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Banking Security System with Face Liveness Detection Using Machine Learning and Image Processing

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Abstract: ***The face is a significant part of the human body, recognizing people in enormous gatherings. Subsequently, on account of its all-inclusiveness and uniqueness, it has turned into the most generally utilized and acknowledged biometric strategy. Biometrics with facial recognition is now widely used. A face identification system should identify not only someone's faces but also detect spoofing attempts with printed face or digital presentations. A sincere spoofing prevention approach is to examine face liveness, such as eye blinking and lips movement. Nevertheless, this approach is helpless when dealing with video-based replay attacks. For this reason, this paper proposes a combined method of face liveness detection and CNN (Convolutional Neural Network) classifier. The anti-spoofing method is designed with two modules, the blinking eye module that evaluates eye openness and lip movement, and the CCN classifier module. The dataset for training our CNN classification can be from a variety of publicly available sources. The test results show that the module created can recognize various kinds of facial spoof attacks, such as using posters, masks, or smartphones.***
Keywords: Biometrics, Facial Recognition, Liveliness, CNN, CCN Classifier, etc.

I. INTRODUCTION

Nowadays, biometrics is one of the most widely used authentication technologies. Face recognition technology is one of them, and it is widely used due to its simplicity and accuracy. Face recognition technology is now being used in a wide range of facial spoof attacks, including those on smartphones, tablets, and laptop computers. Face recognition technology allows us to recognize other people. This facial recognition application works by photographing a person's face with a camera and then running the image through a specific algorithm to determine whether or not the face is recognized from a database. Nonetheless, the facial recognition strategy has a flaw known as spoofing attacks. Facial recognition systems can't tell the difference between real faces and spoofing attacks like masks, videos, or photos. As a result, these flaws allow someone to deceive the machine [8]. Furthermore, obtaining someone's face is far easier than obtaining other biometrics such as fingerprints. Using social media or a profile photo, you can easily obtain someone's face.

Face spoofing attacks can be static or dynamic. Dynamic 2D demonstration spoofing attacks use video replays or a large number of photos in a sequence, whereas static attacks use photos or masks. Static 3D demonstration attacks may employ 3D sculptures, prints, or even masks, whereas animated versions employ complex robots to mimic facial expressions, complete with cosmetics.

Another technique for identifying real people is liveness detection, and Eye-blink detection is a highly accurate liveness detection evaluation. Natural blinking is an easy way to determine whether a face is alive or dead. A blink closes one's eyes for about 250-300 milliseconds. A typical person blinks 5-10 times per minute. Eye blink detection can be used to analyze face landmarks and calculate the surface area of the eyes. However, because modern technology makes it easy to attack video replays with devices like smartphones or tablets, relying on blinking eye detection is no longer sufficient [7].

Face liveness detection classifiers are typically trained on real-world images, where real-face images and corresponding face presentation attacks (PA) are highly overlapping. However, little research has been conducted on the use of a combination of real-world face images and face images generated by deep convolutional neural networks (CNN) for detecting face liveness. Biometrics based on facial recognition is now widely used. A face identification system should be able to recognize not only people's faces, but also attempts at spoofing using printed faces or digital presentations.

Examining the liveness of the face, such as eye blinking and lip movement, is a genuine spoofing prevention strategy. Nonetheless, when dealing with video-based replay attacks, this approach is rendered ineffective. As a result, this system suggests a method of detecting face liveness combined with a CNN (Convolutional Neural Network) classifier. The anti-spoofing method consists of two modules: the blinking eye module (which evaluates eye openness and lip movement) and the CNN classifier module. Our CNN classification algorithm can be trained using data from a variety of publicly available sources. For, we used Python to create a simple facial recognition application by combining these two modules sequentially. The results of the tests show that the developed module can detect various types of facial spoof attacks, such as those using posters, masks, or smart phones [5].

In this study, we will evaluate the adaptive fusion of convolutional-features learned by convolutional layers from real-world face images and deep CNN generated face images for face liveness detection. Furthermore, during training, an adaptive convolutional-features fusion layer is proposed that balances the fusion of convolutional-features from real-world face images and deep CNN generated face images. Extensive experiments on state-of-the-art face anti-spoofing databases, such as CASIA, OULU, and Replay-Attack, with both intra-database and cross-database scenarios, show that the proposed method outperforms state-of-the-art methods on face liveness detection.

