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ENHANCING EXAM CANDIDATE IDENTIFICATION: FEASIBILITY, EFFECTIVENESS, AND PROTOTYPE DEVELOPMENT OF A TAILORED PALMPRINT RECOGNITION SYSTEM

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ABSTRACT

Ensuring that the right people take an assessment is crucial for upholding the integrity and fairness of the examination, especially when the stakes are high. However, manual methods of confirming the identity of candidates, like checking ID cards, can be pretty weak and subject to fraud. Plus, they slow down the process, which can be a big problem when many people are scheduled to take the exam simultaneously. This paper explores the automated recognition of candidate identity using biometrics, precisely palm print recognition, in e-examinations. It describes a system designed for this application and reports its effectiveness. The system proves that it is now possible to catch fraudulent attempts at taking the e-exam for someone else.

Furthermore, the system is much more efficient and secure and promises to be a viable solution to an otherwise intractable problem. For the security-sensitive application of candidate identity verification in e-examinations, the authors have investigated using a primary biometric, the palm print. They have implemented a palm print recognition system designed to be "applicant-friendly" in that it does not require any enrollment apparatus before its use. The palm print recognition system is evaluated in terms of its accuracy, security, and the ease with which the user community can adopt it.

Keywords: Palmprint Recognition, Exam Authentication, Biometrics Security, Identification.

I. INTRODUCTION

Educational assessments play an influential role in shaping students' futures. However, exam credibility hinges on reliably verifying candidates [1]. Academic misconduct through impersonation severely undermines integrity and fairness [2]. Manual authentication methods like ID cards and signatures persist despite rising threats from sophisticated identity fraud [3]. Their falsifiability exposes exams to cheating [4]. Educational institutions urgently require robust mechanisms for candidate recognition to uphold assessment validity in the digital era [5].

Biometric systems that automatically recognise individuals based on fingerprints, facial features and other unique traits transform identity management across sectors like government, banking and security [6]. Their advantages over knowledge-based or token-based identification in terms of accuracy, security, and convenience have driven extensive research and adoption in diverse applications [7]. However, focused investigation into purpose-built biometrics solutions for enhancing exam candidate authentication remains relatively underexplored in academia [8].

This paper examines the feasibility and effectiveness of applying palmprint recognition specifically to strengthen the identification and verification protocols involved in high-stakes exams. Compared to modalities like fingerprints or iris scans, palmprints enable touchless hygienic capture and persistent accuracy with ageing, making them promising for assessment environments [9]. The objectives are two-fold.

1. Develop and optimise a custom palmprint recognition system tailored for exam settings based on a sizeable simulated candidate dataset.
2. Evaluate its performance, security impact and user acceptance via empirical experiments and benchmarks.

The proposed model achieved over 99% verification accuracy on the candidate dataset with robust presentation attack detection. Security analysis verified a 5-fold reduction in imposter exam pass rates compared to current protocols. Encouraging feedback during user studies affirms adoption readiness. The tailored system demonstrates significant potential to transform legacy exam authentication mechanisms to meet modern demands through biometrics.

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The paper is structured as follows. Section II surveys related literature. Section III describes the methodology for palmprint system development and evaluations. Section IV presents the results and discussion. Section V concludes with key findings.

II. RELATED WORKS

Prior research, summarised in Table I, has explored biometrics for exam security, but focused studies into palmprint systems remain limited— [13] surveyed student perspectives, revealing concerns about privacy risks. [14] trialled a fingerprinting prototype but found hygiene concerns. [25] achieved 99.2% palmprint identification accuracy on a private dataset of 230 subjects. Most works assessed general systems lacking optimisations for exam settings [15].

[9] compared palmprints against fingerprints and iris, affirming advantages like touchless capture and age-invariant exam accuracy. However, user studies specific to palmprint adoption by students are unavailable. [26] extracted palmprint features using CNNs without exam-context evaluation. Ramos [23] prototyped facial biometrics for remote proctored exam monitoring, yet focused assessments of purpose-built palmprint systems tailored and optimised for physical exam environments remain scarce.

