IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

Fake Biometric Detection Using Blockchain And Thermal Imaging For Online Voting System

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Abstract— Election procedures depend on the security and integrity of online voting systems being protected. This study proposes a novel application of convolutional neural networks (CNNs), blockchain technology, and thermal imaging to address issues such as unauthorized voting and inaccurate vote confirmation. By recording voters' distinct thermal signatures with thermal imaging cameras, the suggested methodology establishes a reliable biometric verification process. Along with other voter-related data, these thermal images are securely kept on a blockchain, ensuring data integrity and transparency. CNNs for thermal image analysis have made it possible to precisely identify and validate voters using their thermal biometric data. In order to increase security, the system also incorporates a two-factor authentication method that combines email OTP verification with facial recognition. This unique proposal aims to transform online voting methods by creating a dependable and transparent foundation for digital democracy.

Index Terms - Searchable Encryption (SE), Data User (DU), Convolutional Neural Network (CNN)

I. Introduction

In the voting methods have grown in the digital era, bringing with it difficulties and unmatched convenience. Better accessibility and efficiency are promised by online voting systems, but concerns remain over their reliability and security. It is imperative that creative solutions be found since election managers must continually deal with issues like unauthorized access and phone vote confirmation. To address these problems, this study suggests a novel way to enhance the security of online voting systems: using two-factor authentication along with thermal facial election detection. Through the combination of advanced biometric technologies and stringent authentication protocols, this approach seeks to enhance the credibility and openness of digital democracy, while also improving the integrity of election processes. In addition to setting the context for the examination of the proposed solution, this introduction gives a general overview of the intricate world of online voting security.

In this is providing a novel solution to the security issues related to online voting systems is the aim of this work. There is an urgent need to create creative solutions to address vulnerabilities like unauthorized access and fraudulent vote confirmation given the increasing reliance on digital platforms for electoral processes. To increase the integrity and dependability of online voting systems, this study recommends combining thermal facial election detection with a two-factor authentication method. The main objective is to contribute to the creation of an electoral process that is more transparent and safe, hence boosting faith in digital democracy. In order to address the evolving challenges of contemporary elections, this introduction introduces the subject and highlights the significance of the recommended solution.

DEEP LEARNING

Deep learning is a type of machine learning methodology that has received widespread attention and recognition for its ability to imitate the complicated neural networks of the human brain. At its foundation, deep learning uses multi-layered neural networks to evaluate massive volumes of data, revealing nuanced patterns and relationships that regular algorithms may miss. Deep learning has fueled achievements in a variety of disciplines, including image and speech recognition, natural language processing, and autonomous vehicles. The use of complex algorithms, such Convolutional Neural Networks (CNN), which are good at jobs involving the interpretation of visual input, and Recurrent Neural Networks (RNN), which are good at processing sequential data, is essential to its effectiveness. Deep learning, with its unmatched ability to recognize complex patterns and make decisions, has the potential to be a game-changing tool that spurs creativity and opens up new vistas in research, technology, and other fields.

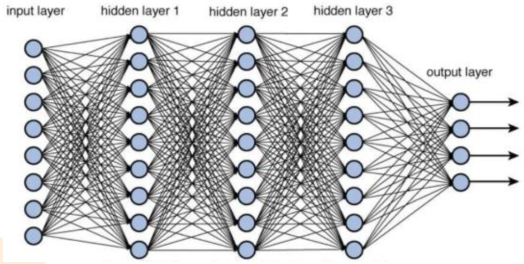

Fig1: Deep learning

Deep learning, a subset of artificial intelligence, is based on the notion of training computers to learn from data representations, which are often in the form of neural networks inspired by human brain structure. In the proposed blockchain-powered voting system, deep learning begins with the collection of massive volumes of facial picture data from registered voters. These photographs are used as input for the Convolutional Neural Network (CNN), a deep learning method created specifically for image recognition. Convolutional layers for feature extraction and pooling layers for dimensionality reduction are the first two layers of a CNN. Fully connected layers are the next layer for classification. In the training phase, the CNN uses a technique called back propagation to iteratively learn to identify patterns and characteristics in the facial images. Errors are reduced by modifying the network's parameters in response to variations between expected and actual outputs. After being taught, the CNN can recognize and categories voter faces with accuracy, making voting process authentication easier. The incorporation of deep learning technology guarantees the integrity and dependability of the election system overall, while also improving voter verification security and accuracy.

