

A MOBILE APPLICATION FOR ELECTRONIC VOTING (e-Voting)

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Abstract

Electronic voting is the process of casting votes in an election using electronic means. With the increase in the rate of development of ICT infrastructures across the globe, there arises a need to migrate from the conventional and traditional means of voting through ballot papers to the electronic style. The traditional means of voting has a lot of challenges such as; it is prone to rigging, it requires more human resources, it is less secured as it puts more lives at risk in a bid to monitor it. Thus, there arises the need to gradually move to electronic voting with a lot of emphasis on applying mobile devices since there are lots of it, and since it allows people to do things on the move.

In this work, a mobile application that can allow for electronic voting through mobile devices was developed. The application was developed using the .NET framework (C sharp programming language), and MySQL server was used as the database end. The developed system was deployed and tested using the Windows phone emulator (version 7). The application allows the user to log-in to the electoral commissions voting platform after due registration, cast their votes and it also guides against multiple voting for a particular election category.

Keywords: e-Voting, Mobile application, ICT, .NET.

1.0 Introduction

In recent times, the proliferation of Information and Communication Technologies (ICT) has affected and impacted every facet of human existence. From banking to commerce and even education, ICT has been applied to enhance human activities worldwide. The use of mobile devices (e.g. Phones, PDA's, Tablets e.t.c.) stands out among the emerging ICT technologies. This is because human beings are nomadic in nature (i.e. they move from place to place), and also due to the fact that mobile devices require little expertise to use. A recent research reported that there are over 6 billion mobile phones on planet earth today. Thus, applications that would reach the entire human race must be extended to mobile devices.

The economic and social growth of a country is largely dependent on how well the government manages the resources and the infrastructures available to such country. Governmental excellence however cannot be divorced from the process through which government officials come into power. With the advent of democratic rule in most nations of the world, the process of electing public office holders becomes a very important issue.

However, ICT can also be positively used to impact electoral processes in these countries. This concern is what has given rise to the deployment of e-Voting (electronic voting), which involves the deployment of ICT related technologies in the electoral process. While modern societies fully rely on ICT for business, work and leisure time activities; the use of ICT for democratic decision making is still in its infancy (Ghassan, 2005).

Electronic voting was recently introduced as a complementary channel for elections and referenda, with great success (Gaston, 2005). One of the reasons might be that remote voting was largely practiced through postal voting for many years. The introduction of Mobile Internet voting came as an alternative and easier way to vote remotely and thus was rapidly accepted.

On the other hand, (Neumann, 2006) suggests that the computer science community seems almost unanimously wary of attempts to enable elections via the Internet. Clearly, electronic voting (e-voting) has a high potential for reliable and secure vote casting, precise vote counting and rapid result dissemination.

Krimmer (2006) stated that countries all over the world are examining e-voting, for it has some striking advantage over the traditional paper voting, including security for casting votes, accuracy of counting and analyzing votes, options to conduct voting in a centralized manner, etc. The reasons why the e-voting technology has not matured to equivalent levels as known for business and leisure time activities lies mostly in an inherent lack of trust and fear of electronic threats. While most countries are still conceptualizing or testing e-voting systems, three cantons in Switzerland have pioneered the development of e-voting to its full technological maturity.

2.0 Voting

Democracy and voting are inseparable and because the majority opinion determines the outcome of an election or policy, voting is by far the most important means in democratic decision-making. Although numerous voting methods have been implemented since the dawn of democracy, a certain degree of trial and error could always be expected according to which voting method was used. Voting and elections are essential ingredients of modern democratic societies. Unlike any other transactional event, the result of elections can have many effects on societies and their economic and financial well being. Recent elections have seen a gradual decline in the overall percentage of the electorate exercising their right to vote. This is worrying from a democratic point of view in that, if the reasons of the decline are left unchecked, the mandate of those elected to hold the positions might eventually be questionable. Moreover, it is interesting to note here that traditional/manual voting systems are slow, complex, inaccurate and inefficient (Ghassan, 2005).

To counter these drawbacks, Governments have proposed a number of possible methods for re-engaging the electorate in the voting process. One of these methods is the modernization of the way in which the elections are being conducted. These methods include the use of electronic voting (e-Voting) as a new and modernized way to carry out the election process. E-Voting extends polling hours (anytime voting) and enables casting of votes from any place (anywhere voting) using different electronic means (any device voting) such as mobile devices and Internet-based voting.

