Direct Sparse Odometry with Rolling Shutter –Supplementary Material–

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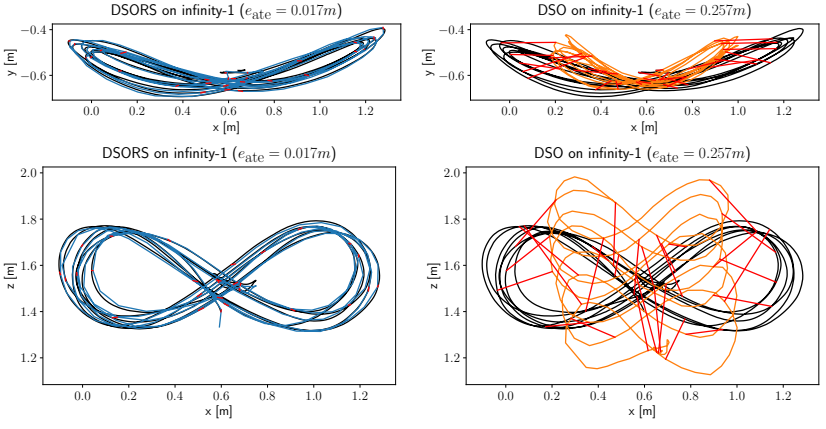
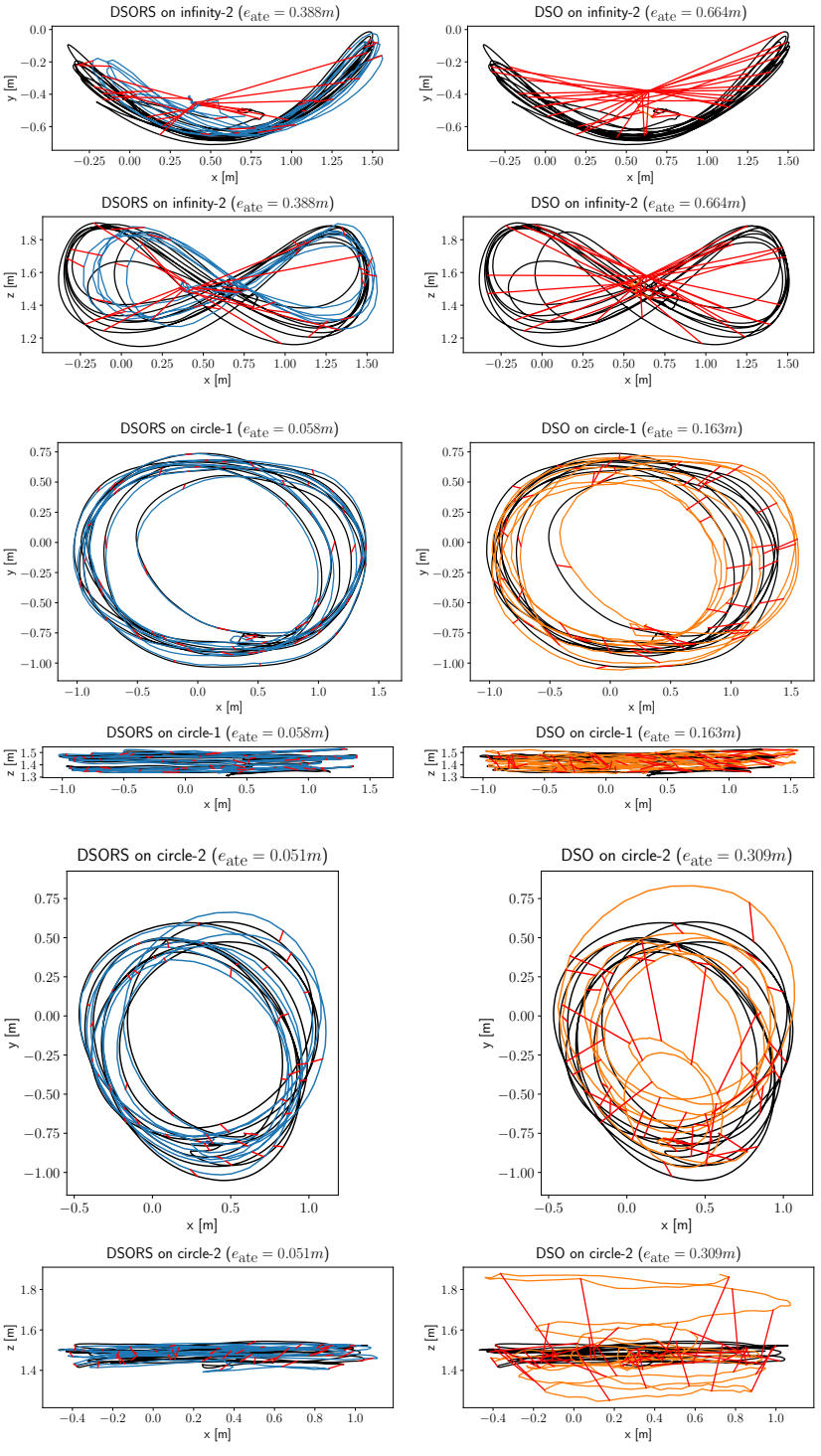
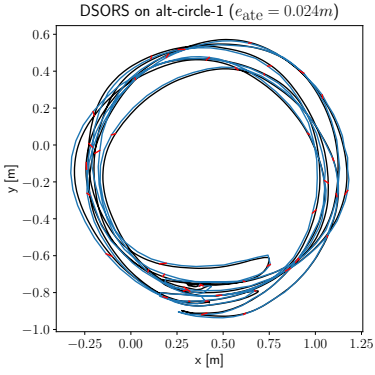
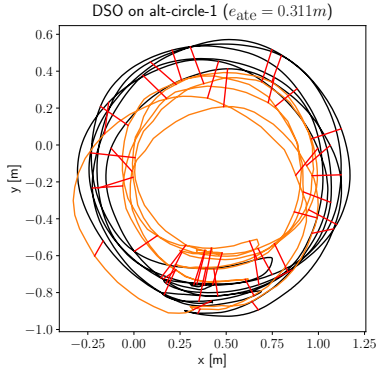
1 Additional Trajectory Plots

