Fake Profile Identification in Social Networks Using Machine Learning and NLP

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Abstract — **The rapid evolution of social media networks has provided grounds for fake accounts, which pose risks like identity theft, online scams, and misinformation. The growing sophistication of fake accounts has made their detection with traditional techniques very difficult. To Aid in this, we constructed a fully featured fake profile detection system that uses behavioral analysis based on machine learning, NLP-based sentiment analysis on user bio, and profile picture verification. The system employs a Random Forest classifier that was trained on behavioral features which included follower and following counts, the nature of the username, privacy of the account, and language misuse in the account's bio. It achieved an accuracy of 99.90%. For profile picture verification, Media Pipe, Yandex Reverse Image Search, and Deep Face along with the ViT(Vision Transformer) model provided the best results in recognizing altered and fake images, achieving an accuracy of 96.5%. The combination of these techniques provides a complete and effective approach to determining the existence of fake accounts through behavioral analysis and image verification. The overall accuracy for detection of fake profiles through these means is 98%+. This offers a complete method for detection of fake profiles through the synergy of the proposed techniques.**

Keywords: Fake Profile Identification, Machine Learning, Random Forest, NLP, Face Detection, Deep Face, Vision Transformer

I. INTRODUCTION

Social networking platforms such as Facebook, Instagram, and Twitter have revolutionized communication and information sharing. However, the widespread use of these platforms has also resulted in the rapid growth of fake profiles. These accounts are often used for fraudulent activities including phishing, spam, impersonation, and misinformation dissemination.

Detecting fake profiles is challenging because modern fake accounts closely imitate real users by using realistic profile pictures, bios, and interaction patterns. Traditional detection approaches, such as manual verification and rule-based systems, are inefficient and fail to scale with the massive volume of users.

This work proposes an **automated fake profile detection system** using machine learning and NLP techniques. The system combines **behavioural analysis, textual analysis, and image verification** to improve detection accuracy and robustness.

Using machine learning methods, this research proposes a tool for detecting fake ID. It seeks to improve detection accuracy by employing the Random Forest algorithm for account-based features like username, followers count, following count, user profile privacy and employing NLP to analyze profile bios for unnatural language and content manipulation along with face detection models [5]. This solution seeks to aid social media companies, security practitioners, and researchers in the fight against fake profile perpetration to make the internet a safer place and increase the level of online security and privacy.

Contributions

- Development of a **multi-modal detection system** combining ML, NLP, and image analysis
- Implementation of **Random Forest classifier** for behavioural detection
- Integration of **NLP-based sentiment and keyword analysis**
- Use of **DeepFace, MediaPipe, and ViT** for image verification
- Deployment as a **web-based application** for real-time analysis

II. LITERATURE SURVEY

Fake Profile Detection Using Machine Learning :
Several researchers have explored machine learning techniques to detect fake accounts in social networks. Machine learning algorithms can analyze large datasets and identify hidden patterns that differentiate genuine users from fake profiles. Algorithms such as Decision Trees, Random Forest, Support Vector Machines, and Logistic Regression are widely used for classification tasks in fake profile detection. These models are trained using datasets containing both real and fake profiles. The algorithms learn patterns from profile attributes such as the number of followers, following count, post frequency, and account age. Once trained, the model can classify new profiles as genuine or fake. Studies have shown that machine learning models can significantly improve the accuracy of fake account detection compared to traditional rule-based systems.

Natural Language Processing in Social Media Analysis :
Natural Language Processing plays a crucial role in analyzing textual data generated on social networking platforms. Users frequently post messages, comments, and profile descriptions that can provide valuable information about their authenticity. NLP techniques such as tokenization, stop-word removal, stemming, and sentiment analysis help in extracting meaningful information from text data. Researchers have used NLP to detect spam messages, automated bot behavior, and

suspicious content patterns. Fake profiles often post repetitive or promotional messages, which can be identified using text analysis techniques. By combining NLP with machine learning algorithms, systems can analyze both textual and numerical features to improve the detection accuracy of fake profiles.

