Streamline The Loan Journey With Smart Identity Checks

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Abstract

The project automates the loan waiver approval process using AIpowered identity verification to enhance accuracy, security, and efficiency. Applicant details such as name, Aadhaar number, and PAN number are extracted from document images using Optical Character Recognition (OCR) and refined with Named Entity Recognition (NER). This data is validated against the applicant's detail from the database. A ResNet-based facial recognition model compares the applicant's live image with their ID document to ensure identity authenticity. To secure the process, a One-Time Password (OTP) is sent via SMS and email for contact verification. Financial eligibility is assessed through a rule-based engine that evaluates income, loan history, and land ownership using bank records. The system ensures regulatory compliance through encryption, reduces manual errors, and provides real-time analytics for administrators. Its modular architecture integrates easily with government databases and banking systems and is optimized for low-resource environments using lightweight models. Overall, the system offers a scalable, transparent, and secure approach to delivering loan waivers to the truly deserving.

Index Terms

Loan Waiver, Identity Verification, OCR, Facial Recognition, ResNet, NER, OTP Authentication

I. INTRODUCTION

The loan waiver approval process plays a critical role in providing financial relief to individuals and families struggling with economic hardship, especially farmers and small-scale borrowers in rural areas. These waivers act as an important social safety net that allows distressed borrowers to recover from debt burdens caused by unpredictable events such as crop failures, market fluctuations, natural disasters, or health emergencies. Governments and financial institutions implement loan waivers not only to stabilize the financial well-being of individuals but also to strengthen rural economies and maintain social harmony. However, the conventional loan waiver approval process is often slow, fragmented, and heavily dependent on manual intervention, making it difficult to handle large numbers of applications accurately and efficiently. As a result, deserving beneficiaries are frequently left waiting for relief, and administrative systems become overwhelmed

A significant challenge in the traditional approval process is the high risk of fraudulent claims, where individuals attempt to take advantage of verification loopholes by submitting forged documents, inaccurate personal details, or impersonating eligible beneficiaries. Without a robust and secure verification mech- anism, institutions struggle to distinguish between genuine and fraudulent claims, leading to financial losses, resource misallocation, and reputational damage. Moreover, the manual nature of verification increases the likelihood of human error, bias, and inconsistencies in decision-making. Applicants often face difficulties due to discrepancies in records, delays in paperwork, or errors in documentation, further slowing the approval process and undermining trust in government schemes. The absence of a standardized, technology-driven system makes it hard to ensure fairness, accuracy, and transparency at every stage of the process.

To address these gaps, the integration of an automated loan waiver approval system has emerged as a game-changing solution. By incorporating advanced technologies such as Optical Character Recognition (OCR) for extracting text from identity documents, Natural Language Processing (NLP) for cleansing and interpreting data, and face verification systems for biometric authentication, the system transforms the approval process into a fast, secure, and reliable operation. Automation eliminates the need for repetitive manual tasks, reduces operational costs, and enhances the overall efficiency of financial institutions. Furthermore, an intelligent eligibility engine, guided by pre-set rules and decision algorithms, can instantly validate applicant data against official records and eligibility criteria. This ensures that only qualified individuals receive aid while reducing the chances of fraudulent approvals. Automated systems also make it possible to apply consistent standards across regions, improving fairness and accountability.

Beyond efficiency gains, an automated loan waiver approval system brings broader benefits to stake- holders. Real-time dashboards and monitoring tools allow administrators to track application progress, generate regional reports, and analyse trends for continuous improvement. Applicants benefit from faster processing times, transparent communication, and reduced paperwork, while institutions gain better control over resource allocation and fraud prevention. Additionally, automated error detection, audit trails, and data security mechanisms strengthen compliance with regulatory requirements and safeguard sensitive personal information. By adopting such systems, governments and financial institutions not only enhance the effectiveness of their loan waiver programs but also build public confidence and ensure that financial support reaches those who need it most, ultimately contributing to greater economic resilience and social equity.

