Supplementary Material to "Adaptive Rank Estimate in Robust Principal Component Analysis"

In this document, we present more real data results which are not included in the main paper due to page limit.

1. More Results

We apply our method to the task of foreground-background separation in a video. The three video we have used for this test are *Backdoor*, *Blizzard* and *Highway* which can be found online[1]. The two video we have used for this test are *Bootstrap* and *Waving Trees* which can be found online[2]. The size of each frame of *Backdoor* is 320×240. The size of each frame of *Blizzard* is 720×480. The size of each frame of *Highway* is 320×240. The size of each frame of *Bootstrap* is 160×120. The size of each frame of *Waving Trees* is 160×120. The total number of frames are 228, 181, 293, 92, 58 in *Backdoor*, *Blizzard*, *Highway*, *Bootstrap* and *Waving Trees*, respectively. Each video can be represented by a matrix, where each column of the matrix is a vectorized frame of the video. In Figs. 1-5, we present the decomposition results of six selected frames for all test algorithm. If the constant regularization parameter C of WNNM set by [1], the algorithm cannot effectively separate the foreground and background in all experiments. Therefore, we use the exhaustive method to adjust the parameter C in the WNNM algorithm to the best. One can observe that both WNNM and ARE-RPCA can effectively remove moving objects, and ARE-RPCA handles ghosting better.

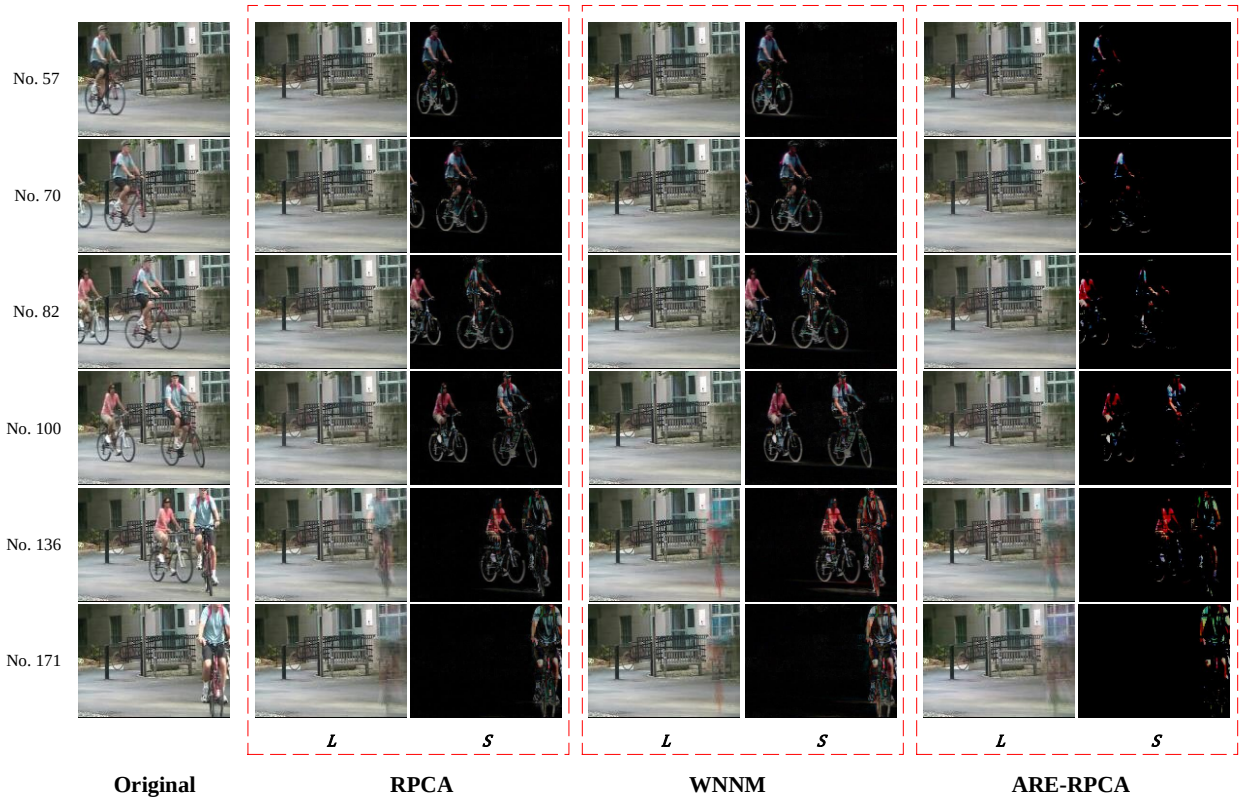

Figure 1 Results on *Backdoor* by different methods. The first column contains the original frames, the second and third columns are the separated background and foreground outputs of RPCA, the fourth and fifth columns are the separated background and foreground outputs of WNNM, the last two columns are the separated background and foreground outputs of ARE-RPCA.

