

NAME INDEX

- Abramowitz, M., 180, 184
Agin, G.J., 17
Arnold, R.D., 34, 206
Arrow, K.J., 174
- Bachman, B.L., 117
Bajcsy, R., 5
Baker, H., 5, 34
Barlow, H.B., 43
Barnard, S.T., 5, 34
Barnea, D.J., 34
Barrow, H.G., 3, 5, 160
Beck, J., 39
Bergen, J.R., 35, 36, 42, 47, 49, 214
Berry, R.N., 213
Binford, T.O., 5, 34, 206
Bishop, P.O., 43, 44
Blakemore, C., 43
Braddick, O., 82, 83
Brady, J.M., 152
Braunsten, M.L., 5
Brewster, D., 34
Brucke, E., 34
Burr, D.C., 39
Burr, D.J., 34
- Campbell, F.W., 35, 41
Chang, J.J., 34, 40, 41, 42
Chien, R.T., 34
Clatworthy, J.L., 40
Clegg, J.M., 40
Courant, R., 154, 155
Crick, F.H.C., 36, 214
- Davis, L., 37, 181
Dev. P., 5, 34, 40
Din, al-, 5
Duchon, J., 151
- Evans, C.R., 40
- Felton, T.B., 41
Fender, D., 40, 41, 42
Fischer, B., 41, 43, 44
Forsyth, A.R., 154
Frisby, J.P., 5, 31, 36, 39, 40, 41, 87, 206
Fukushima, K., 34, 40
- Gennery, D.B., 34
Gibson, J.J., 5
Giese, S.C., 35, 49
Grimson, W.E.L., 5, 12, 15, 47, 101, 107, 164
Gulick, W.L., 35, 102
- Haber, R.N., 5
Hannah, M.J., 5, 34
Helmholtz, H., 5, 34
Henry, G.H., 44
Hershenson, M., 5
Hilbert, D., 154, 155
Hildreth, E.C., 5, 7, 8, 11, 15, 22, 23, 24, 32, 35, 36, 37, 39, 82, 115, 119, 163, 206, 210, 214
Hirai, Y., 34, 40
Horn, B.K.P., 5, 12, 109, 111, 112, 113, 117, 124, 146, 152
Howard, J.H., 213
Hubel, D.H., 37, 43, 44
Huffman, D.A., 124, 146
Hummel, R.A., 164
Hurwicz, L., 174
- Ikeuchi, K., 5
- Johansson, G., 5
Johnston, A.R., 17
Julesz, B., 5, 8, 34, 35, 40, 41, 42, 43, 63, 68, 69, 70, 71
- Kahl, D.J., 34
Kak, A., 37, 181
Kato, H., 43

- Kaufman, L., 41
 Kender, J.R., 5
 Kidd, A.L., 59, 87
 Knight, T.F., 50
 Koffka, K., 34
 Kuhn, H.W., 174

 Lawson, R.B., 35, 102
 Lerman, J.B., 34
 Levine, M.D., 34
 Lewis, R.A., 17
 Lieberman, L., 5
 Lillestrand, R.L., 34
 Longuet-Higgins, H.C., 5
 Luenberger, D.G., 161, 165, 168, 174, 175

 McKee, S., 39
 Mackworth, A.K., 124, 146
 Marr, D.C., 1, 3, 5, 6, 7, 8, 9, 10, 11, 15,
 17, 18, 19, 21, 22, 23, 24, 26, 31, 33,
 34, 35, 36, 37, 39, 40, 42, 44, 47, 53,
 59, 76, 78, 79, 82, 105, 115, 119, 159,
 163, 179, 206, 207, 210, 214, 215, 216
 Mayhew, J.E.W., 5, 31, 36, 39, 40, 41, 87,
 206
 Miles, W.R., 5
 Miller, J.E., 41, 69
 Moravec, H.P., 34
 Mori, K., 34
 Muller, J., 34

 Nelson, J.I., 34, 40, 44
 Nevatia, R., 34
 Nicodemus, F.E., 111, 113
 Niehl, E.W., 40
 Nikara, T., 43
 Nishihara, H.K., 3, 6, 105

 O'Brien, B., 36
 O'Connell, D.N., 5
 Ogle, K.N., 34

 Panum, P.L., 34
 Pettigrew, J.D., 43
 Poggio, G.F., 41, 43, 44
 Poggio, T., 1, 3, 5, 6, 7, 8, 11, 15, 18, 19,
 21, 26, 31, 33, 34, 35, 36, 37, 39, 40,
 42, 47, 53, 59, 76, 78, 79, 82, 159, 163,
 179, 207, 210, 214, 215, 216

 Polit, A., 35
 Pradny, K., 5
 Pratt, W., 37, 181
 Price, K., 34
 Purdy, W.C., 5

 Quam, L.H., 5, 34

 Rashbass, C., 40
 Reddy, D.R., 34
 Rice, S.O., 79
 Richards, W., 35, 40, 41, 44
 Richter, J., 44, 217
 Riggs, L.A., 40
 Robson, J.G., 35, 41
 Rosenfeld, A., 37, 181
 Rosinski, R.R., 5
 Rudin, W., 140, 143