2.1 Conventional or Traditional Voting System

The conventional method of voting – which has been in existence for a long time – involves the use of ballot papers and ballot boxes. Registered voters queue at designated

polling booths to cast their votes by ticking or thumb printing on designated spaces on the ballot papers. After doing so, they cast their votes into ballot boxes which are usually made of various materials such as wood, metal, rubber e.t.c. These ballot boxes are then took to counting centers where their contents are emptied to commence counting and collation before final results are arrived at.

The biggest problem with the conventional voting method was in the most significant loss in terms of manpower, time, and money. In addition, there is a great deal of dispute as to the validity of the votes cast and especially, there is a significant loss of time till the ballot counting. To prevent this from recurring, a new legislation is in the making for introducing new voting procedures and methods (Dary, 2004). Voting is a vital part of the democratic process. As such, the efficiency, reliability, and security of the technologies involved are critical. Traditional voting technologies include hand-counted paper ballots (Kumar et al, 2007). These paper-based systems can result in a number of problems, including:

- ❖ Unacceptable percentages of lost, stolen, or miscounted ballots.
- ❖ Votes lost through unclear or invalid ballot marks.
- ❖ Limited accommodations for people with disabilities.

2.2 Electronic Voting (e-Voting) System

The term “e-Voting” is defined as the process of casting votes in an election using electronic means. It involves a System, where voters can cast their votes anytime, anywhere and using a number of electronic devices including Web and mobile phones (Ghassan, 2005). Electronic voting refers to the use of computers or computerized voting equipment to cast ballots in an election. Sometimes, this term is used more specifically to refer to voting that takes place over the Internet. Electronic systems can be used to register voters, tally ballots, and record votes (Lorrie, 2001).

The main principle of e-voting is that it must be as similar to regular voting as possible and compliant with election legislation and principles. E-voting should offer the same level of security and confidence as traditional voting. Therefore according to the electoral laws e-voting must be uniform and secret, only eligible persons must be allowed to vote, every voter should be able to cast only one vote, a voter must not be able to prove in favour of whom he/she voted. At last, the collecting of votes must be secure, reliable and accountable. From a technical point of view the e-voting system must be as simple as possible as well as transparent so that a wide range of specialists would be able to audit it (CETD, 2010). The e-voting system must be reusable in a way that developing a new system for the next voting is not needed.

2.2.1 Evaluation of Electronic Voting System

The lack of trust in ICTs and the Internet affects very seriously any effort to migrate from the conventional and long established voting procedures to an electronic voting system, since voting is a fundamental process in any democracy. Moreover, the abundance of cases of misconduct in electronic voting has resulted in severe decrease of trust among citizens (SIOE, 2004). However, e-voting, despite the critique, seems to be, still, a hot discussion issue and, possibly, a worldwide reality in the future.

According to the above, any successful e-voting system should target at increasing citizen's trust. Trust, however, is difficult to establish in the e-voting domain since e-voting is

necessarily based on complex distributed information systems, involving complicated interactions between computers, between humans, and between humans and computers. Since trust, as people's attitude, plays a major role in the way people view and use information systems, lack of trust renders even expensive and sophisticated information systems completely useless. In most of the information systems that deliver e-services, trust is based not on some publicly available systematic design process, but rather on the reputation of the system's implementer (e.g. a well-known company) and operator (e.g. the government).

On the other hand, trust is a hard to formalize concept that also raises philosophical and social (i.e. non-engineering) concerns. For instance, Luhmann in 2000 considered trust as a mechanism which causes the reduction of complexity (Luhmann, 2000). Also, Coleman distinguishes certain elements that define a trust situation between a trustor and a trustee. By definition a voting procedure is a trust situation, and in this case trust properties have to be reflected both on individual and system level, independently of the voluntary, custom/norm based, institutional or obtruded nature of the procedure (Coleman, 1990). Trust is an emergent social property based on interactions between actors and for this reason, an e-voting procedure could, in principle, be established, if and only if, actors are convinced that it complies with certain trust properties.

2.2.2 Benefits of Electronic Voting

E-voting systems offer multiple advantages over traditional paper-based voting systems- advantages that increase citizen access to democratic processes and encourage participation (Kumar et al, 2007).

