

## Electronic Voting Software for the Ablekuma South District

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### **Abstract**

Manual voting systems have been deployed for many years with enormous success. If those systems were to be replaced with Electronic Voting Systems, we have to be absolutely sure that they will perform at least as efficient as the traditional voting systems. Failures or flaws in Electronic voting systems will jeopardize Democracy in the country instead of maintaining it. The electronic Voting system described in this project allows voters to log on the system by entering their valid voters ID number and password, Voters see only an electronic representation of ballot installed on the computer. Voters cast their votes by clicking on their preferred candidates and confirming the votes. The software automatically counts and displays the results. The system also generates a report about the results obtained. The system is made with a database that stores record of registered candidates and voters. The main focus of the requirements is on defining and describing what the software system should do to satisfy candidates, voters and the public as a whole. The Electronic Voting system described in the project is robust, accurate and of quality-based design and implementation. The system also presents a great security challenge. It provides adequate security to protect the system against fraudulent and malicious activities. The E-Voting system illustrated is generally efficient, reliable and less prone to electoral deficiencies.

**Keyword:** Electronic Voting, Software for Voting, Ghana District Election, Elections Voting

### **I. INTRODUCTION**

Over the years, elections have been a standard medium for maintaining democracy in many countries and institutions. The manual voting system has been deployed all these years which has yielded enormous success and flaws as well. In Ghana, apart from Presidential and Parliamentary elections, there is also a **District Level Elections** which is conducted to elect Assembly Man and Women and unit committee members at various electoral areas. This project seeks to computerize the manual voting system of the **District Level Elections** which is normally referred to as "Assembly man" elections in most of our communities. Considering the numerous success of I.C.T in many areas such e-business, e-commerce, it is also good to implement I.C.T in elections in the form electronic voting to enhance speed, fairness and accuracy in modern elections. Many innovations that have become familiar features of modern elections originated at least in part as a way to reduce election fraud such as tampering with ballots to change the vote count for a candidate or party. The aim of electronic voting is to provide a set of protocols that allow voters to cast ballots establish a free and fair election at all times.

#### **A. Problem Statement**

The following problems and short falls were realized with the use of the manual voting system that is, the paper ballot system. There is sometimes a shortage Of Electoral material such as ink, stamp, ballot papers and other electoral materials at some polling stations on the day of elections. This situation sometimes halts the Electoral process for hours. This leads to voters having to wait in queues for lengthy periods and this creates problems as some voters turn to think it is a fraudulent move to rig the election, and also some impatient votes turn to leave which causes the elections not to be competitive. There is sometimes misdistribution of ballot papers at the District Assembly. It so happens that the ballot papers for an Electoral area is mixed up with ballot papers of another Electoral area is mixed up with ballot papers of another Electoral area and this brings about a lot of chaos in the Electoral Process. With the printing of ballot papers, it was realized that there are problems associated with it. At times, there is shortage of printing materials. Misplacements of candidates on ballot papers for a different Electoral area and spelling errors that associated with the candidate names on the ballot sheet are another flaw. All these make a voting process a bit undesirable.

It is noted that with the paper ballot, all voters are supposed to go through one point of checking the voters register to prevent double voting and other inconsistencies which creates long undesirable queues. This normally drives some impatient voters away. Moreover after going through the eligibility test, you will have to wait in other separate queues

since there are limited voting points. This also wastes the time of voters. It was realized that candidates normally objected to the results that were established on the basis of the elections not being conducted in a free and fair manner. This normally created misunderstandings among candidates and chaos among supporters of the candidates in that Electoral area. Some of the arguments that are passed include; Ballot stuffing, inaccurate counting leading to inaccurate calculations of results, especially when the results are very close.

The counting process of the entire vote poses problems. This is because, with the manual method of counting it normally takes several hours and this sometimes increases the anxiety of candidate faithful and the candidates themselves. It increases the stress of the Electoral Officers who are at such Electoral areas and puts them in a position of easily causing errors since they will have to be around throughout the day to supervise elections and after supervision they will also have to do the counting. Voters sometimes make mistakes when casting their votes and there are no checks to correct these voters. The preparation of ballot papers, that is; typing of the candidate's names together with their pictures, printing of this ballot papers and the purchasing of ballot boxes together is very expensive and unbearable for the District Assembly and some of these costs shoot up almost every new District Level Election that is conducted.

### ***B. Aims of Project***

This project is intended to introduce the subject of Electronic Voting, and also seek to address the voting procedures being administered by the "**Ablekuma South District for the District**" Level Elections. The project dubbed E-voting intends to establish more accurate, fast and reliable voting system that will help facilitate the voting process of the District Level Elections in the Ablekuma South District and ensure that results are calculated efficiently and quickly as possible to prevent conflicts and misunderstandings in the acceptance of the produced results which has often been the case with the manual way of voting. We leave in an increasingly technological stage with ICT gradually becoming a major driving force behind many activities and entities.

The introduction of ICT has yielded many successes in various sectors such as banking, commerce, and manufacturing, engineering and so on bringing speed, precision, accuracy and efficiency into the world. Therefore it is duly necessary to introduce this new mechanism into electoral processes. The project also seek to establish a more accurate, reliable and transparent voting system at various electoral areas in order to reduce the propensity of electoral fraud and other malicious activities such as tampering with votes and changing ballot boxes. This project is also to set high security measures and controls to prevent deliberate and accidental attempts to manipulate the electoral process. This project also seeks to reduce excessive cost that comes with manual electoral system, which is the paper ballot system. Comparatively, the manual voting system is expensive to operate. The electoral commission has to print ballot sheet, purchase endorsing ink, and stamp pads, ballot boxes and so on. Apart from the ballot box which can be reused, all the other materials have to be bought at every electoral period. The commission also has to pay election officers and other security personnel to maintain order at polling stations. To reduce simple mistakes that voters usually make when casting their votes. Example include instances when the voter selects more candidates than are allowed, called over voting.

## **II. LITERATURE REVIEW**

This project seeks to study the basic methodologies in the Electoral processes in Ghana and see how best Information Technology in the field of Programming will be able to improve these processes. Electronic Voting has been in existence for a while now. It was introduced in the United States for the Presidential Elections as far back in December 2009 which yielded quite tremendous results. For the literature review, one main purpose is to be able to explain the concept of Electronic Voting to the lowest level to enable even the layman understand what this project is all about. It will also extensively look at the operations of the Ablekuma South District Assembly since it happens to be the organization under study.

### ***A. Study Area***

This project is intended to introduce the subject Electronic Voting, and also seek to address the voting proceedings being administered by the Ablekuma South District Assembly Level Elections. Electronic Voting also termed E-Voting is simply a method of using voting software with the aid of computers to perform a voting exercise. With this E-Voting system, unlike the Manual Voting Systems, the voter sees only an electronic representation of ballot installed on a computer. Voters are registered electronically and issued with user names and passwords in order to access the system there by casting their votes. Voters cast their votes by logging into the system with a valid user name and password as assigned to them and clicking on their preferred candidates. The voter then confirms the votes cast.

Once the votes are confirmed, the system registers the votes electronically and increases the tally of candidates accordingly. After the entire voting process, the system generates and displays the final results. The system has high security features that make it less vulnerable to fraud and other malicious activities. Based on research conducted it was realized that the following technologies have been the trend in most countries; it all began with the Stones as the means for conducting Elections, then the need for Paper Ballot voting was introduced, in some advanced countries like the United States after using the Paper Ballot, they also introduced the Lever machine for voting processes, from the lever technology, the punch card was introduced and then the Mark Sense.

Finally, the global growth of computers brought about the need for Electronic Voting. It is to be noted that a nation like Ghana has been through the stone and the Paper Ballot technologies, but for the purpose of the project it was only right to outline the technologies that have so far been used as far as voting is concerned. With the evolution of voting procedures, it is a bit worrying that most countries have not yet adopted the concept of E-Voting. The reservation to adapt to this new technology is due to some controversies, and difficulties can be built securely, whether voters will be able to verify that their votes were cast as intended but not able to provide it to anyone, whether in practical setting for the Electronic Voting, hardware and basic software platform can be trusted and other factors that will be highlighted in the course of the project. The Ablekuma South District Assembly is among the hundred and thirty-eight districts and municipal assemblies under the Local Government in Ghana.

