Supplementary material

In this supplementary material, we will describe 1) more details about MFW+ dataset and 2) additional experimental results of PPL. The MFW+ dataset and all PPL implementation code realesed at our github repository: https://github.com/kim1102/PPL-MFR

Details of MFW+ dataset

MFW+ is an extended version of MFW, a benchmark for measuring masked face recognition performance. The MFW+ datasets, including the original MFW datasets, were manually collected from the web and most of the faces are made up of celebrities, politicians, and athletes. Most of the faces wearing masks in MFW+ cover the lower face including the nose and mouth with the mask, so only the area around the eyes and forehead is visible. The MFW+ dataset contains face masks of different types and colors. A summary of the overall configuration of the MFW+ dataset is shown in Fig. 4.

Types of face mask in MFW+ dataset. Masked faces wearing cloth masks make up most of the MFW+ dataset, consisting of approximately 1194 images. This type of mask is a mask made from materials such as cotton or synthetic fibers. Surgical masks took second place with 817 images. This mask also called a medical mask, is a type of mask that is usually made of non-woven fabric. MFW+ also contains 803 face images of wearing respirator masks such as the N95, N99, and FFP3. The remaining masked face images include 24 images of masks that are not easily seen in everyday life, such as plastic respirators and gas masks. Fig. 5 shows examples of the different types of face masks included in the MFW+ mentioned above.

Face mask color in MFW+ dataset. The MFW+ dataset contains masks of different colors as well as different kinds of masks. There are 1,969 images of faces wearing white and black facemasks, the most common mask colors in the MFW+ dataset. The color of the face mask worn in the 252 face images is the sky blue typically used for surgical masks. MFW+ contains images of faces wearing masks of various colors and patterns in addition to those mentioned. Fig. 6 shows examples of the various color of face masks included in the MFW+.

Additional experiment with PPL

In this section, we additionally performed comparative experiments on models trained with and without PPL. Specifically, as shown in the figure 7, the model trained with PPL achieved performance improvement in all three recognition conditions: unmasked-unmasked face recognition, unmasked-masked face recognition, and masked-masked face recognition. Fig. 8 shows the importance of PPL-SIM loss, which serves to reduce the embedding distance between masked and unmasked faces. Models trained without PPL-SIM loss suffered performance degradation in MFW+ (U-M).
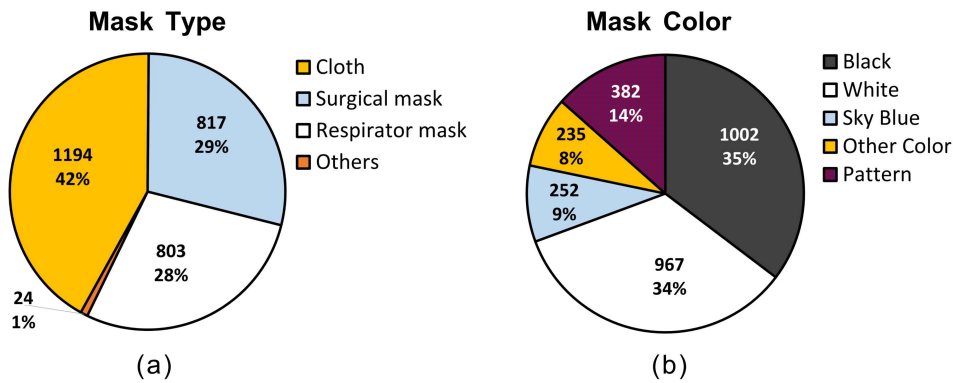
(a)

(b)

Figure 4:   The distribution of face masks present in the MFW+ dataset.

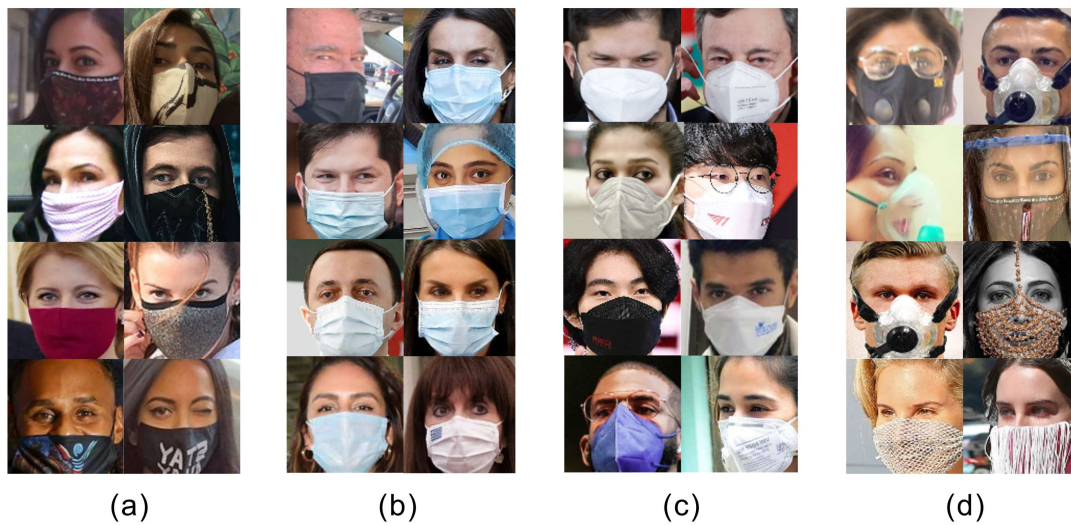(a)   (b)   (c)   (d)