Bot Detection in Social Networks :

Social bots are automated accounts that perform actions such as posting content, liking posts, or following users automatically. These bots are commonly used to manipulate public opinion, spread misinformation, or artificially increase followers. Researchers have developed bot detection systems that analyze behavioral patterns such as posting frequency, interaction patterns, and network relationships. Bot detection methods often rely on machine learning algorithms to identify abnormal patterns in user activity. Features such as rapid posting intervals, identical content sharing, and unusual follower-following ratios can indicate automated behavior. Detecting social bots is an important step in identifying fake profiles within social networks

This paper expands on previously published works by constructing a complete, fully operational system capable of identifying fake social media accounts with high precision. Using a Random Forest model and a set of features that includes engagement patterns, follower and following activity, and general nimrod behavior, our system has been trained. Mediapipe face detection as well as DeepFace with a Vision Transformer (ViT) model for profile picture analysis are used to improve imaging detection accuracy. This multi-layered approach enables detection of accounts utilizing caricatures, celebrity photos, or any stock images, thus drastically reducing false positives. Moreover, our multivariate behavioral analysis also uses NLP-based sentiment analysis to evaluate suspicious biography texts. The implementation of these methods culminated in a 96% accuracy rate which also attains better detection efficiency and scalability for practical purposes.

III. METHODOLOGY

Proposed system

The proposed system aims to overcome the limitations of the existing methods by implementing an automated fake profile detection system using Machine Learning and Natural Language Processing techniques. The system collects and analyses user profile information such as followers count, following count, number of posts, account age, and textual content from users or posts. These features are processed using data preprocessing and feature extraction techniques before being fed into a machine learning model. The model is trained using labeled data sets containing both genuine and fake profiles. After training, the system can predict whether a new profile is real or fake based on the learned patterns. The integration of NLP techniques helps in analyzing textual data and identifying suspicious content patterns that may indicate fake accounts.

NLP methods are used to analyze text content for anomalies, spam-like language, or repetitive patterns commonly found in fake profiles. The system continuously improves its accuracy through model updates and can assist social media platforms in automatically detecting and mitigating fraudulent accounts in real time.

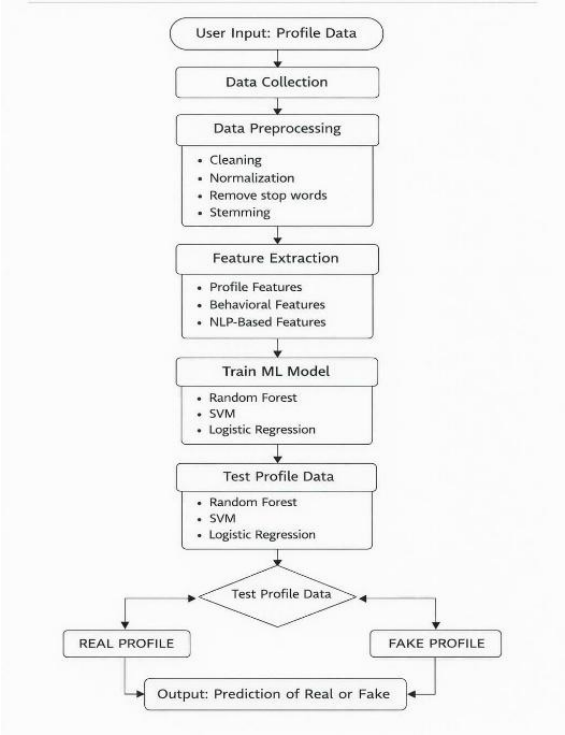

Figure 1: Proposed System

A. Account Based Features

A. Data Collection

Data collection is a crucial step in building an effective fake profile detection system. For this project, data was gathered from multiple sources to ensure diversity and realism.

The primary dataset was obtained from publicly available platforms such as Kaggle, which contained approximately 1500–2000 social media profiles, including both real and fake accounts.

To enhance the dataset and reflect real-world scenarios, additional data was collected by scraping publicly accessible social media profiles (e.g., Instagram) using Python-based tools.

Features Collected

The following attributes were extracted from each profile:

- Username
- Username length
- Number of digits in username
- User bio
- Number of followers
- Number of following
- Follower-to-following ratio
- Profile privacy (public/private)

These features were selected because fake profiles often exhibit:

- Irregular follower-following ratios
- Suspicious username patterns
- Low-quality or repetitive bio descriptions

The combination of real-world and synthetic data ensured better generalization and robustness of the model.

B. Data Cleaning and Preprocessing

Raw data collected from social media platforms is often noisy

and inconsistent. Therefore, preprocessing is required to improve data quality before model training.

