**Normalization results for pairs 18\_0.png\_18\_1.png from subset png\graffiti\_picture\_outside**

**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 ErrIM (pixel) | max ErrIM | Expert rate |
| SIFT | 0,812 | 0,021 | 102,841 | 0,055 | 0,754 | 58,986 | 0 | -0 | 1 | 0,444 | 2,121 |  |
| SURF128 | 0,805 | 0,021 | 103,484 | 0,05 | 0,753 | 59,862 | 0 | -0 | 1 | 0,838 | 2,999 |  |
| SURF64 | 0,799 | 0,016 | 104,527 | 0,049 | 0,744 | 60,559 | 0 | -0 | 1 | 0,857 | 3,335 |  |
| ORB | 0,812 | 0,012 | 103,167 | 0,053 | 0,749 | 59,728 | 0 | -0 | 1 | 0,823 | 3,437 |  |
| ORB1000 | 0,798 | 0,011 | 104,557 | 0,048 | 0,744 | 60,295 | 0 | -0 | 1 | 0,872 | 2,457 |  |
| BRISK | 0,803 | 0,016 | 104,269 | 0,051 | 0,748 | 60,109 | 0 | -0 | 1 | 0,824 | 3,069 |  |
| KAZE | 0,792 | 0,009 | 104,993 | 0,046 | 0,738 | 60,974 | 0 | -0 | 1 | 0,723 | 2,947 |  |
| AKAZE | 0,802 | 0,012 | 104,066 | 0,05 | 0,744 | 60,279 | 0 | -0 | 1 | 0,517 | 2,51 |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |

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 | 2206 | 2111 | 834 | 691 | 0,0092 | 0,0088 | 100 | 46,0517 | 2206 | 1245 | 834 | 0,0092 | 0,0113 | 0,8285 | 0,3132 |  |
| SURF128 | 2640 | 2616 | 642 | 597 | 0,011 | 0,0109 | 100 | 45,9654 | 2640 | 1616 | 642 | 0,011 | 0,0146 | 0,9299 | 0,2261 |  |
| SURF64 | 2640 | 2616 | 764 | 684 | 0,011 | 0,0109 | 100 | 45,9246 | 2640 | 1613 | 764 | 0,011 | 0,0146 | 0,8953 | 0,2591 |  |
| ORB | 7394 | 7833 | 1776 | 1506 | 0,0308 | 0,0326 | 100 | 46,3413 | 7394 | 5988 | 1776 | 0,0308 | 0,0538 | 0,848 | 0,2037 |  |
| ORB1000 | 1000 | 1000 | 288 | 264 | 0,0042 | 0,0042 | 100 | 46,4554 | 1000 | 896 | 288 | 0,0042 | 0,008 | 0,9167 | 0,264 |  |
| BRISK | 3356 | 3003 | 655 | 618 | 0,014 | 0,0125 | 100 | 45,9454 | 3356 | 2174 | 655 | 0,014 | 0,0197 | 0,9435 | 0,1841 |  |
| KAZE | 838 | 571 | 190 | 163 | 0,0035 | 0,0024 | 100 | 46,3879 | 838 | 393 | 190 | 0,0035 | 0,0035 | 0,8579 | 0,1945 |  |
| AKAZE | 796 | 595 | 151 | 141 | 0,0033 | 0,0025 | 100 | 46,2633 | 796 | 465 | 151 | 0,0033 | 0,0042 | 0,9338 | 0,1771 |  |

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 | 2206 | 2111 | 0,054551 | 0,052725 | 0,042251 | 0,000769 | 0,024852 | 0,05066 | 0,001113 | 0,150297 |
| SURF128 | 2640 | 2616 | 0,07361 | 0,071155 | 0,05314 | 0,000579 | 0,027541 | 0,082772 | 0,000969 | 0,198484 |
| SURF64 | 2640 | 2616 | 0,069858 | 0,063003 | 0,030632 | 0,000801 | 0,025272 | 0,040094 | 0,00117 | 0,164293 |
| ORB | 7394 | 7833 | 0,028335 | 0,019121 | 0,131398 | 0,001197 | 0,003136 | 0,073985 | 0,000794 | 0,180051 |
| ORB1000 | 1000 | 1000 | 0,009807 | 0,009254 | 0,003129 | 0,000589 | 0,009529 | 0,010864 | 0,00223 | 0,022778 |
| BRISK | 3356 | 3003 | 0,050148 | 0,042707 | 0,025555 | 0,000517 | 0,014581 | 0,039015 | 0,000836 | 0,118927 |
| KAZE | 838 | 571 | 0,113897 | 0,109086 | 0,004407 | 0,000398 | 0,163479 | 0,023196 | 0,002441 | 0,227788 |
| AKAZE | 796 | 595 | 0,019501 | 0,018459 | 0,002277 | 0,000426 | 0,027761 | 0,015081 | 0,003021 | 0,040664 |

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.