Supplementary File[*]

I. Second Attack with Multiple Streams of PMU Data

The robustness of the proposed scheme is evaluated by injecting the second attack. This attack is injected at multiple streams of PMU data, which corresponds up to 30% corruption. The chosen attack locations were Buses 15, 16 and 17. The comparative analysis for Bus 15 is shown in the main manuscript. This supplementary file shows the additional evaluation and comparative analysis for other buses. The median filter has successfully estimated the corruption signal. This can be noticed from the statistical analysis of the error which is shown in Table 1. In contrast, the l_1-RPCA method under-performed the estimation of the attacked signal. This could be indicated by its associated performance error. Figs. 1 and 2 show the performance of the median filter which has provided an accurate estimate of the original signal for PMU measurements collected from Buses 16 and 17. The l_1-RPCA method was low in performance. This can also be seen while generating false alarms during the residual evaluation phase in Fig. 3(b).

Table 1: SECOND INJECTION WITH MULTIPLE STREAMS OF PMU DATA: MSE-BASED ESTIMATION COMPARISON ANALYSIS

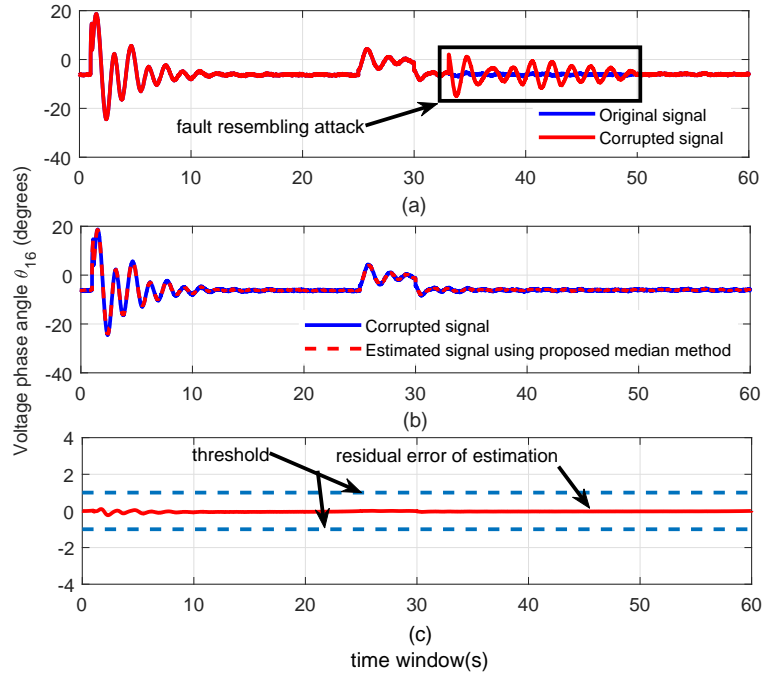| TIME WINDOW	0-5 s	5-10 s	10-15 s	15-20 s
MSP$_{\text{MSE}}$	1.09×10^{-3}	4.16×10^{-3}	1.08×10^{-3}	4.34×10^{-4}
RPCA$_{\text{MSE}}$	5.34×10^{-3}	9.26×10^{-3}	2.86×10^{-3}	2.33×10^{-3}
TIME	20-25 s	25-30 s	30-35 s	35-40 s
MSP$_{\text{MSE}}$	2.11×10^{-4}	1.67×10^{-3}	1.36×10^{-3}	1.12×10^{-3}
RPCA$_{\text{MSE}}$	1.68×10^{-3}	6.09×10^{-3}	3.62×10^{0}	3.41×10^{0}
TIME	40-45 s	45-50 s	50-55 s	55-60 s
MSP$_{\text{MSE}}$	9.56×10^{-4}	8.31×10^{-4}	4.51×10^{-5}	3.78×10^{-4}
RPCA$_{\text{MSE}}$	9.08×10^{0}	4.95×10^{0}	6.74×10^{-4}	8.44×10^{-4}