- ❖ **Reduced costs** - E-voting systems reduce the materials required for printing and distributing ballots. Internet based voting, in particular, offers superior economies of scale in regard to the size of the electoral roll.
- ❖ **Increased participation and voting options** - E-voting offers increased convenience to the voter, encourages more voters to cast their votes remotely (Kumar et al, 2007), and increases the likelihood of participation for mobile voters. Additionally, it permits access to more information regarding voting options.
- ❖ **Greater speed and accuracy placing and tallying votes** -E-voting's step-by-step processes help minimize the number of miscast votes. The electronic gathering and counting of ballots reduces the amount of time spent tallying votes and delivering results.
- ❖ **Greater accessibility for the disabled** - Because they support a variety of interfaces and accessibility features, e-voting systems allow citizens with disabilities-especially the visually impaired-to vote independently and privately (CETD, 2010).
- ❖ **Flexibility** - E-voting can support multiple languages, and the flexible design allows up-to-the-minute ballot modifications.

2.3 Mobile Technology

Mobile technology is evolving at such a rapid pace that new doors have been opened in the field of mobility and wireless applications. During the last few years, as the internet and mobile wireless telephony exploded into public consciences, a number of e – terms began to appear and proliferate. The terms were useful, e-mail and mobile web application brought new possibilities for people to communicate rapidly and share experiences; e –

commerce proposed new ways to conduct business and financial transactions through the internet (Adigun, 2007). The introduction of mobile e-voting represented the promise of information and communication technologies to improve electoral system.

2.3.1 GSM Technology

GSM is widely deployed and is a growing technology supporting a number of new applications being used for it (Vijay, 1999). GSM is a digital cellular radio system that operates on two frequency bands 900 and 1800 MHz. It is a European standard but now has been globally accepted, that reduces the cost of manufacturing and increases the market target (Siegmond, 1995). Standardization is still evolving and up to so far has had two phases 1 and 2. This evolution has achieved higher operational boundaries to what was expected at the birth of the technology. Some of the expected features of the system as mentioned in (Siegmond, 1995) are:

- High audio quality and integrity
- High level of security- preventing fraud and boasting confidentiality
- International and intersystem roaming
- Low cost infrastructure and ability to integrate with existing infrastructure

2.3.2 Security Features in GSM

GSM is a digital wireless network standard widely used in European and Asian countries. It provides a common set of compatible services and capabilities to all GSM mobile users. The services and security features to subscribers are subscriber identity confidentiality, subscriber identity authentication, and user data confidentiality on physical connections, connectionless user data confidentiality and signaling information element confidentiality (Kumar et al, 2007). They are summarized as follows:

- ❖ Subscriber identity confidentiality is the property that the subscriber's real identity remains secret by protecting his International Mobile Subscriber Identity (IMSI), which is an internal subscriber identity used only by the network, and using only temporary identities for visited networks.
- ❖ Subscriber identity authentication is the property that ensures that the mobile subscriber who is accessing the network or using the service is the one claimed. This feature is to protect the network against unauthorized use.
- ❖ Data confidentiality is the property that the user information and signaling data is not disclosed to unauthorized individuals, entities or processes. This feature is to ensure the privacy of the user information.

Fraud and breaking the network is common in the telecommunications industry, particularly in the analog world. The security affects both the service provide as well as the end user. The provider has to be sure that the mobile requesting service has a right to do so and its identity is as claimed; if not so, it should not authenticate it to use the network (Vijay, 1999). The user on the other hand wants to connect to the network but not compromise his/her privacy. Therefore encryption of data is needed to avoid hacking the system. The GSM system has adopted three encryption algorithms, namely, Authentication algorithm (A3), Privacy key generation algorithm (A8) and Encryption algorithm (A5) (Chan, 2005).

This high level of security in GSM virtually is of interest when confidential information has to be transmitted across the air interface for industrial purposes. The ease of interfacing the phone with systems has been thought as the better way of

communicating with a machine or any other application. In GSM mobile voting scheme, communication between the mobile equipment and the GSM network uses standard GSM technology (Kumar et al, 2007). Hence GSM security features apply. Among which, the subscriber identity authentication feature is particularly used in the protocol.

3.0 Methodology

This work aims to develop a mobile application that can be used for electronic voting. It is assumed that voters have successfully registered with the electoral commission, after which they now are given access to download the application to their mobile device. The developed application is then used to connect to the electoral commission's server, and then votes are casted appropriately. This therefore makes the design of the application as well as the overall work simplified, since it is assumed that the voters have already registered with the electoral commission. The application developed in this work was deployed using a Windows Phone 7 emulator. This helped to display the functionality of the application. The design of this application is premised on the fact that a voter has been made eligible by the electoral commission during the registration and verification process.