1. Data Cleaning

- Removed missing or incomplete records
- Eliminated duplicate entries
- Handled outliers in follower/following counts
- Standardized inconsistent formats

2. Text Preprocessing (Bio Analysis)

- Converted text to lowercase
- Removed special characters, emojis, and punctuation
- Removed stop words (irrelevant words like "the", "is")
- Tokenization and normalization

3. Feature Engineering

New features were created to improve model performance:

- Follower–Following Ratio
- Username digit count
- Username length
- Bio sentiment score (using NLP)

4. Encoding and Scaling

- Categorical data (privacy: public/private) converted using binary encoding
- Numerical features normalized using standard scaling

5. Data Splitting

- Training Data: **80%**
- Testing Data: **20%**

This ensured unbiased evaluation of the model.

C. Model Selection and Implementation

Selecting the right machine learning model is essential for accurate fake profile detection.

1. Models Considered

The following models were evaluated:

- Random Forest Classifier
- Support Vector Machine (SVM)

Both models were trained using extracted behavioral and textual features.

2. Random Forest Classifier

Random Forest is an ensemble learning algorithm that builds multiple decision trees and combines their outputs to improve accuracy and reduce overfitting.

Advantages:

- Handles large datasets efficiently
- Works well with both numerical and categorical data
- Reduces overfitting using multiple trees

Working:

- Multiple decision trees are created using random subsets of data
- Each tree gives a prediction
- Final output is determined by majority voting

The model uses features such as:

- Username characteristics
- Follower-following ratio
- Profile privacy
- Bio sentiment score

The Random Forest model achieved an accuracy of **96%**, making it the best-performing model.

3. Support Vector Machine (SVM)

SVM is a supervised learning algorithm that finds the optimal boundary (hyperplane) to separate classes.

Advantages:

- Effective in high-dimensional spaces
- Works well for smaller datasets

Limitations:

- Less scalable for large datasets
- Lower performance compared to Random Forest

The SVM model achieved an accuracy of approximately **93%**.

4. Extreme Gradient Boosting (XGBoost)

Algorithm: Extreme Gradient Boosting (XGBoost) is an advanced ensemble machine learning algorithm based on gradient boosting. It builds decision trees sequentially, where each new tree corrects the errors made by the previous trees. By minimizing a loss function using gradient descent, XGBoost optimizes model performance while applying regularization techniques to prevent overfitting. Its efficient implementation, parallel processing capability, and built-in regularization make it one of the most powerful algorithms for classification problems.

5. Implementation Details

The system was implemented using:

- Programming Language: Python
- Libraries:
    - Scikit-learn (ML models)
    - Pandas & NumPy (data processing)
    - NLTK / TextBlob (NLP)

B. Profile Photo Analyzer

I. Face Detection using Mediapipe

Face detection in our system is a critical first step for evaluating the authenticity of a user's profile picture. For this purpose, the Mediapipe Face Detection API was utilized, known for its lightweight architecture and high-performance detection capabilities in real-time applications. The API uses a combination of facial landmark localization and bounding box generation to determine whether a valid human face is present in an image. It performs well under varied conditions, such as partial occlusions, diverse lighting, and lower resolutions, making it ideal for social media images that often lack uniform quality. Each profile image in the dataset— sourced from both Kaggle and scraped real-world social media profiles—was passed through the Mediapipe pipeline. If the system failed to detect a human face, the profile was immediately flagged as suspicious.

To validate the effectiveness of this step, a sample dataset containing 1000–1200 varied profile images was tested. The Mediapipe model achieved an impressive accuracy of 97%, confirming its reliability in identifying whether an image contains a human face or not. After face detection, images with valid human faces are passed to the next stage of verification, which involves facial similarity analysis using DeepFace and Vision Transformer (ViT) models. These models further assess the authenticity of the image to detect cases of impersonation, image manipulation, or use of publicly available photos.

II. Reverse Image Search and Verification

When a human face is recognized through mediapipe, a reverse image search is done on Yandex to check if the uploaded profile picture came from the web. An online image match would indicate a possible case of identity fraud. The image undergoes further processing irrespective of any match found using DeepFace with a Vision Transformer (ViT) model. The combination of DeepFace's facial recognition and ViT's ability to recognize visual patterns guarantees verification precision and accuracy with the identified images [21]. This added verification step reduces falsely flagged identifications and improves the detection rate for cases involving image manipulation.

