Fitting model parameters in conformal geometric algebra to Euclidean observation data
Cibura, C.

Citation for published version (APA):
Cibura, C. (2012). Fitting model parameters in conformal geometric algebra to Euclidean observation data
List of Figures

2.1. A 2-blade $a \wedge b$ and distributivity over addition .................................. 11
2.2. Reflection at a vector ................................................................................. 15
2.3. Purely Euclidean rotation about the origin as a versor ............................ 18
2.4. A conformal circle by the outer product of three conformal points .......... 23
2.5. Inversion in a hypersphere ......................................................................... 23

3.1. Orthogonal transformation as a sequence of reflections in mid-planes ...... 37
3.2. Set of minimal data: a localized frame and an additional point ............ 39
3.3. Determining minimal data from point correspondences .......................... 45
3.4. Scaling with respect to Cartesian transfer frame ...................................... 46

4.1. Articulated structure with three links in 3D .............................................. 55
4.2. True motion vs. instantaneous motion between two constellations in 2D .. 56
4.3. Progression of meta-motions at different meta-levels ............................... 59
4.4. Parameters of a screw motion in 3D ........................................................... 62
4.5. Chords between Euclidean vectors on a screw axis and rotated versions ... 64
4.6. 1-parameter family of rotations between two Euclidean 3D bivectors ...... 68
4.7. Mid-plane between two 3D Euclidean bivectors ....................................... 71
4.8. A geometric degeneracy where a translation is partially subsumed by a preceding screw motion ................................................................. 78

5.1. Bayesian network showing dependencies in parameter estimation .......... 83
5.2. Gaussian Cartesian functional model for circle estimation ....................... 84
5.3. Geometric rationale for closed form likelihood of circle parameters ....... 90
5.4. Sphere imaged under (near) parallel projection ........................................ 94
5.5. Noisy observations of points on a sphere with different spread parameters .. 95
5.6. MLE and non-linear least squares estimates of spheres given noisy points ... 96
5.7. Estimators’ bias as a function of the spread parameter ............................. 97
5.8. Determinant of estimators’ covariance matrices ....................................... 98
5.9. Ratio of determinants of estimators’ covariance matrices ........................ 99
A.1. Mean instantaneous motion noise for three random elemental motions ..... 117
A.2. Sum of chord errors for three random elemental motions ............... 118
A.3. Mean chord errors of reconstructed true motion, three random links ..... 119
A.4. Mean distance between true point and point moved by reconstructed true motion, three random links ........................................... 120
A.5. Mean instantaneous motion noise for three elemental motions along unit cube .... 121
A.6. Sum of chord errors for three elemental motions along unit cube .......... 122
A.7. Mean chord errors of reconstructed true motion, three links along cube ..... 123
A.8. Mean distance between true point and point moved by reconstructed true motion, three links along cube ........................................ 124
A.9. Mean instantaneous motion noise for two random elemental motions ..... 125
A.10. Sum of chord errors for two random elemental motions .................. 126
A.11. Mean chord errors of reconstructed true motion, two random links ...... 127
A.12. Mean distance between true point and point moved by reconstructed true motion, two random links ........................................ 128
A.13. Mean instantaneous motion noise for two elemental motions along unit cube ... 129
A.14. Sum of chord errors for two elemental motions along unit cube .......... 130
A.15. Mean chord errors of reconstructed true motion, two links along cube ..... 131
A.16. Mean distance between true point and point moved by reconstructed true motion, two links along cube ........................................ 132
A.17. Mean instantaneous motion noise for three elemental motions along unit cube, accelerated third link ........................................... 133
A.18. Sum of chord errors for three elemental motions along unit cube, accelerated third link .................................................. 134
A.19. Mean chord errors of reconstructed true motion, three links along cube, accelerated third link .................................................. 134
A.20. Mean distance between true point and point moved by reconstructed true motion, three links along cube, accelerated third link ................................. 135
A.21. Mean instantaneous motion noise for two elemental motions along unit cube, accelerated second link ........................................... 136
A.22. Sum of chord errors for two elemental motions along unit cube, accelerated second link .................................................. 137
A.23. Mean chord errors of reconstructed true motion, two links along cube, accelerated second link .................................................. 137
A.24. Mean distance between true point and point moved by reconstructed true motion, two links along cube, accelerated second link ................................. 138