A survey of Techniques for Face Liveness Recognition

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***Abstract*- Automatic face recognition is now widely used in applications ranging from de duplication of identity to authentication of mobile payment. This popularity of face recognition has raised concerns about face spoof attacks (also known as biometric sensor presentation attacks), where a photo or video of an authorized person's face could be used to gain access to facilities or services. While a number of face spoof detection techniques have been proposed, their generalization ability has not been adequately addressed. We propose an efficient and rather robust face spoof detection algorithm based on image distortion analysis (IDA). Four different features (specular reflection, blurriness, chromatic moment, and color diversity) are extracted to form the IDA feature vector. An ensemble classifier, consisting of multiple SVM classifiers trained for different face spoof attacks is used to distinguish between genuine (live) and spoof faces. The proposed approach is extended to multiframe face spoof detection in videos using a voting-based scheme. We also collect a face spoof database, MSU mobile face spoofing database (MSU MFSD).**

***Key Words*- Face recognition, spoof detection, image distortion analysis, ensemble classifier, cross-database, cross-device**

I. INTRODUCTION

Spoofing attacks upon face recognition systems involve presenting artificial facial replicas of authorized users to falsely infer their presence in order to bypass the biometric security measures. Such attacks can be carried out easily by means of printed photographs or digital images displayed on tablet, smart phones, etc. In order to distinguish real face features from fake faces, face liveness detection is a commonly used countermeasure approach.

Automatic face recognition has attracted increasing attention in various access control applications, especially for mobile phone unlocking. With the release of face unlocking functionality in the Android mobile operating system, face recognition becomes another biometric authentication technique for mobile phones, similar to finger print authentication (Touch ID) in the iOS system. Unlike fingerprint authentication, face recognition does not require any additional sensor since all smart phones come equipped with a front facing camera. However, similar to other biometric modalities [1], [2], we need to address concerns about face spoof attacks on face recognition systems, particularly in unconstrained sensing and uncooperative subject scenarios [3]. It is relatively easier to acquire a person's face image or video (e.g., with a digital camera or from social media) than it is to acquire other biometric traits such as fingerprint, palm print, and iris. Further, the cost of launching a face spoof attack, such as a printed photo, displayed photo, or replayed video is relatively low (see Fig. 1). State of the art Commercial Off-The-Shelf (COTS) face recognition systems are not well designed to differentiate spoof faces from genuine live faces. Identification performance of a COTS face recognition system (COTS11) when spoof faces as probe are matched to genuine faces in the gallery. In this experiment, more than 70% of probe videos (spoof faces) were successfully matched to the gallery mates by COTS1 at rank-1, indicating that COTS1 cannot effectively distinguish between genuine and spoof faces.

Fig.1. A genuine face image (a) of a subject in the Idiap databases [4], [5] and three examples of spoofs of the same subject using a (b) printed photo, (c) displayed photo (on a tablet screen).

The fragility of face recognition systems to face spoof attacks has motivated a number of studies on face spoof detection [4], [6]–[11]. However, published studies are limited in their scope because the training and testing images (videos) used were captured under the same imaging conditions. It is essential to develop robust and efficient face spoof detection (or anti-spoofing) algorithms that generalize well to new imaging conditions and environments.

II. LITERATURE REVIEW & RELATED WORK

According to different types of cues used in face spoof detection, published methods can be categorized into four groups:

(i) *Motion Based Methods:*

These methods, designed primarily to counter printed photo attacks, capture a very important cue for vitality: the subconscious motion of organs and muscles in a live face, such as eye blink [9], mouth movement [12] and head rotation [11]. Given that motion is a relative feature across video frames, these methods are expected to have better generalization ability than the texture based methods that will be discussed below. However, the

limitations of motion based methods are apparent. The frequency of facial motion is restricted by the human physiological rhythm, which ranges from 0.2 to 0.5 Hz [12]. Therefore, it takes a relatively long time (usually > 3s) to accumulate stable vitality features for face spoof detection. Additionally, motion based methods can be easily circumvented or confused by other motions, e.g., background motion, that are irrelevant to facial liveness or replayed motion in the video attacks.