Figure 5:   Types of face masks in the MFW+ dataset. (a) examples of cloth masks, (b) examples of surgical masks, (c) examples of respiratory masks such as N99 or FFP3, and (d) examples of other objects covering the lower part of the face.

(a)   (b)   (c)   (d)   (e)
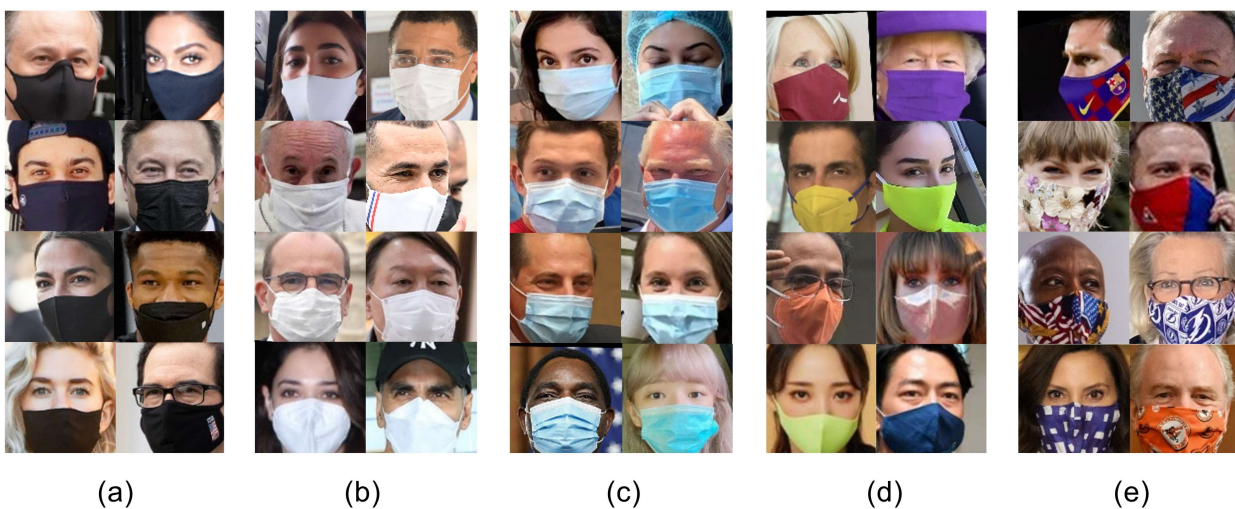
Figure 6:   Color diversity of face masks in the MFW+ dataset. (a) examples of black face masks, (b) examples of white masks, (c) examples of sky blue face masks, (d) examples of face masks with colors other than white, black, and sky blue, and (e) examples of a mask with a pattern of different colors.
