**Normalization results for pairs 18\_0.png\_18\_1.png from subset png\picture\_inside**

**18\_0.png: 18\_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 | 0,697 | 0,334 | 32,093 | -0,355 | 0,733 | 49,707 | -0 | 0 | 1 | 0 | 0,448 | 2,523 | ~ | ~ |  |
| SURF128 | 0,708 | 0,324 | 31,58 | -0,344 | 0,723 | 49,517 | -0 | -0 | 1 | 0 | 1,353 | 4,407 | ~ | ~ |  |
| SURF64 | 0,685 | 0,331 | 33,293 | -0,356 | 0,726 | 50,311 | -0 | 0 | 1 | 0 | 1,213 | 2,764 | ~ | ~ |  |
| ORB | 0,701 | 0,337 | 31,921 | -0,357 | 0,736 | 49,888 | -0 | 0 | 1 | 0 | 0,996 | 3,49 | ~ | ~ |  |
| ORB1000 | 0,762 | 0,375 | 19,119 | -0,347 | 0,784 | 41,421 | -0 | 0 | 1 | 0 | 1,006 | 4,992 | ~ | ~ |  |
| BRISK | 0,685 | 0,317 | 35,408 | -0,35 | 0,715 | 50,911 | -0 | -0 | 1 | 0 | 0,855 | 2,051 | ~ | ~ |  |
| KAZE | 0,698 | 0,335 | 32,36 | -0,354 | 0,742 | 47,39 | -0 | 0 | 1 | 0 | 1,009 | 2,307 | ~ | ~ |  |
| AKAZE | 0,731 | 0,343 | 29,796 | -0,356 | 0,756 | 48,047 | -0 | 0 | 1 | 0 | 0,944 | 2,401 | ~ | ~ |  |
| 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 | 115 | 133 | 72 | 55 | 0,0005 | 0,0006 | 80,7908 | 51,9783 | 103 | 94 | 70 | 0,0005 | 0,0008 | 0,7639 | 0,534 |  |
| SURF128 | 506 | 480 | 134 | 68 | 0,0021 | 0,002 | 81,1554 | 52,3758 | 465 | 365 | 131 | 0,0024 | 0,0029 | 0,5075 | 0,1462 |  |
| SURF64 | 506 | 480 | 142 | 99 | 0,0021 | 0,002 | 80,6404 | 51,7196 | 463 | 364 | 141 | 0,0024 | 0,0029 | 0,6972 | 0,2138 |  |
| ORB | 484 | 652 | 146 | 104 | 0,002 | 0,0027 | 80,7896 | 51,8696 | 482 | 474 | 145 | 0,0025 | 0,0038 | 0,7123 | 0,2158 |  |
| ORB1000 | 484 | 622 | 146 | 113 | 0,002 | 0,0026 | 80,635 | 52,925 | 482 | 447 | 145 | 0,0025 | 0,0035 | 0,774 | 0,2344 |  |
| BRISK | 168 | 245 | 64 | 48 | 0,0007 | 0,001 | 80,9504 | 51,8929 | 168 | 173 | 64 | 0,0009 | 0,0014 | 0,75 | 0,2857 |  |
| KAZE | 131 | 117 | 56 | 38 | 0,0005 | 0,0005 | 80,7375 | 51,9558 | 130 | 96 | 56 | 0,0007 | 0,0008 | 0,6786 | 0,2923 |  |
| AKAZE | 104 | 73 | 53 | 38 | 0,0004 | 0,0003 | 81,3167 | 52,3875 | 104 | 66 | 53 | 0,0005 | 0,0005 | 0,717 | 0,3654 |  |

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 | 115 | 133 | 0,06165 | 0,046027 | 0,000349 | 0,000522 | 0,441075 | 0,00484 | 0,009482 | 0,108547 |
| SURF128 | 506 | 480 | 0,037324 | 0,040627 | 0,002343 | 0,002091 | 0,079201 | 0,017486 | 0,030755 | 0,082386 |
| SURF64 | 506 | 480 | 0,051628 | 0,039754 | 0,002376 | 0,000708 | 0,092425 | 0,01673 | 0,00715 | 0,094466 |
| ORB | 484 | 652 | 0,007168 | 0,007302 | 0,001511 | 0,000685 | 0,013004 | 0,010347 | 0,00659 | 0,016666 |
| ORB1000 | 484 | 622 | 0,007186 | 0,007524 | 0,001371 | 0,000547 | 0,013472 | 0,009391 | 0,004842 | 0,016629 |
| BRISK | 168 | 245 | 0,00417 | 0,005215 | 0,000404 | 0,000535 | 0,023054 | 0,00632 | 0,011143 | 0,010325 |
| KAZE | 131 | 117 | 0,27294 | 0,157499 | 0,00039 | 0,000793 | 1,714826 | 0,00696 | 0,020866 | 0,431621 |
| AKAZE | 104 | 73 | 0,020944 | 0,012661 | 0,000218 | 0,000819 | 0,187412 | 0,004108 | 0,021539 | 0,034642 |

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.