Article 242 clause of the 1992 constitution of the Republic of Ghana States that “a District Assembly shall be the higher political authority in the district and shall have deliberative and executive powers”. The Ablekuma South District Assembly therefore presides over the communities within the district. The "**Ablekuma South District Assembly**" is an organization that undertakes a whole lot of projects and other developmental activities in the Assembly, but for the purpose of this project, only their electoral activities will be reviewed. The District Assembly has electoral activities in the district. It is the duty of the Electoral Commission Department to ensure a smooth and transparent election process.

### *B. Research of Similar Existing System and Software*

The review involves a research on existing system and that are being developed on E-Voting and this section will elaborate further on systems and software that are available to help broaden one's understanding on the subject under discussion. The review strategy involves a scoping exercise to identify, locate and access the amount of research evidence from projects in various developed countries currently in existence. Before the existing system is reviewed, it is essential to outline the following voting technologies.

#### *i. Paper Ballots*

Paper ballot systems use official ballots with the names of all candidates and issues printed on them. Voters mark boxes next to the candidates or issues of their choice to private and drop the completed ballot into a sealed ballot box. This system, also known as the “Australian ballot” because it was first adopted in the

Australian state of Victorian State of Victoria in 1856, was first used in the United States in a statewide election in New York in 1889.

**ii. Mechanical Lever Machines**

In mechanical lever voting system, the voter makes a selection by pulling a lever assigned to a candidate or issue choice identified by a printed strip. When voter opens the privacy curtain and enters the voting booth, the levers are automatically returned to their original positions. As the levers return to position, each causes a wheel to turn one-tenth of a full rotation for the counted vote. This wheel serves as the “ones” position of the count for the particular lever. After each full rotation of this wheel, this wheel causes a “tens” wheel to turn one-tenth of a full rotation. Similarly, the “tens” wheel updates a “hundreds” wheel. If the mechanical connections work [properly and the counting wheels are initially set to zero, the number of votes cast is measured by the position of each counter when the polls close. Mechanical lever machines were invented by Thomas Edison as a way to deter the vote fraud (such as ballot stuffing) that was occurring at the time. The first official use of a mechanical lever voting machine was in New York in 1882. By 1930, they were in almost every large city in the United States. In the 1960s, over half of the country’s votes were counted by mechanical lever machines. These machines are no longer made, and are being replaced with mark sense or direct recording electronic voting systems.

**iii. Punch Cards**

In punch card voting systems, voters punch holes in cards to indicate their candidates or issue choice. The cards are printed with names (with the list of candidates and issue choices printed separately in a book), or the candidate names and issue choices may be printed directly on the ballot next to the location of the hole to be punched. The ballot is either dropped in a ballot box or fed into a computerized tabulating device. The first punch cards and computerized tally machines were used in Georgia in 1964, soon followed by jurisdictions in Oregon and California. Many jurisdictions are switching from punch cards to mark sense or direct recording electronic voting system.

**iv. Direct Recording Electronic (DRE)**

Direct Recording Electronic, or DRE, voting systems are an electronic implementation of mechanical lever voting systems. As in lever voting systems, there is no ballot and the choices are visible to the voter on the front of the machine. Voters use touch-screens, push-buttons, possibly keyboards (to enable write-in votes) or other devices to enter their choices into electronic storage (such as smart cards, diskettes, or memory cartridges). Choices are added to the choices of all other voters.

The first system on E-Voting that is of interest to the project for research is a pilot project that was tested in Tallinn, a city in Estonia. Voting pilot was conducted in Tallinn and Estonian National Electoral Commission organized a public poll among the residents of Tallinn. The question put in poll dealt with the location of the statue of liberty. It was possible to cast a vote to in regular voting booth and also over the internet. Despite a passive attitude towards the question is posed and a low turnout, the election was successful with very little fraud. The enabling factor for E-Voting in Estonia is ID-card. Over 700,000 ID-cards had been delivered in a period of 3 years.

This means half of Estonian’s residents have such a card. ID-card penetration is even higher in Tallinn where it is used as an E-Ticket in public transport. The E-Voting system authenticates a person using ID-card’s authentication certificate. After learning voter’s identity, the system checks whether the person is in the voters list, the system displays appropriate choices of candidates. After he has made his or her choice, it is will be encrypted with system’s public key and sealed with person’s digital signature using, again, the ID-card.

If the person votes repeatedly only one vote will be counted. For achieving anonymity, digital signatures are removed from the submitted votes before counting them.

The secret key of the system is distributed among the members of the Electoral Commission. System design and strictly audited procedures to ensure that the E-Voting system provides all the properties of democratic election such as anonymity, one-person-one-vote, free will, etc. It is believed that there will be a further improvement to the features and efficiency of this system. This E-Voting system has been tested and for now there seem to be no technical obstacle for preventing it from being used in elections. Many innovations that have become familiar features of modern elections, such as the secret ballot and the mechanical lever voting machines, originated at least in part as a way to reduce election fraud and abuse. Computer-assisted counting of ballots, first used in the 1960s, can be done very rapidly and makes some kinds of tampering more difficult.

However, it does not eliminate the potential for fraud, and it has created new possibilities for tampering through manipulating of the counting software and hardware. DREs, introduced in the 1970s, are the first voting systems to be completely computerized. Touch screen DREs are arguably the most versatile and user-friendly of any current voting system. Their use is expected to increase substantially under provisions of The Help America Vote Act of 2002 (HAVA, P.L. 107-252), especially the requirement that, beginning in 2006, each polling place used in a federal election have at least one voting machine that is fully accessible for persons with disabilities. With DREs, unlike document-ballot system, the voter sees only a representation of a ballot; votes are registered electronically, some computer security experts believe that this and other features of DREs make them more vulnerable to tampering than other kinds of voting systems, especially through the use of malicious computer code.

While there are some differences of opinion among experts about the extent and seriousness of those security concerns, there appears to be an emerging consensus that is general, current DREs do not adhere sufficiently to currently accepted security principles for computer systems, especially given the central importance of voting systems to the functioning of democratic government. Others caution, however, that there are no demonstrated cases of computer tampering in public elections, and any major changes that might be made to improve security could have unanticipated negative effects of their own. Several proposals have been made to improve the security of DREs and other computer assisted voting systems.

They include:

- Ensuring that accepted security protocols are followed appropriately.
- Improving security standards and certification of voting systems,
- Use of open source computer code
- Improvement in verifiability and transparency.

Much of the current debate has focused on which such proposals should be implemented and through what means—in particular, whether federal involvement is necessary. Some states are already addressing these issues. The Election Assistance Commission established by HAVA will have some responsibility relating to voting system security and could address this controversy directly. Some observers have also proposed federal funding for research and development in this area, while others have proposed legislative solutions including enhancement of the audit requirements under HAVA.

#### **v. *Electronic Voting Machine***

DREs (Direct Recording Electronic Systems) are the first completely computerized voting systems. They were introduced in the 1970s. DREs are somewhat analogous to (although more sophisticated than) lever machines. The voter chooses candidates from a posted list on the DRE, as it is with a lever machine, or it may be displayed on a computer screen, or using other devices. The voter submits the choices made before leaving the booth, for example by pushing a “vote” button, and the votes are then recorded electronically.

There is considerable variability in the design of DREs, but they can be classified into three basic types. The oldest design essentially mimics the interface of a lever machine.

The entire posted ballot is visible at once. Instead of moving levers to make choices, the voter pushes a button next to a candidate's name, or pushes on the name itself, triggering an underlying electronic micro switch and turning on a small light next to the choice. With the second type, a ballot page is displayed on a computer screen, and the voter uses mechanical devices such as arrow keys and buttons to make choices on a page and to change ballot pages. The third type is similar to the second except that it has a touch screen display, where the voter makes a choice by touching the name of the candidate on the computer screen and casts the ballot by pressing a separate button after all choices have been made. In all kinds of DREs, when a ballot is cast, the votes are directly stored in computer memory devices such as a removable memory card or nonvolatile memory circuit.

