**Normalization results for pairs 19\_0.png\_19\_1.png from subset png\picture\_inside**

**19\_0.png: 19\_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 | 0,147 | 0,597 | 371,707 | -0,289 | 0,028 | 289,796 | 0,001 | 0 | 1 | 0 | 0,528 | 1,211 | ~ | ~ |  |
| SURF128 | 0,182 | 0,628 | 371,05 | -0,287 | 0,038 | 292,65 | 0,001 | 0 | 1 | 0 | 1,041 | 3,09 | ~ | ~ |  |
| SURF64 | 0,149 | 0,668 | 370,349 | -0,296 | 0,053 | 291,592 | 0,001 | 0 | 1 | 0 | 0,962 | 2,737 | ~ | ~ |  |
| ORB | 0,139 | 0,604 | 371,725 | -0,293 | 0,033 | 288,692 | 0 | 0 | 1 | 0 | 0,775 | 1,905 | ~ | ~ |  |
| ORB1000 | 0,132 | 0,606 | 371,775 | -0,295 | 0,033 | 288,453 | 0 | 0 | 1 | 0 | 0,707 | 1,792 | ~ | ~ |  |
| BRISK | 0,145 | 0,634 | 370,481 | -0,292 | 0,042 | 289,827 | 0,001 | 0 | 1 | 0 | 0,796 | 2,411 | ~ | ~ |  |
| KAZE | 0,123 | 0,446 | 377,504 | -0,278 | -0,009 | 280,859 | 0 | -0 | 1 | 0 | 1,045 | 2,207 | ~ | ~ |  |
| AKAZE | 0,189 | 0,624 | 368,289 | -0,287 | 0,038 | 292,012 | 0,001 | 0 | 1 | 0 | 1,115 | 2,17 | ~ | ~ |  |
| 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 | 1065 | 416 | 80 | 58 | 0,0044 | 0,0017 | 100 | 13,6467 | 1065 | 257 | 80 | 0,0044 | 0,0078 | 0,725 | 0,0545 |  |
| SURF128 | 1884 | 712 | 93 | 42 | 0,0078 | 0,003 | 100 | 13,7063 | 1884 | 349 | 93 | 0,0078 | 0,0106 | 0,4516 | 0,0223 |  |
| SURF64 | 1884 | 712 | 109 | 68 | 0,0078 | 0,003 | 100 | 13,6517 | 1884 | 361 | 109 | 0,0078 | 0,011 | 0,6239 | 0,0361 |  |
| ORB | 4728 | 2526 | 93 | 68 | 0,0197 | 0,0105 | 100 | 13,7167 | 4728 | 1393 | 93 | 0,0197 | 0,0423 | 0,7312 | 0,0144 |  |
| ORB1000 | 998 | 998 | 45 | 40 | 0,0042 | 0,0042 | 100 | 13,7358 | 998 | 724 | 45 | 0,0042 | 0,022 | 0,8889 | 0,0401 |  |
| BRISK | 1948 | 837 | 95 | 77 | 0,0081 | 0,0035 | 100 | 13,6746 | 1948 | 494 | 95 | 0,0081 | 0,0151 | 0,8105 | 0,0395 |  |
| KAZE | 446 | 204 | 15 | 10 | 0,0019 | 0,0008 | 100 | 13,1658 | 446 | 123 | 15 | 0,0019 | 0,0039 | 0,6667 | 0,0224 |  |
| AKAZE | 355 | 190 | 16 | 11 | 0,0015 | 0,0008 | 100 | 13,9446 | 355 | 131 | 16 | 0,0015 | 0,0039 | 0,6875 | 0,031 |  |

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 | 1065 | 416 | 0,195991 | 0,170802 | 0,046585 | 0,000585 | 0,297305 | 0,582314 | 0,010081 | 0,413963 |
| SURF128 | 1884 | 712 | 0,056094 | 0,039621 | 0,017447 | 0,003369 | 0,04271 | 0,187597 | 0,080213 | 0,116531 |
| SURF64 | 1884 | 712 | 0,072523 | 0,048151 | 0,008562 | 0,000962 | 0,053061 | 0,078553 | 0,014145 | 0,130199 |
| ORB | 4728 | 2526 | 0,014757 | 0,010067 | 0,033494 | 0,000599 | 0,003553 | 0,36015 | 0,008809 | 0,058916 |
| ORB1000 | 998 | 998 | 0,008855 | 0,007847 | 0,003167 | 0,000305 | 0,008367 | 0,070382 | 0,007637 | 0,020175 |
| BRISK | 1948 | 837 | 0,028588 | 0,012321 | 0,007868 | 0,00042 | 0,014697 | 0,082818 | 0,005452 | 0,049197 |
| KAZE | 446 | 204 | 0,133924 | 0,128872 | 0,001433 | 0,000806 | 0,466001 | 0,095527 | 0,080554 | 0,265034 |
| AKAZE | 355 | 190 | 0,018365 | 0,012988 | 0,000859 | 0,000749 | 0,060046 | 0,053717 | 0,068111 | 0,032962 |

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.