**Normalization results for pairs 4\_0.png\_4\_1.png from subset png\picture\_inside**

**4\_0.png: 4\_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 | 0,861 | 0,006 | 43,125 | -0,004 | 0,473 | 53,702 | 0,001 | -0,001 | 1 | 0 | 0,69 | 3,152 | ~ | ~ |  |
| SURF128 | 0,871 | 0,014 | 41,81 | -0,008 | 0,492 | 51,784 | 0,001 | -0,001 | 1 | 0 | 1,028 | 3,185 | ~ | ~ |  |
| SURF64 | 0,87 | 0,008 | 42,768 | -0,004 | 0,481 | 52,653 | 0,001 | -0,001 | 1 | 0 | 1,148 | 3,914 | ~ | ~ |  |
| ORB | 0,846 | 0,004 | 44,209 | -0,013 | 0,472 | 53,46 | 0 | -0,001 | 1 | 0 | 0,797 | 3,126 | ~ | ~ |  |
| ORB1000 | 0,854 | -0,006 | 45,09 | -0,009 | 0,465 | 54,177 | 0,001 | -0,001 | 1 | 0 | 0,95 | 2,262 | ~ | ~ |  |
| BRISK | 0,857 | 0,006 | 43,273 | -0,008 | 0,475 | 53,186 | 0,001 | -0,001 | 1 | 0 | 0,714 | 3,821 | ~ | ~ |  |
| KAZE | 0,863 | 0,012 | 42,363 | -0,011 | 0,487 | 52,208 | 0,001 | -0,001 | 1 | 0 | 0,844 | 3,087 | ~ | ~ |  |
| AKAZE | 0,864 | 0,013 | 42,121 | -0,012 | 0,49 | 51,802 | 0,001 | -0,001 | 1 | 0 | 0,597 | 1,864 | ~ | ~ |  |
| 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 | 3665 | 2674 | 883 | 784 | 0,0153 | 0,0111 | 100 | 48,0267 | 3665 | 1783 | 883 | 0,0153 | 0,0155 | 0,8879 | 0,2139 |  |
| SURF128 | 2867 | 2433 | 245 | 208 | 0,0119 | 0,0101 | 100 | 48,5708 | 2867 | 1758 | 245 | 0,0119 | 0,0151 | 0,849 | 0,0725 |  |
| SURF64 | 2867 | 2433 | 381 | 316 | 0,0119 | 0,0101 | 100 | 48,1742 | 2867 | 1743 | 381 | 0,0119 | 0,0151 | 0,8294 | 0,1102 |  |
| ORB | 15377 | 11590 | 1427 | 1182 | 0,0641 | 0,0483 | 100 | 49,1912 | 15377 | 10192 | 1427 | 0,0641 | 0,0863 | 0,8283 | 0,0769 |  |
| ORB1000 | 1000 | 1000 | 126 | 106 | 0,0042 | 0,0042 | 100 | 48,7817 | 1000 | 905 | 126 | 0,0042 | 0,0077 | 0,8413 | 0,106 |  |
| BRISK | 6034 | 4177 | 713 | 624 | 0,0251 | 0,0174 | 100 | 48,5683 | 6034 | 3417 | 713 | 0,0251 | 0,0293 | 0,8752 | 0,1034 |  |
| KAZE | 1067 | 836 | 234 | 214 | 0,0044 | 0,0035 | 100 | 48,7954 | 1067 | 600 | 234 | 0,0044 | 0,0051 | 0,9145 | 0,2006 |  |
| AKAZE | 1172 | 878 | 138 | 106 | 0,0049 | 0,0037 | 100 | 48,9221 | 1172 | 713 | 138 | 0,0049 | 0,0061 | 0,7681 | 0,0904 |  |

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 | 3665 | 2674 | 0,077885 | 0,063577 | 0,118586 | 0,000683 | 0,022513 | 0,134299 | 0,000871 | 0,260732 |
| SURF128 | 2867 | 2433 | 0,150286 | 0,090979 | 0,065204 | 0,000619 | 0,044906 | 0,266138 | 0,002976 | 0,307088 |
| SURF64 | 2867 | 2433 | 0,138097 | 0,101407 | 0,040338 | 0,000525 | 0,044923 | 0,105873 | 0,00166 | 0,280366 |
| ORB | 15377 | 11590 | 0,031276 | 0,024653 | 0,588673 | 0,00156 | 0,00208 | 0,412525 | 0,001319 | 0,646163 |
| ORB1000 | 1000 | 1000 | 0,01475 | 0,010717 | 0,031657 | 0,000548 | 0,012733 | 0,251243 | 0,005171 | 0,057672 |
| BRISK | 6034 | 4177 | 0,085885 | 0,057788 | 0,084545 | 0,00062 | 0,014033 | 0,118575 | 0,000993 | 0,228837 |
| KAZE | 1067 | 836 | 0,134813 | 0,137585 | 0,007782 | 0,000386 | 0,14546 | 0,033255 | 0,001802 | 0,280565 |
| AKAZE | 1172 | 878 | 0,024058 | 0,033651 | 0,005661 | 0,000533 | 0,029426 | 0,041024 | 0,005026 | 0,063903 |

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.