**Normalization results for pairs 11\_0.png\_11\_1.png from subset png\picture\_inside**

**11\_0.png: 11\_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 | 1,753 | 0,065 | 92,571 | 0,513 | 1,534 | -219,269 | 0,002 | -0 | 1 | 0 | 0,747 | 3,5 | ~ | ~ |  |
| SURF128 | 1,761 | 0,073 | 91,404 | 0,522 | 1,544 | -220,832 | 0,002 | -0 | 1 | 0 | 1,115 | 2,66 | ~ | ~ |  |
| SURF64 | 1,754 | 0,064 | 93,085 | 0,516 | 1,534 | -219,075 | 0,002 | -0 | 1 | 0 | 1,272 | 3,468 | ~ | ~ |  |
| ORB | 1,745 | 0,068 | 92,291 | 0,513 | 1,536 | -219,461 | 0,002 | -0 | 1 | 0 | 1,049 | 3,091 | ~ | ~ |  |
| ORB1000 | 1,776 | 0,075 | 89,378 | 0,522 | 1,556 | -223,17 | 0,002 | -0 | 1 | 0 | 0,98 | 2,449 | ~ | ~ |  |
| BRISK | 1,751 | 0,061 | 93,071 | 0,514 | 1,531 | -218,811 | 0,002 | -0 | 1 | 0 | 0,861 | 2,272 | ~ | ~ |  |
| KAZE | 1,742 | 0,065 | 94,686 | 0,506 | 1,541 | -219,516 | 0,002 | -0 | 1 | 0 | 1,202 | 2,795 | ~ | ~ |  |
| AKAZE | 1,731 | 0,05 | 95,47 | 0,503 | 1,517 | -215,557 | 0,002 | -0 | 1 | 0 | 1,139 | 2,829 | ~ | ~ |  |
| 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 | 994 | 826 | 288 | 152 | 0,0041 | 0,0034 | 85,1321 | 77,0992 | 838 | 769 | 269 | 0,0041 | 0,0042 | 0,5278 | 0,1814 |  |
| SURF128 | 1529 | 1349 | 156 | 90 | 0,0064 | 0,0056 | 85,29 | 77,0979 | 1365 | 1227 | 149 | 0,0067 | 0,0066 | 0,5769 | 0,0659 |  |
| SURF64 | 1529 | 1349 | 218 | 151 | 0,0064 | 0,0056 | 85,2958 | 77,0254 | 1367 | 1225 | 208 | 0,0067 | 0,0066 | 0,6927 | 0,1105 |  |
| ORB | 2705 | 2146 | 233 | 127 | 0,0113 | 0,0089 | 84,8275 | 77,3033 | 2417 | 2020 | 222 | 0,0119 | 0,0109 | 0,5451 | 0,0525 |  |
| ORB1000 | 1000 | 1000 | 107 | 63 | 0,0042 | 0,0042 | 85,0417 | 77,3463 | 923 | 944 | 105 | 0,0045 | 0,0051 | 0,5888 | 0,0683 |  |
| BRISK | 849 | 675 | 126 | 95 | 0,0035 | 0,0028 | 85,1342 | 77,1121 | 762 | 626 | 121 | 0,0037 | 0,0034 | 0,754 | 0,1247 |  |
| KAZE | 404 | 352 | 66 | 50 | 0,0017 | 0,0015 | 84,7492 | 77,2987 | 350 | 331 | 64 | 0,0017 | 0,0018 | 0,7576 | 0,1429 |  |
| AKAZE | 322 | 269 | 33 | 28 | 0,0013 | 0,0011 | 84,6767 | 77,4658 | 292 | 256 | 33 | 0,0014 | 0,0014 | 0,8485 | 0,0959 |  |

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 | 994 | 826 | 0,061156 | 0,056248 | 0,01648 | 0,001959 | 0,06481 | 0,05722 | 0,012885 | 0,135842 |
| SURF128 | 1529 | 1349 | 0,11131 | 0,067261 | 0,021906 | 0,001389 | 0,061328 | 0,140425 | 0,015428 | 0,201866 |
| SURF64 | 1529 | 1349 | 0,062697 | 0,079053 | 0,038084 | 0,000721 | 0,049803 | 0,174695 | 0,004776 | 0,180555 |
| ORB | 2705 | 2146 | 0,012168 | 0,010571 | 0,023329 | 0,001662 | 0,004711 | 0,100123 | 0,013086 | 0,047729 |
| ORB1000 | 1000 | 1000 | 0,009125 | 0,008599 | 0,0071 | 0,001213 | 0,008861 | 0,066355 | 0,019255 | 0,026036 |
| BRISK | 849 | 675 | 0,014385 | 0,011494 | 0,002425 | 0,000541 | 0,016985 | 0,019247 | 0,005698 | 0,028846 |
| KAZE | 404 | 352 | 0,279588 | 0,154613 | 0,001687 | 0,000526 | 0,565644 | 0,025558 | 0,010526 | 0,436414 |
| AKAZE | 322 | 269 | 0,021053 | 0,032846 | 0,001187 | 0,000504 | 0,093742 | 0,035984 | 0,017993 | 0,05559 |

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.