line, 18
 equation of the plane, 20
 equilibrating transformation, 177
 equivalent cameras, 91
 error function, 144
 essential matrix, 117, 133, 135
 Euclidean reconstruction, 130
 Euclidean transformations, 42
 Euler angles, 112
 exterior orientation, 86, 203
 external camera parameters, 86

 FET, 254
 field of view model, 254
 fish-eye lens, 250
 fish-eye transform, 254
 focal length, 77
 focal point, 76
 FOV, 254
 Frobenius norm, 282
 Frobenius scalar (or inner) product, 282
 fundamental matrix, 117, 123

 Gauss-Newton method, 314
 general configuration, 40
 geometric distortion, 250
 gimbal lock, 115
 gold standard method, 226
 group

- examples
 - special unitary group, 282
 - $SU(n)$, 282
 - $U(n)$, 282
 - unitary group, 282

 H-normalization, 177
 hand-eye calibration, 203
 Hartley normalization, 177
 Hermitean

- matrix, 281
- scalar product, 279

 homogeneous coordinates, 23, 25, 53
 homogeneous method, 152
 homogeneous representation, 17
 homography, 69
 homography transformation, 69
 hybrid method, 314

 ideal data, 157
 ideal point, 34
 identical noise, 158

 identity element, 285
 identity rotation, 101
 image coordinate system, 84
 image mosaic, 93
 image mosaicking, 93
 image plane, 76
 image point, 76
 incidence relations, 29
 independent noise, 158
 indeterministic estimation method, 233
 inhomogeneous method, 151
 inliers, 230
 intercept, 19
 interior orientation, 87
 internal camera parameters, 87
 internal constraint, 59
 inverse of a quaternion, 287
 IPC, 205
 isotropic noise, 158
 iterative closest point, 205

 Jacobian, 313
 Jacobian mask, 274

 keystone effect, 71

 L-normalization, 57
 left singular vectors, 293
 lens distortion, 250
 lens distortion function, 251
 lens effect, 250
 Levenberg-Marquardt method, 314
 line at infinity, 35
 line normalization, 57
 linear transformation, 284

 maximum likelihood estimation, 157
 mean, 145
 measurement error, 157
 method degeneracies, 219
 method degeneracy, 167
 mid-point method, 214
 minimal case estimation, 166
 minimal parameterization, 86, 125
 ML-estimation, 157
 model error, 154

 Newton's method, 312
 non-linear optimization, 309
 norm

- Frobenius, 282

 normalized 8-point algorithm, 222
 normalized camera, 81
 normalized camera matrix, 81
 normalizing transformation, 173, 177

objective function, 144
 observation, 157
 OPP, 298
 optical axis, 77
 optical center, 76
 optical ray, 90
 orientation of a line, 34
 orthogonal Procrustes problem, 298
 outliers, 230
 over-fitting, 154

 P-normalization, 26
 P3P, 212
 panorama stitching, 93
 parameterization of a transformation, 39
 parameters space, 101
 perspective n -point problem, 209
 pin-cushion distortion, 253
 pinhole camera, 75
 pinhole perspective, 75
 pixel coordinates, 84
 pixel scale, 87
 pixels, 77
 Plücker coordinates, 37
 plumb bob distortion, 255
 PnP, 209
 point at infinity, 34
 point cloud, 273
 point normalization, 26
 points of interest, 156, 165
 pose, 86
 pre-conditioning, 177
 principal axis, 77
 principal line, 77
 principal plane, 77
 principal point, 77
 projection line, 69, 90
 projective elements, 283
 projective reconstruction, 130
 projective space, 283
 projectivity, 69
 proper lines, 33
 proper points, 33
 pure quaternion, 286
 putative correspondences, 264

 quaternion, 286
 inverse, 287
 pure, 286
 quaternionic embedding of \mathbb{R}^3 , 108

 radial distortion function, 252
 Random Sample Consensus, 234
 RANSAC, 234
 re-mapping of the residual vector, 189

 re-normalize, 173
 re-parameterization, 187
 reconstruction, 129
 rectified stereo rig, 118, 131
 rectifying homographies, 133
 registration, 205
 representative of a projective element, 283
 reprojection error, 267
 residual error, 145
 residual vector, 184
 right singular vectors, 293
 rigid transformation, 42
 rigid transformation group, 42
 robust errors, 231
 Robust estimation, 230
 robust estimation, 229
 Rodrigues' rotation formula, 102
 rotation, 100
 row compression, 296

 SAD, 149
 sandwich product, 68
 scalar product
 Frobenius, 282
 Schur complement, 292
 Schur complement trick, 276
 semi-linear, 279
 sesqui-linear, 280
 SfM, 264
 shearing, 47
 signed distance, 32
 similarity reconstruction, 130
 similarity transformations, 44
 singular value decomposition, 292
 singular values, 293
 skewing, 47
 solution space, 167
 SOPP, 201
 special orthogonal Procrustes problem, 201
 special QR-factorization, 307
 special SVD, 299
 special unitary group, 282
 SSD, 149
 SSVD, 299
 standard deviation, 158
 standard Plücker coordinates, 58
 step length, 310
 stereo cameras, 117
 stereo rectification, 118
 stereo rig, 117, 118
 structure from motion, 264
 $SU(n)$, 282
 $su(n)$, 281
 SVD, 292

SVD profile, 169
Tait-Bryan angles, 112
the epipolar constraint, 117
the slope, 19
thin-prism distortion, 255
three-angle representation, 112
total least squares, 146
translation group, 42
trial set, 233
triangulation, 118, 129
twisted pair, 115
twisted rotations, 137
 $U(n)$, 282
unbiased estimate, 179
unbiased noise, 158
uncalibrated epipolar geometry, 117, 126
uniform noise, 158
unit quaternion, 287
unitary group, 282
unitary matrix, 282
unperturbed data, 157
variances, 145
vectorization, 164, 181
virtual image plane, 80
visibility function, 267
Wahba's problem, 200
world coordinate system, 82