[1] http://jacarini.dinf.usherbrooke.ca/dataset2014/.
[2] http://research.microsoft.com/en-us/um/people/jckrumm/WallFlower/TestImages.htm.

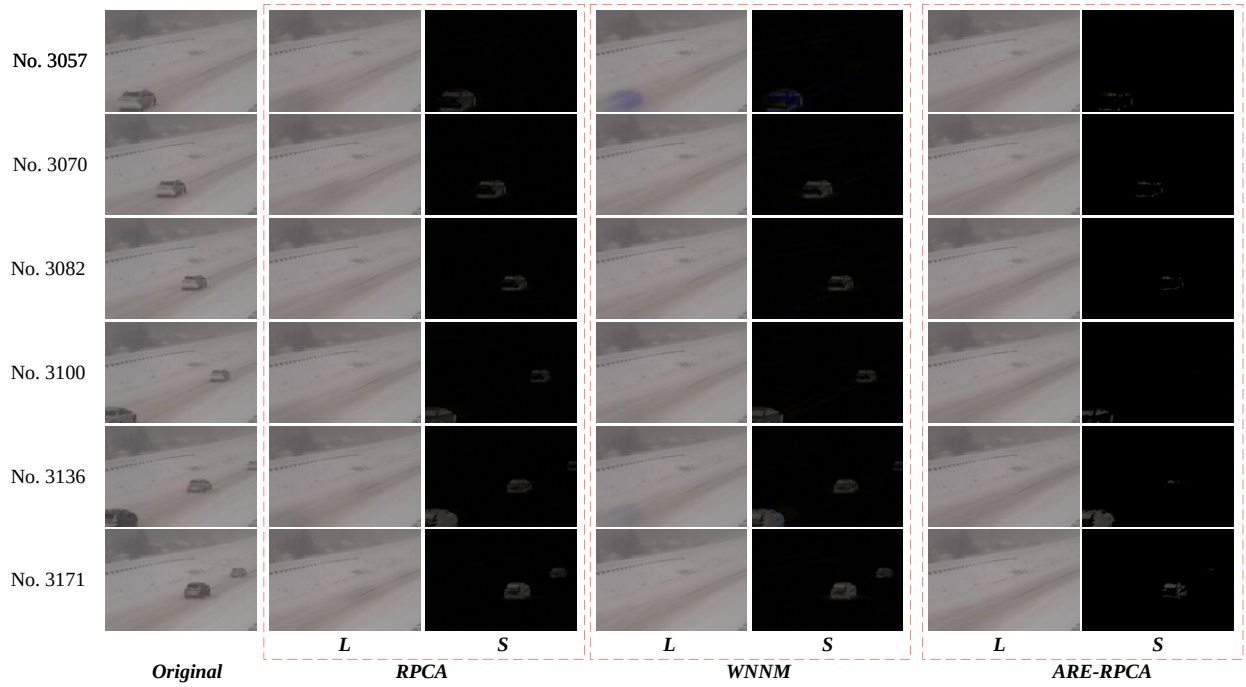

Figure 2 Results on *Blizzard* by different methods. The first column contains the original frames, the second and third columns are the separated background and foreground outputs of RPCA, the fourth and fifth columns are the separated background and foreground outputs of WNNM, the last two columns are the separated background and foreground outputs of ARE-RPCA.

