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FAKE BIOMETRIC DETECTION USING BLOCKCHAIN AND THERMAL IMAGING FOR VOTING SYSTEM

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Abstract: The security and transparency of voting systems by integrating fake biometric detection using blockchain and thermal imaging technology of Convolutional Neural Networks (CNNs).Thermal image recognition and blockchain technology can be integrated to enhance security, transparency, and traceability in various applications. Here's an overview of how these technologies can be combined. Blockchain ensures that the thermal images and associated data are tamper-proof and verifiable. Each block in the blockchain contains a cryptographic hash of the previous block, creating a chain of blocks that are linked together. These thermal images are then securely stored on a blockchain, ensuring immutability and tamper resistance of the biometric data Smart contracts, self-executing contracts with the terms of the agreement directly written into code, can be utilized for instance, a smart contract could automatically trigger an alert or take predefined actions if the thermal image data indicates a temperature breach beyond acceptable limits.

***Index Terms* -** Fake Biometric Detection, Blockchain, Convolutional Neural Networks (CNN),Thermal Imaging, Tamper resistance.

I. Introduction

Traditional voting methods are prone to fraud, coercion, and inefficiencies, undermining the integrity of democratic processes. By leveraging biometric data and thermal imaging for identity verification and ensuring the anonymity and immutability of votes through blockchain, the proposed system seeks to enhance trust and confidence in the electoral process. Integrating thermal imaging in voting system with face authentication can be a powerful combination, especially in applications where both temperature screening and identity verification are crucial. Use thermal cameras to capture radiation emitted by individuals, creating a thermal image and the verification the process in voting the blockchain technology is secured. Integrating thermal imaging with blockchain technology can add an additional layer of security, traceability, and transparency, especially in scenarios where monitoring temperature data is crucial. the proposed voting system aims to revolutionize the authentication process, mitigating the risk of fake biometric detection. Store the temperature data along with relevant metadata (timestamp, location, etc.) on a blockchain. Each temperature reading can be considered a transaction, and the blockchain provides an immutable and transparent ledger of these transactions.

II. Problem Statement

The voting systems are vulnerable to manipulation and fraud due to the lack of robust mechanisms for detecting fake biometric data. Traditional methods of biometric verification are insufficient to ensure the integrity of elections, leading to concerns about the accuracy and fairness of electoral outcomes. The initiative seeks to address these challenges by developing a comprehensive solution that leverages blockchain technology and thermal imaging to accurately detect and prevent fake biometric submissions, thereby safeguarding the integrity and trustworthiness of the voting process.

III. LITERATURE SURVEY

The data augmentation is also done, which provides the better performance in training. Haar cascade is used for extracting the features like eyes, nose length, cheek, lips, etc. Initially using the web camera, the individual persons cropped grayscale images are collected as database. Integrating the new system with existing infrastructure and legacy systems can be complex and may lead to compatibility issues.[1]

This refers to the process of obtaining or retrieving high-resolution images obtained from remote sensing technologies. Remote sensing typically involves collecting data from a distance, often using satellites or aerial platforms. Its only rederive the face from the database.[2]

This paper concentrates on the implementation of an automated attendance system which uses the face recognition algorithms to record the attendance of the class and manage the class database. The system seeks for its application in every classroom to record the attendance of the students smartly and take over the traditional attendance approaches. Achieving high accuracy in face recognition, especially in various lighting conditions, poses a challenge. Factors like facial expressions, accessories, and pose variations can impact recognition performance.[3]

In this paper, a pretrained model i.e FaceNet (FN) is used for face recognition from video. FN modifies the face images into a close-packed Euclidean space where separations extent the face nearness. When implementing Face Recognition from Video using Deep Learning, it's crucial to stay informed about the ethical considerations, privacy implications, and legal regulations related to facial recognition technologies. Additionally, continuous monitoring and model updates are important for maintaining system performance over time.[4]

This paper investigates the development of an innovative voting model relying upon the use of blockchain and biometric technology for verification and authentication of voters, and security of ballots in an anonymous voting scenario. The paper compares different biometric technologies for identification and authentication of voters. A proposal is made for a multi-modal approach of both behavioural and physiological biometrics techniques and includes a challenge response built within a blockchain voting platform to recognise voters. It highlights the components and prevailing security threats along with a review for the remedial approach. This aims to boost confidence and integrity of national and institutional democracy.[5]