(ii) ***Texture Based Methods:***

To counter both the printed photo and replayed video attacks, texture based methods were proposed to extract image artifacts in spoof face images. In [14], the authors argued that texture features (like LBP, DoG, or HOG) are capable of differentiating artifacts in spoof faces from the genuine faces. Texture based methods have achieved significant success on the Idiap and CASIA databases. The Half Total Error Rate (HTER)5 on the Idiap database was reduced from 13.87% in [4] and 7.60% in [13] to 6.62% in [11] by incorporating texture cues. Unlike motion based methods, texture based methods need only a single image to detect a spoof. However, the generalization ability of many texture based methods has been found to be poor. A study reported in [13] showed that for two of the texture based methods (proposed in [4] and [14], the HTER increased dramatically under the cross-database scenarios (where the training and testing sets came from different face spoof databases). Due to the intrinsic data-driven nature of texture based methods, they can be easily over-fitted to one particular illumination and imagery condition and hence do not generalize well to databases collected under different conditions.

(iii) ***Image Quality Analysis Based Methods:***

A recent work [19] proposed a biometric liveness detection method for iris, fingerprint and face images using 25 image quality measures, including 21 full-reference measures and 4 non-reference measures. Compared to [19], our work is different in the following aspects: (1) While 25 features are required in [19] to get good results, no face-specific information has been considered in designing informative features for face spoof detection. On the contrary, four features are designed specifically for face feature representation in our method, and we demonstrate the effectiveness of these features for spoof face detection. (2) While the authors of [19] evaluated their method on *only* the Idiap-Replay database, we have used both the Idiap and CASIA databases, which are two important public-domain databases. (3) While the work in [19] aims at designing a generic liveness detection method across different biometric modalities, the training and testing of each modality were still performed under intra-database scenarios (same database for training and testing, even though cross-validation is used). By contrast, the proposed approach aims to improve the generalization ability under cross-database scenarios, which has seldom been explored in the biometrics community.

(iv) ***Methods Based on Other Cues:***

Face spoof countermeasures using cues derived from sources other than 2D intensity image, such as 3D depth [16], IR image [6], spoofing context [17], and voice [21] have also been proposed. However, these methods impose extra requirements on the user or the face recognition system, and hence have a narrower application range. For example, an IR sensor was required in [6], a microphone and speech analyzer were required in [18], and multiple face images taken from different viewpoints were required in [16]. Additionally, the spoofing context method proposed in [17] can be circumvented by concealing the spoofing medium. A study reported in [11], the authors showed that appropriately magnified motion cue improves the performance of texture based approaches (HTER = 6.62% on the Idiap database with motion magnification compared to HTER = 11.75% without motion magnification, both using LBP features). The authors also showed that combining the Histogram of Oriented Optical Flow (HOOF) feature with motion magnification achieved the best performance on the Idiap database (HTER = 1.25%). However, motion magnification, limited by human physiological rhythm, cannot reach the reported performance [11] without accumulating a large number of video frames (>200 frames), making these methods unsuitable for real-time response. Though a number of face spoof detection methods have been reported, to our knowledge, none of them generalizes well to cross-database scenarios [13]. In particular, there is a lack of investigation on how face spoof detection methods perform in cross-database scenarios.

In this [20] the strategy relies exclusively on colors, significantly hue, while not requiring any geometrical parameter information. One in all the fundamental concepts is to match the intensity power differentiation of specular-free pictures and input pictures iteratively. The specular-free image may be a pseudo-code of diffuse elements which will be generated by shifting a pixel's intensity and hue nonlinearly whereas holding its hue. All processes within the methodology square measure done regionally, involving a most of solely 2 pixels. The experimental results on natural pictures show that the planned methodology is correct and robust below renowned scene illumination hue. In contrast to the prevailing ways that use one image, our methodology is effective for rough-textured objects with advanced multicolor scenes. In [21] a robust face detection technique at the side of mouth localization,

process each frame real time (video rate), is bestowed. Moreover, it is exploited for motion analysis onsite to verify "liveness" moreover on accomplish lip reading of digits. A method novelty is that the instructed