II. Literature Review

Recent research has explored various technological approaches to improve loan processing and identity verification systems. E. Hussein Sayed et al. (2024) emphasized the importance of accurate loan default prediction for financial institutions, utilizing a combination of machine learning and deep learning tech- niques. Their work highlighted the superior performance of ResNet and DenseNet architectures, which aligns with our project's choice of ResNet for reliable identity verification.

Mariana Dias and Carla Teixeira Lopes (2023) explored OCR optimization for scanned archival data, demonstrating that tailored image pre-processing can significantly improve recognition accuracy. Their findings support our use of grayscale conversion, Gaussian blur, and adaptive thresholding for reliable data extraction from Aadhaar and PAN images.

L. Jose Gonzalez-Gomez et al. (2024) reviewed the application of Natural Language Processing (NLP) in workforce development, implementing predictive models and NER techniques to extract structured information from unstructured text. Their work reinforces our use of NLP and NER for document text conversion into semantically structured data.

S. Safwat et al. (2024) proposed a hybrid model combining GAN and ResNet architectures to detect deepfake faces, directly supporting our biometric verification strategy where a ResNet-based model is employed for extracting facial embeddings.

Xolani Dastile and Turgay Celik (2024) introduced counterfactual explanations for Explainable AI (XAI) in loan decisions, setting the foundation for future integration of XAI to make loan waiver decisions more transparent.

Quoc-Dung Nguyen et al. (2023) proposed an unsupervised OCR correction approach using a hill- climbing algorithm, justifying our choice of lightweight, high-accuracy OCR tools like Tesseract integrated with fuzzy matching.

E. S. E. B. Aggrey et al. (2023) suggested a blockchain-based decentralized student loan platform with smart contracts, aligning with our future growth plans to integrate secure verification trails.

Vikas Kumar et al. (2023) explored machine learning applications for loan credit risk prediction, echoing our use of rule-based logic to assess loan waiver eligibility based on financial criteria.

III. System Architecture

The system is designed as a well-structured, modular platform that automates the loan waiver verification process using AI technologies. It follows a three-layered architecture that ensures smooth data flow, secure processing, and clear decision-making [Refer Fig. 1].