As with lever machines, there is no document ballot, although with a DRE each cast ballot may also be separately recorded. Touch screen and other DREs using computer-style displays are arguably the most versatile and user-friendly of any current voting system. Each machine can easily be programmed to display ballots in different languages and for different offices, depending on voters' needs. It can also be programmed to display a voter's ballot choices on a single page for review before casting the vote. It can be made fully accessible for persons with disabilities, including visual impairment. 6 Like lever machines, it can prevent over votes and ambiguous choices or spoilage of the ballot from extraneous marks, since there is no document ballot; but it can also notify voters of under votes. 7 No other kind of voting system possesses all of these features.

***vi. Direct Recording Electronic Systems (DREs) AND HAVA***

The popularity of DREs, particularly the touch screen variety, has grown in recent years, and their use is expected to increase substantially under provisions of HAVA. Three provisions in the Act are likely to provide such an impetus. First, HAVA authorized \$3.65 billion over four years for replacing punch card and lever machines and for making other election administration improvements, including meeting the requirements of the Act. In FY 2003, Congress appropriated \$1.48 billion for these purposes (P.L. 108-7), and the administration requested \$500 million for FY2004. Second, beginning in 2006, HAVA requires that voting systems notify voters of over voted and permit them to review their ballots and correct errors before casting their votes. 9 Third, the Act requires, also beginning in 2006, that it be fully accessible for persons with disabilities. DREs are the only machines at present that can fulfill the accessibility requirement. They can also easily meet the requirements for error prevention and correction.

***vii. Security Concerns about Direct Recording Electronic Systems (DREs)***

One thing that distinguishes DREs from document ballot systems is that with DREs, the voter does not see the actual ballot, but rather a representation of it on the face of the machine. With few exceptions, current DREs do not provide a truly independent record of each individual ballot that can be used in a recount to check for machine error or tampering. The ballot itself consists of redundant electronic records in the machine's computer memory banks, which the voter cannot see. This is analogous to the situation with mechanical lever voting machines, where casting the ballot moves counters that are out of view of the voter. In a lever machine, if the appropriate counters do not move correctly when a voter casts the ballot, the voter will not know, nor would an observer.

Similarly, with a DRE, if the machine recorded a result in its memory that was different from what the voter chose, neither the voter nor an observer will know. The same is true with a computerized counting system when it reads punch cards or optical scan ballots. Even if the ballot is tabulated in the precinct and fed into a reading device in the presence of the voter, neither the voter nor the poll worker manning the reader can

see what is recording in its memory. However, with such a reader, the ballot documents could be counted on another machine or by hand if there were any question about the results. Lever machines also do not have an independent document ballot.

That has led some observers to distrust those machines, but most that use them appear confident that tests and other procedural safeguards render them sufficiently safe from tampering. Is the same true for DREs? Some computer experts think not, arguing that the software could be modified in ways that could alter the results of an election and that would be very difficult to detect. This concern appears to stem largely from three factors:

- i. Malicious computer code, or malware, can often be written in such a way that it is very difficult to detect.
- ii. DRE software is moderately complex, and it is generally accepted that the more complex a piece of software is, the more difficult it can be to detect unauthorized modifications.
- iii. Most manufacturers of DREs treat their software code as proprietary information and therefore not available for public security. Consequently, it is not possible for experts not associated with the companies to determine how vulnerable the code is to tampering.

### *C. Theoretical Review*

The review on the theory of E-Voting with respect to this chapter looks at the means by which this project can be achieved without looking at its practicality. The theoretical review can summarize into three main sections which this chapter will further elaborate on each in detail. The three sections are as follows:

- i. The Analytical Section
- ii. Constructional and Implementation Section
- iii. Finalization and Adaptation of the system Section

#### *i. The Analytical Section*

The Analytical section of his review aims at looking at the feasibility of such a project in the District Level Elections irrespective of the electoral area, though the case study is on the Ablekuma South District Assembly. The main task is to be able to improve the voting techniques of the Ablekuma South District Assembly by introducing an enhanced technology which will ensure an efficient voting process. Taking a look at the manual system, their voting processes were as follows:

- i. Registering Candidates
- ii. Registering Voters
- iii. Preparing ballot papers.
- iv. Gathering electoral materials such as ink pad, ballot box and other materials to ensure a smooth process.
- v. Counting Elections
- vi. Counting of Ballots
- vii. Declaration of election results

With a critical analysis of the manual voting system, the task ahead is to design a computerized system that will be able to do these processes without any hitches.

#### *ii. Constructional and Implementation Section*

This section aims at building an E-Voting system based on the analysis that has been conducted on the manual voting system. The plan to the construction of the E-Voting is based on the processes of the manual voting system. The first step in the designing the software is to be able design forms that will be able to register voters. The next step is to be able to create a form that will prepare the ballot form there by

registering candidates. The form should be designed in such a way that its rights will give to only the administrator which happens to be the Electoral Commission.

The third process which is a vital part in the manual system that is voting will be minimized because with E-Voting only two main electoral materials are used which are the computer and E-Voting software. The next significant step will be to install and run the E-Voting software on the computers to be used to ensure that it functions properly. After this election can then be opened officially for voters to cast their votes based on the time allocated. The next step which is the counting of the votes is very receptive which must be carefully done. The declaration of result and generation of report is the last step. These are after the ballots have been carefully counted.

This briefly explains how the E-Voting software will be implemented. Using Visual Basic 6.0, the software will be developed as according to the constructional plan. The databases are created using Microsoft Access 2003. The E-Voting software will be in on a network and tested continuously to check and rectify flaws. This software will also be distributed to efficient I.T Experts for further scrutiny and constructive criticism to ensure its robustness. After it has gone through all these processes the system will have to undergo redesigning if found necessary until it is found fit and desirable for use.

### *iii. Finalization and Adaption of the System*

The software will be made executable to prevent the source code from reaching the public domain. Packaging the software will be performed at this stage. In order for the Ablekuma South District Assembly to accept the new technology, there will have to thorough education on the benefits of the new system. With "Odododiodio" electoral area being the place for the pilot project, education on the fundamentals of computing will have to be introduced to help voters to conversant with computers and the E-Voting software as well.

### *D. Relevance of Study to Group*

Introducing new technology is always a complex undertaking and has many different aspects. These aspects are partly technical, social, political, organizational, legal and behavioral. This is also the case for information and communication technologies and see how the study of these dimensions in various disciplines. In most cases, the research then aims at bringing forward practical knowledge about design, development and implementation of ICT and same time contributing to the theoretical knowledge of the discipline involved. One of the aims the study has is to inform practical development and use of ICT for politics. The relevance of this project to the group is as follows:

**Scientific Relevance:** Data from E-Voting experiments should make it easy to clarify the influence this new voting method may have on the voter turnout and on the way different contexts could affect voting. An improved insight in social and technical design issues of E-Voting systems. The research studies should also help provide us with knowledge about new voting technologies for overall political participation and quality of representation.

### *E. Research Methodology, Analytical Tools & Techniques Used*

The entire project would not have been possible if there was no research conducted to determine the feasibility of such a project. The first move the group embarked on was to discover all that was involved in the District Level Elections of the Ablekuma South District Assembly. A constructive interview was conducted with District Electoral Commissioner. This step was beneficial because it helped in the analysis of the manual system and all the processes that this project seek to computerize.

Further research was made on other existing voting systems via the internet. The problems that were faced in modeling such systems were well noted. Analysis were also made on the benefits that the existing systems had provided communities that had tried such new technology. Systems studied include those that have been used in Estonia, United States and United Kingdom. Some books relevant to the project were also consulted.

#### *F. Project Plan*

In order to make the project scope clear, this section outlines the plan for the system that is to be developed.

- Research on E-Voting
- Comprehensive of study of the development area
- Gathering of project materials
- Development of E-Voting software
- Testing and evaluation of E-Voting software
- System Re-engineering and finalization
- Implementation of E-Voting software
- System adoption and education.

