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AN ENHANCED VOTERS REGISTRATION AND AUTHENTICATION APPLICATION USING IRIS RECOGNITION TECHNOLOGY

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ABSTRACT

The use of fingerprints in a voting system for registration and authentication application has its limitations. Among these limitations are mismatches caused by disparity in fingerprint trait and templates of voters taken at the point of registration and at the point of authentication (voter's accreditation). Manual labour, aging, variations in user interaction (i.e. pressure on the scanner), environmental changes and injuries are a few of the factors that can cause these disparities. The iris is more resistant to these factors that cause disparity in biometrics. In this designed model, the iris was used in place of fingerprints as the biometric measure to register and authenticate voters. An iris scanner obtains the voter's iris image, segments and digitizes it. The digitized iris image of the voter is used as a training data and stored in the template. This template is stored together with the voter's particulars in a database. An algorithm design using the C# (C sharp) language issues a PIN for the voter's authentication. At the point of authentication, the PIN of the voter is keyed in. The iris scanner obtains the voter's iris image, generates a template of the iris and with the aid of the system's embedded algorithm, compares the details of the voter's pin and iris trait with the one in the database for a match. A match grants the voter the pass to vote. A mismatch denies the voter access to the voting system. This implemented Iris Recognition Technology drastically reduces the chances of mismatches for genuine voters and denies imposters in the voting system due to its reliability and robustness as revealed by the tests carried out on the designed model.

Key words: biometric, iris, registration, e-voting, recognition, authentication.

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1. INTRODUCTION

Political elections in many developing nations are bedeviled with complaints of unfairness. Registration to vote is usually done at the local government level and voters' cards are issued as proof of registration [1]. Although some form of biometrics may be collected during enrolment and perhaps even used during the voting process, many elections in developing nations are still riddled with electoral fraud [2]. Voters' registration is the most expensive and complex activity within the framework of elections. This process is so crucial that the outcome of an election in terms of credibility and smoothness depend largely on it [3].

Voting registration and authentication have not been efficient in developing nations. Developing nations that have tried to incorporate biometric recognition into their voting processes are still grappling with the lingering problems of impersonation, rigging and bribery [4].

This paper suggests the use of iris biometric recognition for voters' enrolment and verification. This will improve the credibility of election results in developing nations. The Iris is a physical biometric trait that is very difficult to spoof. It is also unique to every individual and remains permanent for a lifetime. Iris biometric technology also has a niche benefit of being a non-contact biometric recognition system. This makes iris biometric recognition systems less prone to errors or noise that may arise from inadequate pressure and small contact area. Iris biometric technology also has the advantage of protecting users from communicable diseases that can be transferred through contact [5].

The major objective of this paper is to propose a system of enrolling and verifying eligible voters using iris recognition technology. Microsoft Visual Studio's integrated development environment was used to create a voting system software application. The language used to write the software program was C#. The database was designed using Mini SQL [6]. An iris scanner was incorporated into the design to complete the enhanced iris recognition voters' system. During registration, personal details were taken. The iris scanner captured the image of the iris and embedded algorithms in the scanner localized, segmented, normalized and performed feature extraction on the iris image. A template of the iris' unique characteristics was stored along with the voter's particulars in the database. The implemented system issued a pin to the voter at the completion of the registration/enrolment process [7].

To be authenticated, the voter keys the pin issued after the registration process into the recognition system. The pin was used to call up the voter's particulars and a 1:1 verification using the voter's iris is carried out to confirm the voter's identity. If authenticated, the voter is given the permission to vote. A voter may not be authenticated if there is more than one record of the voter on the database, the voter did not enroll or the iris recognition gives a false non-match result. The use of iris recognition technology in the voting process of developing nations is justified by the inevitable improvement it will bring to the credibility of electoral result in developing nations [8].

2. RELATED WORKS

De and Ghoshal, [9] proposed an electoral process based on a voter's registration list that was created purely with human iris recognition technology. The authors concentrated on the algorithm used to localize, segment, normalize and extract the unique features of the iris image captured by a scanner. The authors used Canny Edge detection algorithm for localizing the iris and pupils. Normalization was carried out using the Daughman's technique. Segmentation by the Log Gabor filter and matching was done using Euclidean distance. The authors also elaborated on the software used to efficiently carry out iris recognition. The authors used MATLAB® to implement their recognition system.