Figure 1: Second injection with multiple streams of PMU data: (a-c) Performance analysis of the proposed median-based predictive method at Bus 16
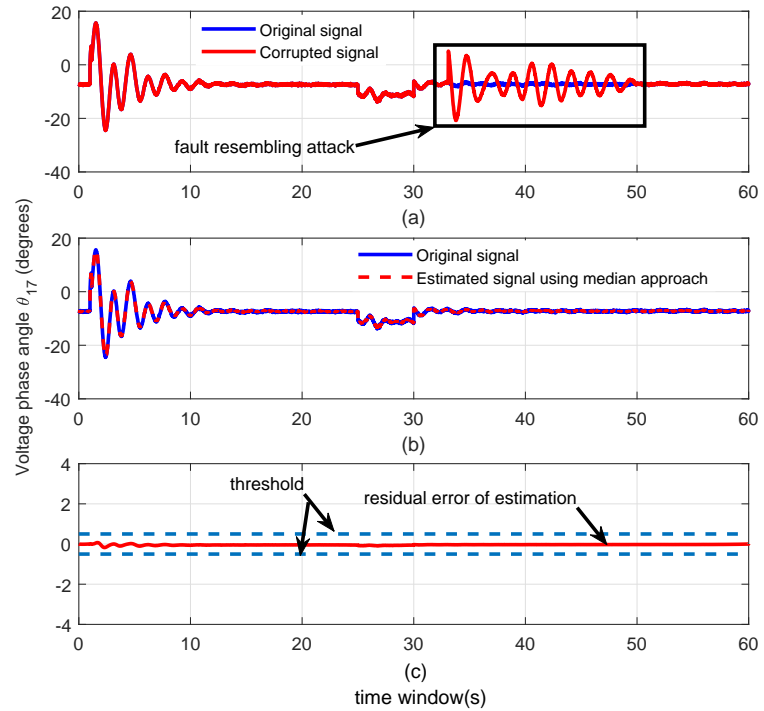

Figure 2: Second injection with multiple streams of PMU data: (a-c) Performance analysis of the proposed scheme at Bus 17
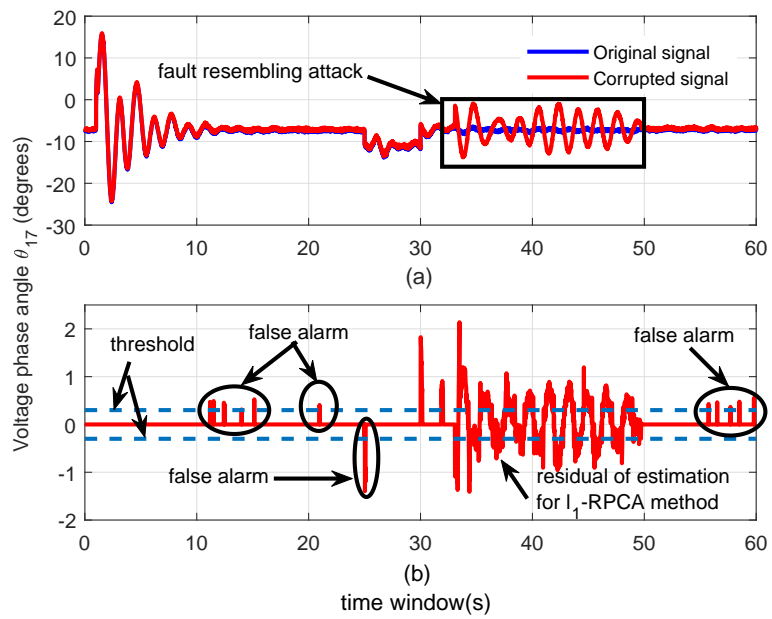
Figure 3: Second injection with multiple streams of PMU data: (a-b) Performance analysis of l_1-RPCA method at Bus 17