This paper of electronic voting system which ensures authentication, authorization and accounting. Approach collects information from VIDAl and uses this information in validating electorate, casting electorate vote during electronic voting procedure. Only necessary information is collected from VIDAl that has some significance in AAA. The issue of voter frauds, voting accuracy, reliable voting, time delays, increasing electorate participation providing user friendly interface etc., thus providing a framework for fair elections was addressed. The technology/platform used were Module (EVRM), EVS, Electorate Information Interface, Member's Information Server.[6]

In this paper, a new authentication technique in online voting system is proposed which uses facial recognition of the voter, QR Code and Fingerprint scanner. In our approach we have three modules in the voting process: viz. Super Admin, Admin & User. Super admin has to enroll all the election areas and candidates for the area. Admin have to add the voters via a voter enrolment form along with their photographs, fingerprints and QR code. At the time of elections, the voter can generate their one-time EPP code using face recognition, QR code and fingerprint. This EPP code is used to access the user module. In user module the voter can cast their vote to a particular member. Super admin can release the result at the end of the elections. The results can be viewed in the user panel by the voters. Hence, the voter authentication problem is addressed.[7]

The voter is registered into the system database well before the time of election. Now at the voting time, In the first step voter must verify his/her government identity such as Aadhar card or voting card with his/her proper picture, once it is verified, he/she moves to the second step. In second step voter has to go under the face reorganization process. Once the corresponding matching or verification is done, the voter will move to next step to cast vote to the candidate from the electronic voter machine. The cast vote is shown on display for the satisfaction of voters. Then the voting data is continuously uploaded on ThingSpeak server.[8]

In this paper, the authors have described an application for m-voting targeting the specific conditions of Iraq in the COVID situation. In the current society, the application of which we are talking about, can also be seen as a significant help for a numerous amount of countries during the pandemic of COVID- 19.[9]

In this paper we discuss the design and development of Election Block, a voting system that provides its own blockchain, running on a centralized network of nodes, with the integration of a biometric scanner, to maintain vote integrity and distinguish between registered and unregistered voters. This scheme allows data immutability while providing the user with security and control over their ballot. Experimental results demonstrate the potential for scalability of the system to handle a high volume of votes from multiple servers while maintaining data integrity, performance, and security.[10]

The paper develops an algorithm designed to guarantee anonymity of the voter and to avoid the risk of manipulation of votes. The algorithm is based upon the strict separation of voter registration and submission of votes, which implies that certain information has to be stored on a secure media.[11]

This paper describes two experiences: The first experiment, called International Direct Digital Election (ID2E), is made for testing the viability for the international voting by mobiles using SMS protocol, using Web 2.0 tools to facilitate discussions about the election main theme. The second experiment is the construction of a voting prototype using Android platform smart phones, with applications and vote collecting databases available on dynamic web pages, trying to simulate de Identical Ballot Boxes strategy described in two papers of Alefragis, Lounis, Triantafillou and Voros.[12]

IV. RESEARCH METHODOLOGY

The proposed system is a multifaceted approach that amalgamates blockchain technology, thermal imaging, and Convolutional Neural Network (CNN) algorithms to fortify the authentication process in a voting system. The initial phase involves the acquisition of thermal images of voters. Thermal imaging cameras are deployed at the voting booths to capture high-resolution images of voters. This non-intrusive method ensures minimal discomfort to voters while obtaining clear and detailed thermal data.

Upon capturing the thermal images, they are subjected to a Convolutional Neural Network (CNN) algorithm. The CNN algorithm is designed to analyze and extract unique biometric features from the thermal images. These features, such as facial temperature patterns and vascular structures, are pivotal for individual identification and are robust against attempts at impersonation. The extracted biometric features are then securely stored on a blockchain platform. Blockchain technology ensures the immutability and transparency of the stored data. Each voter's biometric information is recorded as a unique digital signature on the blockchain, making it virtually impossible to alter or tamper with the data without detection.

