**Normalization results for pairs 1\_0.ppm\_1\_2.ppm from subset HPatches\_mikolajczyk\_set10\_Pairs50\v\_eastsouth**

**1\_0.ppm: 1\_2.ppm: **

**Table 1 - Found homography parameters and normalization accuracy assessment**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Original:  img1: 97,96 img2: 49,479 | 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 | 0,571 | 0,405 | -1,006 | -0,411 | 0,569 | 274,586 | -0 | -0 | 1 | 0,092 | 0,446 | 2,972 | 0,362 | 0,499 |  |
| SURF128 | 0,574 | 0,403 | -1,348 | -0,41 | 0,569 | 274,312 | 0 | -0 | 1 | 0,327 | 1,002 | 3,867 | 1,11 | 2,049 |  |
| SURF64 | 0,571 | 0,405 | -0,955 | -0,41 | 0,568 | 274,151 | -0 | -0 | 1 | 0,16 | 0,981 | 3,53 | 0,827 | 1,234 |  |
| ORB | 0,572 | 0,405 | -1,08 | -0,411 | 0,569 | 274,355 | -0 | -0 | 1 | 0,158 | 0,86 | 3,843 | 0,448 | 0,785 |  |
| ORB1000 | 0,566 | 0,405 | -0,23 | -0,414 | 0,569 | 274,171 | -0 | -0 | 1 | 0,407 | 0,911 | 3,407 | 2,844 | 4,781 |  |
| BRISK | 0,571 | 0,405 | -1,008 | -0,411 | 0,569 | 273,925 | -0 | -0 | 1 | 0,247 | 0,8 | 4,385 | 1,171 | 2,174 |  |
| KAZE | 0,569 | 0,405 | -0,865 | -0,412 | 0,57 | 274,168 | -0 | -0 | 1 | 0,197 | 0,831 | 3,622 | 0,822 | 1,68 |  |
| AKAZE | 0,571 | 0,405 | -1,238 | -0,411 | 0,569 | 274,182 | -0 | -0 | 1 | 0,093 | 0,583 | 3,029 | 0,344 | 0,426 |  |
| Original matrix | 0,571 | 0,405 | -1,07 | -0,411 | 0,569 | 274,36 | -0 | -0 | 1 |  |  |  |  |  |  |

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 | 10261 | 7881 | 2032 | 1999 | 0,0178 | 0,0136 | 97,9773 | 49,4791 | 10254 | 4546 | 2032 | 0,0181 | 0,0159 | 0,9838 | 0,1949 |  |
| SURF128 | 6299 | 5495 | 551 | 456 | 0,0109 | 0,0095 | 98,0021 | 49,4938 | 6274 | 3137 | 551 | 0,0111 | 0,011 | 0,8276 | 0,0727 |  |
| SURF64 | 6299 | 5495 | 804 | 608 | 0,0109 | 0,0095 | 97,9986 | 49,4109 | 6274 | 3122 | 804 | 0,0111 | 0,0109 | 0,7562 | 0,0969 |  |
| ORB | 37625 | 28265 | 9172 | 8511 | 0,0651 | 0,0489 | 97,9766 | 49,4881 | 37624 | 19690 | 9172 | 0,0664 | 0,0688 | 0,9279 | 0,2262 |  |
| ORB1000 | 1000 | 1000 | 337 | 259 | 0,0017 | 0,0017 | 97,8396 | 49,5638 | 1000 | 770 | 337 | 0,0018 | 0,0027 | 0,7685 | 0,259 |  |
| BRISK | 14959 | 10088 | 2249 | 2052 | 0,0259 | 0,0175 | 97,9635 | 49,6439 | 14956 | 6819 | 2249 | 0,0264 | 0,0238 | 0,9124 | 0,1372 |  |
| KAZE | 2922 | 2056 | 635 | 558 | 0,0051 | 0,0036 | 97,9168 | 49,5372 | 2922 | 1364 | 635 | 0,0052 | 0,0048 | 0,8787 | 0,191 |  |
| AKAZE | 3255 | 2184 | 596 | 556 | 0,0056 | 0,0038 | 97,9713 | 49,5022 | 3255 | 1587 | 596 | 0,0057 | 0,0055 | 0,9329 | 0,1708 |  |

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 | 10261 | 7881 | 0,487473 | 0,609943 | 2,383858 | 0,001326 | 0,06245 | 1,173158 | 0,000663 | 3,482601 |
| SURF128 | 6299 | 5495 | 0,453129 | 0,481066 | 0,837404 | 0,000654 | 0,079741 | 1,51979 | 0,001434 | 1,772253 |
| SURF64 | 6299 | 5495 | 0,509015 | 0,376042 | 0,356206 | 0,000993 | 0,07462 | 0,443042 | 0,001633 | 1,242257 |
| ORB | 37625 | 28265 | 0,11932 | 0,086592 | 5,047562 | 0,005399 | 0,003117 | 0,550322 | 0,000634 | 5,258872 |
| ORB1000 | 1000 | 1000 | 0,026952 | 0,023728 | 0,006104 | 0,000675 | 0,025339 | 0,018111 | 0,002608 | 0,057459 |
| BRISK | 14959 | 10088 | 0,267201 | 0,170326 | 0,57274 | 0,001462 | 0,017373 | 0,254664 | 0,000712 | 1,01173 |
| KAZE | 2922 | 2056 | 0,409954 | 0,375148 | 0,063796 | 0,000565 | 0,161382 | 0,100465 | 0,001012 | 0,849464 |
| AKAZE | 3255 | 2184 | 0,082973 | 0,085171 | 0,045801 | 0,000779 | 0,032244 | 0,076848 | 0,0014 | 0,214724 |

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.