II. LITERATURE REVIEW

In this paper, [1] The authors of this article propose a system for dealing with this fingerprint animosity detection, as well as a workable anti-dismissal tool (FLD). Furthermore, the profound neural network (DCNN) based FLD methods were significantly different from most shallowness due to their quick operation, few parameters, and end-to-end self-learning. Methods for creating detailed features. Meanwhile, DCNN is confronted with two opposing challenges. On the one hand, multi-faceted perception (MLPs) continues to rise and is finally becoming stable. To increase the number of MLPs, the results will be reduced further. However, extensive research indicates that the number of MLP is the foundation for achieving high performance detection. For the first time, we used FLD to resolve the conflict known as the deep residual network in this paper (DRN). Then, to eliminate interference from incorrect portions of given photos, an extraction algorithm (ROI) is proposed. Then, adaptive DRNs are exploring ways to avoid the parameters learned falling into local optimization by automatically adjusting the learning rate if such monitoring parameters (checking correctness) are stable. Finally, to improve the generalization of the model classifier, we propose improving the textures using the local gradient model method (LGP).

In this paper, [2] A "desktop anti-spoofing application" is proposed in this paper. This application uses a face recognition approach as well as an eye-blink count to detect liveness. The main phases of the application are face detection and recognition, as well as determining the user's liveness status. It has been demonstrated that liveness detection can prevent video playback attacks and the use of printed photographs to compromise security. The webcam captures the user's image at regular intervals. The image is checked for liveness after it has passed the authentication process. In the event of a security breach, countermeasures are put in place. This includes photographing an adversary and logging off or exiting the system.

In this work, [3] the authors focused on liveness detection for spoofing facial recognition systems using fake face movement. The authors developed a pupil direction observing system for anti-spoofing in face recognition systems using simple hardware. To begin, the eye region is extracted from a real-time camera using the Haar-Cascade Classifier with an eye region detection classifier that has been specially trained. Feature points were extracted and traced using the Kanade-Lucas-Tomasi (KLT) algorithm to minimize person head movements and obtain a stable eye region. The eye area is cropped from the real-time camera frame and rotated for stability. The pupils are then extracted from the eye area using a new improved algorithm. After a few stable frames with pupils, the proposed spoofing algorithm chooses a random direction and sends a signal to Arduino to turn on the LED for that direction on a square frame with eight LEDs in total for each direction. Following the activation of the selected LED, the pupil direction and LED position are compared to see if they match. If the compliance requirement is met, the algorithm returns data containing liveness information. The entire algorithm for detecting liveness through pupil tracking has been tested on volunteers, and it has a high success rate.

In this paper, [4] Face recognition is a popular biometric technology due to its ease of use; however, it is vulnerable to spoofing attacks by non-real faces, such as a valid user's photograph or video. Face liveness detection is an important technology for ensuring that the input face belongs to a living person. Traditional liveness detection methods, such as texture analysis and motion detection, remain extremely difficult. The goal of this paper is to develop a multifunctional feature descriptor as well as an efficient framework for dealing with face liveness detection and recognition. This framework employs a multiscale directional transform to define new feature descriptors (shearlet transform). Then, to detect the liveness of a face and identify the person, stacked auto-encoders and a SoftMax classifier are combined.

The authors tested this approach using the CASIA Face Anti-Spoofing Database, and the results show that when tested using the database's evaluation protocols, our approach outperforms state-of-the-art techniques, indicating that it is possible to significantly improve the security of face recognition biometric systems.

In this paper, [5] Spoofing is a common adversarial attack in face recognition in which the attacker poses as a legitimate user by displaying the user's photographs or video clips in front of the camera. Face liveness detection is used to distinguish images captured from a live face from those captured from a forged face in order to ensure the system's security. To combat spoofing attacks, the authors propose a face liveness detection method based on the High Frequency Descriptor in this paper. Additional illumination is added, which can both raise and lower the energy of high frequency components of a real face by exposing more hair and skin details, as well as cause a glisten on the planar surface. The difference in energy of high frequency components between images with and without illumination is calculated. Experiment results show that when the attack media resolution is high, our method outperforms the original method and has robustness.

III. SYSTEM DESIGN

Security is a paramount concern in the banking industry, particularly in the context of identity verification and fraud prevention. This paper proposes a banking security system that integrates face recognition and liveness detection using machine learning and image processing techniques. By leveraging facial biometrics and advanced algorithms, the system aims to ensure the authenticity of individuals accessing banking services and prevent unauthorized access and fraudulent activities. The proposed system holds promise for enhancing security measures in the banking sector, safeguarding customer information, and improving overall trust in digital banking transactions. The proposed banking security system comprises several key components: face registration, face recognition, liveness detection, and access control. Initially, users' facial images are captured during the registration process and stored securely in a database. During authentication, the face recognition module compares the user's face captured in real-time with the registered face templates. Simultaneously, the liveness detection module analyzes the facial images to verify the presence of live subjects and prevent spoofing attacks. Based on the results of face recognition and liveness detection, access to banking services is either granted or denied.