### **III. METHODOGY**

#### *A. Detailed Description of Existing System*

A detailed description of the manual voting system that is being used by the Ablekuma South District Assembly will aid in a proper analysis and a better design of the E-Voting system that is aimed at being developed. As stated in chapter 2, the electoral commission department of the "**Ablekuma South District**" is responsible for the District Level Elections and it practices the following processes to ensure a smooth and fruitful elections. The first process that it undertakers is to make public a "Notice of Elections". The "Notice of Elections" is for the purpose of informing the general public in the assembly about an upcoming District Level Elections. After that has been done, the E.C. publishes another notice called "Notice of Nomination".

The "Notice of Nomination" serves the general public with information about where to get a nomination form, date and time to submit the filled nomination form and the point of submission of the form. The last notice that the Electoral Commission deals with is the "Notice of Poll". It is a notice that introduces the qualified candidates to the general assembly. It aids the assembly members to familiarize themselves with the candidates they are going to vote for. After these notices have been served, the E.C. beings to vigorously prepare for the upcoming elections by further undertaking the following processes;

1. Designing ballot forms for the District Level Elections and making the necessary corrections to ensure accurate information before printing.
2. Printing ballot form for the District Level Elevtions.
3. Preparation of voter's register as well as auditing of the register to ensure accuracy in the system.
4. Gathering of all the electoral materials that will be needed for the smooth run of the elections (ballot box, ink pad, indelible ink, etc.)
5. Training of electoral personnel to administer and supervise the elections.
6. Conducting the elections on the agreed date and in the frame of the time allocated.
7. Checking of voter's eligibility and allowing them to cast their votes.
8. Counting of the votes and declaration of the results at the voting grounds.
9. Declaration of the results to the E.C office by the Returning Office and also to the assembly to finalize and close the electoral process.

**B. Analysis Of Existing System**

**i. System Analysis**

System analysis is an explicit formal inquiry carried out to help one to identify a better course of action and make a better decision. System analysis decomposes a system into its component pieces for the purpose of studying how well those component parts work together and interact. Many system analysis techniques exist that help system analysts and designers to critically analyze systems and solve problems effectively. Pertinent among these techniques include structured analysis, information engineering and object-oriented techniques.

Structured analysis technique focuses on the flow of data through business and software processes. It is a model-driven, process-centered technique used to either analyze an existing system, define business requirements for a new system or both. Structured analysis usually depicts diagrams such as data flow diagrams, task diagrams and structured task. The models are pictures that illustrate the system's component pieces; processes and their associated inputs, outputs and files. Information Engineering (IE) focuses on the structure of stored data in a system. It is a model-driven and data centered, but process-sensitive technique for planning, analyzing, and designing information system. Information Engineering models are pictures that illustrate and synchronize the system's data and process. The data models in information engineering are called Entity Relation Diagram. The process models in IE also use the same data flow diagrams invented for structured analysis. Both IE and structured analysis attempt to synchronize data and process models. Object-oriented analysis is concerned with developing an object-oriented model of application domain. The objects in the model reflect the entities and operations associated with the problem to be solved. Object-oriented analysis technique integrates data and process concerns into constructs called objects. Object-oriented analysis models are pictures that illustrate the system's object from various perspectives such as the structure, behavior and interactions of the object. The system analysis technique applied for this project is the object-oriented analysis. This is due to the following reasons;

- It is a modern system technique
- It eliminates the artificial separation of concerns about data and processes.
- It uses objects, actors and scenarios to visually depict existing system process and technologies. This makes object-oriented analysis easy to understand.

**ii. Structure of Existing System**

The current voting system is the Paper Ballot System. It uses official ballots with the pictures and names of all candidates printed on them. Voters issue their votes by indicating a thumb print in a box next to their candidates of choice in privacy in a private voting box. The voter then drops the completed ballot paper into a sealed ballot box. Voting is conducted within a time frame, thus between 7 am to 6 pm. Votes are counted after 6pm and the results declared. This system entirely takes place in two stages:

- Registration
- Elections and counting of votes

**iii. Registration**

Registration usually takes place ahead of the Election Day. At this period, nomination is open to the general public for interested candidates to file their nomination by filling a nomination form. Upon receiving the completed forms, interested candidates who will respond in the proper way satisfying the nomination requirement will be nominated. At this stage too, voter's registration is open to general public for people who are eighteen years and above and have registered to do so. Upon registration, a voter is issued with a voter's identification card which makes a voter eligible to vote. After the nomination of candidates, the

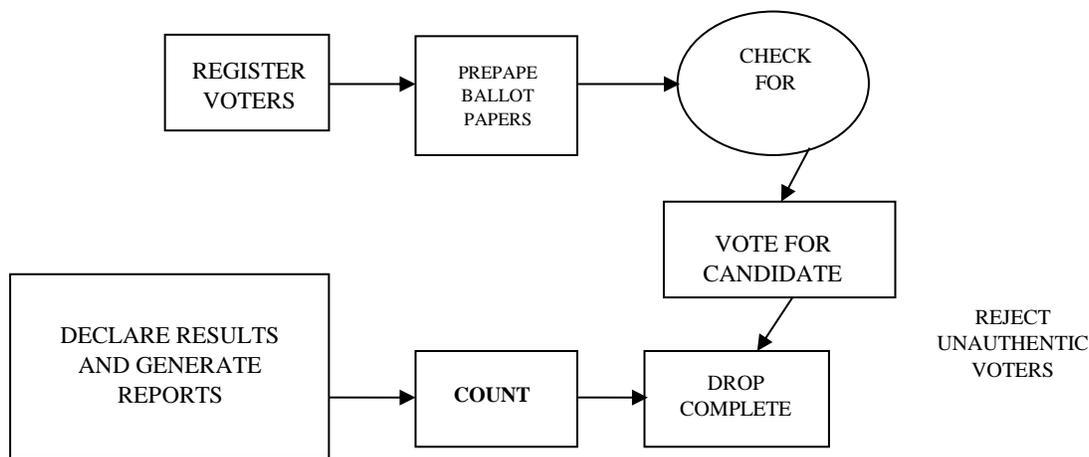
Electoral Commission designs the ballot papers. The ballot paper has the names and pictures of all candidates.

