**Normalization results for pairs 1\_0.ppm\_1\_3.ppm from subset HPatches\_mikolajczyk\_set10\_Pairs50\v\_bark**

**1\_0.ppm: 1\_3.ppm: **

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Original:  img1: 100 img2: 16,039 | 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 | -0,2 | 0,347 | 247,605 | -0,346 | -0,2 | 467,613 | 0 | 0 | 1 | 0,051 | 0,14 | 1,885 | 1,152 | 1,237 |  |
| SURF128 | -0,196 | 0,348 | 247,216 | -0,343 | -0,203 | 468,169 | 0 | -0 | 1 | 0,249 | 0,892 | 2,938 | 3,171 | 4,535 |  |
| SURF64 | -0,201 | 0,35 | 247,831 | -0,347 | -0,197 | 468,19 | 0 | 0 | 1 | 0,289 | 0,985 | 2,967 | 1,413 | 2,702 |  |
| ORB | -0,2 | 0,349 | 247,417 | -0,347 | -0,199 | 467,265 | 0 | 0 | 1 | 0,059 | 0,731 | 2,661 | 1,137 | 2,193 |  |
| ORB1000 | -0,203 | 0,379 | 247,16 | -0,353 | -0,188 | 473,799 | 0 | 0 | 1 | 0,651 | 0,722 | 1,446 | 8,544 | 15,502 |  |
| BRISK | -0,199 | 0,346 | 247,385 | -0,345 | -0,201 | 467,061 | 0 | -0 | 1 | 0,058 | 0,644 | 2,482 | 0,865 | 1,228 |  |
| KAZE | -0,199 | 0,344 | 247,169 | -0,345 | -0,201 | 466,484 | 0 | -0 | 1 | 0,114 | 0,654 | 2,796 | 1,041 | 1,884 |  |
| AKAZE | -0,199 | 0,342 | 247,198 | -0,346 | -0,201 | 466,705 | 0 | -0 | 1 | 0,219 | 0,513 | 1,56 | 2,37 | 3,089 |  |
| Original matrix | -0,2 | 0,346 | 247,36 | -0,346 | -0,2 | 467,21 | 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 | 3702 | 4781 | 694 | 679 | 0,0095 | 0,0122 | 100 | 16,0363 | 3702 | 958 | 694 | 0,0095 | 0,0153 | 0,9784 | 0,1834 |  |
| SURF128 | 3633 | 4326 | 155 | 103 | 0,0093 | 0,011 | 100 | 16,0292 | 3633 | 798 | 155 | 0,0093 | 0,0127 | 0,6645 | 0,0284 |  |
| SURF64 | 3633 | 4326 | 218 | 203 | 0,0093 | 0,011 | 100 | 16,0547 | 3633 | 795 | 218 | 0,0093 | 0,0126 | 0,9312 | 0,0559 |  |
| ORB | 9421 | 15255 | 747 | 721 | 0,0241 | 0,0389 | 100 | 16,0675 | 9421 | 3812 | 747 | 0,0241 | 0,0606 | 0,9652 | 0,0765 |  |
| ORB1000 | 1000 | 1000 | 48 | 41 | 0,0026 | 0,0026 | 100 | 16,4984 | 1000 | 227 | 48 | 0,0026 | 0,0035 | 0,8542 | 0,041 |  |
| BRISK | 2223 | 4020 | 275 | 265 | 0,0057 | 0,0103 | 100 | 16,0381 | 2223 | 911 | 275 | 0,0057 | 0,0145 | 0,9636 | 0,1192 |  |
| KAZE | 760 | 863 | 61 | 56 | 0,0019 | 0,0022 | 100 | 15,9919 | 760 | 162 | 61 | 0,0019 | 0,0026 | 0,918 | 0,0737 |  |
| AKAZE | 705 | 848 | 36 | 32 | 0,0018 | 0,0022 | 100 | 16,0325 | 705 | 191 | 36 | 0,0018 | 0,003 | 0,8889 | 0,0454 |  |

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 | 3702 | 4781 | 0,16009 | 0,184324 | 0,299275 | 0,000566 | 0,040898 | 0,431232 | 0,000833 | 0,644255 |
| SURF128 | 3633 | 4326 | 0,310468 | 0,269604 | 0,266816 | 0,000882 | 0,073889 | 1,72139 | 0,008566 | 0,84777 |
| SURF64 | 3633 | 4326 | 0,198763 | 0,188992 | 0,130774 | 0,000405 | 0,049198 | 0,59988 | 0,001994 | 0,518934 |
| ORB | 9421 | 15255 | 0,03199 | 0,053503 | 0,613931 | 0,000746 | 0,003451 | 0,821861 | 0,001035 | 0,700171 |
| ORB1000 | 1000 | 1000 | 0,015788 | 0,017384 | 0,00836 | 0,00035 | 0,016586 | 0,174165 | 0,008541 | 0,041882 |
| BRISK | 2223 | 4020 | 0,040437 | 0,069725 | 0,049318 | 0,000611 | 0,017767 | 0,179337 | 0,002306 | 0,16009 |
| KAZE | 760 | 863 | 0,357696 | 0,359423 | 0,021985 | 0,0004 | 0,443566 | 0,360414 | 0,007149 | 0,739504 |
| AKAZE | 705 | 848 | 0,068016 | 0,052327 | 0,003719 | 0,000291 | 0,079091 | 0,10331 | 0,009109 | 0,124354 |

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.