

Supplemental Material for Video Segmentation with Background Motion Models

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1 IRLS Details and Algorithm Parameters

Algorithm 1 gives the procedure used to optimize the background motion model as described in Section 4. **GetWeights** computes the residuals from the given model H^k and uses Equation 3 to compute the weight for each track in T . Similarly, **GetCost** computes the total cost (Equation 4). Finally, **WLS** uses a weighted-least-squares variant of the four-point algorithm to re-estimate each homography H_i^k in the model using the computed weights.

Algorithm 1 IRLS for model fitting

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procedure IRLS( $H^0, T$ )
   $s \leftarrow 1.0$  ▷ step size
   $k \leftarrow 0$  ▷ iteration number
   $\mathbf{w}^0 \leftarrow \text{GetWeights}(H^0, T)$  ▷ initialize weights
  repeat
     $\mathbf{w}^{k+1} \leftarrow (1 - s)\mathbf{w}^k + s * \text{GetWeights}(H^k, T)$  ▷ update weights
     $H^{k+1} \leftarrow \text{WLS}(\mathbf{w}^{k+1}, T)$  ▷ update model
     $\text{cost} \leftarrow \text{GetCost}(H^{k+1}, T)$  ▷ compute cost of new model
    if the cost decreased then
       $k \leftarrow k + 1$  ▷ advance one iteration
       $s \leftarrow \min(4s, 1)$  ▷ increase step size
    else
       $s \leftarrow s/4$  ▷ retry with a smaller step size
    end if
  until convergence
end procedure

```

Table 1 gives all parameters used in our method.

| Parameter | Value | Description |
|------------------------------|--|---|
| | 8 | Track spacing (a parameter to \mathbf{Q}). |
| | 5 | Minimum track duration |
| τ | 4 | Inlier threshold (Equations 2–4). |
| λ_u | 100 | Unary cost weight (Equation 7). |
| λ_s | 0.001 | Smoothness cost weight (Equation 7). |
| $(s_{xy}, s_t, s_L, s_{uv})$ | $(\frac{1}{35}, \frac{1}{10}, \frac{1}{7.3}, \frac{1}{8.5})$ | Scales applied to lifted pixel coordinates before splatting. |
| $(w_{xy}, w_t, w_L, w_{uv})$ | (0.5, 0.5, 1.3, 1.5) | Weights on dimension distances in smoothness term (Equation 7). |
| $r_{\text{textureless}}$ | 32 | Distance before textureless prior is applied |
| $w_{\text{textureless}}$ | 32 | Foreground cost applied for each synthetic observation |
| | 8 | Spacing of synthetic textureless prior observations |
| | 0.25 | Threshold on sliced segmentation |

Table 1: A complete list of parameter settings used in our system.

2 Full results tables

This section includes tables for all relevant metrics from the DAVIS benchmark; see \mathbf{Q} for details on how the metrics are computed.

References

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Table 2: Jaccard (Mean)

| | NLC [█] | CVOS [█] | TRC [█] | MSG [█] | KEY [█] | SAL [█] | FST [█] | Ours |
|--------------------|--------------|--------------|--------------|--------------|--------------|---------|--------------|--------------|
| bear | 0.906 | 0.864 | 0.873 | 0.851 | 0.891 | 0.657 | 0.898 | 0.935 |
| blackswan | 0.874 | 0.422 | 0.569 | 0.526 | 0.842 | 0.222 | 0.732 | 0.231 |