**iv. Elections and Counting of Votes**

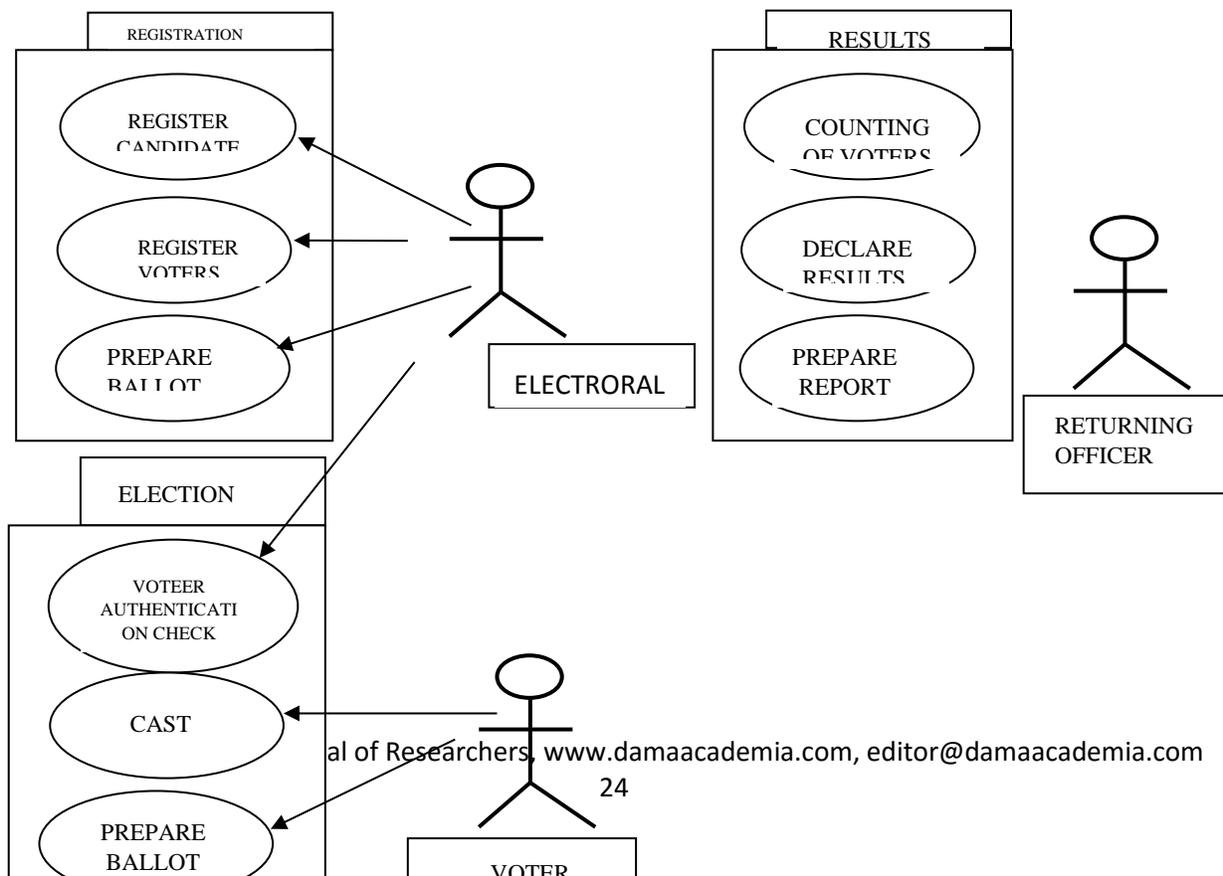
This occurs on the day of elections. On this day the voters go through a routine at the polling station to cast their votes. The voter’s identification card is checked for authentication and eligibility. Eligible voters are issued with ballot papers to cast their votes in privacy and then drop completed ballot paper in a sealed ballot. After the voting processes are over, the election officers and agents count the votes cast to declare the result. The Returning Officer declares the results and sends a report to the District Electoral Commissioner.

**v. Security of Current System**

Security personnel (Police, Army, Fire Service etc....) are normally around to ensure order at the various polling stations.



*Use Case of Current System*



**iv. Requirements**

▪ *Functional Requirements*

- The system must provide voters with accurate data
- The system must ensure voter's secrecy and authentication
- The system must ensure an empty ballot box at the start of voting
- The system must ensure voter is able to verify the vote before it is cast
- The system must verify responsible users ID and location
- The system must provide adequate security
- The system must provide standard error checking
- The system must provide data integrity checks to remains consistent and updated.
- The system must follow technical development standards supported on known operating systems such as Windows, Linux and UNIX.

▪ *Nonfunctional Requirements*

- The system should not allot Election Officials to check results while election is in progress.
- Number of collection failures per voting process must be minimal
- The system should allow adding more voters.
- A process must be devised to support normal precinct business hours
- Due to the shortness of the voting timeframe, the system should support response time for addressing of the serves issues in less than 5 minutes
- The system should provide documentation to inform users of system functionality and any change to the system.

▪ *User Requirements*

- User must be eligible to vote
- User must enter the appropriate ID number and password.
- User must vote once.
- User must submit vote for vote to be counted.

▪ *System Requirements*

- CPU-1.5 GHz Pentium  $\frac{3}{4}$  (512 Kbytes 1.2 cache) or better
- Memory – 256MB or better
- Bus Speed – 330 MHz front side bus
- Monitor – 15” CRT/flat panel (19.0” vis)
- VGA 256Mbytes

▪ *Security Requirements*

- Election process should not be subject to any manipulation including even a single vote manipulation
- The system should provide means for protecting and securing ballots cast in elections
- The system should provide accurate time and date settings
- The system should not allow improper actions by voters and election officials.

### *C. System Design Specifications And Testing Strategy*

#### *i. Systems Design Specifications*

System design in a complementary problem-solving technique that reassembles a system's component place back into a complete system. It specifies a new improved system to replace the existing system. System design focuses on the specification of a detailed computer-based solution. This may involve adding, deleting and changing places relative to the existing system. Many system design techniques exist that help system designers to develop new systems to enhance existing systems. Pertinent among those techniques include modern structured analysis, information engineering and object-oriented techniques. Modern structured design is based on process-oriented technique for breaking up a large programme into a hierarchy of modules that is easier to implement and maintain. A modern structured design technique decomposes the system's processes into manageable components which help system designers to deal with the complexities of programs.

Information Engineering is a model-driven and data centered, but process sensitive technique for planning, analyzing and designing information system. It involves conducting a business area requirements analysis from which information system applications are carved out and prioritized. Object-oriented design is concerned with developing an object-oriented model of a software system to implement the identified requirements. The objects in object –oriented design are related to the solution of the problem. Object-oriented design techniques are used to refine the object requirement definitions identified earlier during analysis and to define design-specific objects.

The system analysis techniques applied for this project is the object-oriented design. This is due to the following reasons:

- Object-oriented design is the newest system design technique.
- It can be used to design a large system
- It uses objects, actors and scenarios to visually depict existing system process and technologies. This makes object-oriented design easy to understand,

#### *ii. Operating System*

The most important system software package for any computer is its operating system. It is the main control program of the computer system. The primary purpose of an operating system is to maximize productivity of computer system by operating it in a more sufficient manner. For many years, Microsoft Disk Operating System (MS-DOS) was the most widely used microcomputer operating system (OS). Currently, there are quite a number of operating system from different vendors available such as Microsoft Soft Windows (MS-Windows 98, 2000, WinMe,NT,XP and Win 7) Solaris 8 UNIX, Linux 6.1 Red Hat, Netware 5.1 Novell. The OS adopted for this project is MS-Windows XP or Win 7. It has improved standards and functionalities to manage computer networks and handle modern programming languages.

#### *iii. Programming Language*

To understand computer software, one needs a basic knowledge of the role programming language play in the development of computer program. Programming language allows a programmer to develop the sets of instructions that constitute a computer program. Programming language has emerged in generations.

Currently, object-oriented programming (OOP) languages are common; this includes C++, Java, and Visual Basic. There are other web-based programming languages such as HTML, XML etc. For the sake of this project Visual Basic was adopted. Visual Basic Programming environment contains all the tools needed to build a powerful program for windows. It performs impressively and it is easy to handle.

**iv. Database Design**

Database design is the process that yield the description of the database structure. The database design process determines the database component. An effective database design is one which has been engineered to meet the actual present and future needs of a company. It contains accurate, vetted data which can withstand rigorous scrutiny. The quest for better data management has led to several different ways of resolving the file system's critical shortcomings. The resulting theoretical database constructs are represented by various database model, some of which are as follows.

Hierarchical database model is based on structure that resembles an upside-down tree in which the trunk sprouts branches that in turn sprouts other branches. The trunk and all of its branches have a one member relationship to the branches that sprout from them. The network database model was created to represent complex data relationship more effectively than the hierarchal model could, to improve database performance, and to impose a database standard. Object-oriented database model reflects a very different way to define and use entities.

It is based on object-oriented concepts and provides support for new user-define data types, inheritance, polymorphism, and encapsulation and so on. Rational database structure stores information about entities, the attributes of those entities, and the relationships among those entities. Rational database model is appropriate for the database modeling of this project. It has improved conceptual simplicity and ad hoc query capability which makes the database very powerful and flexible. It is easy to design, implement, manage and use. The database in the project contains five tables; CandidateList table, VoterList Table, Results Table, and VoterList table.

**v. Normalization of Database Tables**

Normalization is a process for assigning attributes to entities. It reduces data redundancies and by extension helps eliminate data anomalies that results those redundancies. Normalization works through a series of stages called normal form. The first three stages are described as First Normal Form (1NF), Second Normal Form (2NF), and third Normal Form (3NF). For the purpose of this project, 3NF is applied. 3NF contains the features of 1NF and 2NF. It also includes no partial dependencies that is no attribute is dependent on only a portion of the primary key.