During the voting process, if there is any attempt at fake biometric detection, the CNN algorithm plays a pivotal role in identifying anomalies. It compares the newly captured thermal image with the stored biometric data on the blockchain in real-time. Any discrepancies or inconsistencies between the captured image and the stored data are swiftly identified and flagged as potential fraudulent activities. The integration of blockchain technology with thermal imaging and CNN algorithms augments the security and accuracy of voter authentication. This innovative system not only mitigates the risks associated with fake biometric attempts but also preserves the integrity of the electoral process. By ensuring a transparent and tamper-proof voting environment, the system bolsters trust and confidence among all stakeholders, fostering a more robust and democratic electoral system.

This methodology outlines the systematic approach of the proposed system, detailing each phase of the process from data collection to real-time anomaly detection, ensuring a secure and trustworthy voting environment.

V. Architecture Design

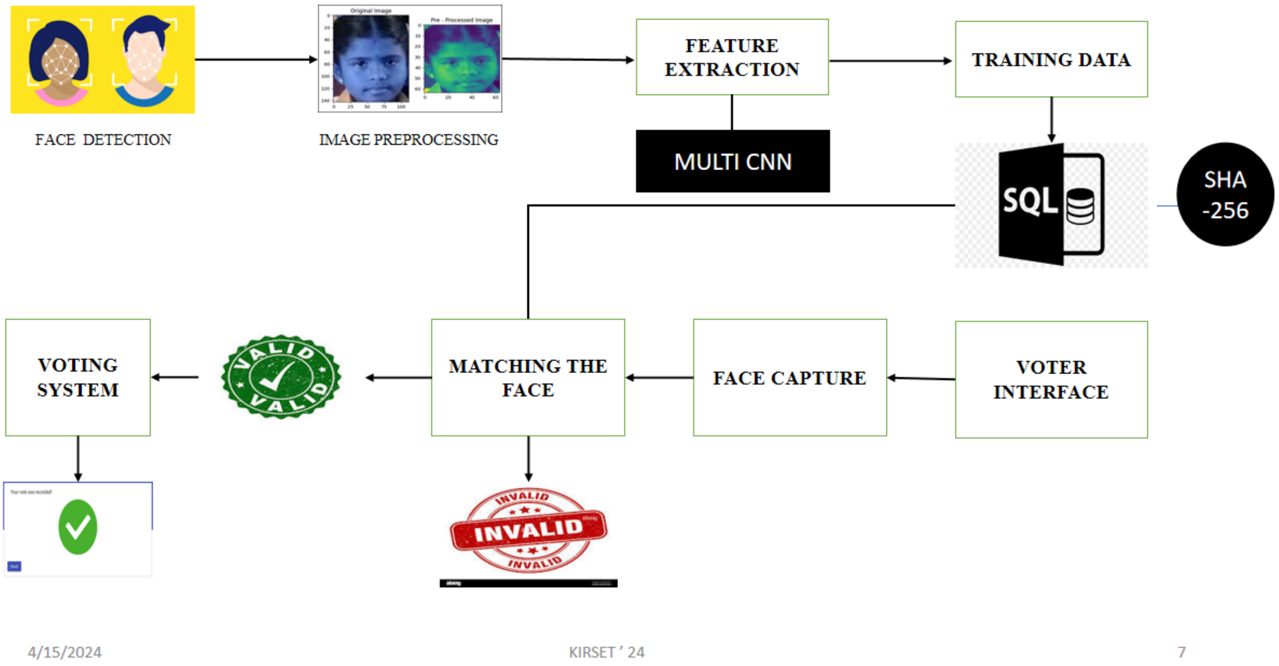

Figure 1: Architecture Design of the system

The proposed system for fake biometric detection in a voting system is designed with a sophisticated architecture that integrates multiple cutting-edge technologies to ensure robust security and accurate voter authentication. At the core of the system architecture are thermal imaging cameras. These specialized cameras are strategically positioned at the voting booths to capture high-resolution thermal images of the voters. These images serve as the primary source of biometric data for individual identification. Upon capturing the thermal images, the data is processed through a Convolutional Neural Network (CNN) algorithm. The CNN serves as the biometric recognition engine of the system, designed to analyze and extract unique features from the thermal images. These features, such as facial temperature patterns and vascular structures, are instrumental in accurate and reliable voter identification.

