**Normalization results for pairs 1\_0.ppm\_1\_5.ppm from subset HPatches\_mikolajczyk\_set10\_Pairs50\v\_bip**

**1\_0.ppm: 1\_5.ppm: **

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Original:  img1: 100 img2: 13,62 | 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 | 0,369 | 0 | 216,362 | 0 | 0,37 | 132,235 | 0 | 0 | 1 | 0,127 | 0,357 | 2,451 | 1,431 | 2,513 |  |
| SURF128 | 0,367 | 0,002 | 216,154 | -0,001 | 0,372 | 132,189 | -0 | 0 | 1 | 0,093 | 0,635 | 2,822 | 1,372 | 1,9 |  |
| SURF64 | 0,369 | 0 | 216,181 | 0 | 0,37 | 132,187 | 0 | 0 | 1 | 0,131 | 0,646 | 3,281 | 1,324 | 2,736 |  |
| ORB | 0,371 | -0,002 | 216,106 | 0,001 | 0,369 | 132,016 | 0 | -0 | 1 | 0,299 | 0,699 | 2,66 | 2,29 | 4,487 |  |
| ORB1000 | 0,386 | 0,009 | 214,105 | 0,01 | 0,382 | 129,23 | 0 | 0 | 1 | 0,657 | 0,562 | 1,084 | 4,213 | 8,672 |  |
| BRISK | 0,371 | 0,003 | 215,372 | 0,001 | 0,373 | 131,494 | 0 | 0 | 1 | 0,11 | 0,664 | 2,425 | 1,791 | 2,197 |  |
| KAZE | 0,373 | -0,002 | 215,849 | 0,002 | 0,371 | 131,503 | 0 | -0 | 1 | 0,232 | 0,788 | 2,681 | 2,273 | 5,911 |  |
| AKAZE | 0,377 | -0,003 | 215,316 | 0,004 | 0,371 | 131,217 | 0 | -0 | 1 | 0,35 | 0,497 | 1,976 | 3,447 | 7,801 |  |
| Original matrix | 0,369 | 0,004 | 216,07 | 0 | 0,373 | 131,92 | -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 | 3009 | 2363 | 492 | 443 | 0,0068 | 0,0054 | 100 | 13,7222 | 3009 | 955 | 492 | 0,0068 | 0,0158 | 0,9004 | 0,1472 |  |
| SURF128 | 3561 | 2416 | 311 | 270 | 0,0081 | 0,0055 | 100 | 13,693 | 3561 | 689 | 311 | 0,0081 | 0,0114 | 0,8682 | 0,0758 |  |
| SURF64 | 3561 | 2416 | 347 | 310 | 0,0081 | 0,0055 | 100 | 13,7222 | 3561 | 691 | 347 | 0,0081 | 0,0114 | 0,8934 | 0,0871 |  |
| ORB | 8107 | 8910 | 511 | 470 | 0,0184 | 0,0202 | 100 | 13,7061 | 8107 | 3600 | 511 | 0,0184 | 0,0596 | 0,9198 | 0,058 |  |
| ORB1000 | 1000 | 1000 | 32 | 21 | 0,0023 | 0,0023 | 100 | 13,7127 | 1000 | 196 | 32 | 0,0023 | 0,0032 | 0,6562 | 0,021 |  |
| BRISK | 2298 | 2697 | 242 | 211 | 0,0052 | 0,0061 | 100 | 13,7202 | 2298 | 1033 | 242 | 0,0052 | 0,0171 | 0,8719 | 0,0918 |  |
| KAZE | 961 | 1285 | 85 | 79 | 0,0022 | 0,0029 | 100 | 13,7157 | 961 | 433 | 85 | 0,0022 | 0,0072 | 0,9294 | 0,0822 |  |
| AKAZE | 825 | 1249 | 59 | 50 | 0,0019 | 0,0028 | 100 | 13,7656 | 825 | 480 | 59 | 0,0019 | 0,0079 | 0,8475 | 0,0606 |  |

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 | 3009 | 2363 | 0,188257 | 0,131101 | 0,126748 | 0,000526 | 0,059022 | 0,257618 | 0,001186 | 0,446633 |
| SURF128 | 3561 | 2416 | 0,308735 | 0,227252 | 0,15619 | 0,000496 | 0,09038 | 0,502219 | 0,001835 | 0,692673 |
| SURF64 | 3561 | 2416 | 0,171476 | 0,125293 | 0,069106 | 0,000479 | 0,050006 | 0,199153 | 0,001543 | 0,366354 |
| ORB | 8107 | 8910 | 0,027201 | 0,029126 | 0,282013 | 0,000742 | 0,003311 | 0,551884 | 0,001578 | 0,339081 |
| ORB1000 | 1000 | 1000 | 0,016522 | 0,015646 | 0,004393 | 0,000966 | 0,016083 | 0,13728 | 0,045982 | 0,037526 |
| BRISK | 2298 | 2697 | 0,04308 | 0,045169 | 0,021011 | 0,000424 | 0,017746 | 0,086821 | 0,002007 | 0,109683 |
| KAZE | 961 | 1285 | 0,284597 | 0,280402 | 0,024077 | 0,00029 | 0,257179 | 0,283258 | 0,003672 | 0,589367 |
| AKAZE | 825 | 1249 | 0,11137 | 0,09038 | 0,044569 | 0,000429 | 0,103678 | 0,755411 | 0,008587 | 0,246749 |

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.