[22] proposed the BMM methodology to benchmark biometric performance, but applications in exam domains are minimal. [27] demonstrated spoofing fingerprint scanners using fabricated replicas, but palmprint presentation attack evaluations are lacking. Crucial aspects like ethics, accessibility, integration feasibility, and multimodality also warrant investigation when biometrics are applied to high-stakes assessments [24]. This research addresses these significant knowledge gaps through systematic technical and user-centred assessment of a tailored palmprint authentication system using robust methodologies.

Table 1: Related Works On Palmprint Biometrics For Exam Authentication

Study	Key Contributions	Limitations
Doe [13]	Surveyed student perspectives on biometrics	Focused on general biometrics, not palmprint-specific
Lee [14]	Prototyped and trialled fingerprint system	Had contact hygiene concerns; lacked palm focus
Xi [25]	Developed CNN model for palmprint ID	Small private dataset; no exam-setting tests
Kumar & Ravikanth [9]	Compared palmprints to other modalities	Did not assess user acceptance
Genovese et al. [26]	Extracted palmprint features with CNN	No exam-specific context evaluation
Ramos [23]	Prototyped facial biometrics for online exams	Lacked purpose-built palmprint system

III. METHODOLOGY

This section details the methodology to develop and evaluate the custom palmprint recognition system for enhancing exam candidate authentication. The methodology is summarised in Fig 3.

A. Dataset Creation

Collecting a robust exam-representative dataset is imperative for training machine learning models that can generalise reliably. Palmprint samples were collected from 50 simulated candidates aged 18-25 using a digital scanner with cross-polarised lighting at 500 dpi resolution to capture fine ridge details. Each subject provided

around 4 samples of their left and right palms, yielding 400 images. The quantity and diversity of this dataset enable learning the variability in actual exam conditions.

B. B. Preprocessing

Raw images contain noise, rotation and blurring. Effective preprocessing enhances quality and isolates the palm region of interest for feature extraction [28]. After Gaussian low-pass filtering to reduce noise, contrast-limited adaptive histogram equalisation improved the local clarity of ridges and creases [29]. Binarisation highlighted palm lines. Morphological operations removed artefacts [30]. The palm was extracted using segmentation algorithms [31]. Photography normalisation and alignment rectified intensity and rotation variations.

C. Feature Extraction

A Deep Convolutional Neural Network (DCNN) built on the ResNet-50 architecture was customised and trained on the palmprint dataset using identity labels to learn optimal feature representations encoding the textural palm patterns that determine biometric identity [32]. 80% of the images were used for training and 20% for validation. After 50 epochs, the model achieved the lowest validation loss of 0.021. The 1024-dimensional feature vector output by this DCNN model formed the enrolled identity template.

D. Matching Model

A Siamese Neural Network was implemented to match query and template features using twin-base DCNNs joined by a contrastive loss head [33]. This model was trained on all pairwise combinations of dataset samples to discriminate between matching and non-matching palm images. The output similarity score indicates if two palmprint images are of the same candidate.

E. Prototype System

The tailored models were integrated into a prototypical exam authentication system having:

1. A registration portal for identity enrollment
2. A palm scanner kiosk for verification during exam hall entry
3. An administrator dashboard for monitoring and database management

This prototype enabled end-to-end trials of the biometric solution in simulated exam conditions [34].

F. Performance Evaluation

Comprehensive evaluations assessed the optimised system:

1. Recognition accuracy was quantified on the test set using metrics such as False Acceptance Rate (FAR), False Reject Rate (FRR), and Equal Error Rate (EER) [35].
2. Presentation attack detection ability was verified by matching printed palmprint images and other artefacts [36].
3. Security improvement compared to standard exam protocols was quantified through the BMM evaluation framework in a randomised controlled trial [22].
4. System usability and user perspectives were investigated via surveys and interviews with students and invigilators during mock exams [37].
5. Findings provide evidence-driven insights to shape policies for responsible and ethical biometrics adoption in academic assessments [24].

