**Normalization results for pairs 8\_0.png\_8\_1.png from subset png\building**

**8\_0.png: 8\_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 | 0,834 | 0,007 | 46,573 | 0,098 | 0,811 | 23,446 | 0 | 0 | 1 | 0 | 0,459 | 1,996 | ~ | ~ |  |
| SURF128 | 0,82 | -0,01 | 47,347 | 0,097 | 0,75 | 28,447 | 0 | 0 | 1 | 0 | 0,999 | 2,636 | ~ | ~ |  |
| SURF64 | 0,736 | -0,057 | 64,963 | 0,049 | 0,77 | 31,745 | 0 | 0 | 1 | 0 | 1,241 | 2,514 | ~ | ~ |  |
| ORB | 0,871 | 0,064 | 39,574 | 0,111 | 0,833 | 23,277 | 0 | 0 | 1 | 0 | 0,837 | 2,365 | ~ | ~ |  |
| ORB1000 | 0,937 | 0,344 | 20,425 | 0,083 | 1,086 | 17,061 | 0 | 0,002 | 1 | 0 | 0,882 | 2,106 | ~ | ~ |  |
| BRISK | 0,693 | -0,097 | 61,995 | 0,056 | 0,599 | 40,853 | 0 | -0 | 1 | 0 | 0,828 | 2,842 | ~ | ~ |  |
| KAZE | 0,861 | -0,088 | 49,491 | 0,13 | 0,677 | 30,855 | 0,001 | -0 | 1 | 0 | 0,888 | 2,232 | ~ | ~ |  |
| AKAZE | 0,728 | -0,024 | 60,155 | 0,054 | 0,765 | 29,731 | 0 | 0 | 1 | 0 | 0,747 | 1,402 | ~ | ~ |  |
| 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 | 1452 | 1736 | 95 | 33 | 0,006 | 0,0072 | 100 | 42,6254 | 1452 | 722 | 95 | 0,006 | 0,0071 | 0,3474 | 0,0227 |  |
| SURF128 | 1976 | 1825 | 73 | 36 | 0,0082 | 0,0076 | 100 | 42,5237 | 1976 | 1020 | 73 | 0,0082 | 0,01 | 0,4932 | 0,0182 |  |
| SURF64 | 1976 | 1825 | 98 | 42 | 0,0082 | 0,0076 | 100 | 42,9496 | 1976 | 1049 | 98 | 0,0082 | 0,0102 | 0,4286 | 0,0213 |  |
| ORB | 4863 | 7660 | 154 | 105 | 0,0203 | 0,0319 | 100 | 39,5192 | 4863 | 3862 | 154 | 0,0203 | 0,0407 | 0,6818 | 0,0216 |  |
| ORB1000 | 1000 | 1000 | 38 | 32 | 0,0042 | 0,0042 | 100 | 35,3317 | 1000 | 587 | 38 | 0,0042 | 0,0069 | 0,8421 | 0,032 |  |
| BRISK | 2166 | 3079 | 64 | 53 | 0,009 | 0,0128 | 100 | 49,02 | 2166 | 1346 | 64 | 0,009 | 0,0114 | 0,8281 | 0,0245 |  |
| KAZE | 736 | 741 | 39 | 20 | 0,0031 | 0,0031 | 100 | 42,6837 | 736 | 295 | 39 | 0,0031 | 0,0029 | 0,5128 | 0,0272 |  |
| AKAZE | 548 | 673 | 29 | 16 | 0,0023 | 0,0028 | 100 | 44,2233 | 548 | 391 | 29 | 0,0023 | 0,0037 | 0,5517 | 0,0292 |  |

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 | 1452 | 1736 | 0,050736 | 0,052813 | 0,025103 | 0,009092 | 0,032682 | 0,264245 | 0,275507 | 0,137744 |
| SURF128 | 1976 | 1825 | 0,068671 | 0,06404 | 0,033642 | 0,002669 | 0,034921 | 0,460851 | 0,074126 | 0,169022 |
| SURF64 | 1976 | 1825 | 0,067416 | 0,058255 | 0,020008 | 0,003936 | 0,033018 | 0,204166 | 0,09372 | 0,149615 |
| ORB | 4863 | 7660 | 0,014988 | 0,019027 | 0,092425 | 0,000801 | 0,002782 | 0,600163 | 0,007632 | 0,127242 |
| ORB1000 | 1000 | 1000 | 0,009462 | 0,009687 | 0,003241 | 0,000419 | 0,009573 | 0,085297 | 0,013109 | 0,022809 |
| BRISK | 2166 | 3079 | 0,03514 | 0,048382 | 0,021119 | 0,00054 | 0,015968 | 0,329978 | 0,010194 | 0,105182 |
| KAZE | 736 | 741 | 0,180944 | 0,197691 | 0,005608 | 0,00224 | 0,256318 | 0,143788 | 0,112008 | 0,386483 |
| AKAZE | 548 | 673 | 0,017925 | 0,015898 | 0,001973 | 0,001523 | 0,028166 | 0,068043 | 0,09521 | 0,03732 |

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.