| bmw-bumps | 0.635 | 0.368 | 0.350 | 0.353 | 0.309 | 0.188 | 0.241 | 0.388 |
| bmw-trees | 0.212 | 0.121 | 0.162 | 0.188 | 0.193 | 0.194 | 0.180 | 0.416 |
| boat | 0.007 | 0.056 | 0.130 | 0.144 | 0.065 | 0.271 | 0.361 | 0.317 |
| breakdance | 0.673 | 0.183 | 0.114 | 0.237 | 0.549 | 0.422 | 0.467 | 0.481 |
| breakdance-flare | 0.804 | 0.317 | 0.245 | 0.157 | 0.559 | 0.476 | 0.616 | 0.825 |
| bus | 0.629 | 0.664 | 0.684 | 0.885 | 0.785 | 0.739 | 0.825 | 0.889 |
| camel | 0.768 | 0.850 | 0.778 | 0.756 | 0.579 | 0.320 | 0.562 | 0.909 |
| car-roundabout | 0.509 | 0.871 | 0.552 | 0.630 | 0.640 | 0.500 | 0.808 | 0.833 |
| car-shadow | 0.645 | 0.759 | 0.449 | 0.880 | 0.589 | 0.538 | 0.698 | 0.786 |
| car-turn | 0.833 | 0.820 | 0.805 | 0.621 | 0.806 | 0.611 | 0.851 | 0.847 |
| cows | 0.883 | 0.562 | 0.833 | 0.799 | 0.337 | 0.623 | 0.791 | 0.814 |
| dance-jump | 0.718 | 0.341 | 0.303 | 0.065 | 0.748 | 0.291 | 0.598 | 0.678 |
| dance-twirl | 0.347 | 0.452 | 0.366 | 0.366 | 0.380 | 0.372 | 0.453 | 0.786 |
| dog | 0.809 | 0.753 | 0.786 | 0.331 | 0.692 | 0.566 | 0.708 | 0.831 |
| dog-agility | 0.652 | 0.193 | 0.138 | 0.110 | 0.132 | 0.055 | 0.280 | 0.050 |
| drift-chicane | 0.324 | 0.313 | 0.722 | 0.758 | 0.188 | 0.244 | 0.667 | 0.642 |
| drift-straight | 0.473 | 0.344 | 0.431 | 0.575 | 0.194 | 0.268 | 0.683 | 0.303 |
| drift-turn | 0.154 | 0.615 | 0.412 | 0.638 | 0.255 | 0.349 | 0.533 | 0.446 |
| elephant | 0.518 | 0.494 | 0.760 | 0.689 | 0.675 | 0.510 | 0.824 | 0.851 |
| flamingo | 0.539 | 0.783 | 0.731 | 0.794 | 0.692 | 0.570 | 0.817 | 0.854 |
| goat | 0.010 | 0.074 | 0.793 | 0.736 | 0.705 | 0.257 | 0.554 | 0.185 |
| hike | 0.918 | 0.878 | 0.756 | 0.603 | 0.895 | 0.683 | 0.889 | 0.930 |
| hockey | 0.810 | 0.817 | 0.674 | 0.713 | 0.515 | 0.566 | 0.468 | 0.875 |
| horsejump-high | 0.834 | 0.830 | 0.364 | 0.734 | 0.370 | 0.568 | 0.578 | 0.795 |
| horsejump-low | 0.651 | 0.743 | 0.705 | 0.682 | 0.630 | 0.388 | 0.526 | 0.740 |
| kite-surf | 0.453 | 0.357 | 0.501 | 0.419 | 0.585 | 0.193 | 0.272 | 0.135 |
| kite-walk | 0.813 | 0.447 | 0.052 | 0.597 | 0.197 | 0.725 | 0.649 | 0.691 |
| libby | 0.635 | 0.169 | 0.073 | 0.050 | 0.611 | 0.470 | 0.507 | 0.087 |
| lucia | 0.876 | 0.840 | 0.669 | 0.417 | 0.847 | 0.706 | 0.644 | 0.913 |
| mallard-fly | 0.617 | 0.380 | 0.293 | 0.033 | 0.585 | 0.227 | 0.601 | 0.144 |
| mallard-water | 0.761 | 0.245 | 0.190 | 0.045 | 0.785 | 0.085 | 0.087 | 0.045 |
| motocross-bumps | 0.614 | 0.603 | 0.502 | 0.466 | 0.689 | 0.351 | 0.617 | 0.787 |
| motocross-jump | 0.251 | 0.245 | 0.338 | 0.618 | 0.288 | 0.491 | 0.602 | 0.395 |
| motorbike | 0.714 | 0.387 | 0.723 | 0.737 | 0.572 | 0.335 | 0.558 | 0.766 |
| paragliding | 0.880 | 0.890 | 0.816 | 0.933 | 0.861 | 0.568 | 0.725 | 0.933 |
| paragliding-launch | 0.628 | 0.591 | 0.555 | 0.513 | 0.559 | 0.539 | 0.506 | 0.636 |
| parkour | 0.901 | 0.146 | 0.345 | 0.295 | 0.410 | 0.392 | 0.458 | 0.148 |
| rhino | 0.682 | 0.520 | 0.846 | 0.902 | 0.675 | 0.685 | 0.776 | 0.571 |