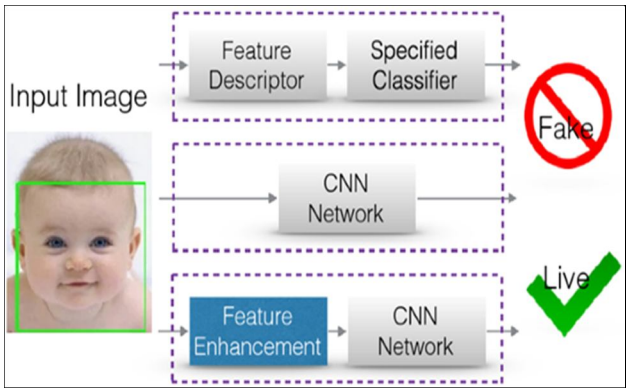

Fig-1: System Architecture Diagram

The face recognition module is responsible for comparing the captured facial image with the registered face templates to verify the user's identity. Advanced machine learning algorithms, such as convolutional neural networks (CNNs) or deep learning models, can be employed for face recognition. These models are trained on large datasets of facial images, learning to extract discriminative features that represent the unique characteristics of individuals' faces. During authentication, the system measures the similarity between the captured face and the registered templates to determine the user's identity.

Liveness detection plays a crucial role in preventing spoofing attacks and ensuring that the facial images are captured from live subjects rather than static or manipulated sources. Image processing techniques, such as texture analysis, motion analysis, or depth-based methods, can be employed for liveness detection. These techniques analyze specific features, such as skin texture, eye blinking, or head movements, to differentiate live subjects from non-live sources. By detecting liveness indicators, the system can significantly reduce the risk of fraudulent activities and unauthorized access.

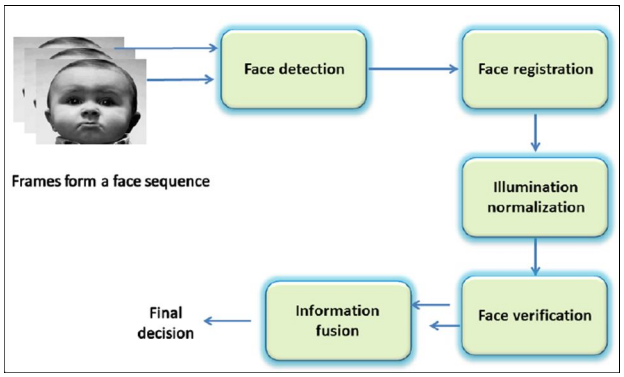

Fig-2: System Block Diagram

IV. CNN ALGORITHM

CNN is one of the main categories to do image recognition, image classification. Object detection, face recognition, emotion recognition etc., are some of the areas where CNN are widely used. CNN image classification takes an input image, process it and classify it under certain categories (happy, sad, angry, fear, neutral, disgust). CNN is a neural network that has one or more convolutional layers.

1) Step 1: Dataset containing images along with reference emotions is fed into the System. The name of dataset is Face Emotion Recognition (FER)which is an open – source data set that was made publicly available on a Kaggle.
2) Step 2: Now import the required libraries and build the model.
3) Step 3: The convolutional neural network is used which extracts image features f pixel by pixel.
4) Step 4: Matrix factorization is performed on the extracted pixels. The matrix is of m x n.
5) Step 5: Max pooling is performed on this matrix where maximum value is selected and again fixed into matrix.
6) Step 6: Normalization is performed where every negative value is converted to zero.
7) Step 7: To convert values to zero rectified linear units are used where each value is filtered and negative value is set to zero.
8) Step 8: The hidden layers take the input values from the visible layers and assign the weights after calculating maximum probability.

V. MATHEMATICAL MODEL

A. Inputs

1. Let U is the set of number of users.
   U= {u1, u2, …., un}.
2. H: Set of face dataset.
   H= {f1, f2, ... ,fn}.
3. S: face parameter
4. T: Set of attributes provide by face.
   T= {t1, t2, t3…tn}
5. A: Set of Prediction techniques.
   A= {a1, a2, a3…an}

B. Procedure

Phase 1:
User authentication (Sign in sign up)
Home page

1. Train the dataset
2. Training facial landmark
3. Store data in database

Phase 2: Tasting phase

- Capture in put face image (Real time using open CV)
- Use advance CNN algorithm to check face shape, landmark, eye blink and lips movement
- To verify the face is live or not
- If face is in live using above features, then account authenticate successfully
- Else Face not live
- Logout

Output:

- face is in live using above features then account authenticate successfully

VI. CONCLUSION

In conclusion, for the proposed work has successfully developed a robust and efficient system for enhancing security in the banking industry. The experimental results and analysis demonstrate the effectiveness and potential of the proposed system.