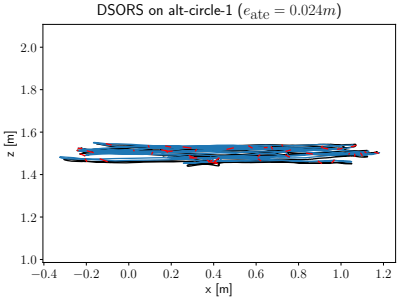
In the following, tracked trajectories (blue for DSORS, orange for DSO) together with ground truth trajectories (black) after Sim(3) alignment are shown. The red lines indicate the discrepancy between tracked and ground truth position of every 10^{th} keyframe. In order to provide representative examples, those runs (out of 20) with median error e_{ate} have been chosen for each sequence and algorithm. They are shown from two different perspectives each.

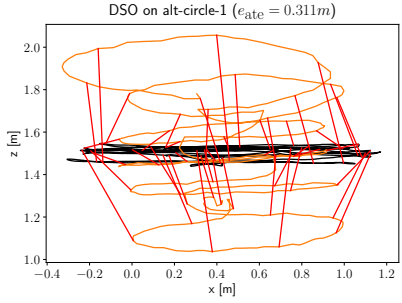


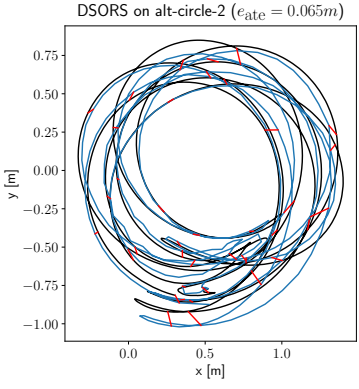

DSORS on infinity-2 ($e_{\text{ate}} = 0.388m$)
DSO on infinity-2 ($e_{\text{ate}} = 0.664m$)
DSORS on infinity-2 ($e_{\text{ate}} = 0.388m$)
DSO on infinity-2 ($e_{\text{ate}} = 0.664m$)
DSORS on circle-1 ($e_{\text{ate}} = 0.058m$)
DSO on circle-1 ($e_{\text{ate}} = 0.163m$)
DSORS on circle-1 ($e_{\text{ate}} = 0.058m$)
DSO on circle-1 ($e_{\text{ate}} = 0.163m$)
DSORS on circle-2 ($e_{\text{ate}} = 0.051m$)
DSO on circle-2 ($e_{\text{ate}} = 0.309m$)
DSORS on circle-2 ($e_{\text{ate}} = 0.051m$)
DSO on circle-2 ($e_{\text{ate}} = 0.309m$)
x [m]
y [m]
z [m]

