**Normalization results for pairs 1\_0.ppm\_1\_1.ppm from subset HPatches\_mikolajczyk\_set10\_Pairs50\v\_bark**

**1\_0.ppm: 1\_1.ppm: **

**Table 1 - Found homography parameters and normalization accuracy assessment**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Original:  img1: 85,695 img2: 57,01 | h11 | h12 | h13 | h21 | h22 | h23 | h31 | h32 | h33 | avg ErrPar (param) | avg ErrIM (pixel) | max ErrIM | avg ErrCPM (corner) | max ErrCPM | Expert rate |
| SIFT | 0,705 | 0,433 | -129,281 | -0,423 | 0,703 | 199,42 | 0 | 0 | 1 | 0,175 | 0,64 | 2,507 | 0,689 | 1,138 |  |
| SURF128 | 0,705 | 0,434 | -129,609 | -0,422 | 0,704 | 198,812 | 0 | 0 | 1 | 0,247 | 0,95 | 3,317 | 0,799 | 1,413 |  |
| SURF64 | 0,705 | 0,433 | -129,411 | -0,423 | 0,704 | 198,936 | 0 | 0 | 1 | 0,23 | 0,984 | 3,21 | 0,899 | 1,135 |  |
| ORB | 0,7 | 0,428 | -126,806 | -0,423 | 0,7 | 198,957 | 0 | 0 | 1 | 0,267 | 1,07 | 3,765 | 0,906 | 2,16 |  |
| ORB1000 | 0,687 | 0,424 | -122,161 | -0,422 | 0,695 | 199,001 | -0 | 0 | 1 | 0,489 | 1,116 | 2,842 | 3,829 | 7,923 |  |
| BRISK | 0,703 | 0,434 | -129,053 | -0,423 | 0,704 | 198,578 | 0 | 0 | 1 | 0,236 | 1,009 | 3,232 | 0,777 | 1,075 |  |
| KAZE | 0,701 | 0,43 | -127,351 | -0,423 | 0,701 | 199,477 | 0 | 0 | 1 | 0,202 | 0,781 | 2,737 | 0,714 | 1,463 |  |
| AKAZE | 0,717 | 0,442 | -133,689 | -0,426 | 0,713 | 199,823 | 0 | 0 | 1 | 0,585 | 0,939 | 2,652 | 3,099 | 6,116 |  |
| Original matrix | 0,702 | 0,432 | -128,54 | -0,424 | 0,703 | 199,3 | 0 | 0 | 1 |  |  |  |  |  |  |

where h11, h12, h13, h21, h22, h23, h31, h32, h33 - parameters of found homography matrix H\* or of original one H;   
avgErrPar - average error of found parameters, the accuracy of found homography matrix parameters with a preliminary minimax normalization of found and original matrices;  
avgErrIM - average error of inlier coordinate matching;  
inliers - correct matches; outliers - false matches;  
maxErrIM – maximum error of inlier coordinate matching;  
avgErrCPM - average error of corner point matching;  
maxErrCPM - maximum error of corner point matching;  
expert rate - experts assessment of normalization accuracy with a 5-point scale: 0 - normalization failed, 1 - insufficient, 2 - satisfactory, 3 - good, 4 – excellent.

**Table 2 - Quantitative evaluation of descriptors, precision and recall estimation (with found overlap)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Name | NP1 | NP2 | NM | NI | DP1 | DP2 | OP1 | OP2 | NPO1 | NPO2 | NMO | DPO1 | DPO2 | Precision | RecallO1 | Comments |
| SIFT | 3702 | 3020 | 616 | 570 | 0,0095 | 0,0077 | 85,6929 | 57,0021 | 3336 | 1446 | 616 | 0,0099 | 0,0065 | 0,9253 | 0,1709 |  |
| SURF128 | 3633 | 3535 | 345 | 320 | 0,0093 | 0,009 | 85,6531 | 57,0346 | 3227 | 2079 | 345 | 0,0096 | 0,0093 | 0,9275 | 0,0992 |  |
| SURF64 | 3633 | 3535 | 493 | 449 | 0,0093 | 0,009 | 85,651 | 57,0366 | 3227 | 2080 | 491 | 0,0096 | 0,0093 | 0,9108 | 0,1391 |  |
| ORB | 9421 | 7852 | 1466 | 1291 | 0,0241 | 0,02 | 85,7866 | 56,995 | 9059 | 4129 | 1466 | 0,027 | 0,0185 | 0,8806 | 0,1425 |  |
| ORB1000 | 1000 | 1000 | 172 | 154 | 0,0026 | 0,0026 | 86,1732 | 56,8691 | 993 | 392 | 172 | 0,0029 | 0,0018 | 0,8953 | 0,1551 |  |
| BRISK | 2223 | 1483 | 245 | 201 | 0,0057 | 0,0038 | 85,6812 | 57,0662 | 2151 | 661 | 245 | 0,0064 | 0,003 | 0,8204 | 0,0934 |  |
| KAZE | 760 | 682 | 244 | 206 | 0,0019 | 0,0017 | 85,8183 | 56,9324 | 724 | 357 | 244 | 0,0022 | 0,0016 | 0,8443 | 0,2845 |  |
| AKAZE | 705 | 646 | 119 | 100 | 0,0018 | 0,0016 | 85,3676 | 57,0287 | 688 | 359 | 119 | 0,0021 | 0,0016 | 0,8403 | 0,1453 |  |