The gradient magnitudes used to identify the edges of the iris image (Canning Edge detection algorithm was:

$$|G| = \sqrt{G_{x^2} + G_{y^2}} \quad (1)$$

Where; G = Gradient Magnitude, G_x = Gradient in the X direction, G_y = Gradient in the Y direction.

The equation used to change the circular nature of the iris into a rectangular shape was given as:

$$\theta_\varepsilon[0, 2\pi], r_e[R_{p,}\ R_l(\theta)] \quad (2)$$

$$x_i = x_p + r.\cos(\theta) \quad (3)$$

$$y_i = y_p + r.\sin(\theta) \quad (4)$$

$(x_{i,}\ y_i)$ – The area between the directions of the pupillary and limbic limits in the heading. θ- Heading. $(x_{p,}\ y_p)$ – The inside direction of the understudy, R_p – Radius of the pupil, $R_l(\theta)$ – The separation between focal point of the understudy and the purpose of limbic limit. The Log Gabor Filter frequency response was given as:

$$G(f) = exp\left(\frac{-\left(log\left(\frac{f}{f_o}\right)\right)^2}{2\left(log\left(\frac{\sigma}{f_o}\right)\right)^2}\right) \quad (5)$$

f_o – Centre frequency, σ – Bandwidth of the filter

The matching, computed using Euclidean distance. The two points in the Euclidean space, P and Q to be compared in terms of distance from each other was given as:

$$X = \sqrt{(P_1 - Q_1)^2 + (P_2 - Q_2)^2 + \cdots + (P_n - Q_n)^2} \quad (6)$$

Where, X – Measured distance, P and Q – Points on Euclidean plane

In the spring of 2016, researchers from the Department of Government, Democracy and Governance Studies Program in the University of Georgetown carried out a research on behalf of the United States Agency for International Development (USAID) on how the introduction of new technology into electoral processes either boosts or drains voters' confidence in electoral processes. The researchers focused on emerging and established sample states to define how technologies have affected voters' confidence in the electoral process. The researchers declared that technology in itself may not completely solve the problem of electoral fraud or boost looters confidence in the electoral process. The researchers extensively explored the use of iris recognition in Somaliland's electoral process and the success it recorded. The researchers also stressed the need to adequately define the electoral problems technology seeks to address before implementing any new technology into electoral processes [10].

Okokpujie *et al.,* [11] extensively analyzed segmentation of the irises using the popular Daugman Integro-differential approach and the less popular Circular Hough Transform. The researchers from Covenant University, Ota, Ogun State, Nigeria, declared that Iris Segmentation, using Circular Hough Transform gave a better result than the more popular integro-differential approach Daugman developed. The authors also recommended the use of Circular Hough Transform for iris segmentation in crucial iris recognition technology applications such as electoral processes to boost the confidence of voters [11].

Schueller and Walls, [12] conducted a research on the voter registration process that took place in Somaliland from January to September, 2016. The researchers highlighted the fact that previous voter registration in Somaliland was riddled with multiple applications and little trust in the electoral process. The researchers also stressed the fact that the government of Somaliland decided to overcome the problem of multiple applications by using iris recognition technology. The implementation of iris recognition technology in registering voters in Somaliland was adjudged successful.

Hobbis and Hobbis, [13] looked closely at voter integrity, trust and the promise of digital technologies using Solomon Islands as a case study. The researchers tried to answer the questions of technological peculiarities, strengths and shortcomings of integrating biometrics into electoral voting processes. They also looked at the way the world is gradually embracing the use of biometrics in electoral processes due to its ability to uniquely identify every individual. Lastly, the researchers examined the efforts made by the government of Solomon Island to show how the use of biometrics in her electoral process has helped to stabilize governance. This lead to several researchers in this area for economic development tending towards sustainability of biometrics in automated teller machines for enhanced user authentication [14-23]

2. METHODOLOGY

The application software that forms the backbone of the designed and implemented iris recognition based voter registration and authentication system was designed specifically for the Windows® operating system. The C# language was used to develop the software application. Mini SQL was used to design the database. Microsoft Visual Studio provided the integrated development environment for writing, compiling and debugging the software application. The iris scanner used infra-red light emitting diodes to illuminate the eyes and thus could capture the iris in all outdoor and indoor conditions. The scanner also has embedded algorithms that can perform localization, segmentation, normalization, template formation, storage and matching.

