**Normalization results for pairs 17\_0.png\_17\_1.png from subset png\building**

**17\_0.png: 17\_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 | 1,787 | 0,062 | -229,183 | -0,152 | 1,604 | -71,593 | 0,001 | -0 | 1 | 0 | 1,006 | 3,343 | ~ | ~ |  |
| SURF128 | 1,807 | 0,153 | -244,742 | -0,149 | 1,634 | -74,789 | 0,001 | -0 | 1 | 0 | 1,253 | 2,751 | ~ | ~ |  |
| SURF64 | 1,753 | 0,03 | -219,091 | -0,148 | 1,563 | -68,487 | 0,001 | -0 | 1 | 0 | 1,125 | 3,515 | ~ | ~ |  |
| ORB | 1,874 | 0,207 | -264,386 | -0,153 | 1,724 | -84,151 | 0,001 | -0 | 1 | 0 | 1,27 | 3,479 | ~ | ~ |  |
| ORB1000 | 1,959 | 0,201 | -274,336 | -0,155 | 1,833 | -94,421 | 0,001 | -0 | 1 | 0 | 1,275 | 3,138 | ~ | ~ |  |
| BRISK | 1,659 | 0,083 | -204,554 | -0,166 | 1,551 | -62,914 | 0 | -0 | 1 | 0 | 1,183 | 3,128 | ~ | ~ |  |
| KAZE | 1,775 | 0,247 | -247,733 | -0,175 | 1,718 | -79,21 | 0,001 | -0 | 1 | 0 | 0,88 | 2,546 | ~ | ~ |  |
| AKAZE | 1,563 | 0,023 | -175,605 | -0,175 | 1,477 | -52,531 | 0 | -0 | 1 | 0 | 1,067 | 3,47 | ~ | ~ |  |
| 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 | 1401 | 1485 | 214 | 113 | 0,0058 | 0,0062 | 46,0804 | 100 | 734 | 1485 | 205 | 0,0066 | 0,0062 | 0,528 | 0,154 |  |
| SURF128 | 2100 | 2296 | 124 | 64 | 0,0088 | 0,0096 | 47,0625 | 100 | 1189 | 2296 | 107 | 0,0105 | 0,0096 | 0,5161 | 0,0538 |  |
| SURF64 | 2100 | 2296 | 189 | 72 | 0,0088 | 0,0096 | 45,9667 | 100 | 1173 | 2296 | 157 | 0,0106 | 0,0096 | 0,381 | 0,0614 |  |
| ORB | 5695 | 5879 | 385 | 240 | 0,0237 | 0,0245 | 46,6421 | 100 | 4242 | 5879 | 381 | 0,0379 | 0,0245 | 0,6234 | 0,0566 |  |
| ORB1000 | 1000 | 1000 | 192 | 128 | 0,0042 | 0,0042 | 48,415 | 100 | 896 | 1000 | 191 | 0,0077 | 0,0042 | 0,6667 | 0,1429 |  |
| BRISK | 1982 | 2144 | 153 | 79 | 0,0083 | 0,0089 | 47,3413 | 100 | 1385 | 2144 | 153 | 0,0122 | 0,0089 | 0,5163 | 0,057 |  |
| KAZE | 562 | 694 | 81 | 52 | 0,0023 | 0,0029 | 47,7125 | 100 | 394 | 694 | 81 | 0,0034 | 0,0029 | 0,642 | 0,132 |  |
| AKAZE | 485 | 544 | 85 | 46 | 0,002 | 0,0023 | 47,9229 | 100 | 400 | 544 | 84 | 0,0035 | 0,0023 | 0,5412 | 0,115 |  |

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 | 1401 | 1485 | 0,187414 | 0,207667 | 0,182168 | 0,002888 | 0,136807 | 0,851253 | 0,025557 | 0,580137 |
| SURF128 | 2100 | 2296 | 0,17217 | 0,126814 | 0,082404 | 0,002042 | 0,068608 | 0,664548 | 0,031898 | 0,383429 |
| SURF64 | 2100 | 2296 | 0,097917 | 0,097714 | 0,034441 | 0,007147 | 0,044592 | 0,182228 | 0,099266 | 0,237219 |
| ORB | 5695 | 5879 | 0,016483 | 0,017257 | 0,115363 | 0,001198 | 0,002914 | 0,299644 | 0,004993 | 0,150301 |
| ORB1000 | 1000 | 1000 | 0,009596 | 0,009935 | 0,005163 | 0,000886 | 0,009764 | 0,02689 | 0,006925 | 0,02558 |
| BRISK | 1982 | 2144 | 0,029387 | 0,034749 | 0,013207 | 0,002141 | 0,015517 | 0,086317 | 0,027099 | 0,079484 |
| KAZE | 562 | 694 | 0,283505 | 0,274894 | 0,007084 | 0,000903 | 0,450278 | 0,087452 | 0,017368 | 0,566385 |
| AKAZE | 485 | 544 | 0,020187 | 0,015994 | 0,001676 | 0,001747 | 0,035511 | 0,019721 | 0,037977 | 0,039605 |

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.