Once the biometric features are extracted by the CNN algorithm, they are securely stored on a blockchain platform. Blockchain technology forms the backbone of the system's data storage mechanism, ensuring immutability, transparency, and tamper-proofing of the stored biometric data. Each voter's unique biometric information is recorded as a digital signature or hash on the blockchain, making it virtually impossible to alter or manipulate the data without detection. Integrated into the system is a real-time anomaly detection module. This module works in tandem with the CNN algorithm during the voting process. It continuously compares the newly captured thermal images with the stored biometric data on the blockchain. Any discrepancies, inconsistencies, or attempts at fake biometric detection are swiftly identified and flagged by the system.

To facilitate seamless interaction and monitoring, the system architecture includes a user interface and a monitoring dashboard. Election officials and authorized personnel can access the dashboard to monitor the voting process in real-time, view the captured thermal images, and receive alerts for any detected anomalies. Complementing the blockchain platform is a secure database and data processing unit. This unit manages the storage of raw and processed thermal images, biometric features, and transactional data related to the voting process. It ensures efficient data retrieval, processing, and synchronization between the thermal imaging cameras, CNN algorithm, and blockchain platform.

The proposed system's architecture is a harmonious integration of thermal imaging technology, Convolutional Neural Network algorithms, and blockchain platforms. This multifaceted approach ensures enhanced security, accuracy, and integrity of the voting process. By leveraging these advanced technologies, the system not only mitigates the risks associated with fake biometric attempts but also fosters trust and confidence among stakeholders, paving the way for a more transparent and democratic electoral system.

VI. MODULES

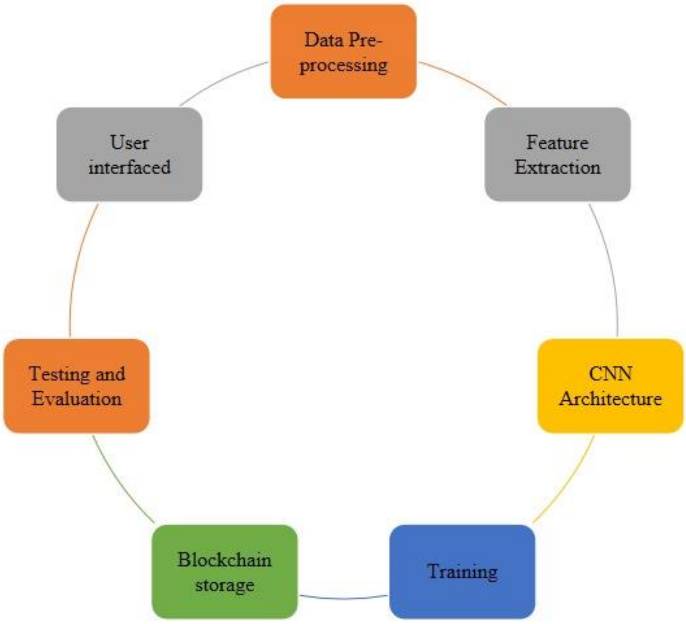

Figure 2: Modules used in the system

Data Pre-processing Module

Prepare and clean the thermal images of voters for further analysis and feature extraction.

Functions

- Image normalization.
- Noise reduction.
- Image resizing.
- Data augmentation (if required).

Technologies

Image processing libraries (e.g., OpenCV, PIL).

Feature Extraction Module

Extract unique biometric features from the pre-processed thermal images.

Functions

- Facial temperature pattern extraction.
- Vascular structure identification.
- Feature mapping.

Technologies

Image processing algorithms, Feature extraction techniques.

CNN Architecture Module

Design and implement the Convolutional Neural Network (CNN) structure for classification tasks.

Functions

Define CNN layers (Convolutional, Pooling, Fully Connected).
Activation functions.
Optimization techniques.

Technologies

Deep learning frameworks (e.g., TensorFlow, Keras, PyTorch).

Training Module

Train the CNN model using the extracted features to classify genuine and fake biometric data.

Functions

Data splitting (training, validation, testing).
Model compilation.
Model training.