Fig. 3.2 (Database Table)

<b>CANDIDATE LIST</b>		<b>VOTER LIST</b>	
C_Name	Text	V_ID	Number
C_Age	Text	V_Name	Text
C_Prof	Text	V_Age	Number
C_Sex	Text	V_Sex	Text
C_Addr	Text	V_Psword	Text
C_Phone	Text		

**RESULTS**

**REPORT**

C_Name	Text	C_Name	Text
V_ID	Number	N_Vote	Text
Time	Date/Time	Percentage	Text

### VOTER LIST

V_ID	Number
V_Psword	Text

#### vi. Structure of the Proposed System

The new system gears towards automating the existing voting system (Paper Ballot System). The new system consists of an administrator interface and a user/voter's interface. The Electoral Officer (Administrator) enters the administrative user name and Password, if the inputs are valid, the Administrator Verification Form is displayed and electoral officer is expected to enter another password and once again the password is valid, the Administrative Right Form is displayed. If a wrong user name or password is entered, a message is displayed asking the administrator to enter the correct user name or password.

The administrative right form has the following buttons;

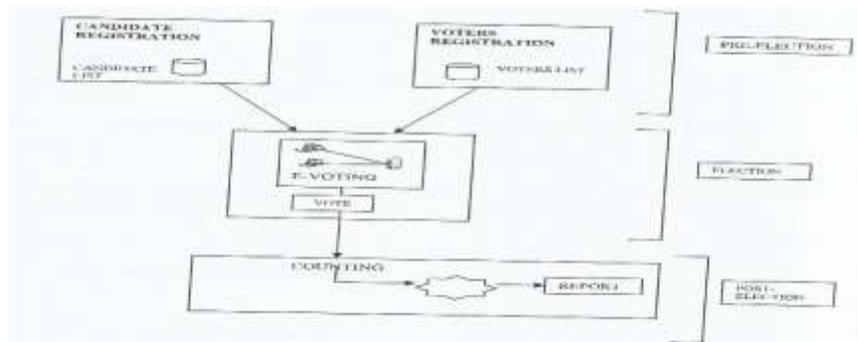
- Register Voters
- Prepare Ballots
- Compile Results

Register voters button displays the registration form which enables the Electoral Officer to register all eligible voters and generate a password for the voters. The records of the voters are stored in the Voters List Table. Prepare ballots button displays the candidate's registration form which enables the Electoral Officer to register candidates. The Electoral Officer enters the required information about the candidate and then clicks on "save" to finally get the candidate registered. The records of the candidates are stored in the Candidate List Table. Based on the number of candidates registered, the system automatically prepares a ballot form.

**Compile Results** button allows the Electoral Officer to compile the results of votes cast at the end of the entire process, recount the votes if necessary and generates a report.

**The Login Form** also allows a voter to log on to the system to cast his/her vote. The voter enters his/her voter's ID number and password. If the entry matches with the records in the Voters List Table, the ballot form is displayed and the voter makes his/her choice of candidate, submits it and then log out.

Fig 3.3 (system Architecture)



The entire system basically consists of three stage;

- Pre-election stage
- Election stage
- Post-election

- **Pre-Election Stage:** Pre-Election stage usually occurs before the day of election.

#### **Use Case 1**

**Actor:** The Election Officer or any one authorized by the Electoral Officer.

**Goal:** To register voters and candidates and prepare ballot form for electoral process.

**Pre-condition:** The process is password protected. The Electoral Officer must enter the right password to have access to the interface.

#### **Scenario:**

- The Election Officer enters a user name and password on the Login Form and signs in
  - If the entries are valid, the Administrator Verification Form is displayed
  - The Electoral Officer enters another password for the system to finally verify the administrator.
  - If the entry is valid, the system displays the Administrative Right form.
  - The Electoral Officer clicks on “Save” to store the record in the Voter List Table.
  - When all eligible voters have been registered, then finalizes the list and then returns to the Administrative Right form.
  - The Electoral Officer clicks on the “Prepare Ballot” button and enters the record in the Candidates List Table.
  - Based on the number candidates registered, the system automatically prepares a ballot form.
  - The Electoral Officer then log out
- **Election Stage:** This is the day of election. The process involves the authentication of the voter and the casting of an individual vote. Before the election begins, the electoral officer sets the date and time within which the electoral process is to last.

#### **Use Case 2**

**Actor:** Eligible Voters

**Goal:** To cast votes in a safe and secure manner.

**Pre-condition:** The process is password protected. The voter must enter the right password to have access to the interface else he/she cannot vote.

#### **Scenario:**

- The voter enters his/her voters ID number and password as issued by electoral officer.
- If the entries are valid, the system performs query check in the “Voted List” table to ensure the voter is not already voted; otherwise a message displays that “sorry you cannot vote twice”
- If the voter is not already voted, the ballot form is displayed and the voter cast his/her vote by clicking in the option button of his/her favorite candidate.
- The voter is allowed to edit his/her votes any number times.
- When the voter is satisfied with the final screen, he/she clicks on “Submit” to finally cast vote.
- If the vote reaches the ballot, a message is displayed that the vote has reached the ballot.
- The voter then clicks on “Done” to log out.

#### **Events**

- Once a voter log out, his voter ID number and password becomes invalid
  - The voter can vote for only one candidate.
  - The system accepts null votes, thus if a voter log in and log out without voting for any candidate.
- **Post – Election:** This stage usually occurs after the election period is elapsed. This is the stage for counting of votes and declaration of final results.

### **Use Case 3**

**Actor:** The Election Officer or any one authorized by the Electoral Officer.

**Goal:** To count votes, declare result and generate reports.

**Pre – condition:** The process is password protected. The Electoral Officer must enter the right password to have access to the interface.

#### **Scenario:**

The Electoral Officer logon to the administrative right form and clicks on “Compile Result”

- i. The results form is displayed and the electoral officer clicks on the “compile” button.
- ii. The system then audit the votes cast and automatically count the votes of each candidate.
- iii. The system publishes the results, both text and graphics (chart) and strikes the percentage of the votes gained by each candidate.
- iv. The votes can be recounted if found necessary
- v. The Election Officer clicks”Report” to generate a report. The Electoral Officer can also click on “Print” to print out the report.
- vi. The returning officer prints out the report appends his/her signature and presents it to the district commissioner (DEC)

#### **vii. Security Of Proposed System**

Electronic voting system represents a great security challenge. The system provides adequate security to protect the system from all forms of fraudulent acts and malicious activities. The overall operation of the voting system must be secured. The system ensures the following security policies;

- *Voter Identification and Confidentiality:* The system ensures that only registered and legitimate voters are able to vote. The system also secures the voter ID numbers and password issued tally with that in the record and performs a query from the audit list to monitor whether a voter has already voted or not before a voter is given access to a ballot form. Every voter is able to vote once. The system also ensures that a vote cast cannot be reviewed by the voter.
- *Accuracy:* The system ensures that cast ballots are counted, and final tally is the correct sum of vote cast. The voting system includes controls that prevent deliberate or accidental attempt to manipulate the system or hamper its operation. The system exhibits zero-tolerance with regards to compromising.

#### **D. System Construction and Testing**

##### **i. System Construction**

System construction is essentially concern with the actual system design, programming and testing. The entire system was basically constructed with a database application and an application program.

##### **ii. System Construction Tools**

Operating system: **Windows XP, Windows 7**

Application Programming: **Visual Basic 6.0**

Database Management System: **Microsoft Access 2003/2007**

##### **iii. Construction Of Database Application**

The database application was constructed by first creating a database and then creating a table within the database. The tables are then indexed and the primary keys and foreign keys are set.

**iv. Construction Of Application Programming**

Microsoft Visual Basic 6.0 programming language was used to design the various interfaces and to code the entire system as well. As a general rule, text boxes, labels, command buttons, option buttons and other properties were selected to design the interface. ADO data control was selected and Open Database Connectivity (ODBC) tools deployed to link up the database to the programming language. Data Report is used to present the report. The components source code was written in such a way that the impact of possible compromise on the component will be subject to efficient security standard. The project was then saved.

