**Normalization results for pairs 1\_0.png\_1\_1.png from subset png\picture\_inside**

**1\_0.png: 1\_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 | 1,774 | 0,154 | -75,727 | 0,413 | 1,521 | -81,214 | 0,001 | -0 | 1 | 0 | 1,036 | 2,458 | ~ | ~ |  |
| SURF128 | 1,791 | 0,192 | -80,911 | 0,429 | 1,547 | -85,758 | 0,001 | -0 | 1 | 0 | 1,241 | 2,449 | ~ | ~ |  |
| SURF64 | 1,8 | 0,088 | -68,75 | 0,428 | 1,503 | -83,155 | 0,001 | -0 | 1 | 0 | 1,299 | 3,197 | ~ | ~ |  |
| ORB | 1,758 | 0,169 | -76,431 | 0,403 | 1,532 | -80,821 | 0,001 | -0 | 1 | 0 | 1,37 | 3,153 | ~ | ~ |  |
| ORB1000 | 1,749 | 0,097 | -59,446 | 0,403 | 1,516 | -80,606 | 0,001 | -0 | 1 | 0 | 1,261 | 3,395 | ~ | ~ |  |
| BRISK | 1,744 | 0,069 | -60,194 | 0,402 | 1,443 | -71,882 | 0,001 | -0 | 1 | 0 | 1,17 | 2,405 | ~ | ~ |  |
| KAZE | 1,734 | 0,139 | -71,437 | 0,393 | 1,497 | -76,767 | 0,001 | -0 | 1 | 0 | 0,974 | 2,924 | ~ | ~ |  |
| AKAZE | 1,819 | 0,254 | -86,098 | 0,44 | 1,612 | -88,878 | 0,001 | -0 | 1 | 0 | 0,59 | 1,012 | ~ | ~ |  |
| 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 | 687 | 746 | 94 | 46 | 0,0029 | 0,0031 | 75,3733 | 88,1358 | 564 | 741 | 91 | 0,0031 | 0,0035 | 0,4894 | 0,0816 |  |
| SURF128 | 1131 | 1020 | 54 | 20 | 0,0047 | 0,0043 | 75,68 | 87,6346 | 884 | 977 | 54 | 0,0049 | 0,0046 | 0,3704 | 0,0226 |  |
| SURF64 | 1131 | 1020 | 78 | 34 | 0,0047 | 0,0043 | 74,85 | 87,9217 | 858 | 979 | 76 | 0,0048 | 0,0046 | 0,4359 | 0,0396 |  |
| ORB | 2557 | 2371 | 84 | 33 | 0,0107 | 0,0099 | 75,4625 | 88,4854 | 2093 | 2370 | 79 | 0,0116 | 0,0112 | 0,3929 | 0,0158 |  |
| ORB1000 | 954 | 982 | 44 | 18 | 0,004 | 0,0041 | 75,5 | 88,9446 | 801 | 982 | 44 | 0,0044 | 0,0046 | 0,4091 | 0,0225 |  |
| BRISK | 861 | 775 | 33 | 23 | 0,0036 | 0,0032 | 75,3017 | 87,7975 | 675 | 773 | 33 | 0,0037 | 0,0037 | 0,697 | 0,0341 |  |
| KAZE | 308 | 321 | 18 | 12 | 0,0013 | 0,0013 | 75,0817 | 88,0563 | 220 | 298 | 18 | 0,0012 | 0,0014 | 0,6667 | 0,0545 |  |
| AKAZE | 248 | 222 | 17 | 7 | 0,001 | 0,0009 | 76,3829 | 87,1979 | 209 | 220 | 16 | 0,0011 | 0,0011 | 0,4118 | 0,0335 |  |

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 | 687 | 746 | 0,043924 | 0,042737 | 0,00567 | 0,003338 | 0,060611 | 0,060321 | 0,07257 | 0,09567 |
| SURF128 | 1131 | 1020 | 0,063946 | 0,064468 | 0,012279 | 0,007128 | 0,059871 | 0,227384 | 0,356386 | 0,147821 |
| SURF64 | 1131 | 1020 | 0,056767 | 0,059121 | 0,005857 | 0,005441 | 0,054076 | 0,075084 | 0,160015 | 0,127185 |
| ORB | 2557 | 2371 | 0,010249 | 0,010035 | 0,020601 | 0,005611 | 0,00412 | 0,245248 | 0,170035 | 0,046495 |
| ORB1000 | 954 | 982 | 0,008554 | 0,009132 | 0,00444 | 0,004827 | 0,009132 | 0,100902 | 0,268155 | 0,026952 |
| BRISK | 861 | 775 | 0,013668 | 0,012829 | 0,003908 | 0,001054 | 0,016213 | 0,118432 | 0,045812 | 0,031459 |
| KAZE | 308 | 321 | 0,171577 | 0,141976 | 0,001535 | 0,00076 | 0,499679 | 0,085276 | 0,063345 | 0,315848 |
| AKAZE | 248 | 222 | 0,01678 | 0,012778 | 0,00052 | 0,004678 | 0,06261 | 0,030579 | 0,66833 | 0,034757 |

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.