Quantal angle options ("quangles") being designed for illumination changelessness while not the requirement for preprocessing(e.g. histogram equalization). This can be achieved by victimization each the gradient direction and also the double angle direction (the structure tensor angle), and by ignoring the magnitude of the gradient. Boosting techniques square measure applied in a very quantal feature house. A significant profit is reduced interval (i.e., that the coaching of effective cascaded classifiers is possible in terribly short time, less than 1 h for data sets of order 104). Scale changelessness is enforced through the employment of a picture scale pyramid. We tend to propose "liveness" verification barriers as applications that a major quantity of computation is avoided once estimating motion. Novel ways to avert advanced spoofing makes an attempt (e.g., replayed videos that embrace person utterances) square measure incontestable. We tend to present favorable results on face detection for the YALE face check set and competitive results for the CMU-MIT frontal face check set moreover as on "liveness" verification barriers. It [22] may be a common spoof to use a photograph to fool face recognition algorithm. In light-weight of variations in optical flow fields generated by movements of two-dimensional planes and three-dimensional objects, we tend to plan a brand new aliveness detection methodology for face recognition. Below the idea that the check region may be a two-dimensional plane, we are able to acquire a reference field from the particular optical flow field knowledge. Then the degree of variations between the 2 fields may be accustomed distinguish between a three-dimensional face and a two-dimensional photograph. Empirical study shows that the the planned approach is each possible and effective. This [23] paper presents a brand new rule for nonlinear spatial property reduction (NLDR). Our rule is developed below the abstract framework of compatible mapping. Every such mapping may be a compound of a tangent space projection and a bunch of splines. Tangent space projection is calculable at every information on the manifold, through that the information purpose itself and its neighbors square measure pictured in tangent space with native coordinates. Splines square measure then made to ensure that every of the native coordinates may be mapped to its own single world coordinate with relevance the underlying manifold. Thus, the compatibility between native alignments is ensured. In such a piece setting, we tend to develop associate improvement framework supported reconstruction error analysis, which may yield a worldwide optimum. The planned rule is additionally extended to insert out of samples via spline interpolation.

In this paper [24] we tend to present multispectral Experiments on toy knowledge sets and real-world knowledge sets illustrate the validity of our methodology.

Face aliveness detection methodology that is user cooperation free. Moreover, the system is adaptation to numerous user-systems distances. Victimization the Lambertian model, we tend to analyze multispectral properties of human skin versus non-skin, and also the discriminative wavelengths square measure then chosen. Coefficient data of real and fake faces at multi-distances square measure chosen to make coaching set. Associate SVM classifier is trained to be told the multispectral distribution for a final Genuine-or-Fake classification. Compared with previous works, the planned methodology has the subsequent advantages: (a) the need on the user's cooperation is not any longer required, creating the aliveness detection user friendly and quick. (b) The system will work while not restricted distance demand from the target being analyzed. Experiments square measure conducted on real versus planar face data, and real versus mask face data. Furthermore a comparison with the visible challenge-response aliveness detection methodology is additionally given. The experimental results clearly demonstrate the prevalence of our methodology over previous systems. They [25] Identity spoofing may be a competition for high-security face-recognition applications. With the arrival of social media and globalised search, peoples face pictures and videos square measure wide-spread on the web and might be doubtless accustomed attack biometric systems while not previous user consent. Yet, analysis to counter these threats is simply on its infancy - the authors lack public customary databases, protocols to live spoofing vulnerability and baseline ways to observe these attacks.
The contributions of this work have 3-fold: 1st, the authors a in public out there PHOTO-ATTACK database with associated protocols to live the effectiveness of counter-measures is introduced. Supported the data out there, a study is conducted on current progressive spoofing detection algorithms supported motion analysis, showing they fail under the light of this new dataset. By last, the authors propose a brand new technique of countermeasure exclusively supported foreground/backgr-ound motion correlation victimization optical flow that outperforms all alternative algorithms achieving nearly excellent evaluation with associate equal error rate of 1.52% on the out there available data. The source code files resulting in the according results are formed out there for the dependableness of findings during this study.
They [26] approach a brand new face anti-spoofing approach that relies on analysis of distinction and texture characteristics of captured and recaptured pictures is planned to observe photograph spoofing. Since photograph image may be a recaptured image, it's going to show quite completely different distinction and texture