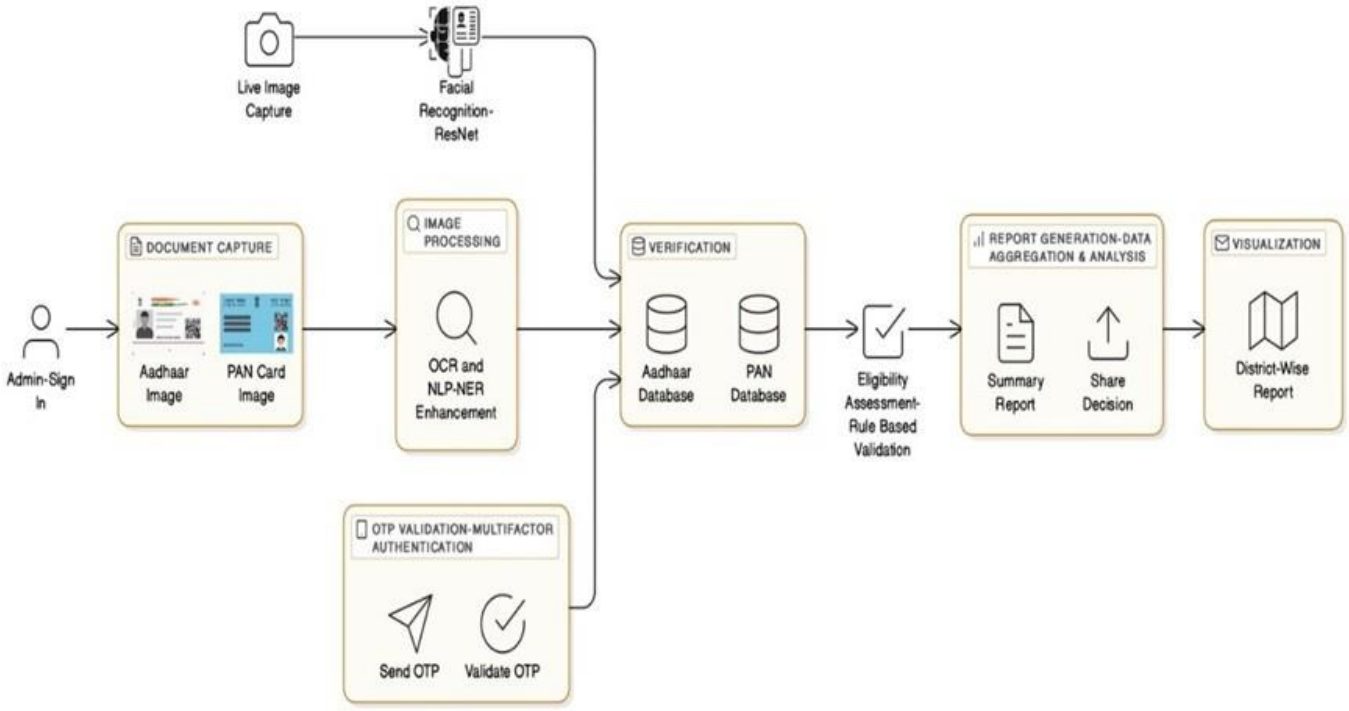

Fig. 1: System Architecture Diagram

The system comprises seven key modules that work in concert to deliver comprehensive loan waiver verification:

A. Document Capture and OCR-Based Verification

This module serves as the entry point for identity verification by enabling real-time document capture using a smartphone or webcam. The system ensures that only live and non-manipulated images of Aadhaar or PAN cards are accepted, mitigating the risk of fraudulent submissions. It utilizes Optical Character Recognition (OCR) techniques to automatically extract critical details such as the applicant's name, date of birth, Aadhaar number, and PAN number. The module is optimized to handle a variety of lighting conditions, document orientations, and image qualities. Robust validation checks are incorporated to ensure completeness, accuracy, and compliance with document standards, forming a foundational layer for secure identity processing.

B. Data Preprocessing using NLP

After OCR extraction, the raw textual data is often noisy and unstructured. This module applies Natural Language Processing (NLP) techniques to clean the data by removing irrelevant symbols, punctuation, and formatting anomalies. It performs tokenization to segment the text into interpretable units and lever- ages Named Entity Recognition (NER) to identify and extract key fields such as the applicant's name, Aadhaar/PAN number, and date of birth. This step ensures that all extracted information is accurately prepared for downstream matching and decision-making.

