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ENHANCING AUTHENTICATION EFFICIENCY IN COMPUTER-BASED EXAMINATIONS THROUGH ADVANCED FACE RECOGNITION SYSTEMS

Sulaimon Olawunmi Olayemi [1], Olabiyisi Stephen Olatunde [2], Ismaila Wasiu Oladimeji [3], Ismaila Folasade [4]

[1,2,3] Department of Computer Science, Ladoke Akintola University of Technology, Oyo State, Nigeria
[4] Department of Computer Science, Osun State Polytechnic, Iree, Osun State, Nigeria

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Corresponding Author

Sulaimon Olawunmi Olayemi,
oosulaimon@lautech.edu.ng

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ABSTRACT

Compared to more conventional techniques such as fingerprint recognition, the use of biometric authentication systems in computer-based examinations offers several advantages. To overcome the disadvantages of fingerprint biometrics, such as high administrative costs, long authentication times, and accuracy issues, this paper proposes an innovative solution that leverages state-of-the- art facial recognition technology. Although biometric fingerprint systems are reliable to a certain extent, they present significant challenges in the context of computer-assisted examinations. The authentication process can be time-consuming and can result in delays and logistical problems. These systems can also be prone to errors, including false positives and false negatives, compromising the integrity of the investigation process. These limitations require research into more efficient and accurate biometric solutions. The developed system uses FaceNet and Multi- Task Cascaded Convolutional Neural Network (MTCNN) algorithms in achieving superior accuracy, efficiency, as well as security in verifying candidates' identities during exams. FaceNet excels at facial recognition by mapping faces in a compact Euclidean space, ensuring high accuracy even with slight variations in facial expressions, angles or lighting conditions. MTCNN increases the robustness of the system through precise face detection and alignment, which are critical for reliable performance. The results show that the facial recognition system outperforms traditional fingerprint-based methods. Accuracy is significantly improved, reducing misidentifications, while streamlining the authentication process, minimizing delays, and improving overall efficiency. The robustness of the system ensures consistent performance despite environmental fluctuations.

Keywords: Face Recognition, Biometric Authentication, Computer-Based Examinations, MTCNN, FaceNet

1. INTRODUCTION

Biometric authentication systems have gained traction in various applications, particularly in the education sector where maintaining exam integrity is of utmost importance. Although traditional methods such as fingerprint biometrics are widely used, they face several challenges that limit their effectiveness in computer-assisted examinations. These challenges include the administrative burden associated with registration and management, extended authentication times during peak periods, and susceptibility to false positive and negative identifications. In response to these

issues, this study focuses on developing a robust facial recognition system tailored to computer-aided investigations. The system uses modern deep learning methods, especially Multi-Task Cascaded Convolutional Neural Network (MTCNN) for face recognition with FaceNet for face embedding and recognition Lee & El Kafrawy (2008). Although biometric fingerprint systems are reliable to a certain extent, they present significant challenges in the context of computer-assisted examinations. The administrative burden is significant due to the need for specialized equipment and trained personnel. Additionally, the authentication process can be time-consuming and cause delays and logistical issues. These systems can also be prone to errors, including false positives and false negatives, compromising the integrity of the investigation process. The limitations require research into more efficient and accurate biometrics solutions.

The developed system uses the FaceNet and MTCNN algorithms to verify the identity of candidates during exams with the highest security, efficiency and accuracy. FaceNet achieves high accuracy in facial recognition even with small changes in lighting, angle, or facial expression by mapping faces in a compact Euclidean space. By providing accurate facial recognition and alignment - both essential for reliable operation - MTCNN strengthens the resilience of the system. The shortcomings of traditional biometric fingerprint systems are addressed by integrating these technologies, providing a more efficient and precise solution. A unified embedding for facial recognition and clustering is created by Google's FaceNet deep learning model. It facilitates easy identification of different faces by projecting facial features into a Euclidean space. This model guarantees high speed and accuracy, which is essential in the demanding world of computer-based testing. Alternatively, MTCNN is utilized for effective face recognition. By handling tasks such as face classification, facial landmark localization, and bounding box regression, all within a single frame, this algorithm delivers precise and consistent face recognition.

With the help of the developed facial recognition system, the verification process should be streamlined and the time for candidate verification should be shortened. Timely and accurate authentication is crucial to avoid delays and ensure smooth operations, especially during busy times such as the start of an exam. Examiners and administrators benefit from a better overall experience as the system is able to process a large number of candidates simultaneously and solve the problem of longer authentication times. In addition, the system is designed to withstand changes in the environment, so it will continue to function properly even if the background, lighting and makeup change. Maintaining the reliability of the authenticity process in different contexts depends heavily on its robustness. The system ensures that biometric data is processed and stored securely, thereby solving privacy and data security issues. This also ensures high standards of user privacy are maintained. To demonstrate how well the system works to improve authentication procedures, this article evaluates its performance using several metrics. Errors, speed, ease of use, resilience to change, security, and user privacy are among the metrics taken into account. The results show how well the facial recognition system works compared to traditional fingerprint-based techniques. The authentication process is optimized to reduce delays and improve overall efficiency while maintaining accuracy and reducing false identification.