**v. System Testing**

System testing is conducted on a complete system to evaluate the system’s compliance with the requirements. System testing is an iterative process that is carried out ensures that an application program written is absolute working properly even when integrated into the total system. Testing is also performed to ensure that the system is responding positively to the required specification. Three levels of testing procedure were performed on this system; stub testing, unit testing, and system testing.

Stub testing was performed on a subset of a program. Unit testing was well performed on an entire program and a system test was performed on an entire system. For the purpose of testing, the following information was fed into the system.

Candidates List					
Name	Age	Profession	Sex	Address	Phone
Ernest Sackey	32	Lawyer	Male	P.O. Box 432 Osu	0277713321
James Saha	26	Footballer	Male	O.O. Box CQ 419, Abetifi	0208673134
Jane Smith	32	Interior Decorator	Female	P.O. Box 3422, Abetifi	0242458765
Kwame Mankah	64	Tailor	Male	P.O. Box 432, Abetifi	0243419491
<b>MansaKwofie</b>	30	Teacher	Male	P.O. Box DC 294 Dansoman	0207120120

*FIG 3.4 (Candidates List)*

**Voters List**

VOTERS ID	VOTERS NAME	AGE	SEX	PASSWORD
0033/03	Ransford Addai	21	Male	Apalapa
0034/03	Kwame Poku	33	Male	Senlor
0035/03	Ben Yamoah	23	Male	Johnl
0055/03	Kwaku Oteng	24	Male	Jllo
0230/05	Tettey Ama	24	Female	NaIna
0494/05	Kwabena Mintah	32	Male	Kllo
3547/04	Adwoa Yeboah	42	Female	Adlyeb
0216/02	Adjei Francis	52	Male	Ajlfra
0463/03	Joyce Osei	34	Female	Joylos
0237/06	Alice Mills	38	Female	Alilms
2270/04	Fidel Botchwey	31	Male	Fd1bot

0051/03	Kojo Frimpong	40	Male	Fr1mkos
4462/04	Addo Ellen	32	Female	E1add
0332/05	Abena Yeboah	52	Female	Ab1yb
Aministrator		-	-	Adm1m
AdminRight		-	-	jesus

#### IV. IMPLEMENTATION & DOCUMENTATION

##### A. Implementation

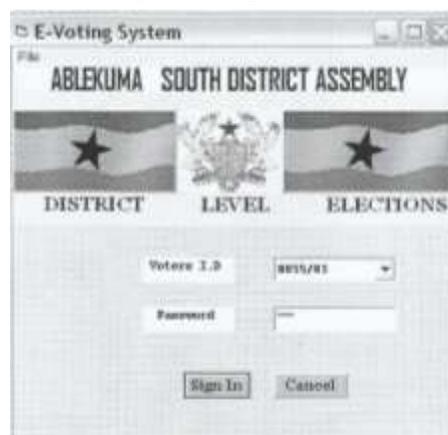
System implementation deals with the installation and delivery of the entire system into production. The E-voting software was installed in 2-tier Client/Server architecture with the help of a network application. The network architecture is protected by firewall and other intrusion detection system. The E-voting system is classified into two separate sections; the Administrators section and the Voters/Users section. It was deemed vigorous that the Administrators section is installed on the server and the voters/users section be installed on the client or workstation to ensure proper functioning and supervision. The administrator section controls the registration, results, and form preparation phase.

It was therefore expedient that this part of the system software should be installed on the server to enable the electoral officer (administrator) appropriately operate this sensitive section of the system. The voter/user section is installed on the client. This enables the voter to sit behind any of the provided clients and vote without any manipulation and intimidation. With this structure of implementation, the voters only partake in the voting process and administrator becomes responsible for controlling the entire operation to ensure a smooth and fraud free voting process. It should also be noted that in the process of implementation all database were installed on the server as a part of the administrative section and this helps the electoral officers to compile the result of the elections. This method of implementation aids in a faster process and also ensures reliability.

##### i. login form

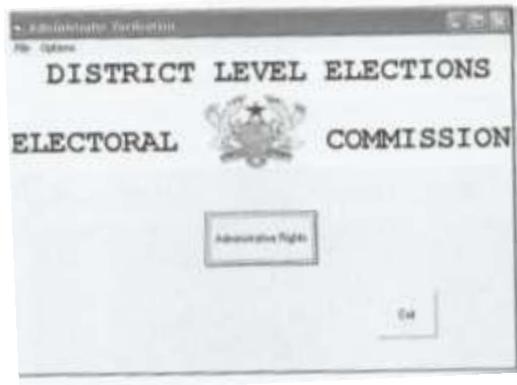
The administrator and voters enter their valid username/voters ID number and password on this form and then click on sign in to enter the next form

Fig. 4.1 (Login Form)



##### ii. Administrative verification form

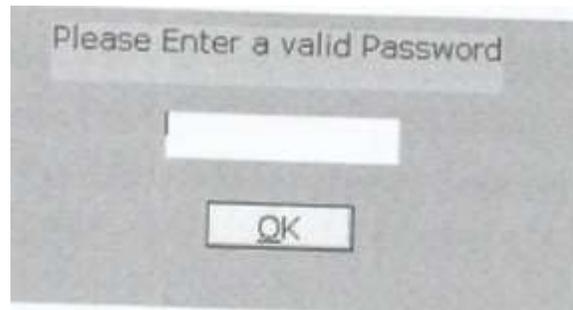
The Administrator clicks on administrative rights to confirm their validity as administrator.



**iii. Password Form**

When the administrator clicks on Administrative Rights, this form pops up for the administrator to enter a valid password and clicks OK.

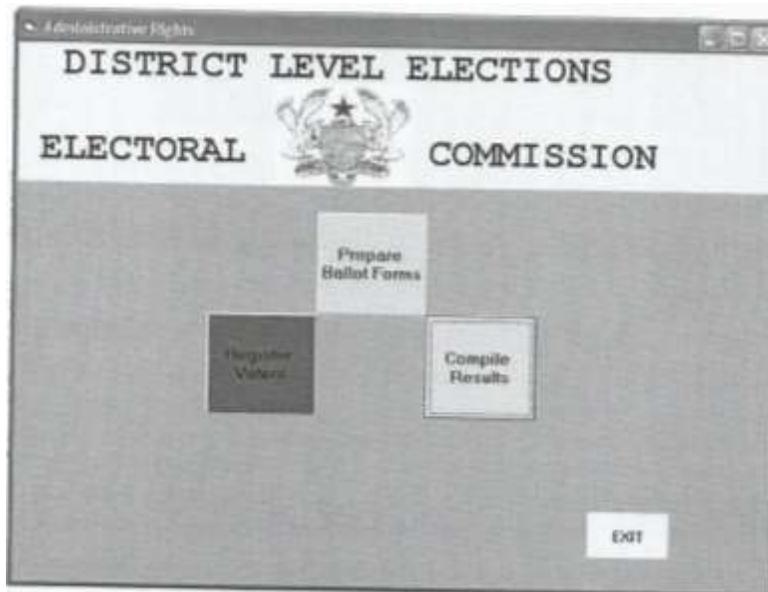
*Fig. 4.3 (Password Form)*



**iv. Administrative right form**

This form is displayed when the administrator enter a valid password on the password form. Register Voters option leads to the Voters Registration Form; prepare Ballots Option leads the Candidate Registration Form and Compile Results Option leads to the Results Form.

