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

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

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Original:  img1: 100 img2: 45,773 | 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 | 0,876 | 0,025 | 100,178 | 0,131 | 0,762 | 59,326 | 0,001 | 0 | 1 | 0,522 | 0,419 | 3,301 | 1,293 | 1,977 |  |
| SURF128 | 0,878 | 0,028 | 99,494 | 0,131 | 0,765 | 58,852 | 0,001 | 0 | 1 | 0,776 | 0,814 | 3,761 | 2,584 | 4,973 |  |
| SURF64 | 0,874 | 0,023 | 100,422 | 0,13 | 0,758 | 59,621 | 0,001 | 0 | 1 | 0,385 | 0,855 | 4,519 | 2,578 | 4,619 |  |
| ORB | 0,877 | 0,025 | 100,113 | 0,131 | 0,761 | 59,506 | 0,001 | 0 | 1 | 0,489 | 0,754 | 3,616 | 1,522 | 2,781 |  |
| ORB1000 | 0,874 | 0,022 | 101,076 | 0,131 | 0,756 | 59,831 | 0,001 | 0 | 1 | 0,516 | 0,774 | 3,003 | 2,807 | 5,66 |  |
| BRISK | 0,875 | 0,026 | 100,021 | 0,13 | 0,761 | 59,179 | 0,001 | 0 | 1 | 0,467 | 0,765 | 3,28 | 1,472 | 2,762 |  |
| KAZE | 0,875 | 0,027 | 100,244 | 0,13 | 0,762 | 59,282 | 0,001 | 0 | 1 | 0,415 | 0,875 | 3,355 | 1,549 | 2,764 |  |
| AKAZE | 0,876 | 0,025 | 100,104 | 0,131 | 0,761 | 59,087 | 0,001 | 0 | 1 | 0,536 | 0,648 | 3,455 | 1,778 | 2,379 |  |
| Original matrix | 0,872 | 0,024 | 101,75 | 0,13 | 0,761 | 59,456 | 0,001 | 0 | 1,002 |  |  |  |  |  |  |

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 | 17804 | 5434 | 2106 | 2008 | 0,0128 | 0,0084 | 100 | 45,7983 | 17804 | 3956 | 2106 | 0,0128 | 0,0134 | 0,9535 | 0,1128 |  |
| SURF128 | 18208 | 7808 | 1222 | 1059 | 0,0131 | 0,0121 | 100 | 45,7736 | 18208 | 4735 | 1222 | 0,0131 | 0,0161 | 0,8666 | 0,0582 |  |
| SURF64 | 18208 | 7808 | 1725 | 1432 | 0,0131 | 0,0121 | 100 | 45,8662 | 18208 | 4745 | 1725 | 0,0131 | 0,0161 | 0,8301 | 0,0786 |  |
| ORB | 63449 | 25763 | 3995 | 3743 | 0,0457 | 0,04 | 100 | 45,8072 | 63449 | 21062 | 3995 | 0,0457 | 0,0714 | 0,9369 | 0,059 |  |
| ORB1000 | 1000 | 1000 | 126 | 105 | 0,0007 | 0,0016 | 100 | 45,7848 | 1000 | 487 | 126 | 0,0007 | 0,0017 | 0,8333 | 0,105 |  |
| BRISK | 18557 | 7875 | 1376 | 1316 | 0,0134 | 0,0122 | 100 | 45,796 | 18557 | 6191 | 1376 | 0,0134 | 0,021 | 0,9564 | 0,0709 |  |
| KAZE | 4397 | 2139 | 427 | 364 | 0,0032 | 0,0033 | 100 | 45,7767 | 4397 | 1307 | 427 | 0,0032 | 0,0044 | 0,8525 | 0,0828 |  |
| AKAZE | 4765 | 2005 | 353 | 304 | 0,0034 | 0,0031 | 100 | 45,8395 | 4765 | 1483 | 353 | 0,0034 | 0,005 | 0,8612 | 0,0638 |  |

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 | 17804 | 5434 | 0,358454 | 0,152571 | 0,808908 | 0,00524 | 0,024105 | 0,384096 | 0,002609 | 1,325173 |
| SURF128 | 18208 | 7808 | 0,956895 | 0,382233 | 2,699876 | 0,001138 | 0,050753 | 2,209391 | 0,001074 | 4,040144 |
| SURF64 | 18208 | 7808 | 0,928622 | 0,449433 | 1,076376 | 0,004948 | 0,05428 | 0,623985 | 0,003455 | 2,459379 |
| ORB | 63449 | 25763 | 0,149921 | 0,060348 | 6,175259 | 0,00246 | 0,002352 | 1,545746 | 0,000657 | 6,387988 |
| ORB1000 | 1000 | 1000 | 0,047758 | 0,023151 | 0,008581 | 0,000603 | 0,035454 | 0,068106 | 0,00574 | 0,080094 |
| BRISK | 18557 | 7875 | 0,311012 | 0,123078 | 0,524636 | 0,001022 | 0,016193 | 0,381275 | 0,000776 | 0,959747 |
| KAZE | 4397 | 2139 | 0,844071 | 0,441591 | 0,107589 | 0,000795 | 0,199206 | 0,251965 | 0,002183 | 1,394046 |
| AKAZE | 4765 | 2005 | 0,188038 | 0,081495 | 0,04924 | 0,000552 | 0,040053 | 0,13949 | 0,001815 | 0,319325 |

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.