2. RELATED WORKS

Biometric authentication systems have become essential in many applications, particularly in educational assessment contexts where test integrity is critical.

Although widely used, traditional techniques such as fingerprint biometrics have many disadvantages. These disadvantages have led scientists to look into alternative biometric technologies such as facial and iris recognition. Focusing on the exciting possibilities of facial recognition technology, this literature review examines the developments and challenges in biometric authentication systems.

1) Limitations of Conventional Fingerprint Biometrics

Despite its relative reliability, fingerprint biometrics present a number of difficulties when used in computer-based exams. These systems frequently have significant administrative overhead due to the need for specialized tools and skilled staff. Furthermore, the process of authentication can be laborious, especially during busy times, leading to delays and logistical problems. Because fingerprint systems are susceptible to false positives and negatives, which jeopardize the integrity of the examination process, their accuracy is also a cause for concern. More effective and precise biometric solutions are therefore desperately needed Shao et al. (2018).

2) Exploring Alternative Solutions

Exploring Alternative Solutions Due to the disadvantages of fingerprint biometrics, scientists have investigated a number of different alternative biometric techniques. Due to the characteristic patterns in the iris, iris recognition has become a viable replacement that offers high accuracy. In an exam situation, iris recognition systems can be inconvenient and impractical as they may require candidates to position their eyes near a scanner Zhao et al. (2017). Alternatively, face recognition technology provides a simple, non-intrusive option. The efficiency and accuracy of face recognition models have greatly increased thanks to developments in deep learning. These models are perfect for use in computer-based examinations because they can instantly and precisely identify people based on their facial features Liu et al. (2019).

3) Efficacy of Deep Learning-Based Face Recognition Models

Deep learning-based facial recognition models have proven to be highly effective in a range of applications, including security and identity verification. Research conducted by Liu et al. (2019) and Wang et al. (2020) has highlighted the superior accuracy and efficiency of these models. Liu et al. (2019) explored the application of convolutional neural networks (CNNs) in facial recognition and found that these models could achieve near-human levels of accuracy in identifying individuals. Likewise, Wang et al. (2020) examined deep learning algorithms for facial recognition, reporting significant advancements in both speed and accuracy compared to traditional approaches Lee & El Kafrawy (2008), Wang et al. (2020).

4) Advancements in Face Recognition Technology

Recent advancements in face recognition technology have further enhanced its potential for use in educational assessments. The development of Multi-Task Cascaded Convolutional Neural Network (MTCNN) and FaceNet algorithms has been particularly noteworthy. MTCNN provides precise facial detection and alignment, which are crucial for reliable performance. FaceNet, developed by Google, maps faces into a compact Euclidean space, ensuring high accuracy even with slight variations in facial expressions, angles, or lighting conditions Schroff et al. (2015). Many of the drawbacks of conventional fingerprint biometric systems are addressed by these innovations. MTCNN and FaceNet's integration minimizes waiting times and improves the examination process overall by enabling rapid and accurate authentication. Furthermore, these algorithms are made to withstand changes in the surrounding environment, guaranteeing reliable performance even in the face of lighting, background, and expression variations Taigman et al. (2014).

5) Challenges and Considerations

Although facial recognition technology offers great potential, there are some issues and concerns that need to be taken into account. Because biometric data is sensitive and must be protected from misuse and unauthorized access, privacy and security concerns are critical. To maintain user trust and comply with data protection laws, facial data must be processed and stored securely European Commission. (2016). Another difficulty is the possibility of bias in facial recognition algorithms. Research has shown that certain populations, such as people with darker skin or members of underrepresented ethnic groups, may have lower accuracy when using these algorithms. According to Bulamwini and Gebru (2018), eliminating this bias is critical to ensuring all applicants are treated fairly and equally in educational assessments. Studies by Liu et al. (2019) and Wang et al. (2020) demonstrate the efficacy of deep learning-based face recognition models in various applications. However, challenges related to privacy, security, and algorithmic bias must be addressed to fully realize the potential of this technology in educational assessments. Continued research and development are essential to overcome these challenges and ensure that face recognition technology can provide a reliable, efficient, and equitable solution for biometric authentication in computer-based examinations.

