**Normalization results for pairs 13\_0.png\_13\_1.png from subset png\texture\_artificial**

**13\_0.png: 13\_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 | 0,576 | 0,128 | 26,089 | -0,05 | 0,518 | 113,357 | 0 | 0 | 1 | 0,432 | 1,324 |  |
| SURF128 | 0,142 | -0,308 | 60,186 | 0,327 | -0,708 | 138,153 | 0,002 | -0,005 | 1 | 9,787 | 88,837 |  |
| SURF64 | -0,139 | -0,169 | 60,186 | -0,318 | -0,391 | 138,152 | -0,002 | -0,003 | 1 | 5,084 | 194,746 |  |
| ORB | 0,572 | 0,121 | 26,4 | -0,051 | 0,506 | 114,307 | 0 | 0 | 1 | 0,669 | 2,392 |  |
| ORB1000 | 0,562 | 0,121 | 26,833 | -0,054 | 0,499 | 114,027 | 0 | -0 | 1 | 0,737 | 1,9 |  |
| BRISK | 0,59 | 0,128 | 24,062 | -0,043 | 0,522 | 111,996 | 0 | 0 | 1 | 0,541 | 1,376 |  |
| KAZE | -0,007 | -0,047 | 12,565 | -0,117 | -0,833 | 220,177 | -0,001 | -0,004 | 1 | 22,848 | 165,34 |  |
| AKAZE | 0,574 | 0,125 | 25,793 | -0,051 | 0,513 | 113,468 | 0 | 0 | 1 | 0,294 | 0,762 |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |

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 | 670 | 1386 | 115 | 78 | 0,0028 | 0,0058 | 100 | 22,2087 | 670 | 325 | 115 | 0,0028 | 0,0061 | 0,6783 | 0,1164 |  |
| SURF128 | 2448 | 4570 | 104 | 19 | 0,0102 | 0,019 | 99,9917 | 62,9062 | 2448 | 2791 | 104 | 0,0102 | 0,0185 | 0,1827 | 0,0078 |  |
| SURF64 | 2448 | 4570 | 149 | 62 | 0,0102 | 0,019 | 99,8612 | 97,9008 | 2443 | 4486 | 147 | 0,0102 | 0,0191 | 0,4161 | 0,0254 |  |
| ORB | 963 | 4475 | 76 | 45 | 0,004 | 0,0186 | 100 | 22,2787 | 963 | 1230 | 76 | 0,004 | 0,023 | 0,5921 | 0,0467 |  |
| ORB1000 | 879 | 1000 | 61 | 23 | 0,0037 | 0,0042 | 100 | 22,4983 | 879 | 526 | 61 | 0,0037 | 0,0097 | 0,377 | 0,0262 |  |
| BRISK | 355 | 1533 | 31 | 12 | 0,0015 | 0,0064 | 100 | 22,3433 | 355 | 472 | 31 | 0,0015 | 0,0088 | 0,3871 | 0,0338 |  |
| KAZE | 538 | 810 | 26 | 13 | 0,0022 | 0,0034 | 99,6254 | 72,2613 | 537 | 522 | 25 | 0,0022 | 0,003 | 0,5 | 0,0242 |  |
| AKAZE | 285 | 735 | 34 | 21 | 0,0012 | 0,0031 | 100 | 22,3346 | 285 | 227 | 34 | 0,0012 | 0,0042 | 0,6176 | 0,0737 |  |

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 | 670 | 1386 | 0,046198 | 0,051527 | 0,00946 | 0,000758 | 0,053064 | 0,082258 | 0,009723 | 0,107943 |
| SURF128 | 2448 | 4570 | 0,078694 | 0,09361 | 0,084978 | 0,050422 | 0,026314 | 0,817099 | 2,653813 | 0,307704 |
| SURF64 | 2448 | 4570 | 0,082222 | 0,084176 | 0,046656 | 0,004623 | 0,026003 | 0,313128 | 0,074559 | 0,217676 |
| ORB | 963 | 4475 | 0,007864 | 0,013619 | 0,011124 | 0,001187 | 0,005604 | 0,146369 | 0,026381 | 0,033794 |
| ORB1000 | 879 | 1000 | 0,007586 | 0,008944 | 0,003039 | 0,006652 | 0,008786 | 0,049817 | 0,289213 | 0,026221 |
| BRISK | 355 | 1533 | 0,008084 | 0,024293 | 0,002083 | 0,005922 | 0,019309 | 0,067198 | 0,493482 | 0,040382 |
| KAZE | 538 | 810 | 0,12142 | 0,119953 | 0,004033 | 0,002545 | 0,186889 | 0,155096 | 0,195794 | 0,247952 |
| AKAZE | 285 | 735 | 0,017941 | 0,018346 | 0,001251 | 0,001009 | 0,043955 | 0,036783 | 0,04803 | 0,038546 |

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.