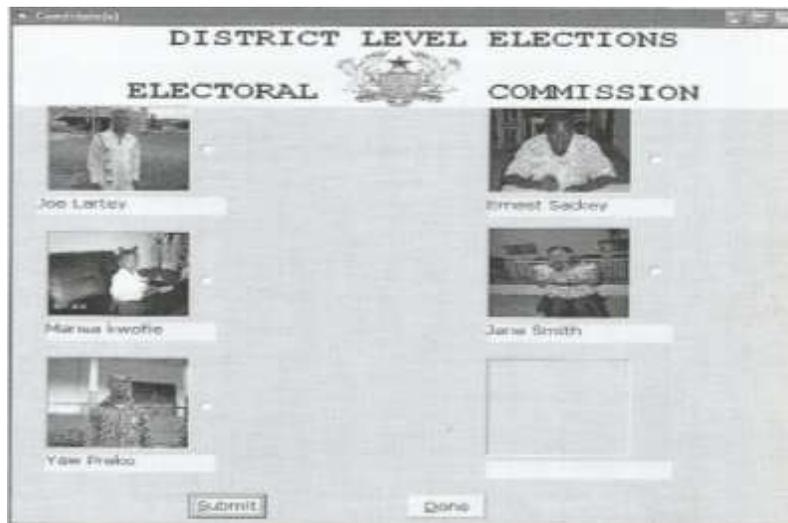
*Fig. 4.4 (Administration Right Form)*



v. **Ballot Form**

This form allows the voter to cast his/her votes. After selecting the preferred candidate, the voter clicks on “Submit” to cast the votes and “Done” to log out.

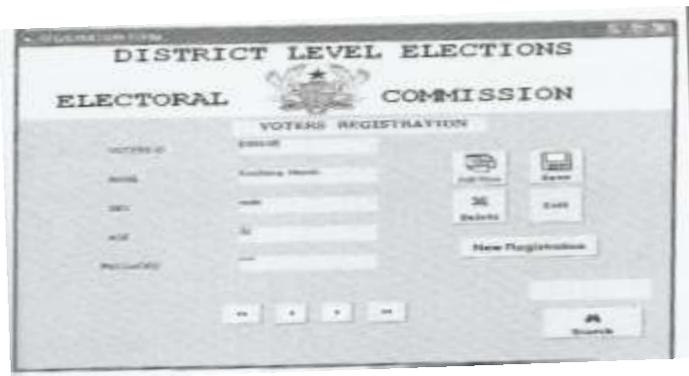
Fig.4.5 (Ballot Form)



vi. **Voters Registration Form**

This form allows the administrator register eligible voters. Add new button allows the administrator to register new voters. Save button allows administrator save voters records in the database. Delete button allows the administrator to delete records in the database. Exit button returns the login form. Search button allows the administrator to search for records in the database. The Previous and Next buttons allow the administrator to check and explore records in the database.

Fig. 4.6 (Voters Registration Form)



vii. **Candidates Registration Form**

This form allows the administrator to register candidates. Add new button allows the administrator to register new voters. Save button allows administrator to save voters records in the database. Delete button allows the administrator to delete records in the database. Exit button returns the login form. Search button allows the administrator to search for records in the database. The previous and next buttons allows the administrator to check and explore records in the database. New registration button allows the administrator clear all registered candidates for a new set of candidate.

Fig. 4.7 (Candidate Registration Form)



- **Software Requirement**
  - Windows advance server 2003
  - Windows XP/Windows 7
  - Microsoft Office 2003/2007
  - Visual basic 6.0
  
- **Hardware Requirement**
  - Server
  - Workstation(s)
  - Networking cable
  - Switch

## **B. Documentation**

This entails the user manual of the system software

### **i. Voters Section**

Enter voter ID number and password and click on “Sign in “when the ballot form is displayed, click in the option button of your favorite candidate.

- Click on “Submit” to cast your vote.
- Then click on “Done” to log out.

### **ii. Administrator Section**

Select “Administrator” in the combo and enter password.

Click on “Sign In”

- The Administrator Verification form appears. Click “Administrative Right”.
- Enter the password and click “Ok” on the form that appears.
- The administrator right form appears. Click on the option you wish to operate.

## **Options**

### **▪ Register Voter**

- i.* Enter records of voters
- ii.* Click on “Add New” to add a new record
- iii.* Click on “Save” to save records entered
- iv.* Click on “Delete” to delete records from the database
- v.* Click on “search” to search for records in the database

### **▪ Prepare Ballot**

- i.* Enter records of candidates
- ii.* Click on “Load Picture” and select the picture of a candidate.
- iii.* Click on “Add New” to add a new record
- iv.* Click on “Save” to save records entered
- v.* Click on “Delete” to delete records from the database
- vi.* Click on “Cancel” to cancel the operation

### **▪ Compile Result**

- i.* Click on “Compile” to compute and display results of election voter turnover
- ii.* Click on “Report” to display report
- iii.* Click on “Exit” to end the operation

## **C. Organization and Implementation Issues**

Since E-voting is a new technology that is yet to be embraced by society, it is important to note that there are several issues both technical and policy related that must be resolved before E-Voting is publicly accepted. Strong technological methods must be employed to establish reliability and public confidence in E-Voting system. Voters must be educated thoroughly on the operation and flexibility of the E-Voting system. The environment for the voting process must be favorable and secured.

Clients/workstations must under good supervision to prevent any form of exploitation. The voting environment must also ensure privacy for voters, because it is essential for voters to cast their votes in secrecy. Auditing and counting of votes must be very carefully controlled to prevent errors and disorder. There should be robust security policies to deal with possible threats and harass. Computer systems and

hardware components to be used for the elections must be of high quality and In good condition. The network should also be well constructed to ensure a smooth election process. Antivirus, firewall and other software protective and security measures should be employed to protect the software and network applications

## **V. CONCLUSION**

### *A. Summary of Findings*

On testing the system software, it was realized that it functions accurately. It executes the data inputs, and outputs precise value and results of the data input. The database tables are able to store data efficiently. It was also realized that the system has adequate security functions though higher function can be included for better functioning of the entire system.

### *B. Conclusion*

Due to the increase reliance on modern technology, it is inevitable that e-voting will ultimately replace the traditional manual voting system. The nervous process that voters have to through is minimized considerably and security issues are greatly improved. This indicates the efficiency and reliability of the new voting system. E-voting also attempts to balance accuracy of results to privacy of voters.

The design of the District Assembly E-Voting system has been presented and the vital components and mechanisms need to develop the system are well described. Essential functional requirements, that lay basis for the system design phase, have been stated. These were supported by nonfunctional requirements including security requirements.

Although there is potential for misuse in voting systems used to date, E-Voting system possess characteristics that expose them to significant risks above and beyond these other voting systems. While there is also potential for substantial new benefit to be derived from E-Voting systems, it remains to be seen whether the benefits outweigh the risks.

It is our belief that E-Voting system will reinstate existing voting system which jeopardize democracy and disappoint voters.

### *C. Suggestion for Business Decision Making*

The E-Voting system software can extended to the national level for presidential and parliamentary election. It can also be extended to other institutions.

### *D. Problems, Limitations, Future Research Possibility.*

#### **a. Problems**

The following problems were realized after the development and implementation of the E-Voting system software;

- i. It is generally accepted that tampering is possible with any computer system given enough time and resources. Therefore, the security measures employed may have a propensity of being intruded. Substantial additional security measures are still needed to make the system trustworthy.
- ii. Frauds and tampering of the e-voting system software may not be detected by the electoral officers.
- iii. Mechanisms and functionalities for recovering damaged information is another complicating problem. There are no measures for retrieving lost or damaged information.

- iv. The level of computer literacy in the Ablekuma South District Assembly is extremely low. Therefore the use of the e-voting system software is likely to be difficult and may take some years before the system will be fully utilized.
- v. Some villages do not have access to electricity and therefore installing the computer system for operation may be a problem. Building a network for the system in the district may also be a problem.

***b. Limitation***

- i. The system cannot obtain more than six candidates
- ii. The system does not fully embrace all the information about candidates. Example, the eighteen endorsers of every candidates is not recorded by the system.
- iii. The aspect of the voting procedure is still operated manually.
- iv. The system does make room for referendums and recounting.

***c. Future Research Possibilities***

Elections are at the heart of the democratic form of government, and providing sufficient security for them is therefore critical to the proper functioning of a democracy. Therefore, additional security measures to strengthen the reliability of the system are very essential. Data recovery and backup system for the voting procedure must be considered. More graphics and animations can also be added to improve the aesthetic features of the system. The system and re-design to include recount function and embrace other important records. Computer education should be encouraged in the district. The E-Voting system software should also be geared towards the national level for presidential and parliamentary election in Ghana.

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