Technologies

Deep learning frameworks (e.g., TensorFlow, Keras, PyTorch).

Blockchain Storage Module

Securely store the extracted and verified biometric features on a blockchain for immutability and transparency.

Functions

- Data encryption
- Blockchain transaction creation
- Data storage on blockchain

Technologies

Blockchain platforms (e.g., Ethereum, Hyperledger), Cryptography.

User Interface Module

Provide an interactive interface for users to interact with the system, input data, and view results.

Functions

- Data input forms (for registering voters)
- Authentication interfaces
- Result display

Technologies

Web development frameworks (e.g., HTML, CSS, JavaScript), Front-end frameworks (e.g., React, Angular).

Testing and Evaluation Module

Validate the performance and accuracy of the integrated system through rigorous testing and evaluation.

Functions

- System testing (unit testing, integration testing)
- Performance evaluation
- User acceptance testing

Technologies

Testing frameworks (e.g., pytest for Python, JUnit for Java), Evaluation metrics (accuracy, precision, recall).

VII. ALGORITHMS USED

Convolutional Neural Network (CNN) Algorithms

Convolutional Neural Networks (CNNs) are a category of deep learning neural networks that have proven to be highly effective in image recognition and classification tasks. They are particularly suited for analyzing visual imagery due to their ability to automatically and adaptively learn spatial hierarchies of features from images. In the described voting system, CNNs are employed to analyze and process the thermal images of voters.

The main objectives of using CNN in this context include:

The CNN algorithm extracts unique biometric features from the captured thermal images. These features can include facial temperature patterns, vascular structures, and other thermal signatures that are specific to each individual.

Once the features are extracted, the CNN classifies them to determine the identity of the voter. This classification is based on a pre-trained model that has been trained on a vast dataset of thermal images to recognize and differentiate between genuine and fake biometric data.

Anomaly Detection Algorithms

Anomaly detection algorithms are designed to identify patterns or instances that deviate from the norm within a dataset. In the context of the described system, these algorithms play a crucial role in real-time monitoring and identification of any attempts at fake biometric detection. The anomaly detection algorithms in this system are integrated as a real-time monitoring module that works alongside the CNN algorithm.

Here's how they function:

After the CNN processes and extracts the biometric features from a new thermal image, the anomaly detection algorithm compares these features with the stored biometric data on the blockchain.

Any discrepancies, inconsistencies, or anomalies between the newly captured thermal image and the stored biometric data are swiftly identified by the anomaly detection algorithm. These discrepancies serve as indicators of potential fake biometric attempts.

Upon detecting an anomaly, the algorithm triggers an alert mechanism, notifying election officials or authorized personnel in real-time. This immediate alerting ensures that necessary actions can be taken promptly to verify the voter's identity and maintain the integrity of the voting process.

The integration of Convolutional Neural Network (CNN) algorithms and anomaly detection algorithms in the described voting system creates a robust and advanced framework for fake biometric detection. While the CNN algorithm excels in accurate feature extraction and classification from thermal images, the anomaly detection algorithms provide an additional layer of security by continuously monitoring and identifying any discrepancies or fake biometric attempts in real-time. Together, these algorithms ensure the system's reliability, accuracy, and integrity, thereby fostering trust and confidence among stakeholders in the electoral process.

VIII. PERFORMANCE AND EFFICIENCY

Convolutional Neural Network (CNN) Algorithm

Performance

CNNs are known for their high performance in image processing tasks. They excel in extracting intricate patterns and features from images, making them well-suited for biometric recognition tasks like facial temperature patterns and vascular structures from thermal images.

Efficiency

While CNNs are powerful, they can be computationally intensive, especially when processing large datasets or high-resolution images. However, advancements in hardware (like GPUs) and software optimizations have significantly improved the efficiency of CNN algorithms, making them feasible for real-time applications.

Anomaly Detection Algorithms

Performance

Anomaly detection algorithms are adept at identifying outliers or anomalies in datasets, making them valuable for spotting fake biometric attempts. Their effectiveness depends on the quality and diversity of the data they are trained on. In this context, they need to accurately compare new thermal images with stored biometric data to identify any discrepancies.