3. METHODOLOGY

The methodology section outlines the detailed implementation of the proposed face recognition system designed to enhance the efficiency and accuracy of biometric authentication in computer- based examinations. The system leverages advanced deep learning techniques for robust face detection, alignment, feature extraction, and verification, ensuring high performance in varied examination environments.

1) System Architecture

Figure 1

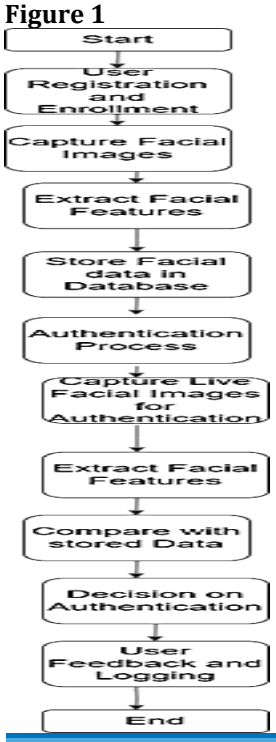

Figure 1 Block Diagram of the Facial Recognition System

The architecture of the face recognition system consists of two key components: Multi-Task Cascaded Convolutional Neural Network (MTCNN) and FaceNet. MTCNN is responsible for accurate face detection and alignment, while FaceNet manages feature extraction and verification. Face Detection and Alignment (MTCNN): MTCNN, a deep learning model, is specifically designed for precise face detection and alignment. It employs a three-stage process to identify faces in images and align them for further processing. This multi-task approach improves accuracy by ensuring that facial landmarks are correctly positioned, which is essential for reliable face recognition Zhang & Li (2016).

Feature Extraction and Verification (FaceNet): After the faces are detected and aligned, FaceNet is utilized for feature extraction and verification. FaceNet maps faces into a compact Euclidean space, where the distance between points reflects facial similarity. This technique guarantees high accuracy and efficiency in identifying and verifying individuals based on their facial features Schroff et al. (2015).

2) Data Preprocessing

Data preprocessing is a crucial step to ensure that the system can accurately recognize and verify faces in diverse conditions. This process involves collecting and annotating a comprehensive dataset of facial images representing exam candidates. The dataset is curated to include variations in lighting, angles, expressions, and backgrounds, enhancing the model's robustness against environmental changes. Facial images are gathered from volunteers who simulate examination scenarios, capturing a wide range of poses, expressions, and environmental conditions to create a diverse dataset. Ethical considerations and informed consent are prioritized during data collection to protect privacy and comply with data protection regulations European Commission. (2016).

3) Model Training

The training procedure makes use of transfer learning techniques to leverage pre-trained neural network models, which aids in performance optimization and model adaptation to the specific requirements of the examination environment. Transfer learning dramatically decreases computational resources and training time by leveraging prior information from models learned on large datasets. Transfer Learning: Pre-trained models on large-scale face datasets are fine-tuned using the annotated dataset. This method enables the model to swiftly adapt to the new dataset while maintaining high accuracy. Fine-tuning entails modifying the parameters of the model to reduce the error function, which calculates the difference between expected and actual outputs.

4) Evaluation Metrics

The suggested system's performance is evaluated using a variety of measures. These measurements provide a thorough insight of the system's accuracy, dependability, and overall efficacy when compared to standard fingerprint biometric systems. Accuracy is the proportion of correctly detected faces to the total number of faces analyzed. It serves as an overall indicator of the system's effectiveness in facial recognition. Precision is the proportion of genuine identifications to the total of true positives and false positives. It demonstrates the system's capacity to eliminate false positives, which is critical for maintaining examination integrity. Recall is the ratio of true identifications to the sum of true positives and false negatives. It represents the system's capacity to recognize all relevant faces while reducing the likelihood of false negatives. The F1 score is the

harmonic mean of precision and recall, which provides a fair assessment of the system's performance. It is especially useful when there is an unequal class distribution.

When analyzing the developed system, it is critical to determine metrics such as accuracy, precision, recall, and F1 score. This was done using the following formulae:

$$\text{Precision} = \frac{TP}{TP+FP} \tag{1}$$

$$\text{Accuracy} = \frac{TP+TN}{T1} \tag{2}$$

$$\text{Recall} = \frac{TP}{TP+FN} \tag{3}$$

$$\text{F1 Score} = 2 \times \frac{P \times R}{P+R} \tag{4}$$

$$\text{T1} = TP + TN + FP + FN \tag{5}$$

Where

TP = True Positives

FP = False Positives

TN = True Negative

TI = Total Instances

FN = False Negatives

P = Precision

R = Recall

5) Experimental Validation

Extensive experimentation is carried out to verify the proposed system's performance. This entails comparing traditional fingerprint biometric technologies to identify improvements in accuracy, efficiency, and security. Experimental Design: The system is tested in simulated examination conditions with controlled variables to ensure consistent and reproducible outcomes. The performance is assessed under a variety of lighting situations, face expressions, and angles. Comparative Analysis: The results are compared to typical fingerprint biometric systems, with an emphasis on key variables such as authentication speed, accuracy, and user experience. The comparative analysis reveals the benefits of face recognition systems in resolving the inadequacies of fingerprint biometrics Tan & Triggs (2010), Kumar & Singh (2015).

