**Normalization results for pairs 12\_0.png\_12\_1.png from subset png\picture\_inside**

**12\_0.png: 12\_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 | 0,744 | 0,004 | 161,224 | 0,078 | 0,713 | 48,574 | 0 | -0 | 1 | 0 | 0,51 | 2,683 | ~ | ~ |  |
| SURF128 | 0,736 | 0,004 | 161,869 | 0,075 | 0,709 | 49,529 | 0 | -0 | 1 | 0 | 1,071 | 3,686 | ~ | ~ |  |
| SURF64 | 0,736 | 0,001 | 162,603 | 0,077 | 0,708 | 48,903 | 0 | -0 | 1 | 0 | 1,138 | 3,981 | ~ | ~ |  |
| ORB | 0,728 | 0,004 | 162,486 | 0,071 | 0,705 | 50,673 | 0 | -0 | 1 | 0 | 0,972 | 3,547 | ~ | ~ |  |
| ORB1000 | 0,736 | 0 | 161,876 | 0,076 | 0,702 | 50,166 | 0 | -0 | 1 | 0 | 0,924 | 2,973 | ~ | ~ |  |
| BRISK | 0,738 | 0,006 | 161,866 | 0,074 | 0,712 | 49,532 | 0 | -0 | 1 | 0 | 0,846 | 3,287 | ~ | ~ |  |
| KAZE | 0,748 | 0,013 | 162,31 | 0,08 | 0,726 | 47,299 | 0 | -0 | 1 | 0 | 1,192 | 3,86 | ~ | ~ |  |
| AKAZE | 0,727 | 0,026 | 162,795 | 0,075 | 0,725 | 48,017 | 0 | 0 | 1 | 0 | 0,922 | 2,539 | ~ | ~ |  |
| 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 | 636 | 344 | 220 | 188 | 0,0027 | 0,0014 | 100 | 37,7679 | 636 | 344 | 220 | 0,0027 | 0,0038 | 0,8545 | 0,2956 |  |
| SURF128 | 1411 | 1117 | 301 | 239 | 0,0059 | 0,0047 | 100 | 37,6017 | 1411 | 949 | 301 | 0,0059 | 0,0105 | 0,794 | 0,1694 |  |
| SURF64 | 1411 | 1117 | 355 | 285 | 0,0059 | 0,0047 | 100 | 37,5983 | 1411 | 956 | 355 | 0,0059 | 0,0106 | 0,8028 | 0,202 |  |
| ORB | 2363 | 1472 | 330 | 297 | 0,0098 | 0,0061 | 100 | 37,5721 | 2363 | 1463 | 330 | 0,0098 | 0,0162 | 0,9 | 0,1257 |  |
| ORB1000 | 985 | 1000 | 173 | 141 | 0,0041 | 0,0042 | 100 | 37,5663 | 985 | 1000 | 173 | 0,0041 | 0,0111 | 0,815 | 0,1431 |  |
| BRISK | 692 | 469 | 122 | 89 | 0,0029 | 0,002 | 100 | 37,6446 | 692 | 469 | 122 | 0,0029 | 0,0052 | 0,7295 | 0,1286 |  |
| KAZE | 296 | 225 | 79 | 54 | 0,0012 | 0,0009 | 100 | 37,4667 | 296 | 216 | 79 | 0,0012 | 0,0024 | 0,6835 | 0,1824 |  |
| AKAZE | 238 | 187 | 53 | 34 | 0,001 | 0,0008 | 100 | 37,2454 | 238 | 187 | 53 | 0,001 | 0,0021 | 0,6415 | 0,1429 |  |

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 | 636 | 344 | 0,067621 | 0,063631 | 0,002473 | 0,000404 | 0,145648 | 0,011242 | 0,002147 | 0,13413 |
| SURF128 | 1411 | 1117 | 0,12206 | 0,136387 | 0,023692 | 0,00051 | 0,104303 | 0,078711 | 0,002133 | 0,28265 |
| SURF64 | 1411 | 1117 | 0,074408 | 0,088159 | 0,011016 | 0,00065 | 0,065829 | 0,031031 | 0,00228 | 0,174233 |
| ORB | 2363 | 1472 | 0,010028 | 0,041559 | 0,079495 | 0,00051 | 0,016238 | 0,240893 | 0,001718 | 0,131592 |
| ORB1000 | 985 | 1000 | 0,00987 | 0,00763 | 0,007601 | 0,000517 | 0,008825 | 0,043935 | 0,003667 | 0,025618 |
| BRISK | 692 | 469 | 0,012348 | 0,008235 | 0,001811 | 0,000674 | 0,0177 | 0,014845 | 0,007578 | 0,023068 |
| KAZE | 296 | 225 | 0,290635 | 0,144548 | 0,001987 | 0,000709 | 0,812154 | 0,025154 | 0,013128 | 0,437879 |
| AKAZE | 238 | 187 | 0,028109 | 0,022325 | 0,000653 | 0,000874 | 0,118744 | 0,012313 | 0,02571 | 0,05196 |

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.