**Normalization results for pairs 17\_0.png\_17\_1.png from subset png\picture\_inside**

**17\_0.png: 17\_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 | 0,531 | 0,233 | 24,78 | -0,249 | 0,531 | 192,968 | -0 | -0 | 1 | 0 | 0,396 | 2,238 | ~ | ~ |  |
| SURF128 | 0,55 | 0,235 | 22,499 | -0,233 | 0,539 | 190,59 | 0 | -0 | 1 | 0 | 1,072 | 2,768 | ~ | ~ |  |
| SURF64 | 0,527 | 0,238 | 25,38 | -0,257 | 0,543 | 192,873 | -0 | 0 | 1 | 0 | 1,06 | 3,03 | ~ | ~ |  |
| ORB | 0,511 | 0,221 | 28,418 | -0,258 | 0,511 | 195,211 | -0 | -0 | 1 | 0 | 0,805 | 3,425 | ~ | ~ |  |
| ORB1000 | 0,54 | 0,237 | 23,465 | -0,244 | 0,54 | 191,58 | -0 | -0 | 1 | 0 | 0,838 | 3,19 | ~ | ~ |  |
| BRISK | 0,55 | 0,236 | 22,046 | -0,233 | 0,538 | 190,668 | 0 | -0 | 1 | 0 | 0,828 | 2,34 | ~ | ~ |  |
| KAZE | 0,536 | 0,23 | 24,859 | -0,242 | 0,528 | 192,926 | -0 | -0 | 1 | 0 | 0,881 | 2,272 | ~ | ~ |  |
| AKAZE | 0,537 | 0,232 | 24,479 | -0,245 | 0,533 | 191,93 | -0 | -0 | 1 | 0 | 0,921 | 2,526 | ~ | ~ |  |
| 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 | 582 | 480 | 181 | 161 | 0,0024 | 0,002 | 100 | 35,7879 | 582 | 357 | 181 | 0,0024 | 0,0042 | 0,8895 | 0,2766 |  |
| SURF128 | 1274 | 1192 | 178 | 109 | 0,0053 | 0,005 | 100 | 35,9596 | 1274 | 605 | 178 | 0,0053 | 0,007 | 0,6124 | 0,0856 |  |
| SURF64 | 1274 | 1192 | 193 | 125 | 0,0053 | 0,005 | 100 | 35,6238 | 1274 | 605 | 193 | 0,0053 | 0,0071 | 0,6477 | 0,0981 |  |
| ORB | 2000 | 2159 | 361 | 287 | 0,0083 | 0,009 | 100 | 35,7796 | 2000 | 1624 | 361 | 0,0083 | 0,0189 | 0,795 | 0,1435 |  |
| ORB1000 | 1000 | 994 | 242 | 197 | 0,0042 | 0,0041 | 100 | 35,8892 | 1000 | 890 | 242 | 0,0042 | 0,0103 | 0,814 | 0,197 |  |
| BRISK | 577 | 705 | 97 | 95 | 0,0024 | 0,0029 | 100 | 35,9408 | 577 | 452 | 97 | 0,0024 | 0,0052 | 0,9794 | 0,1646 |  |
| KAZE | 211 | 308 | 46 | 33 | 0,0009 | 0,0013 | 100 | 35,7458 | 211 | 225 | 46 | 0,0009 | 0,0026 | 0,7174 | 0,1564 |  |
| AKAZE | 174 | 203 | 45 | 40 | 0,0007 | 0,0008 | 100 | 36,0125 | 174 | 167 | 45 | 0,0007 | 0,0019 | 0,8889 | 0,2299 |  |

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 | 582 | 480 | 0,138505 | 0,045922 | 0,003645 | 0,000353 | 0,166825 | 0,02014 | 0,002192 | 0,188425 |
| SURF128 | 1274 | 1192 | 0,05869 | 0,059837 | 0,012614 | 0,001516 | 0,048132 | 0,070863 | 0,01391 | 0,132657 |
| SURF64 | 1274 | 1192 | 0,054215 | 0,053499 | 0,007273 | 0,000895 | 0,043718 | 0,037682 | 0,007162 | 0,115883 |
| ORB | 2000 | 2159 | 0,011471 | 0,010291 | 0,01345 | 0,000575 | 0,00525 | 0,037257 | 0,002005 | 0,035787 |
| ORB1000 | 1000 | 994 | 0,008176 | 0,008629 | 0,00409 | 0,000479 | 0,008428 | 0,016901 | 0,002429 | 0,021374 |
| BRISK | 577 | 705 | 0,009985 | 0,011903 | 0,001959 | 0,000253 | 0,017094 | 0,020198 | 0,002665 | 0,024101 |
| KAZE | 211 | 308 | 0,152126 | 0,135305 | 0,000983 | 0,001296 | 0,580138 | 0,021377 | 0,039274 | 0,28971 |
| AKAZE | 174 | 203 | 0,016382 | 0,014176 | 0,00039 | 0,000298 | 0,081989 | 0,008669 | 0,007441 | 0,031245 |

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.