| rollerblade | 0.814 | 0.406 | 0.566 | 0.801 | 0.510 | 0.141 | 0.318 | 0.845 |
| scooter-black | 0.162 | 0.759 | 0.435 | 0.579 | 0.502 | 0.348 | 0.522 | 0.622 |
| scooter-gray | 0.586 | 0.327 | 0.357 | 0.345 | 0.363 | 0.421 | 0.325 | 0.719 |
| soapbox | 0.634 | 0.832 | 0.294 | 0.672 | 0.757 | 0.332 | 0.410 | 0.787 |
| soccerball | 0.829 | 0.242 | 0.350 | 0.370 | 0.878 | 0.378 | 0.843 | 0.809 |
| stroller | 0.850 | 0.619 | 0.720 | 0.678 | 0.759 | 0.466 | 0.580 | 0.429 |
| surf | 0.775 | 0.273 | 0.464 | 0.770 | 0.893 | 0.312 | 0.475 | 0.681 |
| swing | 0.851 | 0.533 | 0.413 | 0.622 | 0.710 | 0.569 | 0.431 | 0.804 |
| tennis | 0.871 | 0.494 | 0.196 | 0.590 | 0.762 | 0.480 | 0.388 | 0.820 |
| train | 0.729 | 0.903 | 0.876 | 0.887 | 0.450 | 0.620 | 0.831 | 0.868 |
| Average | 0.641 | 0.514 | 0.501 | 0.543 | 0.569 | 0.426 | 0.575 | 0.625 |
| Best | 13 | 5 | 1 | 5 | 5 | 0 | 3 | 18 |

Table 3: Jaccard (Recall)

| | NLC [■] | CVOS [■] | TRC [■] | MSG [■] | KEY [■] | SAL [■] | FST [■] | Ours |
|--------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| bear | 1.000 | 0.938 | 1.000 | 1.000 | 1.000 | 0.738 | 1.000 | 1.000 |
| blackswan | 1.000 | 0.042 | 0.979 | 0.708 | 1.000 | 0.000 | 1.000 | 0.000 |
| bmx-bumps | 0.773 | 0.500 | 0.398 | 0.307 | 0.182 | 0.148 | 0.239 | 0.466 |
| bmx-trees | 0.000 | 0.179 | 0.038 | 0.244 | 0.000 | 0.000 | 0.064 | 0.295 |
| boat | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| breakdance | 0.976 | 0.207 | 0.073 | 0.293 | 0.756 | 0.171 | 0.390 | 0.439 |
| breakdance-flare | 1.000 | 0.333 | 0.145 | 0.000 | 0.768 | 0.362 | 0.783 | 1.000 |
| bus | 0.718 | 0.705 | 0.731 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| camel | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.000 | 0.636 | 1.000 |
| car-roundabout | 0.616 | 1.000 | 0.575 | 0.644 | 0.849 | 0.521 | 1.000 | 1.000 |
| car-shadow | 0.763 | 1.000 | 0.105 | 1.000 | 0.632 | 0.658 | 0.974 | 1.000 |
| car-turn | 1.000 | 1.000 | 0.923 | 0.654 | 1.000 | 0.808 | 1.000 | 1.000 |
| cows | 1.000 | 0.686 | 1.000 | 1.000 | 0.392 | 1.000 | 1.000 | 1.000 |
| dance-jump | 1.000 | 0.431 | 0.328 | 0.000 | 1.000 | 0.052 | 0.793 | 1.000 |
| dance-twirl | 0.034 | 0.636 | 0.250 | 0.386 | 0.295 | 0.000 | 0.375 | 1.000 |
| dog | 1.000 | 0.810 | 1.000 | 0.448 | 1.000 | 0.828 | 1.000 | 1.000 |
| dog-agility | 1.000 | 0.087 | 0.000 | 0.000 | 0.000 | 0.000 | 0.217 | 0.000 |
| drift-chicane | 0.000 | 0.080 | 0.840 | 1.000 | 0.000 | 0.000 | 0.840 | 0.840 |
| drift-straight | 0.521 | 0.333 | 0.583 | 0.646 | 0.083 | 0.104 | 0.979 | 0.271 |
| drift-turn | 0.000 | 0.790 | 0.290 | 0.726 | 0.226 | 0.048 | 0.500 | 0.258 |
| elephant | 0.615 | 0.615 | 1.000 | 1.000 | 1.000 | 0.538 | 1.000 | 1.000 |
| flamingo | 0.372 | 0.974 | 1.000 | 1.000 | 1.000 | 0.885 | 1.000 | 1.000 |
| goat | 0.000 | 0.000 | 1.000 | 1.000 | 1.000 | 0.000 | 0.943 | 0.000 |
| hike | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| hockey | 1.000 | 1.000 | 1.000 | 0.973 | 0.630 | 0.877 | 0.342 | 1.000 |
