



## A REVIEW OF BIOMETRIC FACIAL RECOGNITION ELECTRONIC VOTING SYSTEM: NIGERIA POLLS

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### Abstract

The study examines impacts of artificial intelligence (AI) applications into the social-economic activities technology-driven knowledge management concept for Nigeria democratic poll. Election activities always take another dimension after electoral polls in Nigeria. Democratic process in Nigeria calls for global attention and local media crisis; since the last free and fair election organized, June 12, 1993. Nigerian polls require technological intervention in screening and verification of electorate during voting process to enhance credibility in election process. Biometric features are proven to be a unique process of verification and authentication for individual. This paper discusses a framework for facial biometric system using AI to design a smooth democratic process. The framework is seen as a unique form of electorates screening process and identification. The initiative will promote security, efficiency, and possible solutions for established voters' fraud in Nigeria and enhance the fundamental rights of all citizens to participate in their democratic process using biometric verification and authentication system (BVAS) by the independent national electoral commission (INEC).

**Keywords:** Biometric, facial recognition, verification, polls, electorates

### Introduction

The electoral process lies at the very heart of democratic societies, serving as the cornerstone of political participation and representation. The history revealed post-election crisis of October 1965, August 1983 and June 12, 1993 truncated general election poll processes (Nwosu, 2017). These resulted into many failed Nigeria democratic processes and military interventions until year 1999. Democratic process has not being stabilized due to gaps in electoral voting process. Adoption of technological intervention will address election crisis and enhance collation process towards free and fair election. Furthermore, this will produce credible election and positive outcome of peoples' choice. Technological intervention will undermine gender inequality and cultural factors that militate against the positive outcome of electoral process in Nigeria (Uwa, *et. al*; 2018). This could also reduce human error during collation of paper ballot system, including cost effective and seamless process. Biometric features are in various form ranges from eye (iris), finger, voice and facial. These are unique features of individual deployed in authentication and identification processes (Apena *et al.*, 2015).

The emergence of facial recognition technology has prompted discussions on its potential application for voting identification process. A Facial Recognition Voting System (FRVS) has potential to give better and

quality phase to the democratic process in Nigeria. This could offer awaiting promises of increased security, efficiency, and accessibility in seamless cost and time (Abada *et al.*, 2022). However, the introduction of technological intervention could raise fundamental question on height of education in electorate and poverty level; nevertheless, number of population in the polling station will reduce. The technological initiative will enhance positive outcome towards accuracy, privacy, ethics, and fundamental principles of democracy. The introduction of FRVS biometric features could sets better outcome stage for a comprehensive analysis towards free and fair democratic election process in Nigeria. This paper adopts knowledge management (KM) approach in the introduction of Facial Recognition Electronic Voting System to Nigeria democratic process with holistic understanding and decision-making (artificial intelligence) regarding the potential adoption of facial recognition technology in electoral process.

### The Concept of Facial Recognition Voting System

The concept of facial recognition voting system employs knowledge management concept in the view of applying technology for seamless process to address challenges (Apena *et al.*, 2015). The background of democratic process is tracked back to Athens' direct democracy to modern process of full representation of

peoples' voices and choices. These involve open ballot, mechanical lever machines, punch cards, and electronic voting systems. Each transition aimed to enhance accuracy, accessibility, and the overall integrity of elections (Byne *et al.*, 2007).

Facial recognition technologies take advantages of biometrics natural features and individual uniqueness pattern to enhance security, surveillance, and identity verification. Facial recognition voting system - FRVS involves developing facial recognition algorithms verify and authenticate voters' identities. According to Casiraghi (2018), biometric features can reduce fraud, and increase the accessibility of voter towards their civic rights during democratic process.

**Understanding Facial Recognition Technology and Voting System**

Facial recognition technology (FRT) is proven to be sophisticated biometric system that has gained application and processes in various areas through knowledge management. The application of FRT ranges from security to problem solving such as time management and surveillance (Mann and Smith, 2017). Implementing a FRVS could address militating factor in smooth electoral process with support of linked database system through data acquisition and knowledge sharing (Leslie, 2020). It is essential to understand the knowledge architecture of FRT through simplified steps as follow;

**Step 1: Face Detection**

- Cameras or sensors – data acquisition for capturing facial image(s)
- Software to identifies and isolates the face within the image using pattern recognition techniques.