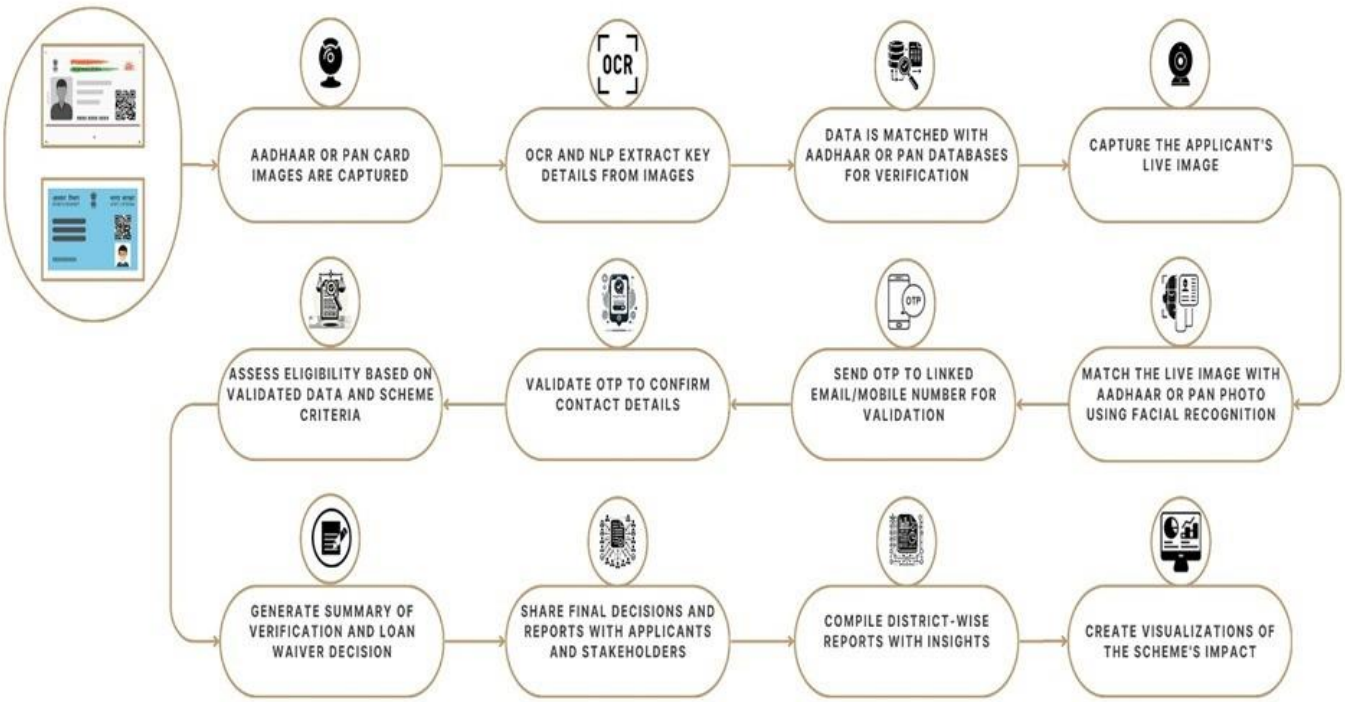

Fig. 2: System Workflow Diagram

C. *Face Verification using Aadhaar/PAN Data*

To provide biometric validation, this module captures a live facial image of the applicant and compares it with the face extracted from the Aadhaar or PAN card using a ResNet-based facial recognition model. The system extracts facial embeddings and computes similarity scores to verify identity authenticity. This module acts as a critical checkpoint against identity theft and impersonation, ensuring that the applicant is physically present and matches the document owner.

D. *Email/SMS OTP Verification Module*

This module confirms the applicant's ownership of the provided email address or phone number through a secure OTP-based system. Upon submission, a One-Time Password (OTP) is generated and sent via email or SMS. The user is prompted to enter this code into the system, where it is verified against the server-side value. This adds a crucial second layer of identity verification and ensures that all communications and approvals are securely linked to the verified applicant.

E. *Bank Loan Decision-Making Module*

This is the core decision engine that evaluates the applicant's eligibility for a loan waiver. It integrates verified data from OCR, facial verification, and contact authentication, along with financial information such as credit scores, income, and historical loan behavior. Based on predefined eligibility criteria and regulatory guidelines, the module applies rule-based and heuristic logic to determine whether the applicant qualifies for loan waiver approval. It ensures transparency, consistency, and compliance in the decision- making process.

F. *Loan Approval Report Email Notification*

Once the evaluation process is completed, this module automatically generates a detailed loan waiver report summarizing the verification results and the decision outcome. The report includes the applicant's verified identity, evaluation metrics, and a final approval or rejection status. It is sent to the applicant's registered email address, ensuring formal, traceable communication and eliminating manual processing delays. This module enhances user experience and administrative efficiency.

G. *Admin Module*

This module offers a comprehensive administrative interface for overseeing the entire workflow. It allows administrators to view and manage applicant records, including identity data, document verification status, and financial details. The dashboard provides real-time insights through charts, statistics, and district-wise reports. It helps track application trends, approval rates, and detect anomalies. The admin module is essential for monitoring system health, generating compliance reports, and improving operational transparency across regions.

IV. PROPOSED WORK

The loan waiver verification system uses AI-based technologies for automatic validation processes that are secure and efficient to ensure applicant verification while avoiding errors that occur through manual processes and time-consuming processing.