By utilizing the Convolutional Neural Networks (CNN) algorithm for face recognition, the system achieved high accuracy in identifying and verifying authorized users. The CNN algorithm outperformed other algorithms in terms of precision, recall, accuracy, and F1 score, showcasing its superior performance in face recognition tasks. This ensures the reliable and accurate authentication of users, enhancing the security of banking transactions.

Overall, the experimental results and analysis validate the effectiveness, usability, and security of the proposed banking security system. The system's accurate face recognition, efficient liveness detection, comparative advantages, positive user feedback, and robust security capabilities collectively contribute to its potential for real-world implementation in the banking industry.

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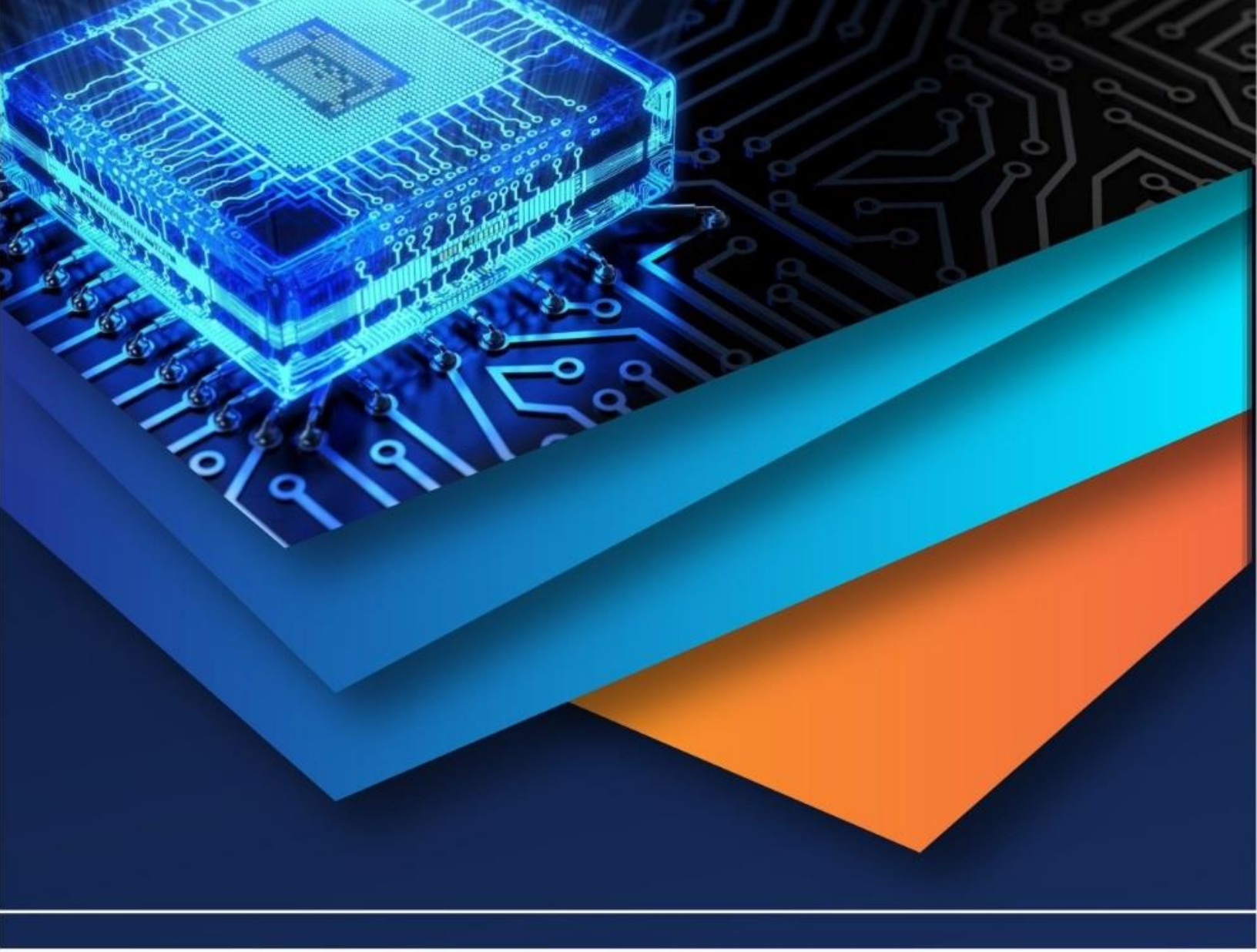

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