INTRODUCTION:

Recently, the generative model based on deep learning such as the generative adversarial net (GAN) is widely used to synthesize the photo-realistic partial or whole content of the image and video. Furthermore, recent research of GANs such as progressive growth of GANs (PGGAN)[1] and BigGAN could be used to synthesize a highly photo-realistic image or video so that the human cannot 20 recognize whether the image is fake or not in the limited time. In general, the generative applications can be used to perform the image translation tasks [3]. However, it may lead to a serious problem once the fake or synthesized image is improperly used on social network or platform. For instance, cycleGAN is used to synthesize the fake face image in a pornography video [4]. Furthermore, GANs may be used to create a speech video with the synthesized facial content of any famous politician, causing severe problems on the society, political, and commercial activities. Therefore, an effective fake face image detection technique is desired. In this paper, we have extended our previous study associated with paper ID #1062 to effectively and efficiently address these issues.

In traditional image forgery detection approach, two types of forensics scheme are widely used: active schemes and passive schemes. With the active schemes, the externally additive signal (i.e., watermark) will be embedded in the source image without visual artifacts. In order to identify whether the image has tampered or not, the watermark extraction process will be performed on the target image to restore the watermark[6]. The extracted watermark image can be used to localize or detect the tampered regions in the target image. However, there is no "source image" for the generated images by GANs such that the active image forgery detector cannot be used to extract the watermark image. The second one-passive image forgery detector–uses the statistical information in the source image that will be highly consistency between different images. With this property, the intrinsic statistical information can be used to detect the fake region in the image[7][8]. However, the passive image forgery detector cannot be used to identify the fake image generated by GANs since they are synthesized from the low-dimensional random vector. Nothing change in the generated image by GANs because the fake image is not modified from its original image

Intuitively, we can adopt the deep neural network to detect the fake image generated by GAN. Recently, there are some studies that investigate a deep learning-based approach for fake image detection in a supervised way. In other words, fake image detection can be treated as a binary classification problem (i.e., fake or real image). For example, the convolution neural network (CNN) network is used to learn the fake image detector [9]. In [10], the performance of the fake face image detection can be further improved by adopting the most advanced CNN–Xception network [11]. However, there are many GANs proposed year by year. For example, recently proposed GANs such as [1][12][13][14][15][16][3][2] can be used to produce the photo-realistic images. It is hard and very time-consuming to collect all training samples of all GANs. In addition, such a supervised learning strategy will tend to learn the discriminative features for a fake image generated by each GANs. In this situation, the learned detector may not be effective for the fake image generated by another new GAN excluded in the training phase.

In order to meet the massive requirement of the fake image detection for GANs-based generator, we propose novel network architecture with a pairwise learning approach, called common fake feature network (CFFN). Based on our previous approach [5], it is clear that the pairwise learning approach can overcome the shortcomings of the supervised learning-based CNN such as methods in [9][10]. In this paper, we further introduce a novel network architecture combining with pairwise learning to improve the performance of the fake image detection. To verify the effectiveness of the proposed method, we apply the proposed deep fake detector (DeepFD) to identify both fake face and generic image. The primary contributions of the proposed method are two-fold:

• We propose a fake face image detector based on the novel CFFN consisting of several dense blocks to improve the representative power of the fake image.

• The pairwise learning approach is first introduced to improve the generalization property of the proposed DeepFD.