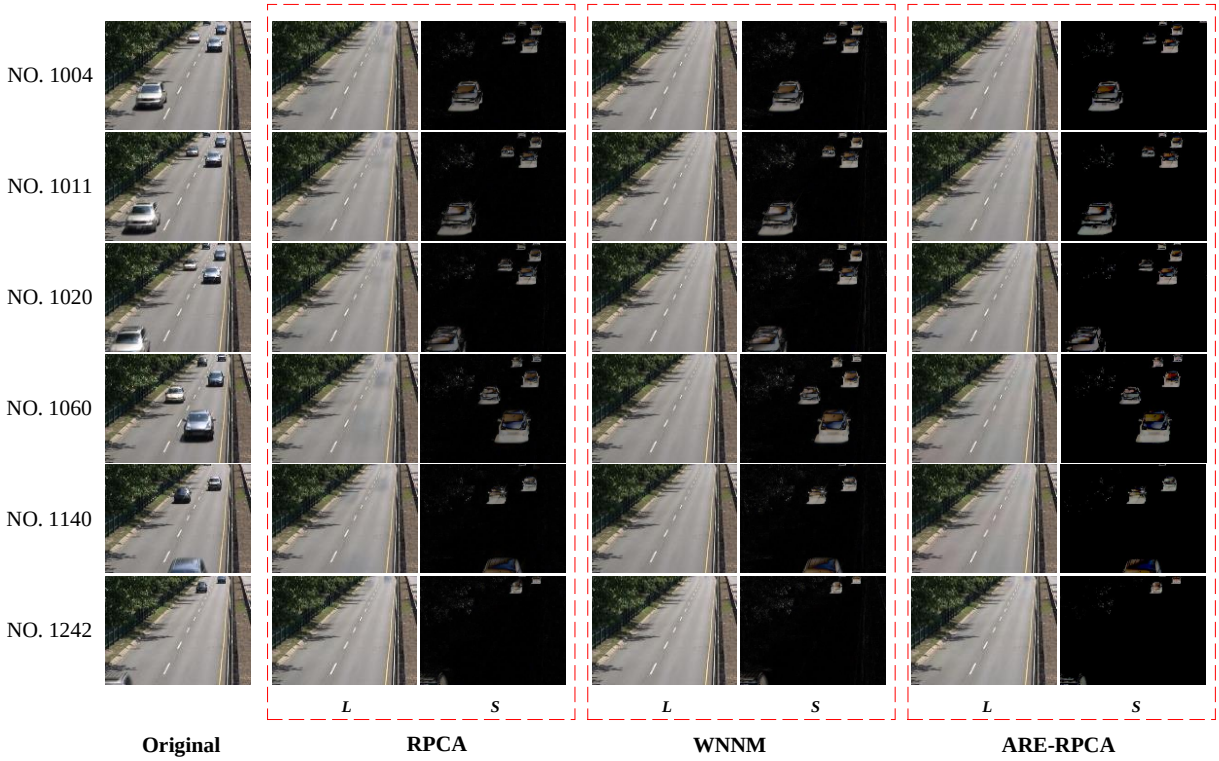

Figure 3 Results on *Highway* by different methods. The first column contains the original frames, the second and third columns are the separated background and foreground outputs of RPCA, the fourth and fifth columns are the separated background and foreground outputs of WNNM, the last two columns are the separated background and foreground outputs of ARE-RPCA.

