**Normalization results for pairs 2\_0.png\_2\_1.png from subset 07\_27\picture\_inside\retest**

**2\_0.png: 2\_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 ErrIM (pixel) | max ErrIM | Expert rate |
| SIFT | 0,131 | 0,501 | 191,477 | -0,343 | 0,024 | 309,882 | 0 | 0 | 1 | 0,248 | 1,238 |  |
| SURF128 | 0,13 | 0,531 | 190,381 | -0,349 | 0,042 | 310,61 | 0 | 0 | 1 | 0,718 | 2,158 |  |
| SURF64 | 0,148 | 0,556 | 188,116 | -0,347 | 0,052 | 313,044 | 0 | 0 | 1 | 0,732 | 3,246 |  |
| ORB | 0,132 | 0,482 | 192,683 | -0,341 | 0,014 | 308,834 | 0 | 0 | 1 | 0,712 | 2,955 |  |
| ORB1000 | 0,153 | 0,441 | 192,386 | -0,323 | -0,014 | 307,78 | 0 | -0 | 1 | 0,766 | 1,703 |  |
| BRISK | 0,115 | 0,474 | 192,573 | -0,345 | 0,019 | 305,512 | 0 | 0 | 1 | 0,743 | 2,809 |  |
| KAZE | 0,105 | 0,685 | 187,194 | -0,38 | 0,124 | 317,026 | 0 | 0,001 | 1 | 0,68 | 1,803 |  |
| AKAZE | 0,076 | 0,556 | 192,675 | -0,377 | 0,074 | 306,81 | 0 | 0 | 1 | 0,439 | 0,794 |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |

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 | 354 | 560 | 56 | 51 | 0,0015 | 0,0023 | 100 | 14,8404 | 354 | 190 | 56 | 0,0015 | 0,0053 | 0,9107 | 0,1441 |  |
| SURF128 | 771 | 1226 | 78 | 62 | 0,0032 | 0,0051 | 100 | 14,8671 | 771 | 379 | 78 | 0,0032 | 0,0106 | 0,7949 | 0,0804 |  |
| SURF64 | 771 | 1226 | 90 | 65 | 0,0032 | 0,0051 | 100 | 14,8896 | 771 | 378 | 90 | 0,0032 | 0,0106 | 0,7222 | 0,0843 |  |
| ORB | 1542 | 3832 | 110 | 104 | 0,0064 | 0,016 | 100 | 14,8704 | 1542 | 1185 | 110 | 0,0064 | 0,0332 | 0,9455 | 0,0674 |  |
| ORB1000 | 1000 | 1000 | 51 | 47 | 0,0042 | 0,0042 | 100 | 15,0412 | 1000 | 370 | 51 | 0,0042 | 0,0102 | 0,9216 | 0,047 |  |
| BRISK | 554 | 1305 | 45 | 43 | 0,0023 | 0,0054 | 100 | 15,0775 | 554 | 385 | 45 | 0,0023 | 0,0106 | 0,9556 | 0,0776 |  |
| KAZE | 278 | 319 | 13 | 10 | 0,0012 | 0,0013 | 100 | 15,2017 | 278 | 115 | 13 | 0,0012 | 0,0032 | 0,7692 | 0,036 |  |
| AKAZE | 206 | 297 | 15 | 13 | 0,0009 | 0,0012 | 100 | 14,9279 | 206 | 109 | 15 | 0,0009 | 0,003 | 0,8667 | 0,0631 |  |

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 | 354 | 560 | 0,045944 | 0,050631 | 0,022114 | 0,004393 | 0,110097 | 0,394897 | 0,086143 | 0,123082 |
| SURF128 | 771 | 1226 | 0,187406 | 0,050958 | 0,040636 | 0,00051 | 0,142316 | 0,520979 | 0,008225 | 0,27951 |
| SURF64 | 771 | 1226 | 0,042874 | 0,051608 | 0,005029 | 0,000981 | 0,048851 | 0,055872 | 0,015097 | 0,100492 |
| ORB | 1542 | 3832 | 0,008835 | 0,012078 | 0,014727 | 0,0003 | 0,00444 | 0,133886 | 0,002881 | 0,035941 |
| ORB1000 | 1000 | 1000 | 0,007738 | 0,008151 | 0,007488 | 0,000471 | 0,007944 | 0,146826 | 0,010022 | 0,023849 |
| BRISK | 554 | 1305 | 0,009891 | 0,018961 | 0,002493 | 0,000308 | 0,016191 | 0,055409 | 0,00716 | 0,031653 |
| KAZE | 278 | 319 | 0,1706 | 0,120154 | 0,001153 | 0,000564 | 0,495163 | 0,088694 | 0,056354 | 0,29247 |
| AKAZE | 206 | 297 | 0,020375 | 0,020695 | 0,000584 | 0,000325 | 0,084293 | 0,038957 | 0,024969 | 0,041979 |

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.