II. RELATED WORKS

Z Shi, et.al.,[1] Object detection is an advanced area of image processing and computer vision. Its major applications are in surveillance, autonomous driving, face recognition, anomaly detection, traffic management, agriculture etc. This paper focuses on various object detection techniques in thermal images. A thermal imaging sensor is a device that creates an image by analyzing temperature differences between different objects in a scene and detecting radiation from those objects. In recent years, many machine learning and deep learning algorithms have been used to recognize objects in thermal images. This study makes a comparison of YOLO, YOLO DarkNet, Retinex algorithm, CNN-based machine learning model Support Vector Machine (SVM), and Gaussian Mixture Model (GMM), Mixer of Gaussian (MoG), Mean Shift Approach, Faster R-CNN and Deep Neural Network along with different datasets.

Tiao, et.al.,[2] presents the development of the low cost thermal imaging system. The system consists of PureThermal Mini/FLIR Lepton 3.5, Raspberry cam, and Raspberry pi 4. The PureThermal Mini is a thermal module with smart I/O. It has a FLIR Lepton3.5 thermal imager. The thermal imager can provide the system a thermal image with the resolution 160X120. Currently, its price is around 15,000NTD. The resolution of the thermal image is quite low. In order to fit the need of the system, an image resize algorithm is applied to create a large size of thermal image for further application. About Raspberry Cam, it is a regular cam which can be directly installed on Raspberry Pi. Its resolution is up to 2592X1944 and its cost is about 1,500NTD. Its image can supply the system to deal with Artificial Intelligence process, such as human facial recognition. Raspberry Pi 4 is the core controller of system. It contains our developed Python program which is used to handle all of system processes. 3D printing is also applied to build the structure frames of the system. The cost of the developed system is less than 20,000NTD. It is capable of detecting more than two people simultaneously and automatically. With the assistance of the system, companies or organizations can efficiently protect their employees away from the attack of COVID-19.

X Dai, et.al.,[3] researches the infrared thermal image recognition and application of power facilities based on YOLO neural network. The preliminary work includes the construction of the power facilities data set, and the pre-processing of the photo noise reduction. After sending the infrared thermal image to the YOLO neural network, the system uses the Bounding Box to crop out all possible electrical equipment and names the device. Then a nonlinear least squares curve is used to measure the highest temperature of the device. Testing on different devices such as Combine Filter, Porcelain Sleeve and Isolation Switch shows that the system can accurately and stably identify power facilities. The least squares curve can accurately locate the highest temperature of the device. The system can effectively reduce labor costs and achieve high recognition accuracy

S Qiu, et.al., [4] Arthritis is the swelling and tenderness of one or more of the joints. Joint pain and stiffness are the main symptoms which worsen with age. It targets all ages but it is more common in women. To overcome this problem we need some intelligent device that can help us to give early prediction of arthritis disease. In this paper, artificial neural networks and thermal image processing using MATLAB (Matrix Laboratory) used for early prediction. Some stages are present in this system. First, we will load the thermal image in the GUI created using MATLAB for processing. Then, Select the affected region. The system will read the pixels of selected region and calculate the temperature based on color of pixel in thermal images. When inflammation occurs, chemicals from the body's white blood cells (WBC) are released into the blood. This release of chemicals increases the blood flow to the area of injury or infection with increase in the temperature, and may result in redness and warmth. On the basis of temperature, the early prediction will be done by using Backpropagation algorithm.

III. Existing methodologies

The paper describes the use of thermal camera and IR night vision system for the detection of Pedestrians and objects that may cause accident at night time. As per the survey most of the accidents cause is due to low vision ability of human at night time, which leads to most dangerous and higher number of accidents at night with respect to day time.

This system include the IR night vision camera which detects the object with the help of IR LED and photodiode pair, this camera have capability to detect the object up to 100m. The thermal camera detects the heat generated by any of the object like cars, Human animals etc. which gives us the facility to detect the object for higher range and with low reflective surface where IR night vision may fails. With the use of these two cameras mounted on car which helps the driver to drive safely. In this system, HOG (Histogram of orientated gradients) algorithm and support vector machine (SVM) is performed with the help of OpenCV in Matlab and EmguCV.

