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

**1\_0.ppm: 1\_1.ppm: **

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Original:  img1: 100 img2: 71,203 | 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 | 0,831 | 0,003 | 81,909 | -0,011 | 0,831 | 63,386 | -0 | -0 | 1 | 0,164 | 0,501 | 3,124 | 0,25 | 0,501 |  |
| SURF128 | 0,832 | 0,003 | 81,699 | -0,011 | 0,831 | 63,236 | -0 | -0 | 1 | 0,139 | 0,865 | 3,27 | 0,229 | 0,579 |  |
| SURF64 | 0,833 | 0,004 | 81,394 | -0,01 | 0,832 | 62,958 | -0 | -0 | 1 | 0,441 | 0,878 | 4,89 | 0,561 | 1,065 |  |
| ORB | 0,832 | 0,002 | 81,965 | -0,01 | 0,83 | 63,224 | -0 | -0 | 1 | 0,383 | 0,912 | 3,992 | 0,586 | 1,047 |  |
| ORB1000 | 0,83 | 0,002 | 82,343 | -0,011 | 0,832 | 63,289 | -0 | -0 | 1 | 0,244 | 0,866 | 3,344 | 0,656 | 1,165 |  |
| BRISK | 0,83 | 0,002 | 81,965 | -0,011 | 0,831 | 63,257 | -0 | -0 | 1 | 0,159 | 0,725 | 3,712 | 0,295 | 0,525 |  |
| KAZE | 0,831 | 0,003 | 81,993 | -0,012 | 0,832 | 63,286 | -0 | -0 | 1 | 0,115 | 0,748 | 4,136 | 0,219 | 0,275 |  |
| AKAZE | 0,832 | 0,001 | 81,909 | -0,01 | 0,83 | 63,176 | -0 | -0 | 1 | 0,458 | 0,717 | 3,394 | 0,726 | 1,233 |  |
| Original matrix | 0,831 | 0,003 | 81,765 | -0,011 | 0,832 | 63,28 | -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 | 8811 | 3036 | 2981 | 0,0178 | 0,0152 | 100 | 71,1749 | 10261 | 6702 | 3036 | 0,0178 | 0,0163 | 0,9819 | 0,2905 |  |
| SURF128 | 6299 | 6494 | 1541 | 1477 | 0,0109 | 0,0112 | 100 | 71,1851 | 6299 | 5116 | 1541 | 0,0109 | 0,0124 | 0,9585 | 0,2345 |  |
| SURF64 | 6299 | 6494 | 2093 | 1860 | 0,0109 | 0,0112 | 100 | 71,1497 | 6299 | 5110 | 2093 | 0,0109 | 0,0124 | 0,8887 | 0,2953 |  |
| ORB | 37625 | 37105 | 15176 | 14757 | 0,0651 | 0,0642 | 100 | 71,1907 | 37625 | 33134 | 15176 | 0,0651 | 0,0805 | 0,9724 | 0,3922 |  |
| ORB1000 | 1000 | 1000 | 458 | 392 | 0,0017 | 0,0017 | 100 | 71,2183 | 1000 | 900 | 458 | 0,0017 | 0,0022 | 0,8559 | 0,392 |  |
| BRISK | 14959 | 14880 | 4939 | 4703 | 0,0259 | 0,0257 | 100 | 71,2426 | 14959 | 12538 | 4939 | 0,0259 | 0,0304 | 0,9522 | 0,3144 |  |
| KAZE | 2922 | 2607 | 1449 | 1336 | 0,0051 | 0,0045 | 100 | 71,21 | 2922 | 2126 | 1449 | 0,0051 | 0,0052 | 0,922 | 0,4572 |  |
| AKAZE | 3255 | 3002 | 979 | 896 | 0,0056 | 0,0052 | 100 | 71,2152 | 3255 | 2631 | 979 | 0,0056 | 0,0064 | 0,9152 | 0,2753 |  |

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 | 8811 | 0,320812 | 0,331879 | 1,418223 | 0,006419 | 0,034465 | 0,467135 | 0,002153 | 2,077334 |
| SURF128 | 6299 | 6494 | 0,609956 | 0,431479 | 0,855378 | 0,016802 | 0,081637 | 0,55508 | 0,011375 | 1,913616 |
| SURF64 | 6299 | 6494 | 0,444425 | 0,490095 | 0,435765 | 0,001444 | 0,073011 | 0,2082 | 0,000776 | 1,371728 |
| ORB | 37625 | 37105 | 0,15104 | 0,115225 | 6,626434 | 0,026195 | 0,003559 | 0,436639 | 0,001775 | 6,918893 |
| ORB1000 | 1000 | 1000 | 0,068582 | 0,059166 | 0,084185 | 0,000784 | 0,063874 | 0,18381 | 0,001999 | 0,212717 |
| BRISK | 14959 | 14880 | 0,329001 | 0,2969 | 1,201207 | 0,003391 | 0,020972 | 0,243208 | 0,000721 | 1,8305 |
| KAZE | 2922 | 2607 | 0,952901 | 0,950614 | 0,176274 | 0,001083 | 0,345375 | 0,121652 | 0,00081 | 2,080872 |
| AKAZE | 3255 | 3002 | 0,191513 | 0,197413 | 0,135077 | 0,000953 | 0,062298 | 0,137974 | 0,001064 | 0,524956 |

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.