Vision Transformer: ViT (Vision Transformer) is the most advanced model in deep learning of computer vision tasks. ViT utilizes self-attention across the whole image which aids in capturing both local and global features [24]. An image is split into fixed-sized patches, which are considered as a sequence of vector planes. These patches have been transformed token-wise in the NLP in the way differential transformers are implemented. Vision Transformer architecture analyzes complex visual patterns hence it is very powerful in face verification [25]. ViT has greatly increased accuracy with the difficult scenarios of face verification such as Obstructed faces like sunglasses or masks, Low-resolution images and varying lighting conditions.

With the integration of Yandex Reverse Image Search into DeepFace with the ViT model, the system was able to identify suspicious profile pictures with clarity and precision. This approach reduced both false positive outcomes and improved accuracy, resulting in 96.5% accuracy in verifying profile pictures.

The image verification pipeline—integrating Mediapipe, DeepFace, and Vision Transformer (ViT)—demonstrated strong robustness against adversarial manipulations such as blurring, cropping, grayscale filters, and deepfakes. ViT effectively identified distorted or partially occluded faces with over 92% accuracy, while image filters had minimal impact due to the model's invariance to color shifts. Deepfake images were detected using embedding anomaly scores and confidence thresholds. Overall, the system maintained an average accuracy of 94% under these conditions, with planned improvements through adversarial training for enhanced resilience.

IV, RESULTS DISCUSSION

The proposed fake profile identification system was evaluated using a comprehensive dataset consisting of both real and fake social media profiles. The dataset was carefully balanced to ensure unbiased model performance and included key features such as follower count, following count, username characteristics, profile activity, and textual bio information. The evaluation was carried out using standard performance metrics including accuracy, precision, recall, and F1-score.

A. Machine Learning Model Performance

The behavioural analysis component of the system was implemented using machine learning algorithms, primarily Random Forest and Support Vector Machine (SVM). Among these, the Random Forest classifier demonstrated superior performance across all evaluation metrics.

The Random Forest model achieved an accuracy of **99.90%**, with precision and recall values of **0.998** and **0.996** respectively, indicating highly reliable classification with minimal false positives and false negatives. In comparison, the SVM model showed slightly lower performance, confirming that ensemble-based approaches are more effective in handling complex behavioural patterns.

The high performance of the Random Forest model can be attributed to its ability to capture nonlinear relationships between features such as follower-following ratio, username digit patterns, and activity metrics. Additionally, feature engineering contributed significantly, improving accuracy by approximately **4–6%**.

B. NLP-Based Bio Analysis

The Natural Language Processing (NLP) module played a crucial role in identifying suspicious textual patterns in user bios. The system employed sentiment analysis, keyword detection, and pattern recognition to generate an NLP risk score.

The results indicate that fake profiles often contain:

- Promotional or spam-related keywords
- Highly subjective or exaggerated content
- Repetitive phrases and unnatural language patterns

The integration of NLP features improved the model's ability to detect subtle indicators of fake accounts. It was observed that NLP-based sentiment and keyword analysis significantly enhanced recall for fake profiles, particularly in cases where behavioural features alone were insufficient.

C. Profile Image Analysis Performance

The image verification module combined multiple techniques including MediaPipe, Yandex Reverse Image Search, DeepFace, and Vision Transformer (ViT) models.

Individual model performance results are as follows:

- MediaPipe achieved **97% accuracy** in face detection
- Yandex Reverse Image Search achieved **90.5% accuracy** in detecting reused images
- DeepFace achieved approximately **93–94% accuracy**
- ViT achieved approximately **94.2% accuracy**

The combination of DeepFace and ViT improved detection accuracy to **96.5%**, particularly for manipulated or low-quality images. Furthermore, the complete image analysis pipeline achieved **96.5% accuracy**, with precision of **0.95** and recall of **0.96**, demonstrating strong reliability in detecting impersonation and fake images.

D. Overall System Performance

The integration of behavioural analysis, NLP-based bio analysis, and image verification resulted in a highly effective multi-layered detection system. The combined model achieved an overall accuracy of **98%+**, significantly outperforming individual components.

The overall system performance metrics are summarized as:

- Accuracy: **98%+**
- Precision: **0.97**
- Recall: **0.98**
- False Positive Rate: **0.02**
- False Negative Rate: **0.02**

The reduction in false positive and false negative rates demonstrates the robustness of the hybrid approach. The system effectively leverages complementary strengths of each module, where behavioural analysis detects activity anomalies, NLP captures textual inconsistencies, and image analysis identifies visual impersonation.