**Step 2: Face Alignment and Normalization**

- The system aligns the detected face to a standardized pose, ensuring consistency in

analysis.

- This step corrects for variations in head orientation, lighting, and scale.

**Step 3: Feature Extraction**

- Facial landmarks, such as the positions of the eyes, nose, and mouth, are identified.
- Distinctive facial features are extracted, creating a unique facial signature.

**Step 4: Face Encoding**

- The extracted features are converted into a numerical representation, often referred to as a facial template.
- This template is used for comparison and matching.

**Step 5: Database Comparison**

- The facial template of the individual is compared to a database of templates containing known individuals' data.
- Algorithms calculate a similarity score or distance between templates to determine if a match exists.

**Step 6: Decision and Verification**

- Based on the similarity score, a decision is made regarding whether the individual's face matches any in the database.
- If a match is found, the person's identity is verified.

The resolution and accuracy of facial recognition technologies could be supported with decision support system (DSS) such as deployments of statistical and AI. Research study presented by Almeida *et al.* (2022), revealed positive outcome in the use of AI in the area security surveillance as decision support tool over the statistical model. The study identifies use of machine learning techniques (convolutional neural networks) and deep learning algorithms as described by Bah and Ming, (2020).

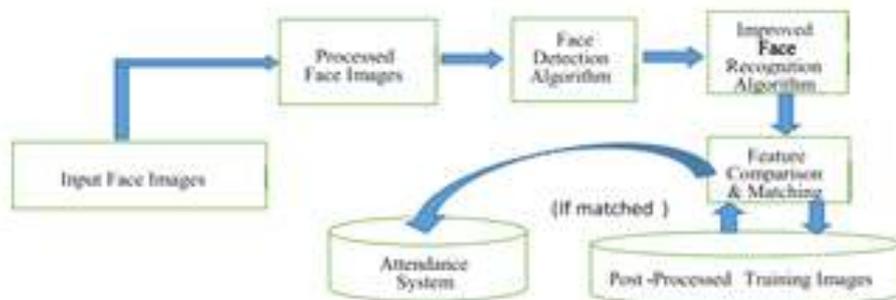


Figure 1: Block diagram of a face recognition algorithm (Bah and Ming, 2020)

The employment of AI for facial recognition could automatically learn (training) through the network and refine facial features towards enhancing accuracy as pictured in Figure 1. The application of this initiative could be employed to address democratic process in Nigeria's election.

**Proposed Facial Recognition E-Voting System**

The concept of a Facial Recognition Voting System involves integration of acquired biometric facial image and technology through feature extraction techniques summarized below;

- **Enrollment:** Registered voters provide a facial image during the voter registration process. This image will be stored securely in the electoral database.
- **Voter Authentication:** On Election Day or during early voting, voters' faces are captured through cameras or scanning devices at polling stations
- **Facial Recognition:** The system employs facial recognition algorithms to analyze the captured image and compare it to the stored facial images in the database.
- **Verification:** If a match is found, the voter's identity is verified, and they are allowed to cast their ballot – Feature Extraction.
- **Access Control:** Only authorized personnel have access to the facial recognition system to prevent unauthorized use or data breaches - Voting.

The proposed e-voting system entails administrator (Admin) and voters' ends to enhance ethical consideration and the legal framework surrounding the electoral rules and guidelines.

### Facial Recognition Electronic Voting Admin Description

Figure 2 shows possible sequential activity diagram of an electronic voting system. It describes the voters' facial identity (scanning the face in camera), data acquisition through electorate registration process. Voters are given access to login by their chosen username and password profile; during electoral process voters can view candidate details and manifestoes. However, all the rule and election guidelines will be upheld such as deadlines for voters' registration. Election can be coordinated through the admin platform with monitoring and on-time collation as shown in Figure 2.