After a successful registration, the voters who desire to vote electronically are given a code which they can use to download the application either from the electoral commission's site, or from a commercial app store (e.g. iTunes, Blackberry app world, Windows app Store e.t.c.). The prototyped application developed in this work can actually be deployed fully and made available on other mobile platforms and their corresponding app stores as customized commercial applications. Figures 1 and 2 show the flowchart and Class diagram for the design of the application.

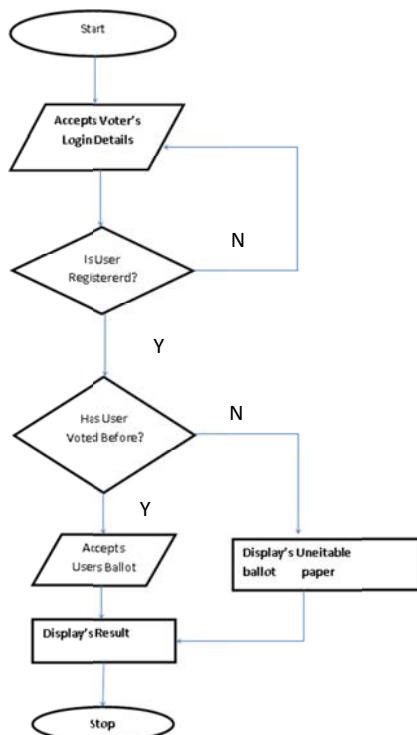


Figure 1: Figure showing the flowchart for the application development

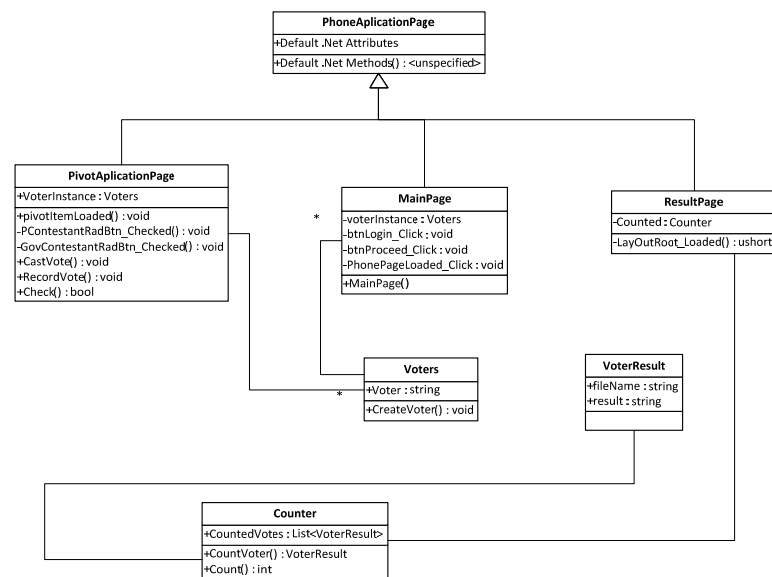


Figure 2: Figure showing the Class diagram for the application development

3.1 Development Tools

The development phase of this work was carried out using the .NET Framework (C Sharp Programming Language). The database was designed using MySQL Server DBMS. Microsoft's .NET Framework is a new computing platform built with the internet in mind, but without sacrificing the traditional desktop application platform. .NET is a collection that works together in a framework to provide the solutions that are needed to easily build and deploy truly robust enterprise applications. These .NET applications are also able to easily communicate with one another and provide information and application logic, regardless of platforms and languages.

The framework sits on the Operating System. Examples of Operating Systems that are currently compatible with .NET are; Windows XP, Windows 2000, Windows NT, Windows Vista and Windows 7. At the base of the .NET Framework is the Common Language Runtime (CLR). The CLR is the engine that manages the execution of the code. The next layer up is the .NET Framework Base Classes. This layer contains classes, value types, and interfaces that are often used the development process. Most notably within the .NET Framework Base Classes is ADO.NET, which provides access to and management of data. The third layer of the framework is ASP.NET and Windows Forms. The ASP.NET section of the .NET Framework is also where the XML Web services model resides.