where NP - number of found key points; NP1, NP2 - number of found key points for image1 and image2 respectively;  
NM - number of matches found with NNDR method, NM=NI+NO;  
NI - number of inliers found with RANSAC method;  
NO - number of outliers discarded with RANSAC method;   
DP - density of key points (per cent), DP= NP/(height x width) , height, width - vertical and horizontal image sizes respectively (pixels)  
DP1, DP2 - density of key points points for image1 and image2 respectively;  
OP1, OP2 - overlap percentage for image1 and image2 respectively;  
NPO1, NPO2 - number of found key points on overlap for image1 and image2 respectivelyy;  
NMO - number of matches on overlap found with NNDR method;  
DPO1, DPO2 - density of key points points on overlap for image1 and image2 respectively;   
OA - overlap area (pixels), OA1, OA2 - overlap area for image1 and image2 respectively;  
DPO1= NPO1/OA1; DPO2= NPO2/OA2;  
Precision = NI/ NM - the rate to evaluate the part of inliers to all found matches with NNDR method;  
RecallO1 = NI/ NPO1 - completeness of inlier retrieval relative to the number of all key points on overlap for image1. The rate illustrates usefulness of the found key points for normalization.

**Table 3 - Estimation of time costs**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Name | NP1 | NP2 | DesT1, sec | DesT2, sec | MatchT, sec | InlierT, sec | AvgDesT, ms | AvgMatchT, ms | AvgInlierT, ms | TotalNormT, sec |
| SIFT | 3702 | 3020 | 0,100665 | 0,093463 | 0,145691 | 0,004972 | 0,029069 | 0,236511 | 0,008721 | 0,34479 |
| SURF128 | 3633 | 3535 | 0,73641 | 0,161401 | 0,129505 | 0,000425 | 0,124178 | 0,375375 | 0,001329 | 1,027741 |
| SURF64 | 3633 | 3535 | 0,140011 | 0,11626 | 0,072347 | 0,000601 | 0,035713 | 0,146748 | 0,001337 | 0,329218 |
| ORB | 9421 | 7852 | 0,025802 | 0,022462 | 0,223971 | 0,0013 | 0,002799 | 0,152776 | 0,001007 | 0,273535 |
| ORB1000 | 1000 | 1000 | 0,013599 | 0,012878 | 0,004721 | 0,000343 | 0,013238 | 0,027449 | 0,002229 | 0,031542 |
| BRISK | 2223 | 1483 | 0,037531 | 0,025517 | 0,01079 | 0,000498 | 0,017044 | 0,04404 | 0,002477 | 0,074336 |
| KAZE | 760 | 682 | 0,194305 | 0,213276 | 0,007256 | 0,000443 | 0,284192 | 0,029737 | 0,002152 | 0,415281 |
| AKAZE | 705 | 646 | 0,041528 | 0,042526 | 0,002572 | 0,000781 | 0,062366 | 0,021613 | 0,007806 | 0,087406 |

where DesT – descriptor creation time (time for key point detection and descriptor computation), DesT1, DesT2 – creation time of descriptors for image1 and image2 respectively;  
MatchT - retrieval time of matching found with NNDR method for the pair;  
InlierT – inlier retrieval time found with RANSAC method for the pair;  
AvgDesT – average time for one descriptor creation;  
AvgMatchT - average time for one match retrieval with NNDR method;  
AvgInlierT – average time for one inlier retrieval with RANSAC method;  
TotalNormT – total normalization time for the pair.