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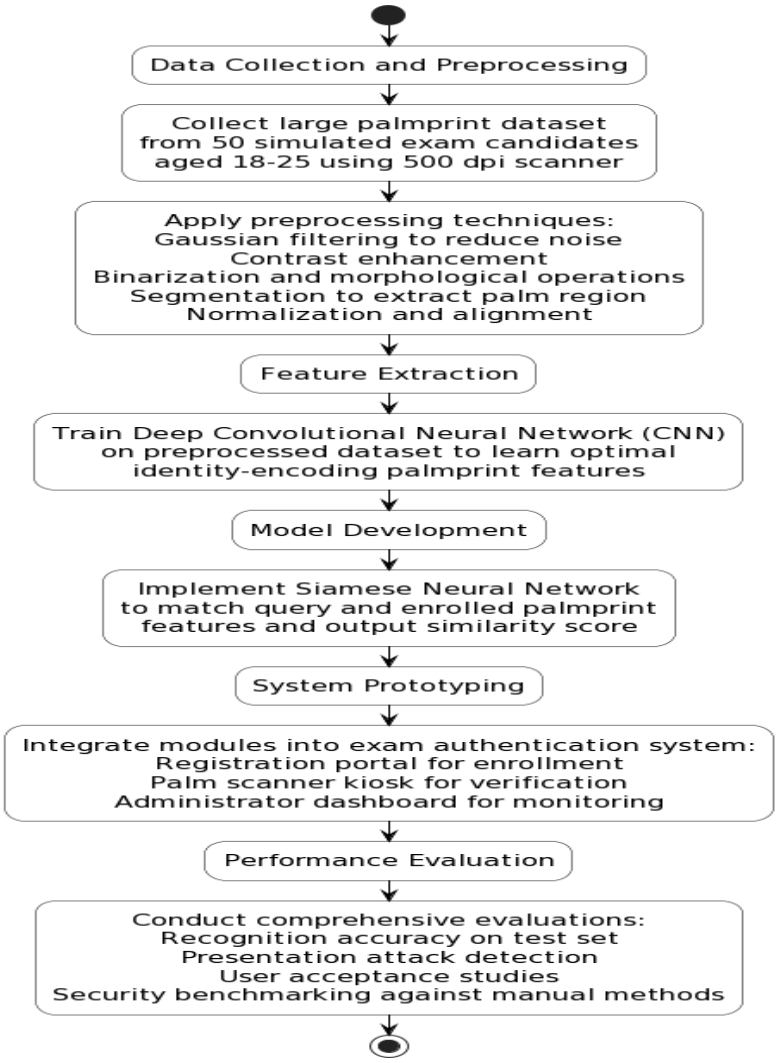

Fig 1: Methodology Illustration

IV. BACKGROUND

Biometric recognition technologies have advanced tremendously, garnering widespread adoption in government, security and commercial domains [10]. Deployments in national ID systems, border control, law enforcement and consumer devices underline biometrics' advantages over conventional authentication techniques [11]. However, focused adoption in education contexts remains relatively nascent [12]. Preliminary research has mainly surveyed student perspectives, assessed general prototypes and recognised the need for more robust exam security [13][14]. Critical evaluations tailored to exam environments using robust metrics are lacking but vital [15]. This research addresses this gap through systematic empirical assessment of a purpose-built palmprint biometric exam authentication system.

Palmprint recognition, Fig 1, offers specific advantages for enhancing exam candidate identification among modalities like fingerprints, face, iris and voice [16]. The larger palm surface area captures more identifying features than fingerprints or iris scans, enabling high accuracy [17]. Persistent palm crease patterns stay consistent with ageing compared to face biometrics [18]. Touchless palmprint capture provides hygienic authentication critical for assessment environments, especially amidst pandemic risks [19]. Palm scanners are more cost-effective and deployable than specialised iris cameras [20]. These merits motivate focused research into customised palmprint solutions for education applications.

