**Normalization results for pairs 10\_0.png\_10\_1.png from subset png\texture\_artificial**

**10\_0.png: 10\_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 | 0,673 | 0,16 | 30,056 | -0,185 | 0,457 | 165,612 | 0 | -0 | 1 | 0,457 | 1,776 |  |
| SURF128 | 0,674 | 0,159 | 29,924 | -0,185 | 0,456 | 165,592 | 0 | -0 | 1 | 1,055 | 2,461 |  |
| SURF64 | 0,683 | 0,17 | 27,281 | -0,184 | 0,467 | 164,87 | 0 | -0 | 1 | 1,061 | 3,203 |  |
| ORB | 0,679 | 0,166 | 28,448 | -0,185 | 0,463 | 164,744 | 0 | -0 | 1 | 0,773 | 3,121 |  |
| ORB1000 | 0,676 | 0,16 | 29,504 | -0,183 | 0,456 | 164,657 | 0 | -0 | 1 | 0,891 | 2,265 |  |
| BRISK | 0,677 | 0,164 | 28,687 | -0,185 | 0,463 | 164,783 | 0 | -0 | 1 | 0,604 | 1,725 |  |
| KAZE | 0,666 | 0,169 | 29,63 | -0,191 | 0,463 | 165,504 | 0 | -0 | 1 | 0,763 | 2,252 |  |
| AKAZE | 0,67 | 0,157 | 30,539 | -0,186 | 0,455 | 165,569 | 0 | -0 | 1 | 0,615 | 1,82 |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |

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 | 1525 | 1873 | 344 | 318 | 0,0064 | 0,0078 | 100 | 38,1808 | 1525 | 750 | 344 | 0,0064 | 0,0082 | 0,9244 | 0,2085 |  |
| SURF128 | 2471 | 2610 | 55 | 33 | 0,0103 | 0,0109 | 100 | 38,2567 | 2471 | 1251 | 55 | 0,0103 | 0,0136 | 0,6 | 0,0134 |  |
| SURF64 | 2471 | 2610 | 90 | 47 | 0,0103 | 0,0109 | 100 | 38,3296 | 2471 | 1249 | 90 | 0,0103 | 0,0136 | 0,5222 | 0,019 |  |
| ORB | 4038 | 6151 | 201 | 155 | 0,0168 | 0,0256 | 100 | 38,5008 | 4038 | 3454 | 201 | 0,0168 | 0,0374 | 0,7711 | 0,0384 |  |
| ORB1000 | 986 | 985 | 71 | 58 | 0,0041 | 0,0041 | 100 | 38,4279 | 986 | 647 | 71 | 0,0041 | 0,007 | 0,8169 | 0,0588 |  |
| BRISK | 904 | 1678 | 82 | 59 | 0,0038 | 0,007 | 100 | 38,5096 | 904 | 909 | 82 | 0,0038 | 0,0098 | 0,7195 | 0,0653 |  |
| KAZE | 216 | 251 | 26 | 16 | 0,0009 | 0,001 | 100 | 38,3621 | 216 | 118 | 26 | 0,0009 | 0,0013 | 0,6154 | 0,0741 |  |
| AKAZE | 159 | 245 | 32 | 22 | 0,0007 | 0,001 | 100 | 38,3204 | 159 | 138 | 32 | 0,0007 | 0,0015 | 0,6875 | 0,1384 |  |

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 | 1525 | 1873 | 0,068377 | 0,059904 | 0,08221 | 0,00443 | 0,03841 | 0,238981 | 0,01393 | 0,214921 |
| SURF128 | 2471 | 2610 | 0,225719 | 0,070835 | 0,054103 | 0,001111 | 0,059243 | 0,983691 | 0,033678 | 0,351769 |
| SURF64 | 2471 | 2610 | 0,06336 | 0,06444 | 0,0278 | 0,001862 | 0,025165 | 0,308891 | 0,039609 | 0,157462 |
| ORB | 4038 | 6151 | 0,013186 | 0,016206 | 0,063696 | 0,000541 | 0,002949 | 0,316894 | 0,003492 | 0,093629 |
| ORB1000 | 986 | 985 | 0,008989 | 0,009034 | 0,003321 | 0,000399 | 0,009143 | 0,046772 | 0,006885 | 0,021743 |
| BRISK | 904 | 1678 | 0,016296 | 0,025608 | 0,004735 | 0,000594 | 0,016643 | 0,057743 | 0,010072 | 0,047233 |
| KAZE | 216 | 251 | 0,17532 | 0,106192 | 0,000725 | 0,001003 | 0,61737 | 0,027897 | 0,062677 | 0,28324 |
| AKAZE | 159 | 245 | 0,018227 | 0,017024 | 0,000469 | 0,000669 | 0,09206 | 0,014666 | 0,030425 | 0,03639 |

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.