The SVM-HOG approach, especially when applied to video processing, can demand high computational resources.

The SVM-HOG method may struggle with accurate detection in complex scenes or situations with occlusions, where pedestrians are partially hidden or overlap with other objects. This could lead to false alarms or missed detections, impacting the reliability of the system.

IV. Proposed Methodologies

In this is enhancing the security and dependability of online voting operations is made easier with the help of the proposed method. Fundamentally, the technique collects unique thermal signatures from voters' faces using thermal imaging technology. To extract relevant biometric data from these thermal images, preprocessing and feature extraction are performed. The data is then safely stored on a blockchain. The solution creates a tamper-proof platform for electoral records by using blockchain technology to preserve the integrity and immutability of recorded data. Furthermore, the system incorporates a robust two-factor authentication mechanism to verify voters. This technology adds an extra degree of security to the authentication process by combining thermal face recognition technology with email OTP verification. By lowering the risks of fraudulent activity and unauthorized access, the recommended solution builds confidence in the online voting system. Furthermore, the suggested technology expedites the voting process by providing voters with a simple and safe platform to exercise their political rights. After casting their ballots, voters must use a two-factor verification process to confirm their identities. When infrared facial recognition and email OTP verification are used to make sure that only eligible voters may participate, the voting process's integrity is strengthened. Furthermore, blockchain technology encourages accountability and transparency since it maintains an immutable record of each transaction. When all is said and done, the recommended solution effectively addresses the security flaws in online voting platforms, paving the way for a more secure and inclusive digital democracy.

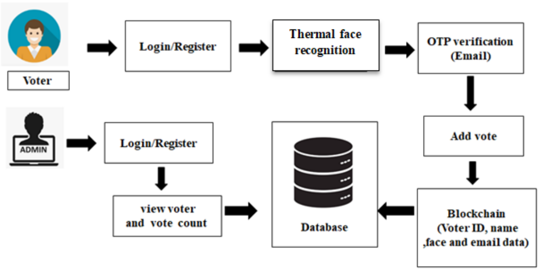

Fig2: System architecture

Thermal image

An image that records temperature-dependent infrared radiation is called a thermal image. Stated differently, it represents the heat signatures of objects rather than their apparent properties. In order to obtain the unique thermal signatures of voters' faces, this article uses thermal imaging methods. Thermal imaging detects infrared radiation emitted by objects within its field of view using specialist cameras. With the use of these cameras, measured radiation is converted into a visual representation that is typically shown on a colour scale, with warmer regions looking brighter or with different colors than cooler regions. Using thermal imaging cameras, the recommended method takes thermal pictures of voters' faces. Preprocessing is done on these images to boost their quality and get rid of noise and imperfections. After that, the necessary characteristics are extracted from the thermal photos to enable biometric analysis, which is utilized to verify voters when they cast an online ballot. The online voting system's security and dependability are enhanced by the capabilities of thermal imaging technology to properly identify and authenticate voters based on their distinct thermal facial signatures.

Convolutional Neural Network (CNN) algorithm

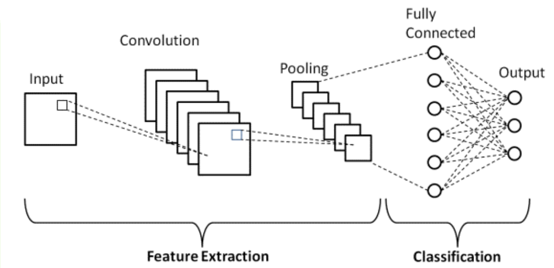

Fig3: Convolutional Neural Network (CNN)