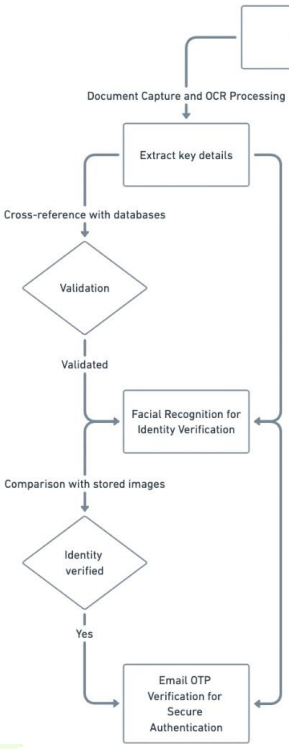

Fig. 3: System Workflow Diagram

A. *Document Capture and OCR Processing*

The system captures images of Aadhaar or PAN cards using a webcam. Optical Character Recognition (OCR) extracts key details such as Aadhaar/PAN number, name, and gender. Named Entity Recognition (NER) in NLP enhances data extraction accuracy from documents. Extracted data is cross-referenced with official Aadhaar and PAN databases for validation.

B. *Facial Recognition for Identity Verification*

The system captures a live image of the applicant and processes it using ResNet-based facial recognition technology. The captured image is compared with stored images from Aadhaar and PAN databases to verify identity, ensuring that only genuine applicants proceed with the loan waiver process [Refer Fig. 4].

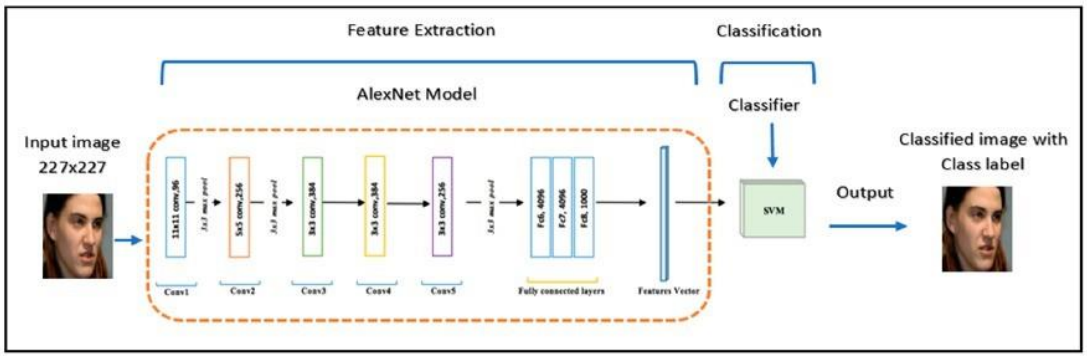

Fig. 4: ResNet-based Facial Recognition Module

C. *Email/SMS OTP Verification*

Upon successful identity verification, an OTP is sent to the applicant's registered email and mobile number. The system validates the OTP to verify the authenticity of the applicant's contact details, adding an additional layer of security to detect fraudulent applications.

D. *Financial Eligibility Assessment*

The system extracts key financial details from submitted bank statements and evaluates eligibility using rule-based validation, considering income, outstanding loans, and transaction patterns. This ensures automatic decision-making, approving loan waivers only for eligible applicants.

E. *Automated Report Generation*

The system generates a summary of the verification process and loan waiver decision for applicants. It performs data aggregation to compile reports on successful applicants across districts, supporting document generation with visual analytics and pictorial representations.

V. Evaluation Metrics

To evaluate the effectiveness of the face recognition module, we conducted a comprehensive comparison using multiple well-known deep learning models, including Dlib ResNet, FaceNet, VGGFace2, OpenFace, and DeepFace. The focus was on assessing each model's accuracy in real-world conditions while con- sidering their compatibility with our system and deployment efficiency. Although models like FaceNet and DeepFace offered slightly higher benchmark accuracy, Dlib ResNet was chosen due to its lightweight nature, ease of integration, and decent performance, making it ideal for our loan waiver verification system. We tested the models using a custom dataset that included face images captured under diverse condi- tions—such as poor lighting, different facial angles, and partial occlusions—to simulate real-life scenarios. The verification process involved comparing pairs of images by calculating the Euclidean distance between their facial embeddings. A threshold value of 0.5 was used to classify whether the pair belonged to the same individual. The distribution of distances showed a clear separation between genuine and imposter pairs, confirming the reliability of the embedding-based matching process.

