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

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

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Original:  img1: 100 img2: 74,485 | 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 | 0,737 | -0,003 | 13,05 | 0,017 | 0,711 | 35,86 | 0 | -0 | 1 | 0,239 | 0,387 | 2,962 | 0,316 | 0,441 |  |
| SURF128 | 0,736 | -0,003 | 13,072 | 0,017 | 0,71 | 36,057 | 0 | -0 | 1 | 0,166 | 0,749 | 3,529 | 0,129 | 0,26 |  |
| SURF64 | 0,736 | -0,003 | 13,201 | 0,017 | 0,71 | 36,067 | 0 | -0 | 1 | 0,158 | 0,757 | 4,07 | 0,168 | 0,203 |  |
| ORB | 0,736 | -0,003 | 13,542 | 0,017 | 0,71 | 36,357 | 0 | -0 | 1 | 0,247 | 0,844 | 4,485 | 0,407 | 0,764 |  |
| ORB1000 | 0,737 | -0,001 | 13,117 | 0,017 | 0,712 | 36,004 | 0 | -0 | 1 | 0,36 | 0,867 | 2,817 | 2,102 | 4,044 |  |
| BRISK | 0,735 | -0,003 | 13,294 | 0,017 | 0,71 | 36,072 | 0 | -0 | 1 | 0,221 | 0,936 | 3,299 | 0,538 | 0,888 |  |
| KAZE | 0,734 | -0,005 | 14,37 | 0,016 | 0,708 | 37,031 | 0 | -0 | 1 | 0,694 | 0,661 | 4,268 | 0,83 | 2,234 |  |
| AKAZE | 0,735 | -0,003 | 13,47 | 0,017 | 0,71 | 36,195 | 0 | -0 | 1 | 0,253 | 0,532 | 3,11 | 0,364 | 0,7 |  |
| Original matrix | 0,736 | -0,003 | 13,11 | 0,017 | 0,71 | 36,002 | 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 | 11196 | 7249 | 4380 | 3959 | 0,0111 | 0,0113 | 100 | 74,4734 | 11196 | 6547 | 4380 | 0,0111 | 0,0137 | 0,9039 | 0,3536 |  |
| SURF128 | 16204 | 9580 | 3802 | 3611 | 0,0161 | 0,0149 | 100 | 74,4733 | 16204 | 8632 | 3802 | 0,0161 | 0,018 | 0,9498 | 0,2228 |  |
| SURF64 | 16204 | 9580 | 4581 | 4251 | 0,0161 | 0,0149 | 100 | 74,4939 | 16204 | 8632 | 4581 | 0,0161 | 0,018 | 0,928 | 0,2623 |  |
| ORB | 64719 | 43596 | 18328 | 17226 | 0,0644 | 0,0677 | 100 | 74,406 | 64719 | 42403 | 18328 | 0,0644 | 0,0885 | 0,9399 | 0,2662 |  |
| ORB1000 | 1000 | 1000 | 388 | 340 | 0,001 | 0,0016 | 100 | 74,133 | 1000 | 998 | 388 | 0,001 | 0,0021 | 0,8763 | 0,34 |  |
| BRISK | 27371 | 18635 | 4816 | 4628 | 0,0272 | 0,0289 | 100 | 74,4301 | 27371 | 17666 | 4816 | 0,0272 | 0,0369 | 0,961 | 0,1691 |  |
| KAZE | 6700 | 4166 | 1901 | 1531 | 0,0067 | 0,0065 | 100 | 74,3962 | 6700 | 3873 | 1901 | 0,0067 | 0,0081 | 0,8054 | 0,2285 |  |
| AKAZE | 7407 | 4709 | 1820 | 1736 | 0,0074 | 0,0073 | 100 | 74,4091 | 7407 | 4523 | 1820 | 0,0074 | 0,0094 | 0,9538 | 0,2344 |  |

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 | 11196 | 7249 | 0,335658 | 0,240875 | 1,111032 | 0,020565 | 0,031604 | 0,25366 | 0,005194 | 1,708129 |
| SURF128 | 16204 | 9580 | 1,234088 | 0,644724 | 3,378125 | 0,003004 | 0,071728 | 0,888512 | 0,000832 | 5,259941 |
| SURF64 | 16204 | 9580 | 0,945556 | 0,645763 | 1,613048 | 0,003338 | 0,06288 | 0,352117 | 0,000785 | 3,207705 |
| ORB | 64719 | 43596 | 0,254763 | 0,132053 | 14,167518 | 0,015059 | 0,003482 | 0,772998 | 0,000874 | 14,569393 |
| ORB1000 | 1000 | 1000 | 0,13326 | 0,055834 | 0,041627 | 0,00053 | 0,094546 | 0,107286 | 0,00156 | 0,231252 |
| BRISK | 27371 | 18635 | 0,455669 | 0,292238 | 2,013254 | 0,003233 | 0,016164 | 0,418034 | 0,000698 | 2,764393 |
| KAZE | 6700 | 4166 | 0,794559 | 0,518495 | 0,343167 | 0,001568 | 0,121524 | 0,180519 | 0,001024 | 1,657789 |
| AKAZE | 7407 | 4709 | 0,142162 | 0,106856 | 0,165814 | 0,001176 | 0,020941 | 0,091106 | 0,000677 | 0,416008 |

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.