**Normalization results for pairs 14\_0.png\_14\_1.png from subset png\picture\_inside**

**14\_0.png: 14\_1.png: **

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Original:  img1: 0 img2: 0 | 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 | 1,248 | 0,293 | -32,292 | 0,034 | 1,066 | -16,7 | 0,001 | -0 | 1 | 0 | 0,645 | 2,179 | ~ | ~ |  |
| SURF128 | 1,231 | 0,272 | -28,391 | 0,032 | 1,054 | -15,879 | 0,001 | -0 | 1 | 0 | 1,084 | 4,132 | ~ | ~ |  |
| SURF64 | 1,246 | 0,278 | -30,076 | 0,035 | 1,058 | -16,12 | 0,001 | -0 | 1 | 0 | 1,254 | 3,933 | ~ | ~ |  |
| ORB | 1,255 | 0,288 | -31,576 | 0,034 | 1,083 | -18,663 | 0,001 | -0 | 1 | 0 | 0,949 | 3,846 | ~ | ~ |  |
| ORB1000 | 1,241 | 0,257 | -27,173 | 0,034 | 1,063 | -17,215 | 0,001 | -0 | 1 | 0 | 0,962 | 3,098 | ~ | ~ |  |
| BRISK | 1,244 | 0,28 | -29,539 | 0,032 | 1,074 | -17,669 | 0,001 | -0 | 1 | 0 | 0,823 | 3,454 | ~ | ~ |  |
| KAZE | 1,265 | 0,322 | -36,65 | 0,033 | 1,1 | -19,82 | 0,001 | -0 | 1 | 0 | 0,987 | 4,153 | ~ | ~ |  |
| AKAZE | 1,243 | 0,278 | -29,474 | 0,032 | 1,072 | -17,455 | 0,001 | -0 | 1 | 0 | 0,786 | 2,484 | ~ | ~ |  |
| Original matrix |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

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 | 468 | 549 | 215 | 198 | 0,0019 | 0,0023 | 93,0467 | 90,4058 | 446 | 479 | 215 | 0,002 | 0,0022 | 0,9209 | 0,4439 |  |
| SURF128 | 992 | 1048 | 195 | 121 | 0,0041 | 0,0044 | 92,9229 | 90,7442 | 983 | 1007 | 194 | 0,0044 | 0,0046 | 0,6205 | 0,1231 |  |
| SURF64 | 992 | 1048 | 296 | 211 | 0,0041 | 0,0044 | 93,1404 | 90,5208 | 984 | 1006 | 296 | 0,0044 | 0,0046 | 0,7128 | 0,2144 |  |
| ORB | 2126 | 2277 | 518 | 393 | 0,0089 | 0,0095 | 92,6887 | 90,7758 | 2126 | 2269 | 518 | 0,0096 | 0,0104 | 0,7587 | 0,1849 |  |
| ORB1000 | 1000 | 1000 | 274 | 225 | 0,0042 | 0,0042 | 92,6975 | 91,3167 | 1000 | 999 | 274 | 0,0045 | 0,0046 | 0,8212 | 0,225 |  |
| BRISK | 906 | 974 | 312 | 249 | 0,0038 | 0,0041 | 92,7388 | 90,7754 | 904 | 954 | 312 | 0,0041 | 0,0044 | 0,7981 | 0,2754 |  |
| KAZE | 421 | 496 | 148 | 114 | 0,0018 | 0,0021 | 92,7362 | 90,0438 | 420 | 464 | 148 | 0,0019 | 0,0021 | 0,7703 | 0,2714 |  |
| AKAZE | 343 | 364 | 134 | 114 | 0,0014 | 0,0015 | 92,9537 | 90,7458 | 343 | 363 | 134 | 0,0015 | 0,0017 | 0,8507 | 0,3324 |  |

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 | 468 | 549 | 0,0468 | 0,043037 | 0,003068 | 0,00038 | 0,089195 | 0,01427 | 0,001916 | 0,093284 |
| SURF128 | 992 | 1048 | 0,053717 | 0,058837 | 0,009497 | 0,001409 | 0,055146 | 0,048702 | 0,011647 | 0,123461 |
| SURF64 | 992 | 1048 | 0,061274 | 0,050534 | 0,005321 | 0,000917 | 0,054993 | 0,017976 | 0,004346 | 0,118046 |
| ORB | 2126 | 2277 | 0,01193 | 0,00985 | 0,013622 | 0,0007 | 0,004968 | 0,026297 | 0,00178 | 0,036102 |
| ORB1000 | 1000 | 1000 | 0,008174 | 0,008091 | 0,003903 | 0,000561 | 0,008132 | 0,014243 | 0,002495 | 0,02073 |
| BRISK | 906 | 974 | 0,014631 | 0,016048 | 0,003099 | 0,000607 | 0,016312 | 0,009931 | 0,002435 | 0,034384 |
| KAZE | 421 | 496 | 0,222028 | 0,136375 | 0,002101 | 0,000519 | 0,401165 | 0,014193 | 0,004554 | 0,361023 |
| AKAZE | 343 | 364 | 0,019127 | 0,018323 | 0,000895 | 0,000436 | 0,05305 | 0,006678 | 0,003823 | 0,038781 |

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.