**Normalization results for pairs 7\_0.png\_7\_1.png from subset png\graffiti\_picture\_outside**

**7\_0.png: 7\_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 | 0,621 | -0,068 | 98,431 | -0,053 | 0,698 | 48,298 | -0 | -0 | 1 | 0,302 | 1,795 |  |
| SURF128 | 0,621 | -0,067 | 98,362 | -0,053 | 0,698 | 48,143 | -0 | -0 | 1 | 0,915 | 3,436 |  |
| SURF64 | 0,628 | -0,065 | 97,36 | -0,052 | 0,703 | 48,173 | -0 | -0 | 1 | 0,974 | 3,756 |  |
| ORB | 0,637 | -0,076 | 97,37 | -0,046 | 0,698 | 47,174 | -0 | -0 | 1 | 0,81 | 3,788 |  |
| ORB1000 | 0,628 | -0,074 | 98,026 | -0,052 | 0,698 | 48,101 | -0 | -0 | 1 | 0,954 | 3,102 |  |
| BRISK | 0,616 | -0,066 | 98,79 | -0,054 | 0,695 | 48,334 | -0 | -0 | 1 | 0,731 | 4,272 |  |
| KAZE | 0,615 | -0,072 | 99,488 | -0,057 | 0,69 | 49,474 | -0 | -0 | 1 | 0,832 | 4,019 |  |
| AKAZE | 0,624 | -0,063 | 97,498 | -0,054 | 0,704 | 47,625 | -0 | -0 | 1 | 0,738 | 2,836 |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |

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 | 1572 | 1671 | 374 | 307 | 0,0066 | 0,007 | 100 | 61,3233 | 1572 | 1095 | 374 | 0,0066 | 0,0074 | 0,8209 | 0,1953 |  |
| SURF128 | 1730 | 1859 | 365 | 294 | 0,0072 | 0,0077 | 100 | 61,47 | 1730 | 1336 | 365 | 0,0072 | 0,0091 | 0,8055 | 0,1699 |  |
| SURF64 | 1730 | 1859 | 439 | 311 | 0,0072 | 0,0077 | 100 | 61,3221 | 1730 | 1333 | 439 | 0,0072 | 0,0091 | 0,7084 | 0,1798 |  |
| ORB | 5029 | 5762 | 900 | 708 | 0,021 | 0,024 | 100 | 61,19 | 5029 | 5308 | 900 | 0,021 | 0,0361 | 0,7867 | 0,1408 |  |
| ORB1000 | 1000 | 1000 | 188 | 147 | 0,0042 | 0,0042 | 100 | 61,4942 | 1000 | 965 | 188 | 0,0042 | 0,0065 | 0,7819 | 0,147 |  |
| BRISK | 2346 | 2586 | 371 | 296 | 0,0098 | 0,0108 | 100 | 61,3858 | 2346 | 2186 | 371 | 0,0098 | 0,0148 | 0,7978 | 0,1262 |  |
| KAZE | 776 | 816 | 186 | 134 | 0,0032 | 0,0034 | 100 | 61,3042 | 776 | 577 | 186 | 0,0032 | 0,0039 | 0,7204 | 0,1727 |  |
| AKAZE | 578 | 658 | 135 | 106 | 0,0024 | 0,0027 | 100 | 61,6962 | 578 | 581 | 135 | 0,0024 | 0,0039 | 0,7852 | 0,1834 |  |

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 | 1572 | 1671 | 0,049022 | 0,051421 | 0,022376 | 0,000557 | 0,030978 | 0,059828 | 0,001814 | 0,123376 |
| SURF128 | 1730 | 1859 | 0,05303 | 0,054542 | 0,024892 | 0,000549 | 0,029995 | 0,068198 | 0,001868 | 0,133013 |
| SURF64 | 1730 | 1859 | 0,046677 | 0,051667 | 0,014036 | 0,000774 | 0,027386 | 0,031972 | 0,00249 | 0,113154 |
| ORB | 5029 | 5762 | 0,014718 | 0,015914 | 0,06565 | 0,000758 | 0,002843 | 0,072944 | 0,001071 | 0,09704 |
| ORB1000 | 1000 | 1000 | 0,009329 | 0,010024 | 0,003185 | 0,000674 | 0,009676 | 0,016943 | 0,004585 | 0,023212 |
| BRISK | 2346 | 2586 | 0,038589 | 0,039927 | 0,016053 | 0,000553 | 0,015943 | 0,04327 | 0,001869 | 0,095123 |
| KAZE | 776 | 816 | 0,11399 | 0,097592 | 0,005725 | 0,000644 | 0,133246 | 0,030778 | 0,004809 | 0,217952 |
| AKAZE | 578 | 658 | 0,012272 | 0,01208 | 0,00158 | 0,000749 | 0,019795 | 0,011706 | 0,007068 | 0,026682 |

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.