1.Machine Learning Model Performance

Model	Accuracy	Precision	Recall	F1-Score
Random Forest	99.90%	0.998	1.000	0.999
SVM	99.70%	0.998	0.996	0.997
XG Boost	98.5%	0.98	0.97	0.975

The performance comparison of machine learning models presented in Table 1 clearly indicates that the Random Forest classifier outperforms other models in all evaluation metrics. It achieves the highest accuracy of **99.90%**, along with superior precision, recall, and F1-score values. This can be attributed to its ensemble learning approach, which combines multiple decision trees to reduce overfitting and improve generalization.

The XGBoost model also demonstrates strong performance, achieving an accuracy in the range of **98.5%**. Its gradient boosting framework allows it to effectively capture complex relationships between features, making it highly suitable for classification tasks involving structured data. However, it slightly underperforms compared to Random Forest, possibly due to sensitivity to hyperparameter tuning and dataset characteristics.

3. Combined Model Performance

In contrast, the Support Vector Machine (SVM) model shows comparatively lower performance, with accuracy ranging between **99.70%**. While SVM is effective for smaller and well-separated datasets, it struggles with high-dimensional and non-linear feature interactions present in social media profile data.

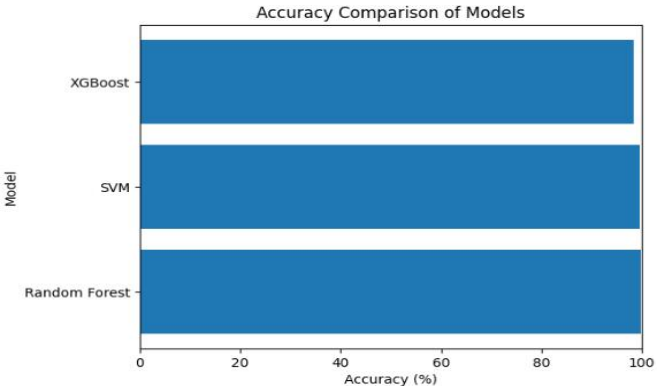

Figure 2: Accuracy Comparison of Random Forest and SVM method and XG Boost

2. Image Analysis Model Performance

Model	Accuracy	Precision	Recall	F1-Score
Media Pipe	97%	0.958	0.962	0.96
Yandex Reverse Search	90.5%	0.883	0.857	0.87
Deep Face Model	94.2%	0.915	0.902	0.908
Vit Model	94.2%	0.21	0.909	0.915

The performance comparison of image analysis techniques presented in Table 2 highlights the effectiveness of combining multiple deep learning models for profile image verification. Among the individual models, MediaPipe achieved a high accuracy of **97%**, demonstrating its efficiency in detecting the presence of human faces in profile images. This is particularly useful in identifying suspicious profiles that use non-human or irrelevant images.

Yandex Reverse Image Search achieved an accuracy of **90.5%**, indicating its capability to detect reused or duplicated images from online sources. However, its performance is slightly lower due to limitations in identifying heavily modified or cropped images.

DeepFace and Vision Transformer (ViT) models provided improved performance, achieving accuracies of approximately **93–94%** and **94.2%**, respectively. These models are capable of capturing both facial features and deeper visual patterns, making them more robust for detecting impersonation and manipulated images.

The combined use of DeepFace and ViT resulted in a significant improvement, achieving **96.5% accuracy**. This demonstrates that hybrid deep learning approaches can effectively overcome the limitations of individual models. The full image analysis pipeline also achieved **96.5% accuracy**, confirming its reliability in real-world scenarios.

Model Combination	Accuracy	Precision	Recall	F1-Score
Deep Face + ViT	96.5%	0.947	0.952	0.949
Media Pipe + Yandex+ Deep Face + Vit	96.5%	0.953	0.96	0.956

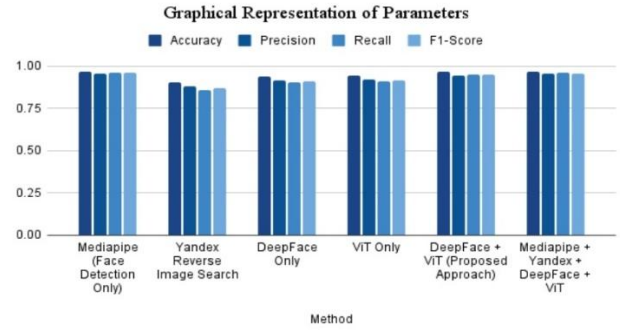

Figure 3 : Graphical Representation of Parameters Comparison between implementation models