The Waterfall software development model was adopted to create the application software used in tandem with the iris scanner. The aim and objectives of the application software were clearly defined at the beginning of the design process. Afterward, the application software was developed, tested and debugged. This is shown diagrammatically in Figure 1.

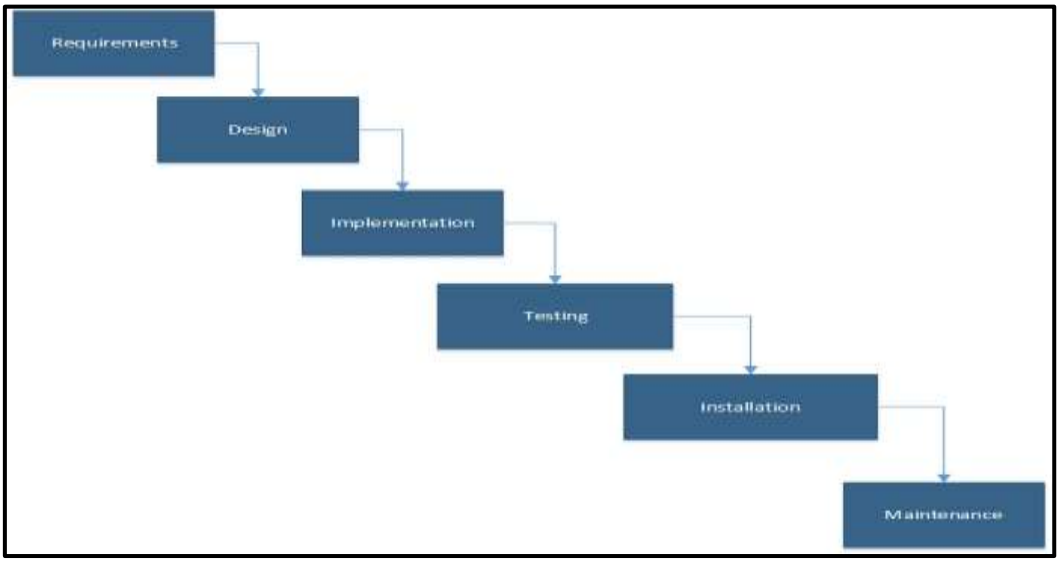

Figure 1 Application Software Development Model

The database was created using Mini SQL (MSQL), a light-weight database management tool used to create memory-efficient, performance-efficient and portable databases. Mini SQL can support basic query generation, load and save SQL script files, quick table data lookups, generation of SQL code and data scripts. The integrated development environment is shown in Figure 2.