| horsejump-high | 1.000 | 1.000 | 0.479 | 1.000 | 0.292 | 0.688 | 0.708 | 1.000 |
| horsejump-low | 0.897 | 0.983 | 1.000 | 1.000 | 1.000 | 0.103 | 0.776 | 1.000 |
| kite-surf | 0.188 | 0.562 | 0.583 | 0.292 | 0.938 | 0.000 | 0.021 | 0.000 |
| kite-walk | 1.000 | 0.500 | 0.000 | 0.949 | 0.295 | 1.000 | 1.000 | 0.833 |
| libby | 0.660 | 0.191 | 0.000 | 0.000 | 0.745 | 0.596 | 0.489 | 0.000 |
| lucia | 1.000 | 1.000 | 0.662 | 0.176 | 1.000 | 1.000 | 0.868 | 1.000 |
| mallard-fly | 0.632 | 0.456 | 0.338 | 0.000 | 0.588 | 0.015 | 0.618 | 0.000 |
| mallard-water | 1.000 | 0.269 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 |
| motocross-bumps | 0.741 | 0.741 | 0.552 | 0.603 | 0.793 | 0.069 | 0.707 | 1.000 |
| motocross-jump | 0.000 | 0.316 | 0.263 | 0.658 | 0.289 | 0.421 | 0.816 | 0.237 |
| motorbike | 1.000 | 0.512 | 1.000 | 1.000 | 0.488 | 0.220 | 0.732 | 1.000 |
| paragliding | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.544 | 0.794 | 1.000 |
| paragliding-launch | 0.654 | 0.615 | 0.641 | 0.564 | 0.615 | 0.577 | 0.487 | 0.667 |
| parkour | 1.000 | 0.143 | 0.133 | 0.276 | 0.255 | 0.224 | 0.469 | 0.000 |
| rhino | 1.000 | 0.625 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.966 |
| rollerblade | 1.000 | 0.303 | 0.818 | 1.000 | 0.515 | 0.000 | 0.000 | 1.000 |
| scooter-black | 0.000 | 1.000 | 0.317 | 0.463 | 0.683 | 0.122 | 0.439 | 0.732 |
| scooter-gray | 0.822 | 0.466 | 0.425 | 0.438 | 0.192 | 0.233 | 0.260 | 1.000 |
| soapbox | 0.753 | 1.000 | 0.000 | 0.691 | 1.000 | 0.082 | 0.351 | 1.000 |
| soccerball | 0.913 | 0.283 | 0.370 | 0.391 | 1.000 | 0.239 | 1.000 | 0.913 |
| stroller | 1.000 | 0.775 | 1.000 | 0.989 | 1.000 | 0.303 | 0.719 | 0.135 |
| surf | 0.906 | 0.000 | 0.396 | 0.811 | 0.925 | 0.057 | 0.566 | 0.943 |
| swing | 1.000 | 0.655 | 0.638 | 0.724 | 1.000 | 0.793 | 0.483 | 1.000 |
| tennis | 1.000 | 0.324 | 0.147 | 0.735 | 0.809 | 0.397 | 0.221 | 1.000 |
| train | 1.000 | 0.987 | 1.000 | 1.000 | 0.321 | 0.885 | 1.000 | 1.000 |
| Average | 0.731 | 0.581 | 0.560 | 0.636 | 0.671 | 0.386 | 0.652 | 0.700 |
| Best | 28 | 13 | 16 | 18 | 23 | 7 | 17 | 31 |

Table 4: Boundary (F), mean

| | NLC [█] | CVOS [█] | TRC [█] | MSG [█] | KEY [█] | SAL [█] | FST [█] | Ours |
|--------------------|--------------|--------------|--------------|--------------|--------------|---------|--------------|--------------|
| bear | 0.850 | 0.845 | 0.832 | 0.781 | 0.775 | 0.495 | 0.860 | 0.869 |
| blackswan | 0.820 | 0.695 | 0.654 | 0.700 | 0.787 | 0.430 | 0.736 | 0.411 |
| bmw-bumps | 0.734 | 0.409 | 0.325 | 0.410 | 0.453 | 0.313 | 0.349 | 0.448 |
| bmw-trees | 0.330 | 0.118 | 0.189 | 0.263 | 0.366 | 0.206 | 0.348 | 0.658 |
| boat | 0.036 | 0.108 | 0.403 | 0.485 | 0.000 | 0.264 | 0.197 | 0.467 |
| breakdance | 0.661 | 0.191 | 0.121 | 0.231 | 0.463 | 0.300 | 0.411 | 0.382 |
| breakdance-flare | 0.808 | 0.335 | 0.301 | 0.230 | 0.585 | 0.512 | 0.694 | 0.866 |
| bus | 0.406 | 0.535 | 0.542 | 0.657 | 0.635 | 0.570 | 0.584 | 0.800 |
| camel | 0.719 | 0.873 | 0.698 | 0.629 | 0.437 | 0.432 | 0.590 | 0.883 |