 Saye, A., 40
 Schumaker, L.L., 164
 Schwartz, T., 39
 Schwartz, E.L., 214
 Shirai, Y., 17
 Silver, W., 5, 117
 Silverman, H.F., 34
 Sjoberg, R.W., 109, 111, 112, 113, 117
 Smith, C.J., 44
 Smith, R.A., 41
 Sperling, G., 34, 40
 Stegun, L.A., 180, 184
 Stevens, K.A., 5, 120
 Sugie, N., 34, 40
 Sutro, L.L., 34
 Suwa, M., 17, 34, 40

 Tanimoto, S.L., 34
 Tenenbaum, J.M., 3, 5, 160
 Thompson, W.B., 5, 34
 Tucker, A.W., 174
 Tyler, C.W., 213

 Ullman, S., 5, 7, 8, 9, 10, 12, 44, 82, 101,
 159, 163, 164, 179, 207, 210, 216, 217
 Uzawa, H., 174

 Wallach, H., 5
 Westheimer, G., 39, 40
 Wheatstone, C., 5, 34

Weisel, T.N., 37, 43, 44
Wilson, H.R., 35, 36, 42, 47, 49, 214
Witkin, A.P., 5
Woodburne, L.S., 213
Woodham, R.J., 5, 109, 111, 115

Zucker, S.W., 164

SUBJECT INDEX

- Acuity, 36, 39, 213-214
Albedo (ρ), 112-119, 121-123, 223-227
Algorithm, 7, 9-10
Algorithmic criteria, 10, 161, 163-164
- Bi-directional reflectance-distribution function (*BRDF*), *see* reflectance function
Biharmonic equation, 155, 157
Biological feasibility, *see* algorithmic criteria
Brightness, apparent, 111-112
- Calculus of variations, 140, 154-156, 232-237; natural boundary conditions for, 155-156, 236-237
Computational paradigm, 1, 5-10; constraints in, 7-8; levels of description of, 7-10;
Condition of linear variation, 23, 119
Conjugate directions; 170-172; theorem, 172
Conjugate gradient method, 169-172
Conjugate gradient algorithm, 172, 191, 196; examples, 197-202
Constrained optimization, 161-178
Constraint: continuity in stereo matching, 26; uniqueness in stereo matching, 26; surface consistency, 101, 106-109, 139-142, 159
Constraints: on false targets problem, 19; on correspondence problem, 26
Correspondence problem, 15-18, 26-31, 32; elements to be matched in, 17-18, 20-26
Curvature, of a curve, 148; principal directions of, of a surface, 149; principal, of a surface, (κ_a, κ_b) 149; first (or mean) (J), 149-150; second (or Gaussian) (K), 150
- Depth, 15
- Developable surface, 120-123, 127, 148-149, 223-227
Direction cosines, 126
Directional derivative ($\mathbf{v} \cdot \nabla$), 21-24, 37-39, 118-119, 126
Dirichlet problem, 158
Discontinuities in depth, 208-212
Disparity, 15, 16; crossed, 15, 16; measuring, 17; layers, 40-41; range versus resolution, 26, 28, 30-32; relation to surface shape, 94-99; uncrossed, 15, 16
Disparity map, examples, 57, 58, 64-75, 84, 85
Distance, 15, 94-96; relative, 96-97
- Edge effects, 89-93
Euler equations, 155-156, 232-237
Eye movements, *see* vergence movements,
- False targets problem, 18-20, 28, 32, 87-88; relationship range and resolution to, 28, 30, 31
Feasible: points, 166-167, 173; directions, 167, 169-172
Functional (Θ), 139-142; conditions for unique solution, 142-146; null space of, (\mathcal{N}), 141-145, 156-159; rotationally symmetric, 152-154
Functionals of surface consistency, 139; constraints on, 146-147, 151-152; difference between possible forms, 154-156; effect of null space on minimal solutions of, 156-159; possible forms, 146-151; vector space of possible forms, 152-154
- Gaussian, 24, 32, 118
Gradient (p, q), *see also* surface orientation, 116
Gradient of hypersurface, 167