characteristics compared to a true face image. In a very spoofing try, image rotation is sort of potential. Therefore, during this paper, a rotation invariant native binary pattern variance (LBPV) primarily based methodology is chosen to be used. The approach is tested on the in public out there NUAA photo-impostor database, that is built below illumination and place amendment. The results show that the approach is competitive with alternative existing ways tested on identical database. It is particularly helpful for conditions once photos square measure control by hand to spoof the system. Since associate LBPV primarily based methodology is employed, it's sturdy to illumination changes. It's non-intrusive and straightforward. They [27] planned that User authentication is a crucial step to shield information and during this field face biometry is advantageous. Face biometry is natural, simple to use and fewer human invasive. Tragically, recent work has disclosed that face biometry is at risk of spoofing attacks utilizing low-tech low-cost provides. This text presents a measure against such attacks supported the LBP-TOP operator consolidating each space and time information into one multi-resolution texture descriptor. Experiments did with the REPLAY ATTACK database demonstrate Half Total Error Rate (HTER) improvement from 15:16% to 7:60%. Remark that results with SVM classifier have to be compelled to be soft on care as a result of with the rise of the multi-resolution vary, the SVM classifier tends to over-train on the knowledge. Be that because it might, experiments with easier classifiers, as an example, LDA, incontestable that the LBP-TOP multi-resolution approach still incontestable an out of this world potential against face spoofing in numerous type of attacks things, beating the state of art results. They [28] discovered that for a robust face biometric system, a reliable anti-spoofing approach should be deployed to bypass the print and replay attacks. Many techniques are planned to counter face spoofing, but a robust answer that's computationally efficient is still unavailable. This paper presents another approach for spoofing detection in face videos utilizing motion magnification. Eulerian motion magnification approach is employed to boost the facial expressions normally exhibited by subjects in a much captured video. Next, 2 varieties of feature extraction Calculations Square measured proposed: (i) a configuration of LBP that gives improved performance compared to alternative computationally, expensive texture primarily based approaches and (ii) motion estimation approach utilizing HOOF descriptor. The HOOF descriptors noninheritable from motion enlarged videos give progressive performance on the Print Attack and Replay Attack datasets in terms of preciseness and procedure potency. On the Print Attack and Replay Attack spoofing datasets, the planned framework improves the state-of-art performance; significantly the state-of-art performance; significantly HOOF descriptor yielding a close to excellent Half Total Error Rate of 0% and 1.25% on an individual basis. They [29] propose a component-based face coding approach for aliveness detection. The planned methodology consists of 4 steps: (1) locating the elements of face; (2) writing the low-level features for all the elements ;(3) derivation the high-level faces illustration by pooling the codes with weights derived from Fisher criterion; (4) concatenating the histograms from all components into a classifier for identification. The planned framework makes sensible use of small variations between real faces and fake faces. Meanwhile, the inherent look variations among completely different elements square measure maintained. In depth experiments on 3 revealed customary databases demonstrate that the strategy can do the most effective aliveness detection performance in 3 databases. This [30] paper emphasized on face recognition, that is security-critical, has been wide deployed in our everyday life. However, ancient face recognition technologies in observe may be spoofed simply, as an example, by employing a simple printed photograph. During this paper, we tend to propose a completely unique face aliveness detection approach to counter spoofing attacks by convalescent thin 3D facial structure. Given a face video or many pictures captured from over 2 viewpoints, we tend to observe facial landmarks and choose key frames. Then, the thin 3D facial structure may be recovered from the chosen key frames. Finally, a Support Vector Machine (SVM) classifier is trained to differentiate the real and fake faces. Compared with previous works, the planned methodology has the subsequent benefits. First it offers excellent aliveness detection results that meet the safety demand offace biometric system. Second it is independent on cameras or systems that work well on completely different devices. Experiments with real faces versus planar photograph faces and crooked photograph faces demonstrate the prevalence of the planned methodology over the progressive aliveness detection ways. To [31] make sure the actual presence of a true legitimate attribute in distinction to a fake self-manufactured artificial or reconstructed sample may be a vital downside in identification, which needs the event of latest and economical protection measures .During this paper, we tend to present completely unique software based fake observation methodology which will be utilized in multiple biometric systems to detect differing kinds of dishonorable access makes an attempt. The target of the planned system is to boost the safety of biometric recognition frameworks, by adding aliveness assessment in a very quick, easy, and non-intrusive manner, through the employment of image quality assessment. The planned approach presents a really low degree of quality, that makes it appropriate for period applications, victimization 25 general image quality options extracted from one image(i.e., identical noninheritable for