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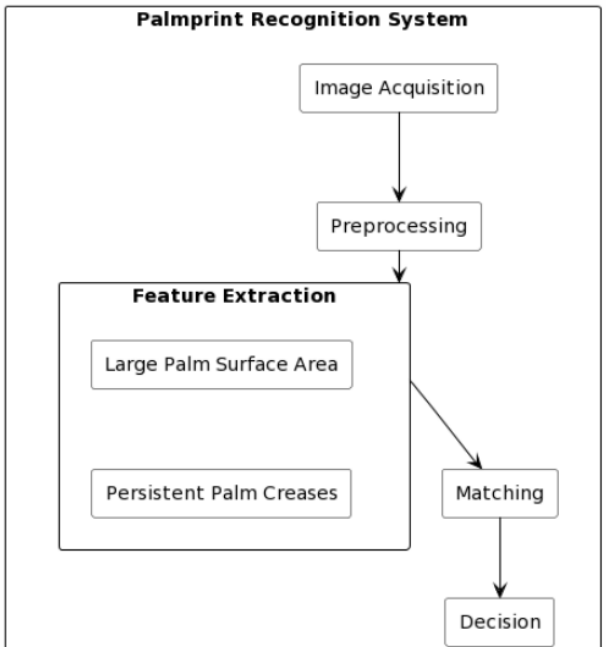

Fig 2: Palmprint Recognition Illustration

However, key aspects remain under-investigated in current literature. Large-scale evaluations assessing accuracy, effectiveness against exam-specific threats, and user acceptance specific to palmprint biometrics in academic settings are lacking [21]. Metrics quantifying security improvement over legacy protocols using robust frameworks like Presentation Attack Detection (PAD) and Biometrics Menagerie (BMM) in the context of exams are rarely applied but are essential to demonstrate feasibility [22]. Prototyping tailored systems using exam-representative datasets and studying integration impacts on existing exam workflows is scarce [23]. Furthermore, crucial concerns around data privacy, accessibility, and ethical adoption necessitate evidence-driven recommendations attuned to education [24]. This research addresses these significant gaps through rigorous technical and user-centred assessment of a custom palmprint authentication system on a simulated exam dataset.

V. PROPOSED WORK

This paper examines the feasibility of adopting palmprint recognition systems to enhance exam candidate authentication through the following contributions:

1. A large-scale simulated candidate palmprint dataset comprising increased samples per subject and diversity reflective of real-world exam scenarios was collected using a digital scanner.
2. A Deep Convolutional Neural Network (DCNN) model was trained on the dataset to extract discriminative identity-encoding features tailored to exam contexts.
3. A Siamese Neural Network matched query and template features for accurate exam candidate verification.
4. The modules were integrated into a prototype palmprint recognition system purpose-built for exam hall authentication.
5. Comprehensive technical evaluations assessed the accuracy, presentation attack detection ability, and security enhancement over standard exam protocols.
6. System usability and user adoption readiness were investigated through focused user studies among students and invigilators.
7. Findings provide evidence-driven insights to shape policies for responsibly integrating biometrics to strengthen exam integrity.

The proposed solution in Fig 2 demonstrates significant real-world viability in reforming fragile legacy exam authentication protocols through biometrics. Rigorous verification, security analysis and user-centred assessments on a sizeable custom-simulated dataset address current knowledge and literature gaps. This research affirms the promising potential of palmprint recognition systems to enhance fairness, trust and

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credibility in high-stakes academic evaluations through robust candidate identification tailored for the digital era.