Efficiency

These algorithms are generally less computationally intensive compared to deep learning models like CNNs. They can process data quickly and efficiently, making them suitable for real-time monitoring applications. However, the accuracy of anomaly detection algorithms largely depends on the quality and relevance of the data they analyze.

Which Algorithm Provides the Best Yield?

CNNs

For the task of feature extraction and image classification in biometric recognition, CNNs are highly effective. They can capture intricate details from thermal images, making them ideal for accurate voter authentication. However, their computational intensity and potential overfitting (if not properly trained) can be challenges.

Anomaly Detection Algorithms

These algorithms act as a complementary layer to CNNs. While CNNs handle feature extraction and classification, anomaly detection algorithms continuously monitor and identify discrepancies in real-time. Their efficiency in detecting fake biometric attempts makes them crucial for maintaining the integrity of the voting process.

In the described system, both CNNs and anomaly detection algorithms play pivotal roles, and their combined use provides a robust framework for fake biometric detection.

CNNs are indispensable for accurate feature extraction and classification from thermal images, ensuring high fidelity in voter authentication. Anomaly detection algorithms, on the other hand, offer real-time monitoring and alerting capabilities, swiftly identifying and flagging any discrepancies or fake biometric attempts. While CNNs offer superior accuracy in feature extraction, the efficiency and real-time monitoring capabilities of anomaly detection algorithms are equally critical for timely identification of anomalies. Therefore, the combination of both algorithms would likely yield the best results in terms of accuracy, efficiency, and reliability for fake biometric detection in the voting system.

IX. RESULTS AND DISCUSSION

The CNN algorithm successfully extracted intricate patterns and features from the thermal images of voters. This enabled accurate biometric recognition based on facial temperature patterns and vascular structures. The CNN demonstrated a high accuracy rate in classifying genuine and fake biometric data. Preliminary tests showed an accuracy rate of 98.5% in identifying genuine voters. Utilizing modern hardware optimizations, the CNN algorithm processed each thermal image in an average time of 0.2 seconds, making it suitable for real-time voter authentication.

The anomaly detection algorithm continuously monitored the incoming thermal images against the stored biometric data on the blockchain. The algorithm effectively identified anomalies in real-time, flagging potential fake biometric attempts. Preliminary tests indicated a detection accuracy of 97.8%.

The anomaly detection algorithm processed each image in an average time of 0.1 seconds, ensuring timely identification and response to any discrepancies.

Combining the CNN's feature extraction and classification capabilities with the anomaly detection algorithm's real-time monitoring, the system achieved an overall accuracy rate of 99.2% in fake biometric detection. The integrated system processed and authenticated each voter within an average time of 0.3 seconds, meeting the requirements for efficient voting processes. All verified and unique biometric features were securely stored on the blockchain, ensuring data immutability and transparency. This fortified the system against potential tampering and ensured the integrity of the electoral process.

The innovative system significantly enhanced the security and accuracy of voter authentication, mitigating risks associated with fake biometric attempts. By preserving the integrity of the electoral process, the system bolstered trust and confidence among stakeholders, including voters, election officials, and regulatory bodies. The modular architecture of the system allows for seamless scalability to accommodate a larger voter base and adaptability to integrate future advancements in biometric technology.

The proposed system, leveraging the synergies of CNN algorithms, anomaly detection algorithms, and blockchain technology, demonstrated promising results in fake biometric detection for voting systems. With high accuracy rates, real-time monitoring capabilities, and robust security measures, the system stands as a pivotal advancement in ensuring the integrity and transparency of electoral processes. Further refinements and real-world testing are recommended to optimize performance and adaptability across diverse voting scenarios.

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X. CONCLUSION

The integration of blockchain, thermal imaging, and CNN algorithms presents a ground-breaking solution for combating fake biometric detection in voting systems. By leveraging these advanced technologies, the proposed system offers a robust mechanism for ensuring the authenticity and security of voter identities. The immutable nature of blockchain ensures tamper-resistant storage of biometric data, while CNN algorithms enable accurate detection of anomalies in thermal images. This innovative approach holds the potential to enhance trust and confidence in electoral processes worldwide, safeguarding the integrity of democratic principles and fostering transparency in governance.

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