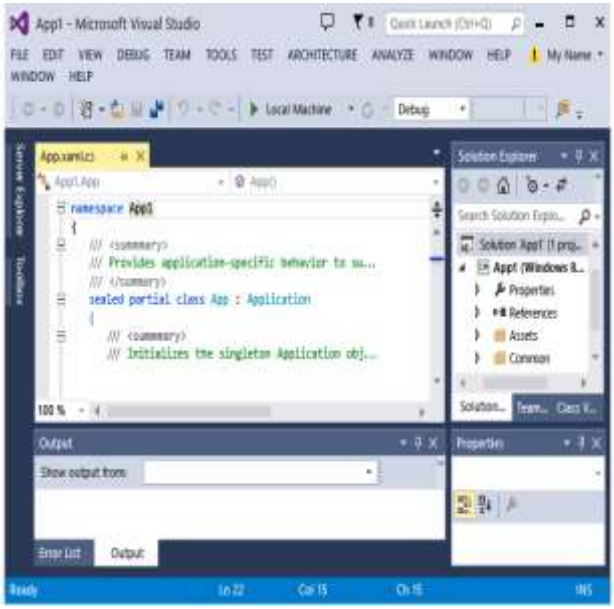

Figure 2 The Integrated Development Environment

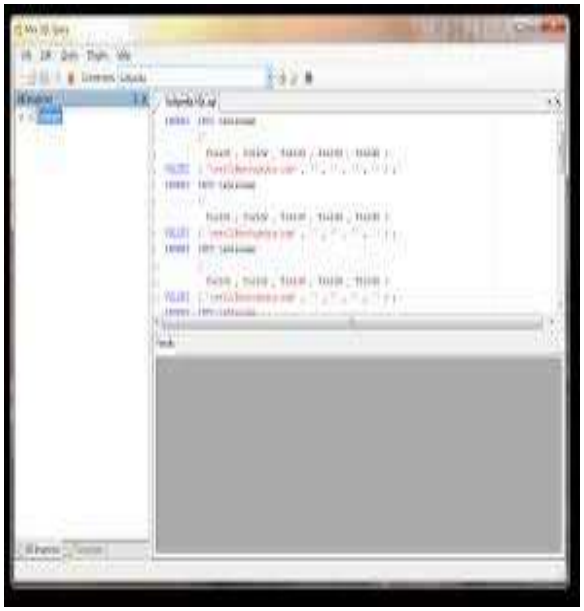

Figure 3 The Mini SQL Window

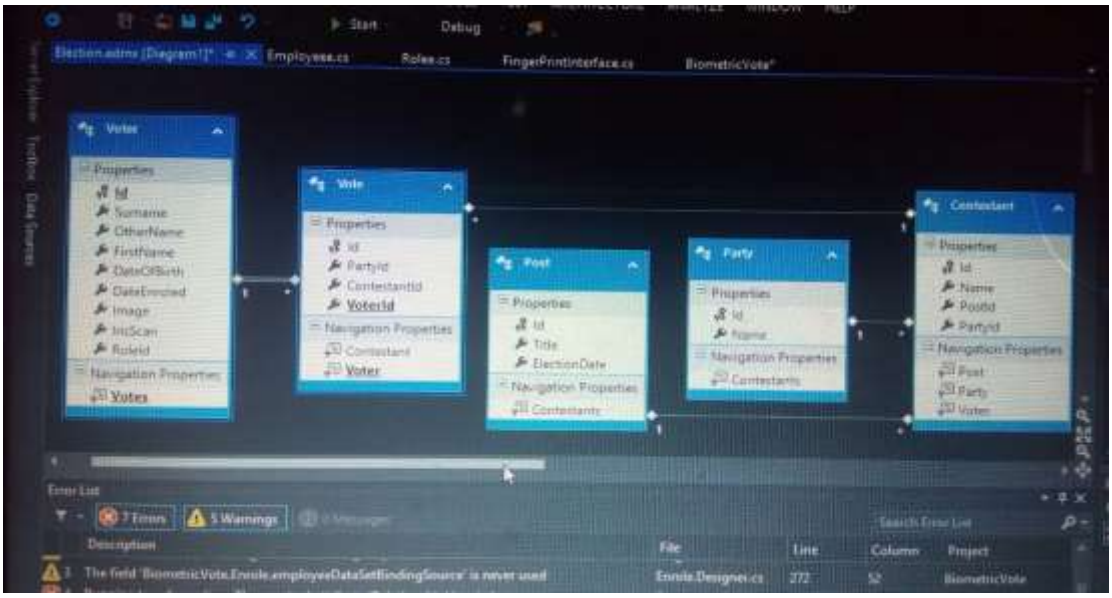

Figure 4 Sample of Relationships between Tables

The Mini SQL program was used to create tables that were linked together with primary and foreign keys. A sample of the relationship between the tables is shown in Figure 4. Upon completion of the Windows application software, the key objectives of being able to register, enroll and authenticate voters were achieved.