To further quantify performance, a confusion matrix was generated. This matrix revealed 16 true negatives, 5 true positives, 4 false positives, and notably, 0 false negatives. The absence of false negatives is particularly important in our context, as it indicates that the system is highly reliable in detecting genuine matches, ensuring that eligible applicants are not mistakenly rejected. The low number of false positives also demonstrates strong discrimination ability, reducing the likelihood of identity fraud or impersonation.

A. Performance Metrics

The model's effectiveness was evaluated using standard classification metrics derived from the confusion matrix. The performance metrics are as follows:

- **Accuracy:** 84%
- **Precision:** 91%
- **Recall:** 84%
- **F1-Score:** 85%

Lastly, the overall classification performance was summarized through standard metrics such as preci- sion, recall, F1-score, and accuracy. The Dlib ResNet model delivered an overall accuracy of 84

Models were tested on a proprietary dataset of face images, meticulously curated to encompass real environmental conditions including suboptimal lighting, partial occlusions, and diverse facial angles. Performance metrics were derived using a pairwise comparison method, quantifying facial similarity through the Euclidean distance between face embeddings with a threshold of 0.5 to delineate positive matches.

VI. Results and Discussion

The rigorous evaluation of our AI-powered loan waiver system yielded compelling results, underscoring its efficacy and operational benefits. The Dlib ResNet-based facial recognition module demonstrated high accuracy and robustness, even when faced with challenging real-world conditions [Refer Fig. 6].

Our multi-layered verification approach, encompassing precise OCR for document data extraction, facial biometrics, and secure OTP authentication, proved highly effective in ensuring data integrity and mitigating fraudulent applications. This comprehensive method significantly reduces the potential for human error inherent in manual methods.

The system delivers substantial improvements in processing efficiency. Automatic data extraction and rule-based financial assessment significantly reduce application processing time, while the automated report generation and data visualization features provide real-time insights into scheme performance across districts [Refer Fig. 8].

VII. Conclusion and Future Work

The project delivers an advanced AI-driven system purpose-built to automate the loan waiver verification process, addressing longstanding challenges such as inefficiency, human error, and susceptibility to fraud in manual systems. By integrating Optical Character Recognition (OCR) combined with document prepro- cessing techniques—including adaptive thresholding, grayscale conversion, noise reduction using Gaussian blur, and morphological operations—the system achieves highly accurate extraction of critical identity details from Aadhaar and PAN card images. To ensure the integrity and reliability of the extracted data, regular expressions (regex) and pattern-matching algorithms are applied for format validation, flagging anomalies such as invalid Aadhaar numbers or PAN formats early in the pipeline. This multi-layered preprocessing not only reduces manual intervention but also improves throughput, allowing the system to handle a large volume of applications with speed and precision.

To further enhance the semantic understanding of the extracted text, Natural Language Processing (NLP) techniques—particularly Named Entity Recognition (NER) models—are applied to isolate key entities like name, date of birth, address, and document numbers. Leveraging state-of-the-art NLP frameworks such

MODEL	LFW BENCHMARK ACCURACY (%)	REAL-WORLD ACCURACY (%)	Remarks
Dlib ResNet	99.38	84.00	Lightweight, fast CPU inference and no deep framework required.
FaceNet	99.63	~86–90	Requires TensorFlow and large model size.
VGGFace2	98.95	~85–89	Heavy dependencies and deep architecture.
OpenFace	92.92	~80–83	Lightweight and lower accuracy compared to others.
DeepFace	97.35	~84–88	Limited availability and potential privacy concerns

Fig. 5: Comparative Evaluation of Face Recognition Models

as spaCy, BERT, or IndicNLP ensures that the system can handle both English and regional languages, overcoming the multilingual and irregular formatting challenges commonly present in Indian government documents. The structured data output is formatted into JSON or relational database records, enabling seamless integration with backend databases and ensuring efficient data retrieval, search, and audit capa- bilities. This linguistic robustness ensures inclusivity and strengthens the system's ability to serve diverse user groups, especially in rural and semi-urban regions.

