**Normalization results for pairs 1\_0.ppm\_1\_5.ppm from subset HPatches\_mikolajczyk\_set10\_Pairs50\v\_artisans**

**1\_0.ppm: 1\_5.ppm: **

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Original:  img1: 83,014 img2: 42,731 | 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 | 0,229 | 0,006 | 271,806 | -0,077 | 0,392 | 202,94 | -0 | -0 | 1 | 0,329 | 0,28 | 3,254 | 0,467 | 0,713 |  |
| SURF128 | 0,229 | 0,006 | 271,377 | -0,077 | 0,392 | 202,751 | -0 | -0 | 1 | 0,469 | 0,748 | 3,387 | 0,773 | 1,041 |  |
| SURF64 | 0,229 | 0,006 | 271,225 | -0,077 | 0,392 | 202,96 | -0 | -0 | 1 | 0,383 | 0,8 | 3,772 | 1,189 | 1,875 |  |
| ORB | 0,229 | 0,006 | 271,845 | -0,077 | 0,392 | 202,936 | -0 | -0 | 1 | 0,32 | 0,767 | 3,459 | 0,576 | 1,061 |  |
| ORB1000 | 0,228 | 0,003 | 272,762 | -0,077 | 0,391 | 203,059 | -0 | -0 | 1 | 0,629 | 0,768 | 3,379 | 2,013 | 3,782 |  |
| BRISK | 0,228 | 0,004 | 271,917 | -0,077 | 0,39 | 202,847 | -0 | -0 | 1 | 0,557 | 0,648 | 3,039 | 1,44 | 3,526 |  |
| KAZE | 0,229 | 0,005 | 271,571 | -0,077 | 0,392 | 202,665 | -0 | -0 | 1 | 0,518 | 0,785 | 3,223 | 0,595 | 1,19 |  |
| AKAZE | 0,229 | 0,006 | 271,429 | -0,077 | 0,392 | 202,849 | -0 | -0 | 1 | 0,364 | 0,634 | 2,74 | 0,63 | 1,084 |  |
| Original matrix | 0,229 | 0,006 | 272,09 | -0,077 | 0,392 | 203,08 | -0 | -0 | 1,002 |  |  |  |  |  |  |

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 | 17804 | 5469 | 2374 | 2277 | 0,0128 | 0,0085 | 83,0122 | 42,7218 | 13843 | 3780 | 2355 | 0,012 | 0,0137 | 0,9591 | 0,1645 |  |
| SURF128 | 18208 | 8481 | 1525 | 1410 | 0,0131 | 0,0132 | 83,0225 | 42,7416 | 15332 | 4503 | 1521 | 0,0133 | 0,0164 | 0,9246 | 0,092 |  |
| SURF64 | 18208 | 8481 | 2075 | 1840 | 0,0131 | 0,0132 | 83,0176 | 42,7527 | 15332 | 4499 | 2068 | 0,0133 | 0,0163 | 0,8867 | 0,12 |  |
| ORB | 63449 | 26207 | 4885 | 4667 | 0,0457 | 0,0407 | 82,9865 | 42,7259 | 51540 | 19641 | 4853 | 0,0447 | 0,0714 | 0,9554 | 0,0906 |  |
| ORB1000 | 1000 | 1000 | 165 | 156 | 0,0007 | 0,0016 | 82,9912 | 42,7444 | 918 | 334 | 165 | 0,0008 | 0,0012 | 0,9455 | 0,1699 |  |
| BRISK | 18557 | 8928 | 1718 | 1455 | 0,0134 | 0,0139 | 82,9799 | 42,7947 | 15038 | 6477 | 1715 | 0,013 | 0,0235 | 0,8469 | 0,0968 |  |
| KAZE | 4397 | 2429 | 483 | 440 | 0,0032 | 0,0038 | 83,0158 | 42,7481 | 3669 | 1254 | 482 | 0,0032 | 0,0046 | 0,911 | 0,1199 |  |
| AKAZE | 4765 | 2298 | 463 | 401 | 0,0034 | 0,0036 | 83,0088 | 42,761 | 3956 | 1387 | 459 | 0,0034 | 0,005 | 0,8661 | 0,1014 |  |

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 | 17804 | 5469 | 0,418484 | 0,159816 | 1,099569 | 0,001353 | 0,026363 | 0,463171 | 0,000594 | 1,679222 |
| SURF128 | 18208 | 8481 | 0,653114 | 0,295785 | 1,549901 | 0,00086 | 0,035372 | 1,016328 | 0,00061 | 2,49966 |
| SURF64 | 18208 | 8481 | 0,615246 | 0,301407 | 0,839488 | 0,001303 | 0,034664 | 0,404572 | 0,000708 | 1,757444 |
| ORB | 63449 | 26207 | 0,140192 | 0,05843 | 4,669386 | 0,002514 | 0,002219 | 0,955861 | 0,000538 | 4,870522 |
| ORB1000 | 1000 | 1000 | 0,046414 | 0,021501 | 0,003044 | 0,000511 | 0,033957 | 0,018446 | 0,003277 | 0,07147 |
| BRISK | 18557 | 8928 | 0,290263 | 0,136441 | 0,457318 | 0,001025 | 0,015461 | 0,266191 | 0,000704 | 0,885046 |
| KAZE | 4397 | 2429 | 0,695805 | 0,33497 | 0,093639 | 0,000609 | 0,148074 | 0,193869 | 0,001383 | 1,125023 |
| AKAZE | 4765 | 2298 | 0,150247 | 0,066179 | 0,043041 | 0,000489 | 0,030164 | 0,09296 | 0,00122 | 0,259956 |

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.