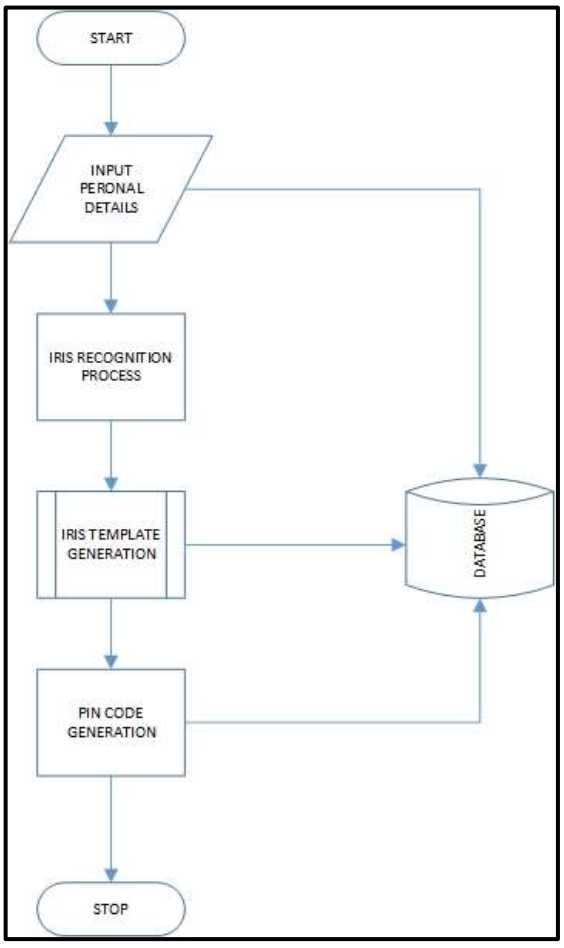

Figure 5 Flowchart for Voters' Registration

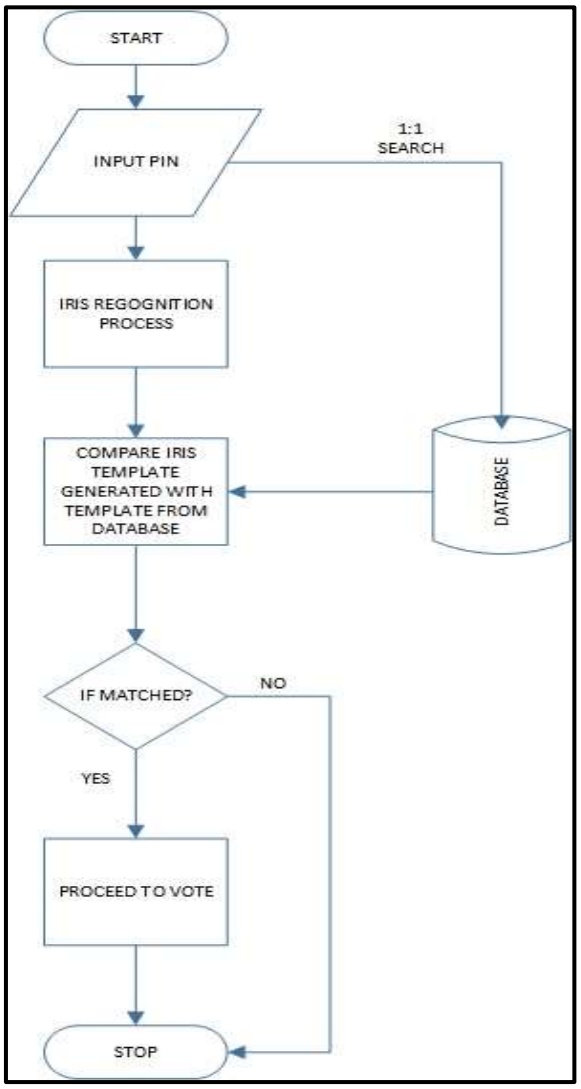

Figure 6 Flowchart for Voters' Authentication

The Algorithm for the Registration (Iris recognition enrollment) process is shown in Figure 5

During registration or enrolment, the following data were acquired:

a. Personal details such as age, name, sex etc.

b. Iris image.

Voters particulars are stored in the database alongside the unique iris template created from the iris image captured. Each unique iris details are stored as templates indexes by the voter registration particulars it represents. At the end of the enrolment process, a Personal Identification Number (PIN) is issued to the voter.

Authentication in this context is the process of carrying out a one-to-one verification to determine if a voter is indeed eligible to vote. The voter keys in the PIN acquired at the point of registration. The PIN enables the system to pull up the particulars related to the PIN. The iris scanner captures the voter's iris image, localizes, segments, normalizes, extracts its features and forms a template (query template) which is compared with the stored template indexed by the voter's particulars for a match. If there is s match, the voter is allowed to vote, otherwise, the voter is disallowed from voting. The algorithm for the authentication process is shown in Figure 6.