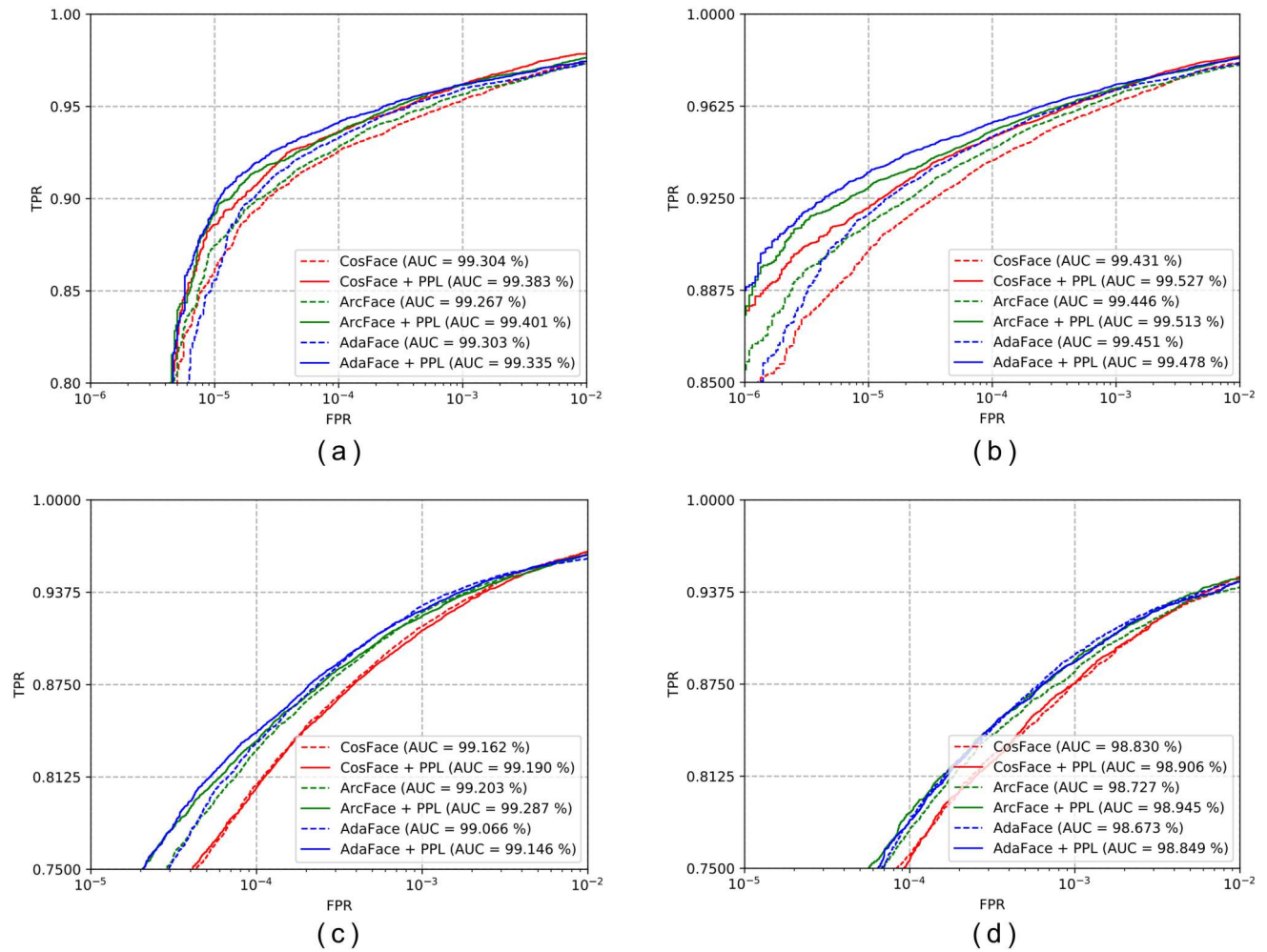
Figure 7: ROC curves on IJB and MFW datasets. (a) ROC curves of 1:1 verification on IJB-B, (b) ROC curves of 1:1 verification on IJB-C, (c) ROC curves of 1:1 verification on MFW+ (U-M), and (d) ROC curves of 1:1 verification on MFW+ (M-M).
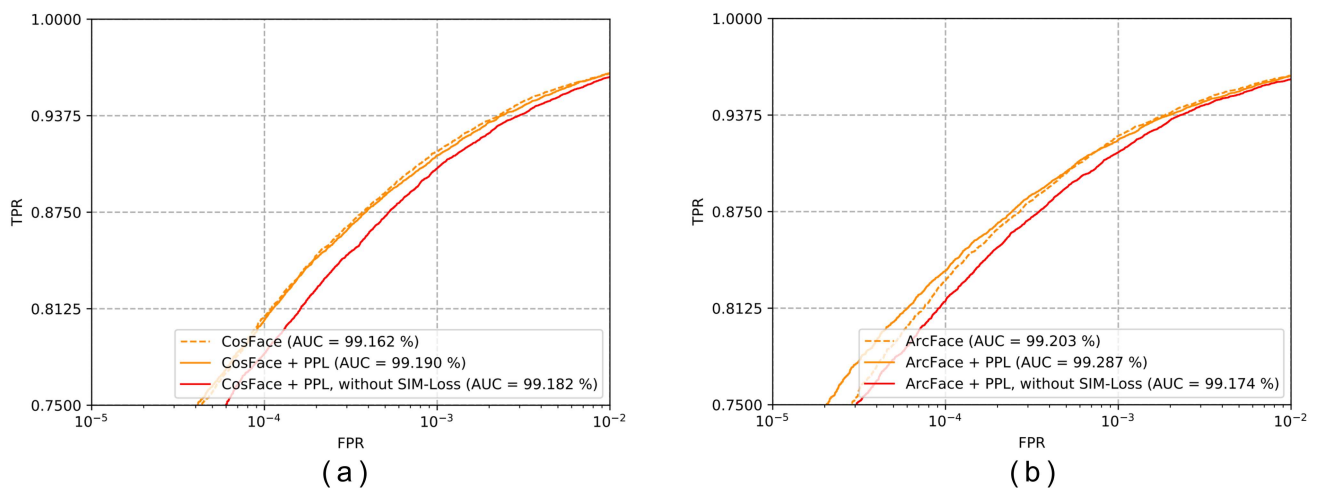

Figure 8: Effect of PPL-SIM loss on model training. (a) ROC curves of the model trained using CosFace on MFW+(U-M) and (b) ROC curves of the model trained using ArcFace on MFW+ (U-M).