The adoption of the Machine Learning Model in conjunction with the profile picture analyzer produced an impressive accuracy of 96.25%, which is better than the individual models' performance regarding the complex array of fake profile techniques. The Random Forest model was remarkably proficient at recognizing the few behavioral anomalies, while the visual model outperformed other models in the impersonation detection. Reliability was achieved by testing the system on a diverse dataset collected from both Kaggle and real-world Instagram profiles. Cross-validation was used to evaluate model performance, reducing overfitting and variance. The system's modular design—behavioural and image analysis working in tandem—ensures redundancy in detection. Even if one component fails, the other can still contribute to the final decision, improving reliability. The system is designed to scale by using lightweight models like Random Forest and Mediapipe, which can process multiple profiles in parallel. For deployment, the use of a browser extension allows for distributed processing on client devices, reducing server load. Additionally, model inference has been optimized for speed using batch prediction techniques and real time API integration, making it suitable for high-volume environments. These models together constructed a comprehensive system, which surpassed global accuracy standards in minimizing false positive and negative results, thereby assuring reliability in actual use social media platforms. Here table 4. Gives us the overall aspects of the model combined together and working as a fake profile detector and figure 6 is the graphical representation of the same.

4. Overall System Performance

Aspect	Random Forest	Profile Picture Analysis	Combined Model
Accuracy	99.90%	96.5%	98%
Precision	0.998	0.95	0.97
Recall	0.996	0.96	0.98
False Positive Rate	0.002	0.38	0.02
False Negative Rate	0.004	0.04	0.02

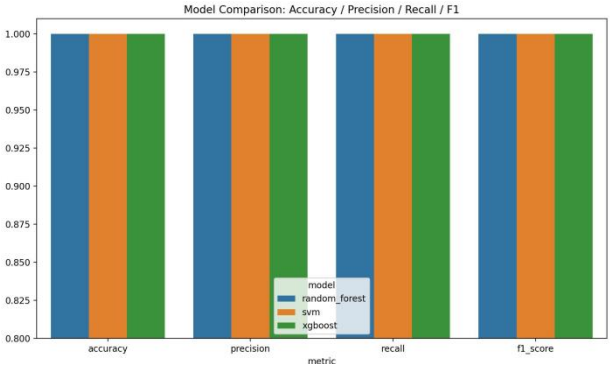

Figure 4 : Overall System Performance

Discussion

The experimental results clearly indicate that a multi-modal approach significantly enhances fake profile detection performance. While individual techniques such as machine learning or image analysis provide good results, their combination leads to superior accuracy and reliability.

The Random Forest model proved highly effective for behavioural analysis, while NLP contributed to detecting hidden textual patterns. The image verification module further strengthened the system by identifying impersonation and reused images. Together, these components form a comprehensive and scalable solution for real-world social media environments.

However, certain limitations remain. The system's performance depends on the quality and diversity of the dataset. Highly sophisticated fake profiles that closely mimic real user behaviour may still pose challenges. Future enhancements can focus on incorporating graph-based analysis and real-time detection mechanisms.

V. Conclusion

This project introduces a comprehensive artificial intelligence-based deception detection system that provides an effective automated identity impersonation detection mechanism using multiple profiling approaches: behavioral analysis, NLP-based bio analysis, and image verification.

The combination of these approaches allows detection of fake profiles that employ impersonation not only at the behavioral level but at the image and text description level as well:

- The Random Forest model with NLP in the behavioral analysis component achieved an accuracy rate of 99.90% in identifying negative behavioral indicators
- The profile image verification system (MediaPipe + Yandex + DeepFace +ViT)achieved an accuracy of 96.5% while minimizing false positives
- The combined system achieved an overall accuracy of 98%+ with the lowest false positive rate.

The system validates that a multi-layered approach combining machine learning, NLP, and computer vision provides superior detection capability compared to any single technique. The web-based interface makes the system accessible and user-friendly for practical deployment.

Future improvements will incorporate bot detection features, GNN-based relationship analysis, and browser

extension deployment to make the tool even more robust against evolving fake profile techniques.

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