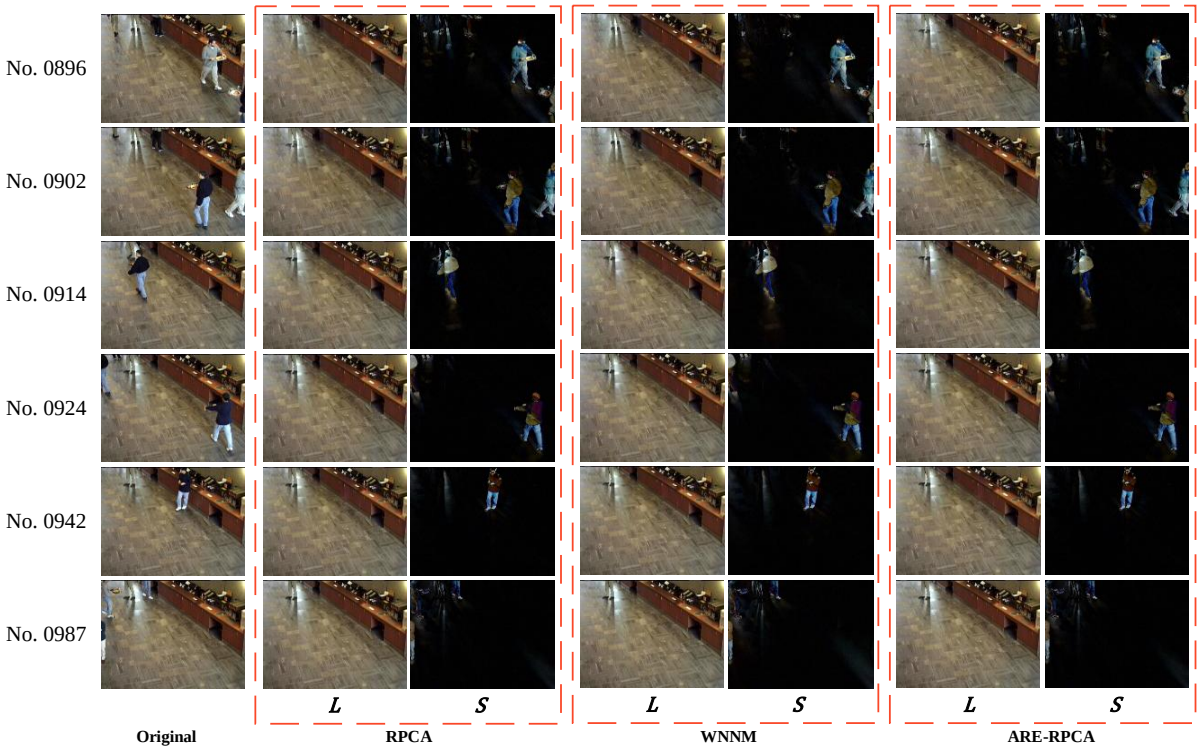

Figure 4 Results on *Bootstrap* by different methods. The first column contains the original frames, the second and third columns are the separated background and foreground outputs of RPCA, the fourth and fifth columns are the separated background and foreground outputs of WNNM, the last two columns are the separated background and foreground outputs of ARE-RPCA.

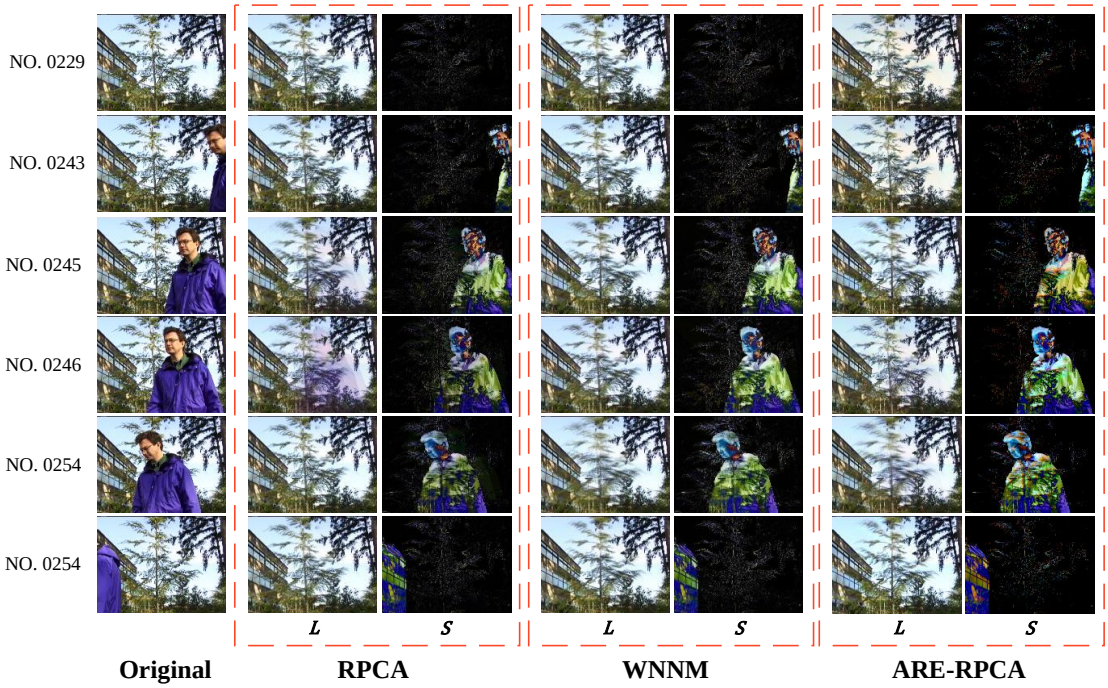

Figure 5 Results on *Waving Trees* by different methods. The first column contains the original frames, the second and third columns are the separated background and foreground outputs of RPCA, the fourth and fifth columns are the separated background and foreground outputs of WNNM, the last two columns are the separated background and foreground outputs of ARE-RPCA.

2. Result video

In folder *Video* and *One Frame*, we respectively present the decomposition result of all frame and one frame for all test algorithm. The more result videos can be found online:

https://sites.google.com/view/are-rpca/%E9%A6%96%E9%A1%B5.

One can observe that both WNNM and ARE-RPCA effectively remove moving objects, and ARE-RPCA handles ghosting better. For the data Bootstrap, *Arch* and *Waving Trees*, ARE-RPCA converges to the optimal result fastly.