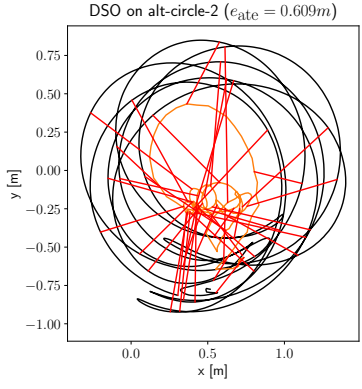

DSORS on alt-circle-1 ($e_{\text{ate}} = 0.024m$)
y [m]
x [m]

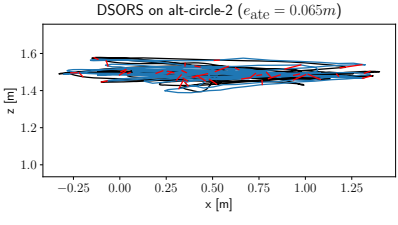

DSO on alt-circle-1 ($e_{\text{ate}} = 0.311m$)
y [m]
x [m]

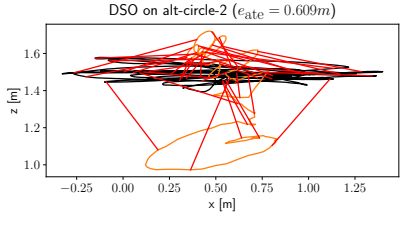

DSORS on alt-circle-1 ($e_{\text{ate}} = 0.024m$)
z [m]
x [m]


DSO on alt-circle-1 ($e_{\text{ate}} = 0.311m$)
z [m]
x [m]


DSORS on alt-circle-2 ($e_{\text{ate}} = 0.065m$)
y [m]
x [m]


DSO on alt-circle-2 ($e_{\text{ate}} = 0.609m$)
y [m]
x [m]


DSORS on alt-circle-2 ($e_{\text{ate}} = 0.065m$)
z [m]
x [m]


DSO on alt-circle-2 ($e_{\text{ate}} = 0.609m$)
z [m]
x [m]

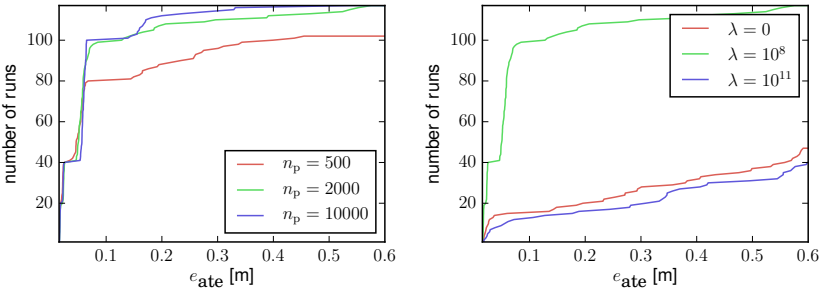


Fig. A. Cumulative histograms for our new dataset, run with DSORS using different velocity prior weights λ (right) and with different numbers of points n_{p} (left), the latter with $\lambda \propto n_{\text{p}}$ to keep the balance between energy terms.

2 Number of Points

Fig. A (left) shows that using more points can slightly increase stability for the unstable sequence, while not changing accuracy for the remaining sequences much. It also shows that in many cases, it is possible to obtain good results using only 500 points. Our choice of 2000 points seems like a good trade-off between stability and runtime.

3 Velocity Prior and Choice of Weight

Though a velocity prior can introduce a bias, Fig. A (right) shows that it is necessary to improve the stability of the method. It also shows that if the weight is too large, the method becomes unstable again. With our moderate choice of weight, the algorithm is still flexible enough to handle changes of direction (*alt-circle* sequences). The numerical value of λ seems rather large, but the numerical values of the velocities are very small, and the velocity prior energy has to be balanced with the photometric energy which contains many residuals. It would make sense to choose different weights for translational and rotational components of the velocity prior, but as we obtained good results without, we kept the number of parameters low to avoid overfitting to our sequences. In the context of up-to-scale estimation, the meaning of the translational weight is ambiguous and depends on scale initialization. Adaptively choosing the weights would be an interesting topic for future work.