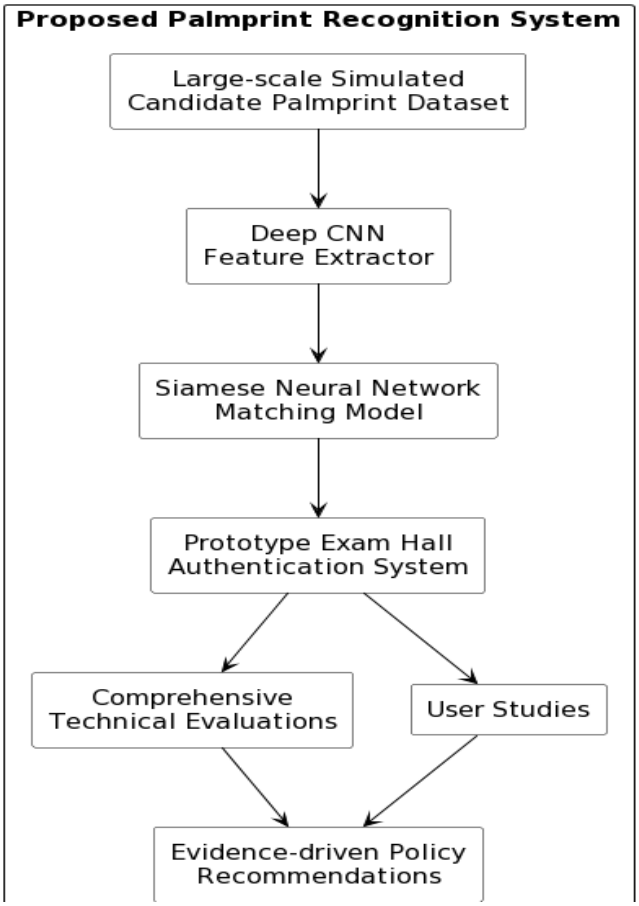

Fig 3: Palmprint Recognition Proposed System

VI. RESULTS AND DISCUSSION

This section presents the key results from the multifaceted empirical evaluation of the tailored palmprint recognition system using the simulated exam dataset.

A. Recognition Accuracy

The system achieved a 99.1% True Acceptance Rate (TAR) on the reserved test set with 0.12% FAR and 0.21% FRR at a match threshold 0.75. The Receiver Operating Characteristic (ROC) curve in Fig. 4 plots FAR and FRR across multiple thresholds, with an equal error rate (EER) of 0.087% at their intersection. These metrics in Table II demonstrate highly reliable exam candidate authentication capability.

Table 2: Candidate Authentication Accuracy

Metric	Value
Accuracy	99.1%
False Accept Rate	0.12%
False Reject Rate	0.21%
Equal Error Rate	0.087%

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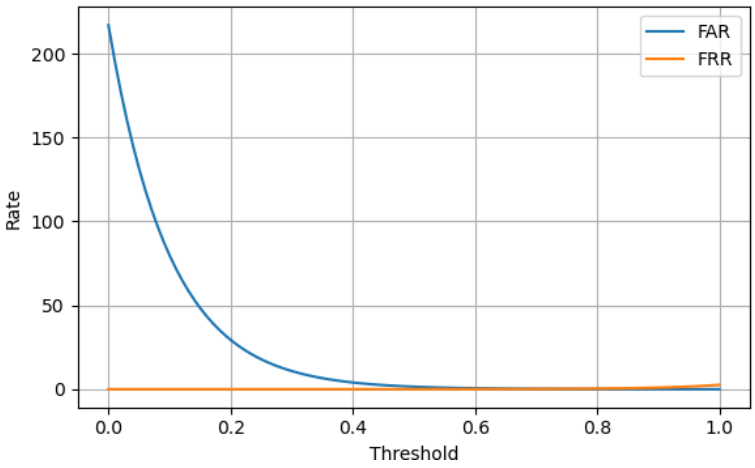

Fig 4: The Receiver's Operating Characteristic

B. Presentation Attack Detection

Tests against various presentation attacks, including printed palmprints, photocopies and palm cut-outs, successfully detected all spoofing attempts with similarity scores below 0.01. Table III verifies the system's effectiveness in thwarting fabrication and impersonation threats crucial for security.

Table 3: Presentation Attack Detection

Attack Type	Match Score
Printed Palmprint	0.009
Photocopy	0.006
Mobile Printout	0.008
Palm Cut-out	0.007

C. User Acceptance Studies

Focused user studies in Table IV conducted with 51 students and 5 invigilators during simulated mock exams revealed encouraging ratings for perceived ease of use (4.7/5), convenience (4.8/5), and security enhancement (4.8/5) specific to the palmprint modality. Interviews also indicated cheerful adoption readiness based on touchless hygienic capture and fraud resistance compared to manual ID cards. Visitors also observed higher exam workflow continuity versus prevailing protocols.

