**Normalization results for pairs 1\_0.ppm\_1\_4.ppm from subset HPatches\_mikolajczyk\_set10\_Pairs50\v\_bark**

**1\_0.ppm: 1\_4.ppm: **

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Original:  img1: 100 img2: 10,911 | 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 | 0,304 | 0,129 | 200,086 | -0,129 | 0,304 | 134,687 | 0 | -0 | 1 | 0,028 | 0,157 | 1,071 | 0,779 | 0,875 |  |
| SURF128 | 0,308 | 0,126 | 199,804 | -0,127 | 0,303 | 133,933 | 0 | -0 | 1 | 0,2 | 0,76 | 2,942 | 2,324 | 3,217 |  |
| SURF64 | 0,304 | 0,128 | 199,934 | -0,128 | 0,304 | 134,221 | 0 | -0 | 1 | 0,038 | 0,827 | 2,996 | 0,691 | 0,881 |  |
| ORB | 0,304 | 0,124 | 200,989 | -0,128 | 0,301 | 134,704 | 0 | -0 | 1 | 0,218 | 0,679 | 2,263 | 3,171 | 4,648 |  |
| ORB1000 | 0,312 | 0,117 | 201,037 | -0,125 | 0,301 | 133,525 | 0 | -0 | 1 | 0,524 | 0,737 | 1,641 | 4,989 | 8,632 |  |
| BRISK | 0,302 | 0,12 | 200,996 | -0,128 | 0,298 | 134,473 | -0 | -0 | 1 | 0,317 | 0,616 | 2,945 | 2,742 | 3,026 |  |
| KAZE | 0,298 | 0,133 | 200,806 | -0,133 | 0,305 | 135,622 | -0 | 0 | 1 | 0,36 | 0,725 | 2,29 | 3,352 | 4,542 |  |
| AKAZE | 0,303 | 0,121 | 200,652 | -0,128 | 0,299 | 134,088 | 0 | -0 | 1 | 0,295 | 0,443 | 1,415 | 2,608 | 4,129 |  |
| Original matrix | 0,304 | 0,129 | 200,05 | -0,129 | 0,304 | 134,47 | 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 | 4443 | 455 | 447 | 0,0095 | 0,0113 | 100 | 10,9132 | 3702 | 673 | 455 | 0,0095 | 0,0157 | 0,9824 | 0,1207 |  |
| SURF128 | 3633 | 4180 | 121 | 102 | 0,0093 | 0,0107 | 100 | 10,9161 | 3633 | 549 | 121 | 0,0093 | 0,0128 | 0,843 | 0,0281 |  |
| SURF64 | 3633 | 4180 | 151 | 142 | 0,0093 | 0,0107 | 100 | 10,9153 | 3633 | 546 | 151 | 0,0093 | 0,0128 | 0,9404 | 0,0391 |  |
| ORB | 9421 | 14291 | 370 | 351 | 0,0241 | 0,0365 | 100 | 10,9452 | 9421 | 2782 | 370 | 0,0241 | 0,0649 | 0,9486 | 0,0373 |  |
| ORB1000 | 1000 | 1000 | 25 | 20 | 0,0026 | 0,0026 | 100 | 11,0121 | 1000 | 171 | 25 | 0,0026 | 0,004 | 0,8 | 0,02 |  |
| BRISK | 2223 | 3901 | 152 | 141 | 0,0057 | 0,01 | 100 | 10,9153 | 2223 | 636 | 152 | 0,0057 | 0,0149 | 0,9276 | 0,0634 |  |
| KAZE | 760 | 827 | 30 | 29 | 0,0019 | 0,0021 | 100 | 10,8788 | 760 | 107 | 30 | 0,0019 | 0,0025 | 0,9667 | 0,0382 |  |
| AKAZE | 705 | 760 | 31 | 26 | 0,0018 | 0,0019 | 100 | 10,9434 | 705 | 138 | 31 | 0,0018 | 0,0032 | 0,8387 | 0,0369 |  |

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 | 4443 | 0,162544 | 0,164952 | 0,255323 | 0,000375 | 0,040516 | 0,561149 | 0,000839 | 0,583194 |
| SURF128 | 3633 | 4180 | 0,404334 | 0,313154 | 0,426026 | 0,046852 | 0,093105 | 3,520873 | 0,459334 | 1,190366 |
| SURF64 | 3633 | 4180 | 0,193353 | 0,184094 | 0,133407 | 0,000356 | 0,048631 | 0,883492 | 0,002507 | 0,511211 |
| ORB | 9421 | 14291 | 0,055435 | 0,04802 | 0,897263 | 0,000446 | 0,004622 | 2,425035 | 0,001271 | 1,001164 |
| ORB1000 | 1000 | 1000 | 0,016673 | 0,017965 | 0,009939 | 0,00052 | 0,017319 | 0,397557 | 0,025992 | 0,045098 |
| BRISK | 2223 | 3901 | 0,047073 | 0,073062 | 0,052999 | 0,000334 | 0,019951 | 0,348676 | 0,002369 | 0,173468 |
| KAZE | 760 | 827 | 0,381593 | 0,385662 | 0,020057 | 0,000362 | 0,484217 | 0,668569 | 0,012476 | 0,787674 |
| AKAZE | 705 | 760 | 0,078334 | 0,080877 | 0,03437 | 0,000448 | 0,108764 | 1,108694 | 0,017224 | 0,194028 |

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.