

Fig. 10: Score distributions of baseline face verification systems. The full green line shows how SFAR changes with moving the threshold.

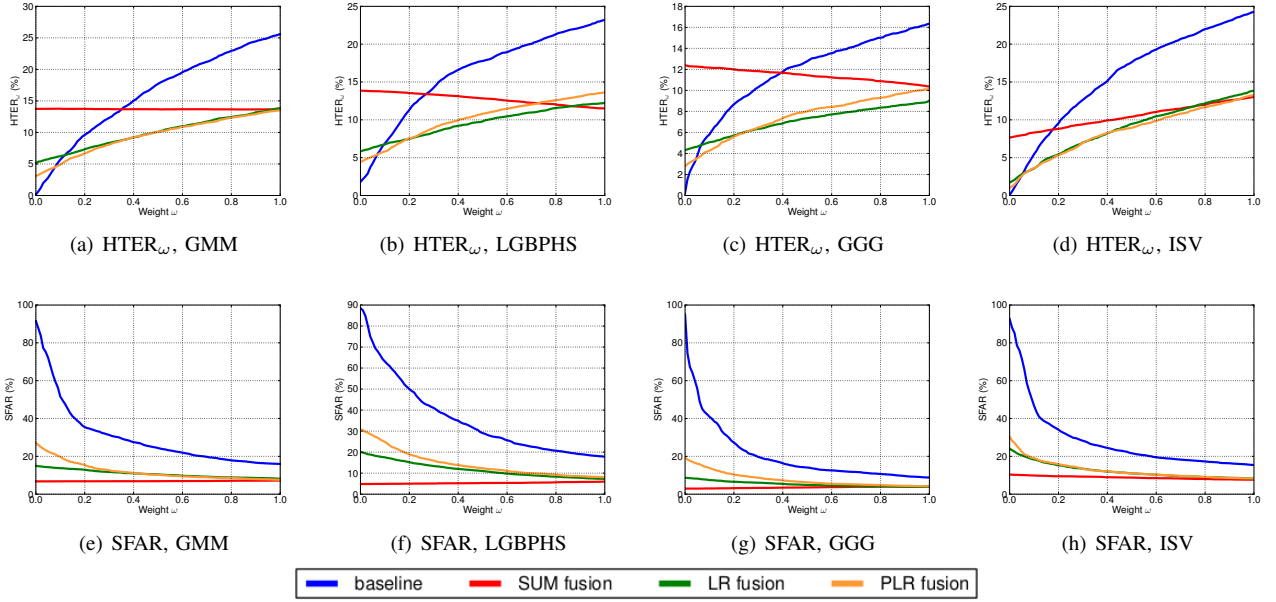


Fig. 12: EPSC for comparison of fusion techniques of baselines with LBP anti-spoofing algorithm

D. Performance of fused systems

In our last experiment, we compare the four face verification systems when fused with ALL counter-measures using PLR fusion scheme. Firstly, we illustrate how fusion changes the score distribution for each of them separately in Figure 14. Then, in Figure 15 we compare which of the fused systems performs the best.

While Figure 10 shows that the spoofing attacks of Replay-Attack are in the optimal category when fed to the baseline face verification systems, Figure 14 illustrates that their effectiveness has vastly changed after fusion. The score distribution of the spoofing attacks is now mostly overlapping with the score distribution of the zero-effort impostors, allowing for better discriminability between the positive class and the two negative classes. The results are reflecting this observation: even when the threshold is obtained using the licit scenario, SFAR has dropped to less than 6%.

The comparison between the EPSC curves given in Figure 11(a) and Figure 15(a), confirms the above observations:

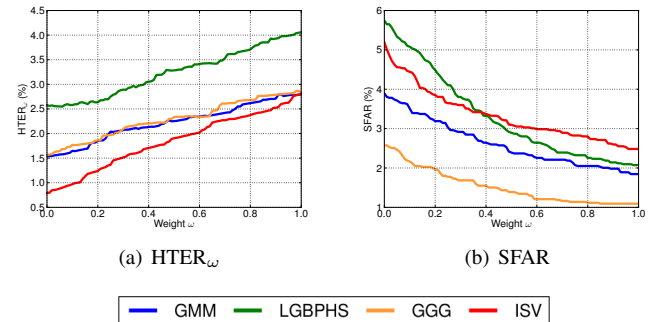


Fig. 15: EPSC curves to compare fused systems

while $HTER_{\omega}$ increases rapidly with ω and reaches up to 25% for some of the baseline systems, it increases very mildly and does not exceed 4.1% for the fused systems. The major augmentation of the robustness to spoofing of the systems after