- Contestants Section: All qualified contestants are registered via the contestants' window.
- Voters Section: Represents the portal for voters are registration and authentication.
- Iris enrolment Window: The portal was used to acquire and store the unique features of voters' iris image.
- The application interface has the following windows: they are depicted in Figures 7 to 12.
- Post Section: The various posts to be filled are highlighted in this window.
- Party Window: Participating political parties are registered here.

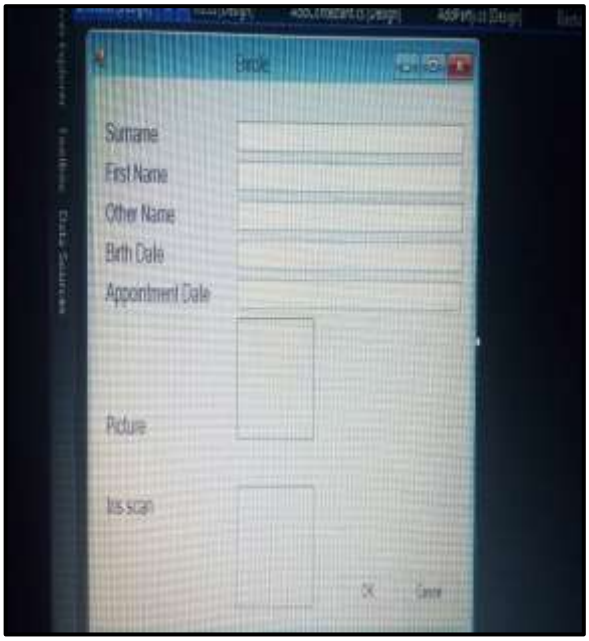

Figure 7 The Voters' Registration Portal

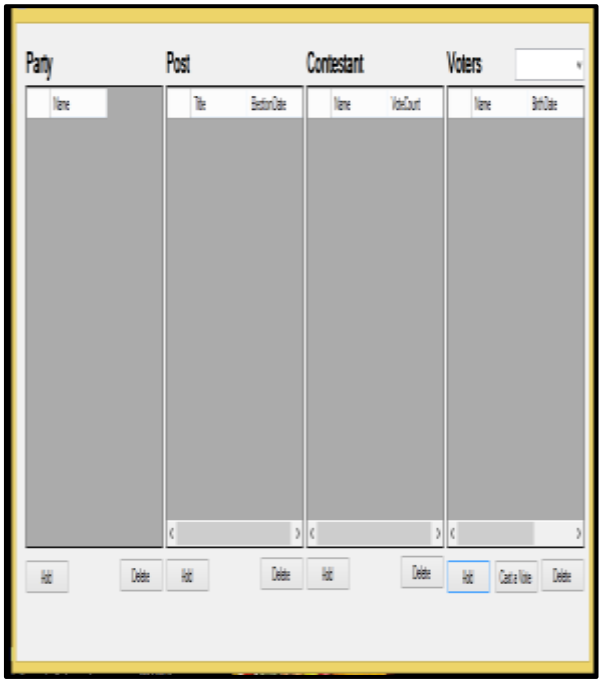

Figure 8 The Application Interface for Contestants and Voter

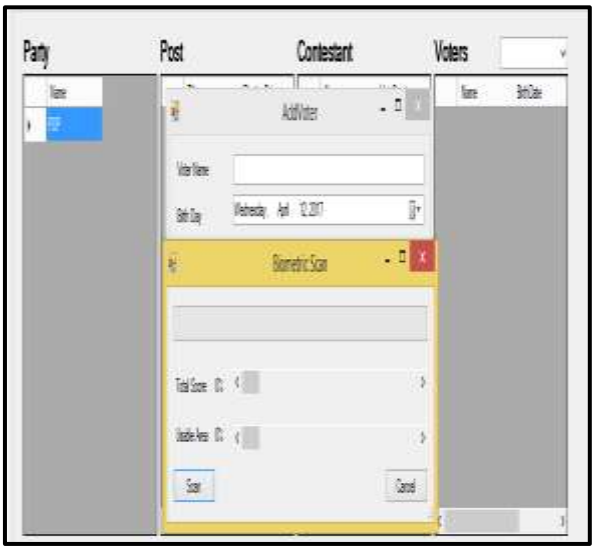

Figure 9 The Application Interface for Political Positions

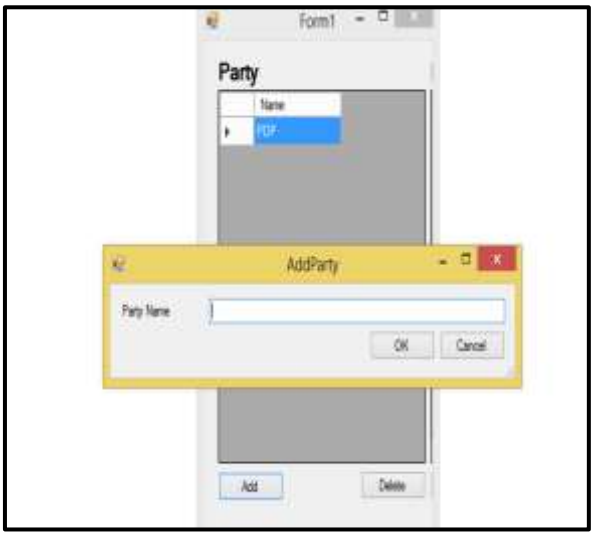

Figure 10 The Application Interface for Political Parties

