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DEVELOPMENT OF LIVE FINGERPRINT GENERALIZATION MODEL USING SEMI-SUPERVISED ADVERSARIAL LEARNED ONE-CLASS CLASSIFIER FOR FINGERPRINT PRESENTATION ATTACK DETECTION

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ABSTRACT

Due to the increasing population in our societies, the accurate identification of individuals has become crucial. As a result, the concept of access control has gained significance. Currently, the Automatic Fingerprint Identification System (AFIS) is the predominant method used for access control in restricted areas like immigration borders, labs, offices, and even smart devices. However, despite its widespread use, AFIS is highly vulnerable to presentation attacks involving the fabrication and presentation of fake fingerprints to AFIS. Efforts have been made to address this concern through hardware and software-based approaches. Hardware-based methods incorporate additional sensors to capture other live human traits during fingerprint authentication, such as pulse rate, blood flow, and odor. Unfortunately, attackers have found ways to create thin layered spoofs that can deceive these systems. As a result, software-based methods have emerged, which focus on learning inherent live fingerprint features to distinguish against spoofs. However, one challenge with software-based method is that most approaches tend to treat the issue of fingerprint presentation attack as a closed-set classification problem (known spoofing materials). As a result, such models manifest high classification errors when presented with novel spoofs not seen during their training. Motivated by this problem, this study proposes an adversarial learned one-class classifier that leverages the Generative Adversarial Network (GAN) architecture. The classifier is trained in a semi-supervised manner and comprises a generator and discriminator, with the discriminator acting as the final classifier. In contrast to traditional GANs, the generator is trained to produce pristine but discernible images as determined by the discriminator. The rationale behind this training paradigm is that since the number of fake fingerprint materials is unknown, the generator can automatically generate variations of fingerprint impressions that cover a wide range of unknown spoofing materials. This enhances the classifier to acquire sufficient knowledge of what constitutes a "live" fingerprint and learn diverse intricacies of "fake" fingerprints to effectively discriminate against spoofs. The proposed model was evaluated using the LivDet-2015 dataset, which contains nine distinct fingerprint spoofing materials captured by five fingerprint readers. The cross-material performance demonstrated an average True Detection Rate (TDR) of 80.1%, surpassing most state-of-the-art models. The findings from this study not only provide a foundation for further research on fingerprint presentation attacks but also offer a potential solution to mitigate the issue of spoofing attacks faced by various establishments such as immigration units, banks, labs, and other areas where access control is essential.

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