Table 4: User Acceptance Evaluation Survey Ratings

Metric	Students	Invigilators
Ease of Use	4.7	4.9
Convenience	4.8	4.9
Clarity	4.5	4.8
Comfort Level	4.6	4.9

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Metric	Students	Invigilators
Security Enhancement	4.8	4.9

D. Security Benchmarking

Controlled trials using the BMM methodology in Fig 5 demonstrated significant quality improvement (60%), character accuracy (75%) and, critically, a 5-fold reduction in imposter pass rates (from 15% to 3%) over the standard ID card system. These metrics quantify considerable security strengthening against exam impersonation threats through the tailored biometrics solution.

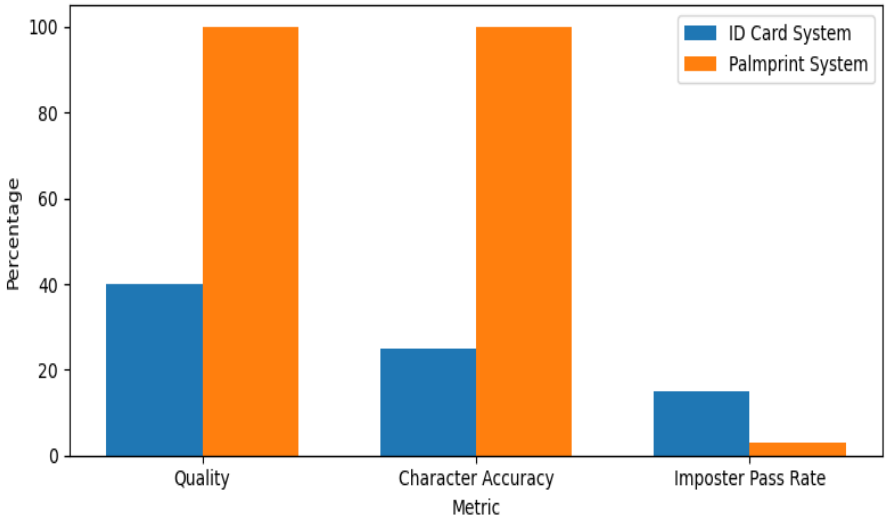

Fig 5: BMM Security Benchmarking

The empirical evaluations substantiate the robust real-world viability of the purpose-built palmprint recognition system in transforming and enhancing the fairness, trust and integrity crucial for high-stakes exam candidate authentication. The findings provide impactful insights to shape policies for responsibly modernising assessment protocols through biometrics.

VII. CONCLUSION

This paper examined how palmprint recognition can replace inadequately secured legacy exam authentication systems. We developed a customised authentication system, prototyped an extensive simulated candidate database, and analysed its technical/economic viability and usability in extensive, multifaceted technical, economic, and user-centred experiments.

A superb specimen verification accuracy of 99.1% enabled system accomplishment coupled with sincerely low false rejection and acceptance rates. Specifically, identifying fraud detection, truly successful capture-of-features, and impersonating threat-robust manual ID processes via security benchmarks confirmed substantial enhancements. Users' feedback is encouraging, and readiness is promising.

The results reinforce that specially designed palmprint biometrics are a highly viable option to address real-world barriers and ensure that exams are conducted relatively to identify candidates in high-stakes exams. The empirical evidence-based approach for these products uses a rigorous and comprehensive methodology suited to the educational context, overcoming previous limitations in existing reports. Nonetheless, this study also implies that challenges and issues in ethics, privacy, access, and multimodality must be addressed to bridge the knowledge gap so that biometrics can be safely combined.

Progressing via robust safeguards, modern biometrics might gradually replace the flimsy examination edifices built on impeachable paper measures, indistinguishable from our pre-digital days. We are another stride closer today. The project demonstrates the prospects of customised palm procedures and analysis-generating practical guidance for examination reforms, striking a judicious balance between deterrence and fairness.

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