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

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

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Original:  img1: 100 img2: 15,179 | 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 | 0,372 | -0,093 | 319,007 | 0,087 | 0,375 | 188,06 | -0 | -0 | 1 | 0,184 | 0,427 | 2,503 | 0,688 | 1,035 |  |
| SURF128 | 0,363 | -0,103 | 319,182 | 0,083 | 0,356 | 190,306 | -0 | -0 | 1 | 0,54 | 0,925 | 3,796 | 6,995 | 11,291 |  |
| SURF64 | 0,373 | -0,091 | 318,818 | 0,087 | 0,377 | 187,809 | -0 | 0 | 1 | 0,093 | 0,922 | 2,585 | 1,482 | 4,005 |  |
| ORB | 0,373 | -0,093 | 318,72 | 0,088 | 0,375 | 188,063 | -0 | -0 | 1 | 0,073 | 0,797 | 3,169 | 1,269 | 2,521 |  |
| ORB1000 | 0,368 | -0,093 | 318,95 | 0,085 | 0,373 | 188,572 | -0 | -0 | 1 | 0,142 | 0,685 | 2,698 | 1,137 | 2,322 |  |
| BRISK | 0,38 | -0,097 | 318,27 | 0,093 | 0,372 | 187,365 | 0 | -0 | 1 | 0,364 | 0,819 | 3,487 | 3,403 | 6,242 |  |
| KAZE | 0,369 | -0,089 | 318,832 | 0,086 | 0,378 | 187,862 | -0 | 0 | 1 | 0,106 | 0,798 | 2,726 | 1,423 | 3,091 |  |
| AKAZE | 0,369 | -0,089 | 318,702 | 0,085 | 0,378 | 187,746 | -0 | 0 | 1 | 0,124 | 0,636 | 3,145 | 1,47 | 2,397 |  |
| Original matrix | 0,371 | -0,092 | 318,73 | 0,086 | 0,375 | 188,02 | -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 | 10261 | 5189 | 546 | 488 | 0,0178 | 0,009 | 100 | 15,158 | 10261 | 1363 | 546 | 0,0178 | 0,0156 | 0,8938 | 0,0476 |  |
| SURF128 | 6299 | 4768 | 227 | 154 | 0,0109 | 0,0082 | 100 | 15,1676 | 6299 | 1139 | 227 | 0,0109 | 0,013 | 0,6784 | 0,0244 |  |
| SURF64 | 6299 | 4768 | 328 | 261 | 0,0109 | 0,0082 | 100 | 15,1242 | 6299 | 1130 | 328 | 0,0109 | 0,0129 | 0,7957 | 0,0414 |  |
| ORB | 37625 | 21001 | 1847 | 1736 | 0,0651 | 0,0363 | 100 | 15,1571 | 37625 | 6521 | 1847 | 0,0651 | 0,0744 | 0,9399 | 0,0461 |  |
| ORB1000 | 1000 | 1000 | 51 | 48 | 0,0017 | 0,0017 | 100 | 15,1946 | 1000 | 277 | 51 | 0,0017 | 0,0032 | 0,9412 | 0,048 |  |
| BRISK | 14959 | 7238 | 697 | 569 | 0,0259 | 0,0125 | 100 | 15,173 | 14959 | 2348 | 697 | 0,0259 | 0,0268 | 0,8164 | 0,038 |  |
| KAZE | 2922 | 1521 | 126 | 108 | 0,0051 | 0,0026 | 100 | 15,1389 | 2922 | 506 | 126 | 0,0051 | 0,0058 | 0,8571 | 0,037 |  |
| AKAZE | 3255 | 1514 | 107 | 81 | 0,0056 | 0,0026 | 100 | 15,1953 | 3255 | 541 | 107 | 0,0056 | 0,0062 | 0,757 | 0,0249 |  |

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 | 10261 | 5189 | 0,275185 | 0,187579 | 0,730047 | 0,000589 | 0,031483 | 1,337082 | 0,001206 | 1,193399 |
| SURF128 | 6299 | 4768 | 0,275596 | 0,233422 | 0,454536 | 0,000874 | 0,046353 | 2,002359 | 0,005678 | 0,964428 |
| SURF64 | 6299 | 4768 | 0,288901 | 0,246712 | 0,253649 | 0,000686 | 0,048803 | 0,773318 | 0,002628 | 0,789948 |
| ORB | 37625 | 21001 | 0,083231 | 0,051698 | 3,350974 | 0,001071 | 0,002336 | 1,814279 | 0,000617 | 3,486975 |
| ORB1000 | 1000 | 1000 | 0,026851 | 0,021325 | 0,005731 | 0,000259 | 0,024087 | 0,112365 | 0,00539 | 0,054166 |
| BRISK | 14959 | 7238 | 0,256723 | 0,115568 | 0,439659 | 0,000719 | 0,016563 | 0,630788 | 0,001263 | 0,812669 |
| KAZE | 2922 | 1521 | 0,431277 | 0,408353 | 0,059474 | 0,000376 | 0,208036 | 0,472012 | 0,003486 | 0,89948 |
| AKAZE | 3255 | 1514 | 0,083532 | 0,076781 | 0,027096 | 0,000536 | 0,038187 | 0,253234 | 0,006615 | 0,187945 |

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.