| car-roundabout | 0.250 | 0.678 | 0.451 | 0.602 | 0.362 | 0.301 | 0.625 | 0.592 |
| car-shadow | 0.546 | 0.617 | 0.474 | 0.858 | 0.459 | 0.441 | 0.540 | 0.599 |
| car-turn | 0.634 | 0.703 | 0.741 | 0.677 | 0.632 | 0.485 | 0.731 | 0.658 |
| cows | 0.807 | 0.499 | 0.721 | 0.621 | 0.293 | 0.499 | 0.681 | 0.755 |
| dance-jump | 0.567 | 0.282 | 0.272 | 0.038 | 0.569 | 0.262 | 0.462 | 0.540 |
| dance-twirl | 0.365 | 0.444 | 0.376 | 0.325 | 0.317 | 0.301 | 0.471 | 0.645 |
| dog | 0.707 | 0.761 | 0.695 | 0.304 | 0.633 | 0.418 | 0.659 | 0.611 |
| dog-agility | 0.551 | 0.262 | 0.122 | 0.076 | 0.095 | 0.102 | 0.265 | 0.130 |
| drift-chicane | 0.312 | 0.397 | 0.823 | 0.886 | 0.192 | 0.206 | 0.731 | 0.726 |
| drift-straight | 0.385 | 0.330 | 0.408 | 0.509 | 0.053 | 0.167 | 0.470 | 0.170 |
| drift-turn | 0.185 | 0.480 | 0.310 | 0.459 | 0.018 | 0.231 | 0.442 | 0.301 |
| elephant | 0.251 | 0.359 | 0.546 | 0.505 | 0.324 | 0.231 | 0.569 | 0.682 |
| flamingo | 0.610 | 0.806 | 0.663 | 0.776 | 0.589 | 0.621 | 0.763 | 0.805 |
| goat | 0.133 | 0.241 | 0.724 | 0.657 | 0.552 | 0.187 | 0.400 | 0.376 |
| hike | 0.943 | 0.922 | 0.804 | 0.702 | 0.925 | 0.691 | 0.918 | 0.938 |
| hockey | 0.808 | 0.789 | 0.651 | 0.761 | 0.560 | 0.559 | 0.584 | 0.889 |
| horsejump-high | 0.881 | 0.841 | 0.405 | 0.748 | 0.392 | 0.613 | 0.621 | 0.824 |
| horsejump-low | 0.659 | 0.709 | 0.672 | 0.637 | 0.533 | 0.419 | 0.490 | 0.722 |
| kite-surf | 0.448 | 0.241 | 0.422 | 0.521 | 0.504 | 0.368 | 0.346 | 0.347 |
| kite-walk | 0.662 | 0.438 | 0.014 | 0.577 | 0.128 | 0.526 | 0.561 | 0.791 |
| libby | 0.748 | 0.185 | 0.086 | 0.118 | 0.730 | 0.529 | 0.718 | 0.231 |
| lucia | 0.872 | 0.801 | 0.663 | 0.491 | 0.819 | 0.691 | 0.568 | 0.906 |
| mallard-fly | 0.660 | 0.391 | 0.332 | 0.019 | 0.631 | 0.293 | 0.633 | 0.259 |
| mallard-water | 0.692 | 0.254 | 0.225 | 0.000 | 0.733 | 0.115 | 0.079 | 0.060 |
| motocross-bumps | 0.560 | 0.567 | 0.497 | 0.466 | 0.674 | 0.300 | 0.610 | 0.591 |
| motocross-jump | 0.303 | 0.186 | 0.307 | 0.393 | 0.237 | 0.388 | 0.453 | 0.339 |
| motorbike | 0.571 | 0.380 | 0.541 | 0.594 | 0.726 | 0.391 | 0.585 | 0.754 |
| paragliding | 0.744 | 0.744 | 0.724 | 0.909 | 0.681 | 0.541 | 0.675 | 0.857 |
| paragliding-launch | 0.243 | 0.182 | 0.157 | 0.196 | 0.253 | 0.169 | 0.185 | 0.286 |
| parkour | 0.916 | 0.158 | 0.421 | 0.401 | 0.374 | 0.359 | 0.478 | 0.231 |
| rhino | 0.431 | 0.469 | 0.739 | 0.826 | 0.429 | 0.487 | 0.634 | 0.467 |
| rollerblade | 0.868 | 0.475 | 0.687 | 0.822 | 0.351 | 0.211 | 0.411 | 0.784 |
| scooter-black | 0.228 | 0.557 | 0.304 | 0.565 | 0.420 | 0.257 | 0.395 | 0.479 |
| scooter-gray | 0.467 | 0.212 | 0.266 | 0.272 | 0.367 | 0.333 | 0.321 | 0.564 |
| soapbox | 0.658 | 0.754 | 0.389 | 0.633 | 0.719 | 0.307 | 0.355 | 0.674 |
| soccerball | 0.855 | 0.262 | 0.377 | 0.401 | 0.924 | 0.355 | 0.900 | 0.849 |
| stroller | 0.874 | 0.606 | 0.691 | 0.662 | 0.751 | 0.417 | 0.558 | 0.485 |
| surf | 0.673 | 0.515 | 0.637 | 0.804 | 0.820 | 0.395 | 0.445 | 0.585 |
