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

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

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Original:  img1: 99,64 img2: 53,926 | 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 | 1,191 | 0,017 | 93,638 | 0,232 | 1,065 | -19,68 | 0,001 | 0 | 1 | 0,42 | 0,567 | 3,311 | 7,774 | 15,558 |  |
| SURF128 | 1,191 | 0,017 | 93,311 | 0,233 | 1,064 | -19,799 | 0,001 | 0 | 1 | 0,44 | 0,924 | 3,285 | 2,617 | 7,413 |  |
| SURF64 | 1,19 | 0,018 | 93,456 | 0,231 | 1,066 | -19,893 | 0,001 | 0 | 1 | 0,414 | 1,016 | 3,123 | 6,635 | 12,804 |  |
| ORB | 1,192 | 0,018 | 93,314 | 0,231 | 1,065 | -19,675 | 0,001 | 0 | 1 | 0,46 | 0,827 | 3,931 | 8,537 | 17,976 |  |
| ORB1000 | 1,192 | 0,01 | 94,432 | 0,238 | 1,055 | -20,349 | 0,001 | 0 | 1 | 0,674 | 0,938 | 2,937 | 7,181 | 12,216 |  |
| BRISK | 1,19 | 0,018 | 93,504 | 0,231 | 1,065 | -19,727 | 0,001 | 0 | 1 | 0,419 | 0,764 | 3,01 | 6,635 | 13,585 |  |
| KAZE | 1,194 | 0,013 | 93,538 | 0,232 | 1,062 | -19,358 | 0,001 | 0 | 1 | 0,616 | 0,81 | 3,307 | 6,193 | 13,873 |  |
| AKAZE | 1,189 | 0,016 | 93,597 | 0,23 | 1,063 | -19,49 | 0,001 | 0 | 1 | 0,478 | 0,753 | 3,05 | 12,429 | 26,475 |  |
| Original matrix | 1,188 | 0,015 | 95,776 | 0,233 | 1,068 | -20,551 | 0,001 | 0 | 1,001 |  |  |  |  |  |  |

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 | 6046 | 1979 | 1881 | 0,0128 | 0,0094 | 99,6464 | 54,1216 | 17787 | 4682 | 1979 | 0,0129 | 0,0134 | 0,9505 | 0,1058 |  |
| SURF128 | 18208 | 7651 | 855 | 741 | 0,0131 | 0,0119 | 99,6447 | 54,0038 | 18190 | 5123 | 855 | 0,0131 | 0,0147 | 0,8667 | 0,0407 |  |
| SURF64 | 18208 | 7651 | 1255 | 1120 | 0,0131 | 0,0119 | 99,6495 | 54,0903 | 18190 | 5134 | 1255 | 0,0131 | 0,0147 | 0,8924 | 0,0616 |  |
| ORB | 63449 | 25564 | 2977 | 2748 | 0,0457 | 0,0397 | 99,6448 | 54,1518 | 63445 | 21235 | 2977 | 0,0458 | 0,0609 | 0,9231 | 0,0433 |  |
| ORB1000 | 1000 | 1000 | 92 | 76 | 0,0007 | 0,0016 | 99,6299 | 54,0099 | 1000 | 556 | 92 | 0,0007 | 0,0016 | 0,8261 | 0,076 |  |
| BRISK | 18557 | 7720 | 1177 | 1116 | 0,0134 | 0,012 | 99,6501 | 54,0806 | 18556 | 6061 | 1177 | 0,0134 | 0,0174 | 0,9482 | 0,0601 |  |
| KAZE | 4397 | 1940 | 411 | 347 | 0,0032 | 0,003 | 99,6315 | 54,1268 | 4389 | 1333 | 410 | 0,0032 | 0,0038 | 0,8443 | 0,0791 |  |
| AKAZE | 4765 | 1862 | 345 | 302 | 0,0034 | 0,0029 | 99,6437 | 54,2671 | 4765 | 1452 | 345 | 0,0034 | 0,0042 | 0,8754 | 0,0634 |  |

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 | 6046 | 0,414681 | 0,176499 | 1,15808 | 0,001499 | 0,026241 | 0,585184 | 0,000796 | 1,750759 |
| SURF128 | 18208 | 7651 | 0,909425 | 0,343757 | 1,892362 | 0,000756 | 0,047437 | 2,213288 | 0,00102 | 3,1463 |
| SURF64 | 18208 | 7651 | 1,238418 | 0,721129 | 1,5744 | 0,000985 | 0,081133 | 1,254501 | 0,000879 | 3,534932 |
| ORB | 63449 | 25564 | 0,205091 | 0,086498 | 8,509786 | 0,002022 | 0,003307 | 2,85851 | 0,000735 | 8,803397 |
| ORB1000 | 1000 | 1000 | 0,049022 | 0,023645 | 0,005742 | 0,00072 | 0,036332 | 0,062415 | 0,009476 | 0,079129 |
| BRISK | 18557 | 7720 | 0,318446 | 0,144462 | 0,560122 | 0,000907 | 0,017936 | 0,475889 | 0,000812 | 1,023936 |
| KAZE | 4397 | 1940 | 0,887553 | 0,426495 | 0,090785 | 0,000584 | 0,210848 | 0,220887 | 0,001682 | 1,405416 |
| AKAZE | 4765 | 1862 | 0,174308 | 0,082455 | 0,036279 | 0,00098 | 0,040431 | 0,105156 | 0,003244 | 0,294022 |

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.