**Normalization results for pairs 1\_0.ppm\_1\_2.ppm from subset HPatches\_mikolajczyk\_set10\_Pairs50\v\_bark**

**1\_0.ppm: 1\_2.ppm: **

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Original:  img1: 79,672 img2: 24,395 | 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 | -0,471 | -0,284 | 870,753 | 0,293 | -0,471 | 397,315 | 0 | 0 | 1 | 0,273 | 0,44 | 2,585 | 1,372 | 2,357 |  |
| SURF128 | -0,473 | -0,28 | 870,891 | 0,293 | -0,469 | 396,76 | 0 | 0 | 1 | 0,252 | 0,847 | 2,927 | 1,177 | 2,309 |  |
| SURF64 | -0,474 | -0,278 | 870,975 | 0,291 | -0,467 | 396,586 | 0 | 0 | 1 | 0,271 | 0,914 | 3,462 | 1,854 | 2,466 |  |
| ORB | -0,47 | -0,291 | 866,887 | 0,288 | -0,473 | 396,434 | 0 | -0 | 1 | 0,349 | 1,012 | 3,032 | 2,593 | 4,897 |  |
| ORB1000 | -0,464 | -0,299 | 867,162 | 0,293 | -0,48 | 396,768 | 0 | -0 | 1 | 0,595 | 1,015 | 2,819 | 4,066 | 5,121 |  |
| BRISK | -0,469 | -0,297 | 864,966 | 0,285 | -0,475 | 395,815 | -0 | -0 | 1 | 0,591 | 0,812 | 2,457 | 4,479 | 8,617 |  |
| KAZE | -0,47 | -0,284 | 870,397 | 0,293 | -0,469 | 396,506 | 0 | 0 | 1 | 0,245 | 0,84 | 2,238 | 1,153 | 1,483 |  |
| AKAZE | -0,471 | -0,282 | 870,61 | 0,294 | -0,471 | 397,28 | 0 | 0 | 1 | 0,32 | 0,616 | 2,503 | 1,103 | 2,098 |  |
| Original matrix | -0,472 | -0,284 | 869,57 | 0,29 | -0,47 | 396,67 | 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 | 4047 | 533 | 526 | 0,0095 | 0,0103 | 79,4779 | 24,3553 | 3207 | 1153 | 532 | 0,0103 | 0,0121 | 0,9869 | 0,164 |  |
| SURF128 | 3633 | 3646 | 222 | 195 | 0,0093 | 0,0093 | 79,553 | 24,4056 | 3042 | 954 | 219 | 0,0098 | 0,01 | 0,8784 | 0,0641 |  |
| SURF64 | 3633 | 3646 | 288 | 251 | 0,0093 | 0,0093 | 79,5295 | 24,4102 | 3042 | 953 | 285 | 0,0098 | 0,01 | 0,8715 | 0,0825 |  |
| ORB | 9421 | 10154 | 781 | 724 | 0,0241 | 0,0259 | 80,0567 | 24,4294 | 8816 | 2829 | 779 | 0,0281 | 0,0296 | 0,927 | 0,0821 |  |
| ORB1000 | 1000 | 1000 | 83 | 66 | 0,0026 | 0,0026 | 80,0465 | 24,5951 | 989 | 213 | 83 | 0,0032 | 0,0022 | 0,7952 | 0,0667 |  |
| BRISK | 2223 | 2098 | 200 | 187 | 0,0057 | 0,0054 | 80,2831 | 24,433 | 2121 | 565 | 200 | 0,0067 | 0,0059 | 0,935 | 0,0882 |  |
| KAZE | 760 | 675 | 74 | 70 | 0,0019 | 0,0017 | 79,7051 | 24,373 | 715 | 200 | 74 | 0,0023 | 0,0021 | 0,9459 | 0,0979 |  |
| AKAZE | 705 | 650 | 68 | 65 | 0,0018 | 0,0017 | 79,5821 | 24,4199 | 671 | 203 | 67 | 0,0022 | 0,0021 | 0,9559 | 0,0969 |  |

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 | 4047 | 0,099568 | 0,113133 | 0,15902 | 0,000606 | 0,027424 | 0,298349 | 0,001151 | 0,372327 |
| SURF128 | 3633 | 3646 | 0,210749 | 0,164624 | 0,215995 | 0,000486 | 0,05158 | 0,97295 | 0,00249 | 0,591854 |
| SURF64 | 3633 | 3646 | 0,128093 | 0,149592 | 0,097506 | 0,000404 | 0,038143 | 0,338562 | 0,001608 | 0,375594 |
| ORB | 9421 | 10154 | 0,049454 | 0,051702 | 0,636452 | 0,00083 | 0,00517 | 0,814918 | 0,001146 | 0,738438 |
| ORB1000 | 1000 | 1000 | 0,020016 | 0,01425 | 0,008684 | 0,000736 | 0,017132 | 0,10462 | 0,01115 | 0,043686 |
| BRISK | 2223 | 2098 | 0,039295 | 0,038151 | 0,030159 | 0,000339 | 0,01793 | 0,150795 | 0,00181 | 0,107943 |
| KAZE | 760 | 675 | 0,332718 | 0,338533 | 0,005856 | 0,000623 | 0,469659 | 0,079129 | 0,008903 | 0,677731 |
| AKAZE | 705 | 650 | 0,079367 | 0,072491 | 0,008374 | 0,00026 | 0,11205 | 0,123146 | 0,004006 | 0,160493 |

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.