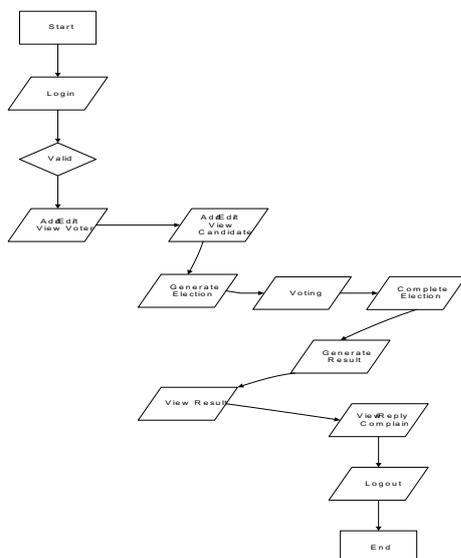


Figure 2: Electronic voting admin description

Once election starts, the platform will be strictly activated for online voting. The access control utilizes the authentication process. The system proposed two factor authentications where voters are given the mobile one-time password OTP through voter's registered mobile number with the option of either email one-time password to enhance security and prevent identity theft in a friendly manner or through short message system SMS.

### Electronic Voters End Platform Description

The electronic voter platform gives access to only registered electorate to exercise their civic rights through facial and intelligent identification (scanning the face via camera). Electorates' logs into the platform, updates their details and get to know candidates' profile before election date as shown Figure 3.

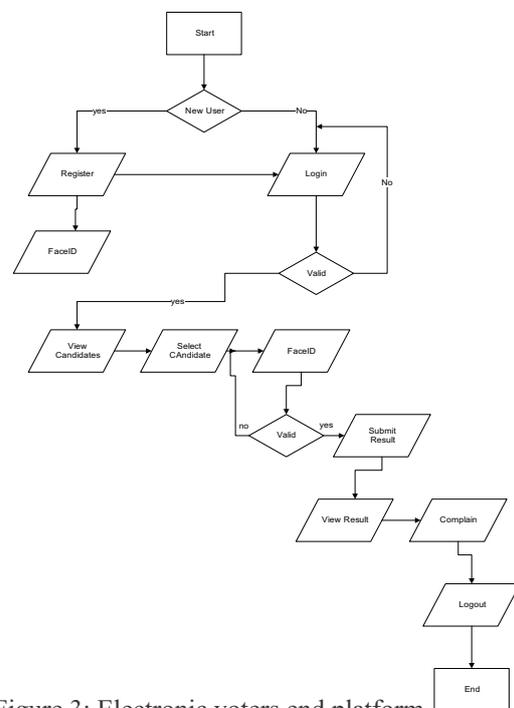


Figure 3: Electronic voters end platform

The platform allows electorate to selects a candidate(s) from the list and verifies their identity. The access authentication follows the same process like admin end as discussed above. Following the generation of results and election updates, these can be viewed on the platform and reversible communication such as complaint to the administrator.

### The Proposed Facial Recognition E-Voting System Architecture

The proposed electronic system architecture (Figure 3) adopted knowledge management (KM) in the conceptual view towards seamless democratic process. The study presents a unified secure framework of data acquisition and artificial intelligence (AI) application as shown in Figure 4.

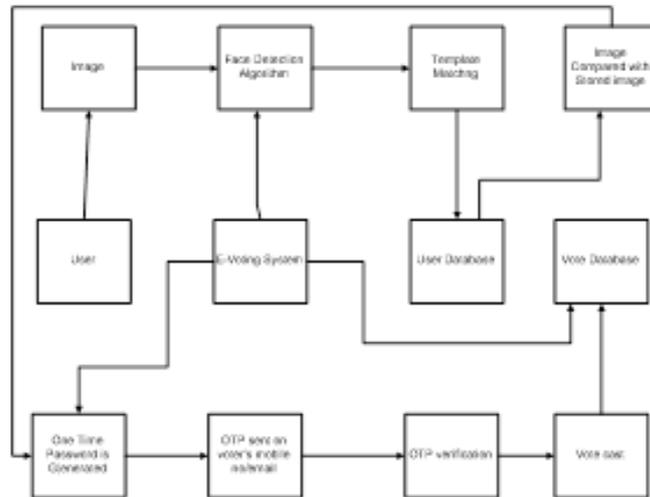


Figure 4: The proposed facial recognition E-voting System architecture

The proposed architecture (Figure 4) will effectively unify identified process in the blocks. The framework aim to enhance security and promote individual democratic rights without any forms of intimidations and fear through friendly users' accessibility. Nigeria democratic process could be run over electronic platform; this could totally present free and fear election. The administrative stakeholder could provide center where electorate can exercise their civic right, this will address citizen(s) without smart phone of access to internet access. The proposed could be supported and integrated to real time electronic voting system.

