**Normalization results for pairs 3\_0.png\_3\_1.png from subset png\picture\_inside**

**3\_0.png: 3\_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 | 0,74 | 0,025 | 58,239 | 0,037 | 0,764 | 93,434 | 0 | 0 | 1 | 0 | 0,414 | 2,814 | ~ | ~ |  |
| SURF128 | 0,743 | 0,025 | 57,995 | 0,04 | 0,767 | 92,86 | 0 | 0 | 1 | 0 | 1,012 | 3,55 | ~ | ~ |  |
| SURF64 | 0,744 | 0,024 | 57,994 | 0,046 | 0,76 | 92,802 | 0 | 0 | 1 | 0 | 1,004 | 3,884 | ~ | ~ |  |
| ORB | 0,733 | 0,022 | 59,077 | 0,036 | 0,756 | 93,687 | 0 | 0 | 1 | 0 | 0,754 | 4,18 | ~ | ~ |  |
| ORB1000 | 0,738 | 0,026 | 58,444 | 0,035 | 0,766 | 93,362 | 0 | 0 | 1 | 0 | 0,808 | 3,002 | ~ | ~ |  |
| BRISK | 0,746 | 0,024 | 58,058 | 0,043 | 0,762 | 93,069 | 0 | 0 | 1 | 0 | 0,7 | 2,977 | ~ | ~ |  |
| KAZE | 0,745 | 0,028 | 57,206 | 0,036 | 0,773 | 92,394 | 0 | 0 | 1 | 0 | 0,84 | 2,731 | ~ | ~ |  |
| AKAZE | 0,752 | 0,027 | 57,005 | 0,048 | 0,773 | 90,818 | 0 | 0 | 1 | 0 | 0,868 | 3,449 | ~ | ~ |  |
| 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 | 933 | 471 | 273 | 251 | 0,0039 | 0,002 | 100 | 46,2104 | 933 | 403 | 273 | 0,0039 | 0,0036 | 0,9194 | 0,269 |  |
| SURF128 | 3003 | 1129 | 417 | 369 | 0,0125 | 0,0047 | 100 | 46,2229 | 3003 | 912 | 417 | 0,0125 | 0,0082 | 0,8849 | 0,1229 |  |
| SURF64 | 3003 | 1129 | 516 | 408 | 0,0125 | 0,0047 | 100 | 46,0892 | 3003 | 911 | 516 | 0,0125 | 0,0082 | 0,7907 | 0,1359 |  |
| ORB | 6255 | 3476 | 985 | 768 | 0,0261 | 0,0145 | 100 | 46,3562 | 6255 | 3055 | 985 | 0,0261 | 0,0275 | 0,7797 | 0,1228 |  |
| ORB1000 | 1000 | 1000 | 305 | 292 | 0,0042 | 0,0042 | 100 | 46,1938 | 1000 | 853 | 305 | 0,0042 | 0,0077 | 0,9574 | 0,292 |  |
| BRISK | 2650 | 1075 | 275 | 256 | 0,011 | 0,0045 | 100 | 46,2733 | 2650 | 917 | 275 | 0,011 | 0,0083 | 0,9309 | 0,0966 |  |
| KAZE | 392 | 298 | 91 | 69 | 0,0016 | 0,0012 | 100 | 46,4683 | 392 | 234 | 91 | 0,0016 | 0,0021 | 0,7582 | 0,176 |  |
| AKAZE | 307 | 246 | 67 | 55 | 0,0013 | 0,001 | 100 | 46,4129 | 307 | 215 | 67 | 0,0013 | 0,0019 | 0,8209 | 0,1792 |  |

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 | 933 | 471 | 0,052757 | 0,045233 | 0,004336 | 0,000401 | 0,07629 | 0,015881 | 0,001597 | 0,102727 |
| SURF128 | 3003 | 1129 | 0,079222 | 0,052534 | 0,034711 | 0,000717 | 0,036455 | 0,08324 | 0,001942 | 0,167184 |
| SURF64 | 3003 | 1129 | 0,115085 | 0,054905 | 0,018371 | 0,000906 | 0,043477 | 0,035601 | 0,002221 | 0,189266 |
| ORB | 6255 | 3476 | 0,016996 | 0,011656 | 0,060468 | 0,000852 | 0,003035 | 0,061389 | 0,001109 | 0,089972 |
| ORB1000 | 1000 | 1000 | 0,009477 | 0,008619 | 0,004452 | 0,000408 | 0,009047 | 0,014597 | 0,001395 | 0,022956 |
| BRISK | 2650 | 1075 | 0,036937 | 0,015472 | 0,010451 | 0,000424 | 0,014165 | 0,038002 | 0,001654 | 0,063284 |
| KAZE | 392 | 298 | 0,131523 | 0,125664 | 0,002188 | 0,000512 | 0,378603 | 0,024047 | 0,007415 | 0,259886 |
| AKAZE | 307 | 246 | 0,020146 | 0,017804 | 0,000671 | 0,000407 | 0,068997 | 0,01002 | 0,007397 | 0,039028 |

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.