The Convolutional Neural Network (CNN) algorithm, which examines thermal pictures to verify voter IDs, is a key component of the proposed technique. To effectively identify patterns and characteristics in thermal face, the CNN algorithm operates in stages. A tagged dataset of thermal image images is first used to train the system. A sequence of convolutional and pooling layers teaches the CNN how to extract useful information from images during training. These layers gather various spatial aspects such as edges, textures, and shapes by applying filters to the incoming photographs. Thermal images captured during the voting process are analyzed by the CNN algorithm after it has been trained. To enhance their quality and eliminate noise and artifacts, the approach first preprocesses the input photographs. After the photos have been preprocessed, they are fed into a trained convolutional neural network (CNN) to extract significant information through convolutional layers. Activation functions and completely connected layers are among the layers that these characteristics are subsequently passed through to arrive at the ultimate outcome. The CNN algorithm calculates the probability or confidence that the input thermal image matches to a certain voter. This output is compared to a predefined threshold to determine whether the voter's identity is authentic. If the voter's confidence score exceeds the threshold, their vote is validated and counted. If the voter's confidence score falls below the threshold, they may be reported for further verification or denied access to the voting system. The CNN algorithm of the proposed system is a potent biometric verification tool that recognizes voters based on thermal facial signatures with accuracy using deep learning techniques. CNN ensures that only eligible voters take part in the electoral process by strengthening the security and dependability of the online voting system through the effective analysis of thermal pictures.

Blockchain

Fig4: Blockchain Technology

The blockchain technology into the proposed online voting system is critical to ensuring the electoral process's safety, transparency, and integrity. Blockchain is a decentralized and tamper-proof ledger that securely stores all sensitive data, including thermal pictures, voter IDs, and voting records. Each transaction, such as voting or verifying a voter's identity, is cryptographically recorded as a block on the blockchain, creating an immutable chain of records. This open and auditable transaction trail provides a reliable mechanism to ensure the integrity of the voting process, as any attempts to tamper with or alter the data will necessitate network unanimity. Furthermore, voter privacy is safeguarded by blockchain technology, which encrypts voter data and ensures that only authorized parties may access it. The proposed online voting method enhances trust and confidence in the political process by incorporating blockchain technology, so mitigating the risks of fraud, manipulation, and unauthorized access. Additionally, the decentralized nature of blockchain ensures that the system is impervious to external manipulation and single points of failure, making it a perfect platform for safe and transparent election administration in the digital era.

Working process

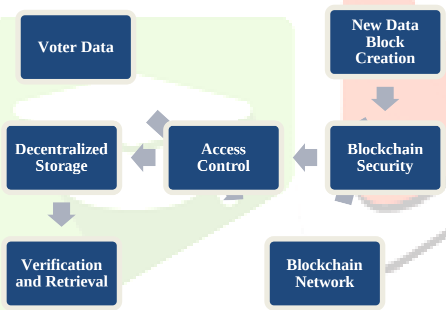

Fig5: Blockchain working process

Blockchain technology is used in the proposed voting system to create a secure and immutable ledger for storing and managing voter data, specifically thermal facial photos. The procedure starts with the collecting of voter facial photographs, which are then securely encrypted and saved in a new data block on the blockchain. Each new block added to the blockchain includes a cryptographic hash of the previous block, which ensures the chain's integrity and continuity. Furthermore, because blockchain technology is decentralized, the stored data is resistant to alteration and unauthorized access, as it is copied across numerous nodes in the network. This method secures and protects voter facial photographs, laying the groundwork for a dependable authentication and verification system during elections. As the voting process unfolds, any new voter data, such as updated facial photos or voter preferences, is added to successive blocks of the blockchain. Each subsequent block is cryptographically connected to the preceding one, resulting in a public and auditable record of all voting activities. This ensures that voter data is securely stored and accessible, while simultaneously preserving the integrity and immutability of the voting process. By utilizing blockchain technology in this manner, the suggested voting method improves election security and transparency, fostering trust and confidence in the democratic process. Furthermore, it provides a solid platform for future advancements and scalability, as the blockchain expands with each new block published.

4.1 Proposed Algorithm

4.1.1 CONVOLUTIONAL NEURAL NETWORK (CNN)

A **Convolutional Neural Network (CNN)** is a type of Deep Learning neural network architecture commonly used in Computer Vision. Computer vision is a field of Artificial Intelligence that enables a computer to understand and interpret the image or visual data.