authentication purposes) to differentiate between legitimate and cheater samples. The experimental results, obtained on in public out there knowledge sets of fingerprint, iris, and 2D face, show that the planned methodology extremely competitive compared with alternative progressive approaches which the analysis of the final image quality of real biometric samples reveals highly valuable information which will be very expeditiously accustomed discriminate them from fake traits. They [32] discovered that Automatic face recognition is presently wide utilized in applications starting from de-duplication of identity to authentication of mobile payment. This quality of face recognition has raised issues regarding face spoof attacks (Otherwise known as biometric sensor attacks). Wherever a photograph or video of a certified person's face can be used to gain access to offices or services. Whereas variety of face spoofs detection techniques are planned, their speculation capability has not been adequately addressed.
We tend to propose associate economical and rather robust face spoof detection rule supported Image Distortion Analysis (IDA). Four completely different options (specular reflection, haziness, chromatic moment, and color diversity) are extracted to frame the IDA feature vector. A gathering classifier, comprising of varied SVM classifiers trained for various face spoof attacks (e.g., printed photograph and replayed video), is employed to differentiate amongst real and spoof faces. The planned approach is extended to multi-frame face spoof detection in videos utilizing a voting based scheme. We tend to collect a face spoof database, MSU Mobile Face Spoofing info (MSU MFSD), utilizing 2 mobile devices (Google Nexus five and MacBook Air) with 3 varieties of spoof attacks (printed photograph, replayed video with iPhone 5S and iPad Air). Experimental results on 2 public-domain face spoof databases (Idiap REPLAY-ATTACK and CASIA FASD), and also the MSU MFSD database demonstrate that the planned approach outperforms progressive ways in spoof detection. Our results likewise highlight the problem in separating real and spoof faces, significantly in cross-database and cross-device situations.

III. PROPOSED SYSTEM

In this work proposed approach boosts the likelihood of correctly identifying the person of interest through the use of different schemes video frame selection.

An efficient and rather robust face spoof detection algorithm proposed in this work is based on image distortion analysis (IDA). Four different features (specular reflection, blurriness, chromatic moment, and color diversity) are extracted to form the IDA feature vector.

In this work also collect a face spoof database, MSU mobile face spoofing database (MSU MFSD), with spoof attacks for replayed video i. e. mobile. Our propose results also highlight the difficulty in separating genuine and spoof faces, especially in cross-database and cross-device scenarios.

The proposed method has the ability to perform consistently at different biometric traits (multi biometric). The proposed methods provide a high level of protection from different types of attacks (multi attack). The error rates are very low when compared to other anti-spoofing attacks; Due to the multi biometrics and multi attack characteristics, the proposed method is fast, user-friendly and effective.

Flow chart of proposed system:

Fig. 2:- Check Temp ID Authentication

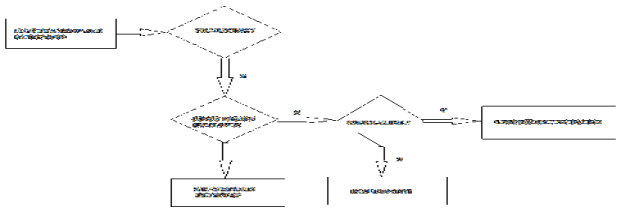

Fig. 3:- Check Authentication

IV. RESULTS AND DISCUSSION

In this work collecting a face spoof database, MSU mobile face spoofing database (MSU MFSD), with spoof attacks for replayed video i. e. mobile. Most of the published methods use motion or texture based features, this work proposes to perform face spoof detection based on Image Distortion Analysis (IDA). Four different features (specular reflection, blurriness, chromatic moment, and color diversity) are extracted to form the IDA feature vector. This work proposed to use of Matlab as front end and back end to approach boosts the likelihood of correctly identifying the person of interest through the use of different fusion schemes incorporation of quality measures for fusion and video frame selection.

V. CONCLUSION

In this work, it is been concluded that face spoof detection is the technique which is been applied to improve security of the bio-metric system

Anti-spoofing is becoming a vital issue in biometric authentication systems. It is highly critical for a system to correctly discover and prevent attackers especially with the diverse variation of attacks. In this work, a face spoof detection method based on Image Distortion Analysis (IDA) is proposed.

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