| swing | 0.778 | 0.493 | 0.417 | 0.611 | 0.614 | 0.502 | 0.491 | 0.758 |
| tennis | 0.927 | 0.547 | 0.301 | 0.670 | 0.818 | 0.530 | 0.567 | 0.853 |
| train | 0.521 | 0.831 | 0.766 | 0.770 | 0.464 | 0.440 | 0.660 | 0.735 |
| Average | 0.593 | 0.490 | 0.478 | 0.525 | 0.503 | 0.383 | 0.536 | 0.593 |
| Best | 14 | 6 | 2 | 8 | 5 | 0 | 1 | 14 |

Table 5: F (boundary) recall

| | NLC [□] | CVOS [□] | TRC [□] | MSG [□] | KEY [□] | SAL [□] | FST [□] | Ours |
|--------------------|--------------|--------------|--------------|--------------|--------------|---------|--------------|--------------|
| bear | 1.000 | 0.938 | 1.000 | 1.000 | 1.000 | 0.662 | 1.000 | 1.000 |
| blackswan | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.062 | 1.000 | 0.000 |
| bmx-bumps | 0.795 | 0.523 | 0.170 | 0.477 | 0.523 | 0.250 | 0.364 | 0.477 |
| bmx-trees | 0.179 | 0.192 | 0.167 | 0.308 | 0.115 | 0.000 | 0.154 | 0.962 |
| boat | 0.000 | 0.000 | 0.000 | 0.247 | 0.000 | 0.000 | 0.000 | 0.233 |
| breakdance | 0.951 | 0.220 | 0.110 | 0.293 | 0.317 | 0.000 | 0.049 | 0.049 |
| breakdance-flare | 1.000 | 0.348 | 0.130 | 0.000 | 0.855 | 0.594 | 0.884 | 1.000 |
| bus | 0.397 | 0.513 | 0.500 | 0.551 | 1.000 | 0.808 | 0.667 | 1.000 |
| camel | 1.000 | 1.000 | 1.000 | 0.955 | 0.125 | 0.091 | 0.773 | 1.000 |
| car-roundabout | 0.000 | 1.000 | 0.137 | 0.863 | 0.055 | 0.000 | 0.904 | 0.808 |
| car-shadow | 0.816 | 0.842 | 0.368 | 1.000 | 0.579 | 0.184 | 0.632 | 0.974 |
| car-turn | 1.000 | 0.936 | 0.987 | 0.936 | 0.808 | 0.449 | 1.000 | 1.000 |
| cows | 1.000 | 0.686 | 1.000 | 0.961 | 0.392 | 0.500 | 1.000 | 1.000 |
| dance-jump | 0.828 | 0.328 | 0.121 | 0.000 | 0.828 | 0.000 | 0.259 | 0.776 |
| dance-twirl | 0.114 | 0.614 | 0.091 | 0.318 | 0.000 | 0.011 | 0.466 | 1.000 |
| dog | 1.000 | 0.948 | 1.000 | 0.086 | 0.931 | 0.121 | 1.000 | 0.948 |
| dog-agility | 0.652 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| drift-chicane | 0.040 | 0.380 | 0.840 | 1.000 | 0.000 | 0.000 | 0.900 | 1.000 |
| drift-straight | 0.333 | 0.167 | 0.458 | 0.604 | 0.000 | 0.000 | 0.458 | 0.000 |
| drift-turn | 0.000 | 0.645 | 0.194 | 0.339 | 0.000 | 0.000 | 0.387 | 0.000 |
| elephant | 0.000 | 0.462 | 0.795 | 0.615 | 0.077 | 0.000 | 0.821 | 1.000 |
| flamingo | 1.000 | 1.000 | 1.000 | 1.000 | 0.872 | 0.923 | 1.000 | 1.000 |
| goat | 0.000 | 0.023 | 1.000 | 0.989 | 0.568 | 0.000 | 0.057 | 0.000 |
| hike | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.936 | 1.000 | 1.000 |
| hockey | 1.000 | 1.000 | 0.904 | 1.000 | 1.000 | 0.808 | 0.932 | 1.000 |
| horsejump-high | 1.000 | 1.000 | 0.500 | 0.979 | 0.354 | 0.854 | 0.875 | 1.000 |
| horsejump-low | 0.914 | 0.966 | 1.000 | 1.000 | 0.621 | 0.155 | 0.397 | 1.000 |
| kite-surf | 0.167 | 0.125 | 0.146 | 0.625 | 0.479 | 0.042 | 0.000 | 0.000 |
| kite-walk | 1.000 | 0.449 | 0.000 | 0.718 | 0.000 | 0.590 | 0.782 | 1.000 |
| libby | 0.851 | 0.255 | 0.000 | 0.000 | 0.936 | 0.660 | 0.936 | 0.000 |
| lucia | 1.000 | 1.000 | 0.868 | 0.382 | 1.000 | 0.985 | 0.750 | 1.000 |