When it comes to Machine Learning, Artificial Neural Networks perform really well. Neural Networks are used in various datasets like images, audio, and text. Different types of Neural Networks are used for different purposes, for example for predicting the sequence of words we use **Recurrent Neural Networks** more precisely an LSTM, similarly for image classification we use Convolution Neural networks. In this blog, we are going to build a basic building block for CNN.

In a regular Neural Network there are three types of layers:

1. **Input Layers:** It's the layer in which we give input to our model. The number of neurons in this layer is equal to the total number of features in our data (number of pixels in the case of an image).
2. **Hidden Layer:** The input from the Input layer is then feed into the hidden layer. There can be many hidden layers depending upon our model and data size. Each hidden layer can have different numbers of neurons which are generally greater than the number of features. The output from each layer is computed by matrix multiplication of output of the previous layer with learnable weights of that layer and then by the addition of learnable biases followed by activation function which makes the network nonlinear.
3. **Output Layer:** The output from the hidden layer is then fed into a logistic function like sigmoid or softmax which converts the output of each class into the probability score of each class.

The data is fed into the model and output from each layer is obtained from the above step is called **feed forward**, we then calculate the error using an error function, some common error functions are cross-entropy, square loss error, etc. The error function measures how well the network is performing. After that, we back propagate into the model by calculating the derivatives. This step is called **Back propagation** which basically is used to minimize the loss.

4.1.2 MODULES

Thermal Picture Data Collection This module uses sophisticated thermal imaging cameras to take thermal pictures of voters' faces. It makes certain that high-quality thermal data is collected and serves as the basis for additional biometric analysis. It might also contain strategies for adhering to moral and legal requirements while protecting voters' consent and privacy during the data gathering process. **Preprocessing and Feature Extraction**: This module is used to enhance the quality of thermal images and eliminate noise or artifacts that could compromise the accuracy of further analysis. It then uses sophisticated image processing techniques to retrieve important information, such heat signature patterns, from the preprocessed images. Voter verification is achieved by feeding these recovered features into a Convolutional Neural Network (CNN).

Blockchain Integration: This module aids in the voting system's integration of blockchain technology. It guarantees the safe storage of the preprocessed thermal photos on a blockchain, together with additional voter-related data. In order to provide a tamper-proof platform for storing and retrieving election data, the module employs blockchain to ensure data integrity, immutability, and transparency.

The **training module** for convolutional neural networks (CNNs): This module uses previously processed thermal images with feature extraction to train a CNN. Iterative training on a tagged dataset enables the CNN to identify patterns and features in images. The essential element for assessing thermal images and verifying voters' identities during the voting process is this trained CNN.

Two-Factor Authentication: This module securely verifies voters' identities by employing a two-factor authentication method. To strengthen the authentication process, it combines thermal facial recognition technology with email OTP verification. By requiring voters to go through both thermal facial recognition and email OTP verification, this module increases the voting system's security even more.

Voting Process: This responsible for managing the entire voting procedure, which includes registering voters, casting ballots, and tallying the results. It guarantees a safe, transparent voting procedure and that only voters who are verified may cast ballots. It might also have methods, such audit trails or cryptographic protocols, for verifying and validating the voting process's integrity.

The **User Interface** allows voters to interact with the online voting system through an easy-to-use interface. It enables voters to register, vote, and validate their identities via a two-factor authentication method. It also gives real-time feedback and progress updates on the voting process, ensuring a smooth and accessible voting experience for all users.

V. Conclusion

The online voting system offers a comprehensive and creative solution to the security and dependability concerns inherent in modern electoral processes. By combining thermal imaging technologies, blockchain, Convolutional Neural Networks (CNNs), and two-factor authentication techniques, the system provides a strong framework for ensuring vote integrity and transparency. Thermal imaging allows for accurate biometric verification of voters' identities, while blockchain technology assures that voting records are stored securely and without tampering. Furthermore, CNN-based analysis improves the accuracy of voter verification, while two-factor authentication adds an extra degree of security against unauthorized access. These components work together to establish a credible and accessible platform for holding online elections, building trust and confidence in the democratic process. Moving forward, further research and development in this area will be critical to refining and improving the effectiveness of online voting systems, ultimately advancing the objective of building a more inclusive and active democracy in the digital era.

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