- Gradient projection algorithm, 177, 182-186; examples, 187-195
- Gradient projection method, 175-177
- Gradient space, 116, 124-132, 146
- Hessian, 167
- Hilbert space, 140, 145-146, 231
- Hypersurface, *see* objective surface
- Image formation, 109-117; geometric transformations, 109-111; grey-level formation, 111-117
- Image irradiance (E): detecting changes in, 21-26; equation, 117; factors involved in formation of, 111-116; photometric effects, 112; topographic effects, 112, 117-118
- Incident angle (\hat{i}), 115-117
- Information processor, visual system as, 1, 6
- Inner product, 145-146, 231
- Interpolation: of visual information, 159, 179; psychophysics of, 102-104; techniques, 238-246; *see also* surface interpolation
- Irradiance, *see* image irradiance
- Kuhn-Tucker conditions, 174
- Lagrangian, 175
- Laplacian (∇^2), 24, 118, 120, 223-227; versus directional derivatives, 21-24, 37-39, 118-119, 155-156
- Laplacian of a Gaussian ($\nabla^2 G$), 24-27, 29, 32, 35-36, 44, 206, 221-222; examples of convolution by, 27, 29, 51, 52
- Levels of description, 7-10
- Marr-Poggio stereo algorithm, 31-33; implementation of, 47-61; testing of, 63-76; discussion of, 76-89
- Mathematical physics, differential equations of, 234-237
- Mathematical programming, 164-178
- Minima: conditions for local, 168, 174-175; conditions for global, 168; global, 165-166; local, 165-166; local versus global, 162, 168
- Motion correspondence problem, 101
- Natural boundary conditions, *see* Calculus of variations, natural boundary conditions for
- Noise removal, 212-213
- No news is good news*, 102, 107-109, *see also* surface consistency constraint
- Null space, *see* functional, null space of
- Objective surface, in constrained optimization, 161-162, 164-178; convex, 166, 168-169; gradient of, 167; Hessian of, 167
- Occluding boundaries, 149
- Occluding contours, effects of matching, 89-93
- Occlusions, 208, 210; interpolation across, 212
- Optimization: basic steps in iterative algorithms for, 162
- Overview, 10-14
- Parallelogram law, 142-143, 230
- Phase angle (g), 115-117
- Primal Sketch, 3-6, 35-39, 101, 205, 210-212; extracting, from image, 20-26; operator, 25
- Principle: of general position, 132; of graceful degradation, 9; of least commitment, 9; of modular design, 9
- Projection: perspective, 109-110; orthographic, 110-111
- Quadratic variation, 141, 148-149, 151-152, 154, 157-158
- Quotient space, 143, 229
- Random dot stereogram, 2, 8, 63-72, 102-104
- Reflectance: function, 113-114; isotropic, 114, 132; map (R), 117, 121-132, 223-227; surface, *see* reflectance map
- Regular point, 173-175
- Representation, 1, 3-6, 83-85, 205; of surface shape, 101-105
- Retinal mappings, 214-215
- Semi-inner product, 141, 145-146, 152-153, 231
- Semi-norm, 142-144, 229

- Shape: from focusing, 5; from motion, 5; from occluding contour, 5; from shading, 5; from stereo vision, 5; from surface contours, 5; from texture, 5
- Signum function (*sgn*), 121
- Splines, thin plate, 151
- Square Laplacian, 141, 150, 152, 154, 157-158
- Steepest descent methods, 169
- Stereo implementation, 47-61; constraint checking, 82; convolution, 50; depth discontinuities, 81-82; detection and description of zero-crossings, 50-53; direction of matching, 83; discussion, 80-89; input, 47-50; matching, 53-58; matching errors, 81; natural images, 72-76, 86-87; parallel versus serial, 88-89; pool responses, 80-81; testing of, on random dot stereograms, 63-72; testing of, on natural images, 72-76
- Stereopsis: channels, 41-42; hysteresis, 42-43; previous models, 34; psychophysical evidence, 35-43; neurophysiological evidence, 43-44
- Surface approximation, 139, 164-165; algorithm, 191, 196; examples, 198-202
- Surface consistency: constraint, 101, 106-109, 139-142, 159; theorem, 119, 130-132; one-dimensional example of, 120-123
- Surface interpolation, 139; algorithm, 182-186; comparison of square Laplacian to quadratic variation, 186-190; conversion to image domain, 179-182; computational needs, 105; effect of noise removal on, 212-213; examples, 187-195; general problem, 105-109; psychophysics, 102-104, 215-217; theorem, 117-132
- Surface normal (N_f), *see also* surface orientation: 124, p - q representation of, 116
- Surface orientation, 97-99, 124-132
- Terminations, 26, 50
- Thin plate: minimum energy solutions to, 154-156, 234-237; tension factor of, 155-156, 235-237
- Unconstrained optimization, 166-169
- Vector spaces, 228-230
- Vergence movements, 31, 39-40, 58-60
- View angle (e), 115-117
- Visual processing, stages of, 3-5
- Zero-crossing, 21-23, 27, 29, 32, 33, 37-39, 50-53, 56, 90, 101, 106-109, 115-119, 205-207; examples of, 27, 29, 54, 55; imaging factors causing, 115-117; statistics of, 33, 76-79, 221-222; theorems on, 121-123, 223-227; topographic changes and, 118-132; topographic changes causing, examples, 133-137
- $2\frac{1}{2}$ -D Sketch, 4-6, 59, 60, 83-85, 105