| mallard-fly | 0.750 | 0.456 | 0.353 | 0.000 | 0.647 | 0.000 | 0.603 | 0.000 |
| mallard-water | 1.000 | 0.231 | 0.026 | 0.000 | 1.000 | 0.000 | 0.000 | 0.000 |
| motocross-bumps | 0.690 | 0.655 | 0.466 | 0.517 | 0.879 | 0.034 | 0.655 | 0.914 |
| motocross-jump | 0.132 | 0.158 | 0.158 | 0.447 | 0.184 | 0.316 | 0.500 | 0.105 |
| motorbike | 0.707 | 0.512 | 0.659 | 0.659 | 1.000 | 0.220 | 0.878 | 1.000 |
| paragliding | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.456 | 0.779 | 1.000 |
| paragliding-launch | 0.038 | 0.013 | 0.000 | 0.000 | 0.038 | 0.000 | 0.000 | 0.077 |
| parkour | 1.000 | 0.184 | 0.439 | 0.347 | 0.235 | 0.224 | 0.500 | 0.000 |
| rhino | 0.011 | 0.625 | 0.977 | 1.000 | 0.000 | 0.398 | 1.000 | 0.273 |
| rollerblade | 1.000 | 0.576 | 1.000 | 1.000 | 0.121 | 0.000 | 0.121 | 1.000 |
| scooter-black | 0.000 | 0.707 | 0.122 | 0.537 | 0.195 | 0.000 | 0.122 | 0.488 |
| scooter-gray | 0.329 | 0.082 | 0.233 | 0.164 | 0.068 | 0.014 | 0.000 | 0.767 |
| soapbox | 0.763 | 1.000 | 0.186 | 0.691 | 1.000 | 0.021 | 0.000 | 0.990 |
| soccerball | 0.913 | 0.283 | 0.391 | 0.391 | 1.000 | 0.087 | 1.000 | 0.913 |
| stroller | 1.000 | 0.775 | 1.000 | 1.000 | 1.000 | 0.124 | 0.618 | 0.461 |
| surf | 0.887 | 0.830 | 0.642 | 0.981 | 0.887 | 0.283 | 0.453 | 0.906 |
| swing | 1.000 | 0.655 | 0.569 | 0.759 | 0.983 | 0.500 | 0.517 | 1.000 |
| tennis | 1.000 | 0.618 | 0.265 | 0.926 | 0.882 | 0.632 | 0.735 | 1.000 |
| train | 0.641 | 0.987 | 1.000 | 1.000 | 0.154 | 0.218 | 1.000 | 1.000 |
| Average | 0.658 | 0.578 | 0.519 | 0.613 | 0.534 | 0.264 | 0.579 | 0.662 |
| Best | 25 | 12 | 13 | 17 | 14 | 0 | 12 | 26 |

Table 6: Temporal Stability (T) mean. Note that nans appear as a result of running the code provided by [6].

| | NLC [6] | CVOS [6] | TRC [6] | MSG [6] | KEY [6] | SAL [6] | FST [6] | Ours |
|--------------------|--------------|--------------|--------------|--------------|--------------|---------|---------|--------------|
| bear | 0.151 | 0.059 | 0.272 | 0.156 | 0.068 | 0.448 | 0.227 | 0.106 |
| blackswan | 0.110 | 0.058 | 0.219 | 0.145 | 0.048 | 0.660 | 0.225 | 0.069 |
| bmw-bumps | nan | nan | nan | nan | nan | nan | nan | nan |
| bmw-trees | nan | nan | nan | nan | nan | nan | nan | nan |
| boat | 0.557 | 1.213 | 0.350 | 0.163 | 0.015 | 0.382 | 0.177 | 0.485 |
| breakdance | nan | nan | nan | nan | nan | nan | nan | nan |
| breakdance-flare | nan | nan | nan | nan | nan | nan | nan | nan |
| bus | 0.178 | 0.146 | 0.194 | 0.154 | 0.143 | 0.369 | 0.270 | 0.244 |
| camel | 0.232 | 0.123 | 0.173 | 0.129 | 0.138 | 0.380 | 0.161 | 0.127 |
| car-roundabout | 0.352 | 0.064 | 0.382 | 0.291 | 0.160 | 0.536 | 0.242 | 0.152 |
| car-shadow | 0.361 | 0.180 | 0.452 | 0.206 | 0.314 | 0.793 | 0.353 | 0.207 |
| car-turn | 0.236 | 0.118 | 0.201 | 0.204 | 0.108 | 0.566 | 0.214 | 0.100 |
| cows | 0.147 | 0.133 | 0.148 | 0.195 | 0.412 | 0.511 | 0.281 | 0.133 |
| dance-jump | 0.318 | 0.459 | 0.576 | 0.000 | 0.214 | 0.586 | 0.241 | 0.316 |