A cornerstone of the system is the biometric verification module, powered by a ResNet-based deep convolutional neural network (CNN). This module performs facial embedding extraction and applies similarity measures such as cosine similarity or Euclidean distance to match the livecaptured image against the stored photograph from Aadhaar or PAN cards. To further secure the verification process, the system implements multifactor authentication (MFA) by dispatching One-Time Passwords (OTPs) via both email and SMS channels, ensuring possession-based authentication alongside biometric validation. The combination of facial recognition and OTP verification makes the system highly resistant to impersonation, deepfakes, or fraudulent submissions, thereby significantly enhancing the overall security posture of the loan waiver pipeline.

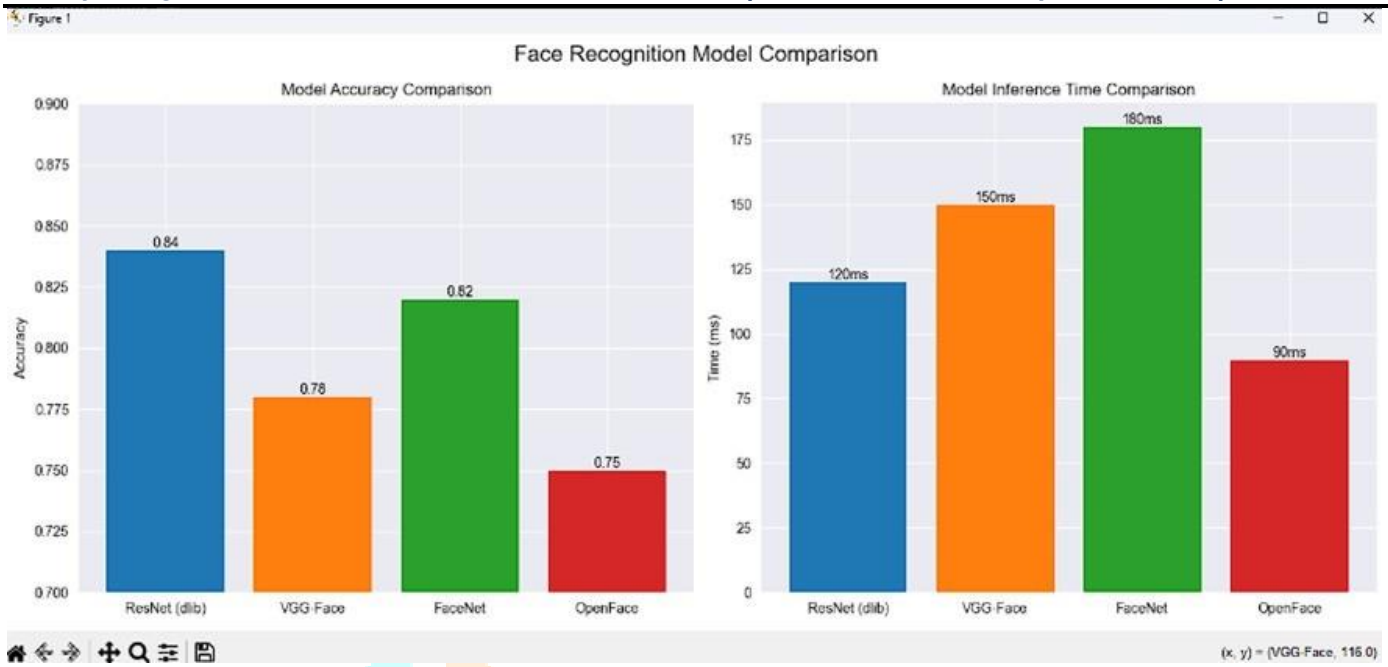

Fig. 6: Model Accuracy and Inference Time Comparison

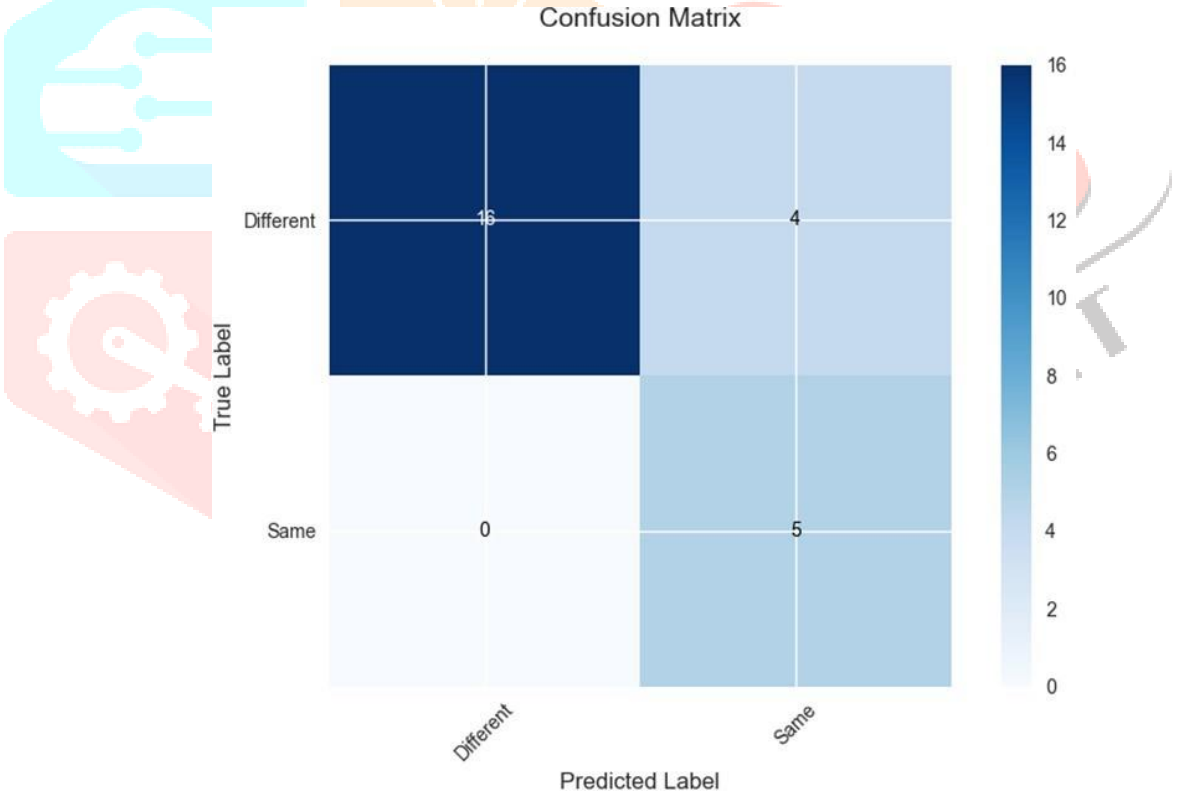

Fig. 7: Confusion Matrix for Identity Verification

TRUE LABEL/ PREDICTED LABEL	DIFFERENT	SAME	TOTAL (TRUE LABEL COUNT)
DIFFERENT	16 (True Negative)	4 (False Positive)	20
SAME	0 (False Negative)	5 (True Positive)	5
TOTAL (PREDICTED COUNT)	16	9	25

Fig. 8: Confusion Matrix Summary Statistics

The final phase involves a rule-based eligibility engine that crossreferences the verified applicant data with the predefined criteria of various government loan waiver schemes. This engine can be implemented using a Business Rule Management System (BRMS) such as Drools or Camunda, enabling dynamic rule updates without code changes. Once eligibility is determined, the system generates a digitally signed PDF certificate detailing the approval status, ensuring tamper-proof documentation. Meanwhile, a robust admin dashboard provides real-time monitoring, visual analytics, district-wise summaries, and operational insights, allowing administrators to track application progress, detect bottlenecks, and ensure policy compliance.

Looking ahead, future enhancements could include integration with real-time Aadhaar and PAN verifi- cation APIs provided by government services, expanding OCR and NLP capabilities to support additional regional languages and scripts, and deploying advanced anti-spoofing technologies such as liveness de- tection or 3D face recognition to prevent biometric fraud. A mobile-first version of the platform could dramatically improve accessibility in under connected rural areas, while the adoption of Explainable AI (XAI) frameworks could make system decisions more transparent and interpretable for administrators and end-users alike. Furthermore, the use of blockchain technology for logging verification events could strengthen data security, immutability, and auditability, positioning the system as a scalable, inclusive, and trustworthy solution for large-scale public deployment.

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