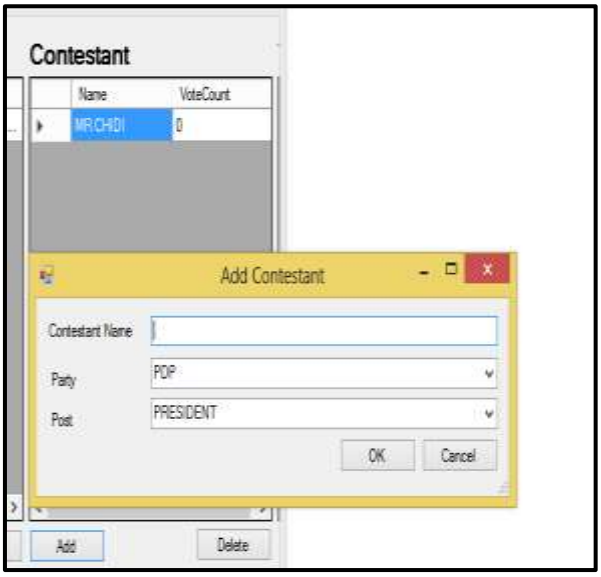

Figure 11 The Application Interface for Contestants' Registration

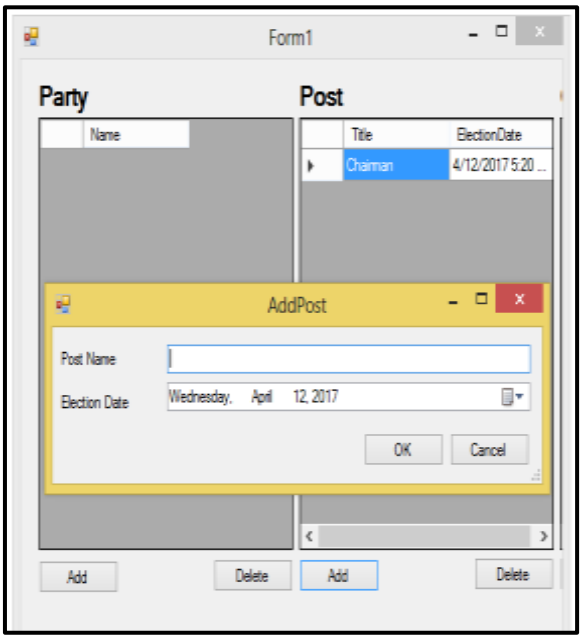

Figure 12 The Iris Image Acquiring Window.

3. CONCLUSIONS

The False Rejection Rate (FRR) which is the probability that the system will not authorize a duly enrolled applicant and False Acceptance Rate which is the probability that the system will authorize an unregistered applicant were zero (0). The objective of creating an iris biometric recognition based voter registration and authentication system was achieved. The application software worked seamlessly with the iris scanner.

FUTURE WORK

The creation of better and more efficient matching algorithms to lower the time it takes to make a decision based on the match score. An iris camera with a high image acquiring distance would be used for future applications.

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