| dance-twirl | nan | nan | nan | nan | nan | nan | nan | nan |
| dog | nan | nan | nan | nan | nan | nan | nan | nan |
| dog-agility | nan | nan | nan | nan | nan | nan | nan | nan |
| drift-chicane | nan | nan | nan | nan | nan | nan | nan | nan |
| drift-straight | 0.597 | 0.828 | 0.683 | 0.450 | 0.291 | 0.950 | 0.482 | 0.488 |
| drift-turn | 0.850 | 0.334 | 0.475 | 0.403 | 0.150 | 1.002 | 0.258 | 0.433 |
| elephant | 0.315 | 0.118 | 0.236 | 0.236 | 0.085 | 0.426 | 0.139 | 0.152 |
| flamingo | 0.138 | 0.173 | 0.215 | 0.382 | 0.112 | 0.486 | 0.175 | 0.170 |
| goat | nan | nan | nan | nan | nan | nan | nan | nan |
| hike | 0.158 | 0.125 | 0.230 | 0.251 | 0.117 | 0.412 | 0.247 | 0.132 |
| hockey | 0.228 | 0.159 | 0.228 | 0.211 | 0.162 | 0.377 | 0.276 | 0.238 |
| horsejump-high | nan | nan | nan | nan | nan | nan | nan | nan |
| horsejump-low | nan | nan | nan | nan | nan | nan | nan | nan |
| kite-surf | 0.942 | 0.249 | 0.432 | 0.507 | 0.234 | 0.568 | 0.404 | 0.197 |
| kite-walk | 0.221 | 0.127 | 0.002 | 0.328 | 0.366 | 0.356 | 0.301 | 0.427 |
| libby | nan | nan | nan | nan | nan | nan | nan | nan |
| lucia | nan | nan | nan | nan | nan | nan | nan | nan |
| mallard-fly | nan | nan | nan | nan | nan | nan | nan | nan |
| mallard-water | 0.242 | 0.394 | 0.641 | 0.000 | 0.184 | 1.070 | 0.230 | 0.596 |
| motocross-bumps | 0.542 | 0.327 | 0.566 | 0.481 | 0.344 | 0.903 | 0.329 | 0.415 |
| motocross-jump | nan | nan | nan | nan | nan | nan | nan | nan |
| motorbike | nan | nan | nan | nan | nan | nan | nan | nan |
| paragliding | nan | nan | nan | nan | nan | nan | nan | nan |
| paragliding-launch | 0.257 | 0.273 | 0.347 | 0.331 | 0.213 | 0.602 | 0.703 | 0.207 |
| parkour | nan | nan | nan | nan | nan | nan | nan | nan |
| rhino | 0.188 | 0.064 | 0.153 | 0.093 | 0.056 | 0.390 | 0.138 | 0.100 |
| rollerblade | nan | nan | nan | nan | nan | nan | nan | nan |
| scooter-black | 0.761 | 0.320 | 0.577 | 0.364 | 0.514 | 0.790 | 0.475 | 0.694 |
| scooter-gray | nan | nan | nan | nan | nan | nan | nan | nan |
| soapbox | 0.389 | 0.154 | 0.412 | 0.214 | 0.161 | 0.613 | 0.158 | 0.211 |
| soccerball | nan | nan | nan | nan | nan | nan | nan | nan |
| stroller | 0.206 | 0.116 | 0.235 | 0.346 | 0.128 | 0.546 | 0.184 | 0.294 |
| surf | 0.364 | 0.168 | 0.375 | 0.223 | 0.086 | 1.093 | 0.398 | 0.323 |
| swing | nan | nan | nan | nan | nan | nan | nan | nan |
| tennis | nan | nan | nan | nan | nan | nan | nan | nan |
| train | 0.575 | 0.056 | 0.110 | 0.070 | 0.270 | 0.396 | 0.159 | 0.109 |
| Average | 0.356 | 0.242 | 0.329 | 0.242 | 0.189 | 0.600 | 0.276 | 0.264 |
| Best | 1 | 9 | 1 | 2 | 12 | 0 | 0 | 2 |

- [8] Brian Taylor, Vasily Karasev, and Stefano Soatto. Causal video object segmentation from persistence of occlusions. In *IEEE Conference on Computer Vision and Pattern Recognition, CVPR 2015, Boston, MA, USA, June 7-12, 2015*, 2015.
- [9] Wenguan Wang, Jianbing Shen, and F. Porikli. Saliency-aware geodesic video object segmentation. In *2015 IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, 2015.