**Implementing Facial Recognition Electronic Voting System**

The study identifies some sociological local factors of human inequalities that could be limitation to the efficacy of the proposed system such as education, religion and tribal discrimination. The implementation of the proposed Facial Recognition Electronic Voting System will require consideration of technical requirement, financial implication and other public opinion for the proposed system robustness (criticisms).

**Technical Requirements**

The deployment of facial recognition electronic voting system in Nigeria poll requires highly accurate facial recognition algorithms to minimize false positives and negatives outputs. The study proposed three (s) strategies in minimizing human face detection error through Viola-Jones calculation as stated by Sikder *et al.* (2021). The steps are stated in summary; (1) An integrated facial image features extraction, (2) Machine-learning strategy (Adaboost) for subset selection algorithm, and (3) Combination of all cascaded numerous features. The study propose Viola-Jones calculation cascade the images in rectangles compared with database as stated in Equation (1).

$$q(z) = \frac{\text{Number of black rectangle}}{\text{Number of white rectangle}}$$

The machine learning strategy propose Adaboost algorithm; as a powerful classifier in its linear combination process for cropping, this is revealed in Equation (2).

$$S(Z) = n_1 s_1(z) + n_2 s_2(z) + \dots \quad (2)$$

The extraction and matching of subset selection of extracted features, entails process of cascaded image training with database such as, Let  $A = [XYZ\dots]$  be the training sample with pixel factor(s) – dimension(s) resulting matrix. Therefore, the designed matrix can be expressed as  $G = [G_1, G_2, G_3, \dots, G_n]$  among sampling subtracted average and eigenvectors where from Equation (3).

$$G = B^T * v \quad (3)$$

The final output stage of feature extraction Let,  $S = [S_1, S_2, S_3, \dots]$  this will be projection image for face vector space as shown in Equations (4) and (5).

$$S = G^T * B_1 \quad (4)$$

$$S_1 = G^T * B_2 \quad (5)$$

In this study, Principal Component Analysis (PCA) is proposed for this stage. PCA is an image training method, and calculating projection of testing images by same process utilizing same eigenfaces of value, vector and subtraction of mean. Determining projection of testing images using eigenfaces of value and vector and subtraction of mean, where  $\alpha$  would be space of eigenface and training images. This will determine the disparity of feature recognition, Equation 6.

$$\alpha < T_c \quad (6)$$

On the other hand, an unidentified person in the data base could be ascertain through Equation 7.

$$T_c = \frac{1}{2} \max_{i,j} (\|S_i - S_j\|); i, j=1,2,3.. N \quad (7)$$

The matching calculation score could be consisted with minimal error equation (6) and (7). The testing features of images by Euclidian distance with deep learning method through Equation 8.

$$\alpha_j^2 = \|S_i - S_j\|^2; j = 1,2,3 \dots N \quad (8)$$

If the minimum is  $\alpha_j^2$  then the testing of features could match along with training of features. The image features accuracy findings through Equations (7), (8) and for detection and recognition could be adapted using Equation 9.

$$Accuracy Rate = 100 - \frac{FAR+FRR}{2} \quad (9)$$

The accuracy perform will enhance system efficacy and smooth verification process of the electorate towards voting.

### Conclusion

The introduction of facial recognition electronic voting (E-Voting) system to Nigeria democratic activities could present a technological frontier in the evolution of electoral process and time management. The paper examines administrative and electorates (voters) activities to design an electoral activity diagram; these will be unified as a process with aid of artificial intelligence (AI), while the process will eradicate voter accreditation in open ballot system. The process will employ authentication and access control through biometric features. The research identify national database as technical limitation, although the periodical voters' registration could enhance independent national electoral commission (INEC) database for electronic voting system in Nigeria. The study will not undermine ethical considerations and legal implications to acquire voters' details towards pilot project. This initiative will offer security, efficiency, and possible solutions for established voters' fraud in Nigeria. Furthermore, the propose work will enhance privacy, equity, principles of fairness, and the fundamental rights of all citizens to participate in their democratic process.

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