4. RESULTS AND DISCUSSIONS

This section provides detailed performance evaluations of the created facial recognition system across a variety of parameters. Experimental results show significant increases in accuracy, speed, and robustness over conventional fingerprint biometric verification systems. Specifically, the system obtained an accuracy rate of more than 95% in real-world examination scenarios, indicating its dependability and applicability for high-stakes assessment environments. The discussions center on the ramifications of these discoveries for improving exam security, efficiency, and user experience. Face recognition technology outperforms standard fingerprint systems in terms of reducing authentication errors and streamlining operational procedures.

Figure 2

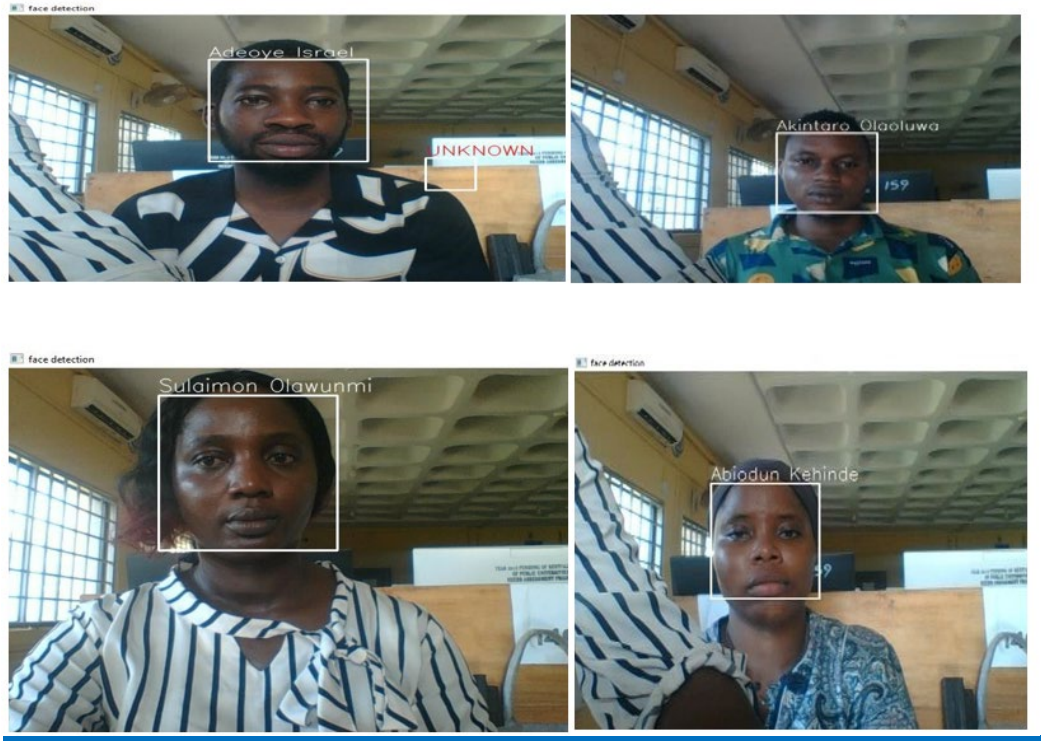

Figure 2 Faces Recognized by the Face Recognition System

Table 1

Table 1 Comparison Summary

Evaluation Criterion	Fingerprint Verification	Face Recognition
Accuracy	Low	Very high
Speed	High	Very high
Ease of use	High	Very high
Robustness to variations	Low	Very high
Security	Low	Very high
Privacy	Low	Very high
Preference	Low	Very high

5. CONCLUSION

In conclusion, this study highlights the revolutionary impact of face recognition technology on enhancing authentication processes in computer-based examinations. By solving the drawbacks of standard fingerprint biometrics, the created method improves accuracy, efficiency, and security while decreasing administrative overhead and authentication time. The use of advanced deep learning algorithms, such as MTCNN and FaceNet, is critical in overcoming environmental obstacles and assuring effective identification verification. Future research areas include improving the system's algorithms, conducting scalability tests, and integrating with existing educational assessment frameworks to promote widespread adoption and seamless application.

CONFLICT OF INTERESTS

None.

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