The application – after it was developed – was deployed and tested using the windows phone emulator version 7. This application would have been given a real life implementation if a windows Smartphone was acquired, and the application was then transferred to the windows application market. It would have been possible for voters to download it from the marketplace onto their devices. However, the emulator was used in this work since the real life implementation was not carried out in this work. Thus, the application developed in this work is restricted to the windows mobile platform, but can still be extended to other common platforms like the blackberry, Android and apple.

4.0 Result and Discussion

The implementation of this work was done using Microsoft Visual Studio 2010 Integrated Development Environment (IDE). Visual Studio .NET is Microsoft's IDE for creating, documenting, running and debugging programs written in a variety of .NET programming languages. Visual Studio .NET also offers editing tools for manipulating several types of files .NET is the Microsoft Web services strategy to connect information, people, systems, and devices through software. Integrated across the Microsoft platform, .NET technology provides the ability to quickly build, deploy, manage, and use connected, security-enhanced solutions with Web services.

.NET-connected solutions enable heterogeneous systems to integrate more rapidly and in a more agile manner and help them to realize the promise of information anytime, anywhere, on any device. .NET is not just about easy-to implement components. .NET applications run under the control of a runtime called the common language runtime (CLR). CLR compiles all code at execution time, it implements strict type checking. Errors such as unsafe casting of one object type to another, addressing an array of bounds, or writing past the end of a buffer are just not possible. The common language runtime also manages security, allowing much finer control over the functions that a piece of code is allowed to perform and the resources it may access. The development and deployment of this work was carried out on a HP 630 Laptop Computer with the following specifications;

- 500 Gigabytes Hard disk
- 4 Gigabytes RAM (Random Access Memory)
- 4 Gigahertz Processor Speed (Intel Pentium Dual Core)
- A 64-bit Operating System (Windows 7)

The application developed in this work was developed based on certain assumptions as well as considering a typical election scenario. The first part of the application is the log-in part. Here, users of the application log-in into it on their mobile devices. Their default username and password is that given to them upon downloading the application either from the electoral commission's site or from the commercial application marketplace. The moment a user types in the unique ID he/she receives upon downloading the application into the log-in page, it automatically displays he user's name and image as earlier captured during registration. Figures 3 and 4 show the log-in side of the application.



Figure 3: Figure showing the log-in Page of the application

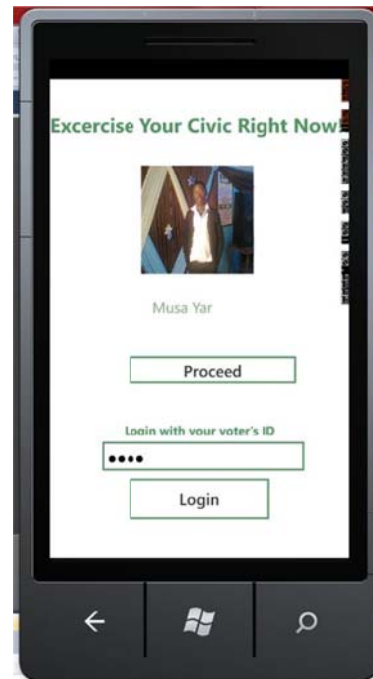


Figure 4: Figure showing a voters picture and name after logging in.

After a successful log-in has been done, the user can then proceed to cast their votes. At this juncture, the application displays the list of contestants for each election category so that voters can choose one person they want to vote for. The application would not allow more than one vote for a particular election category. Figures 5 to 10 capture these actions.

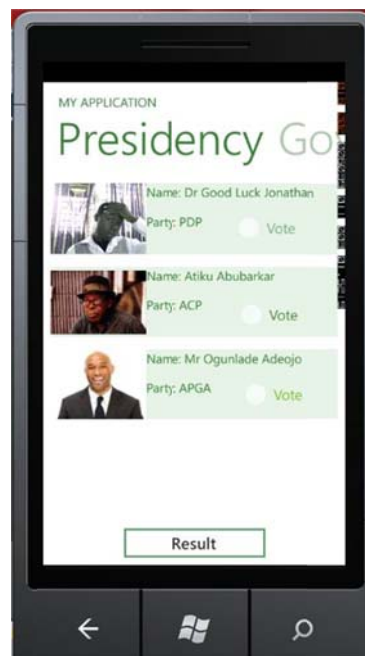
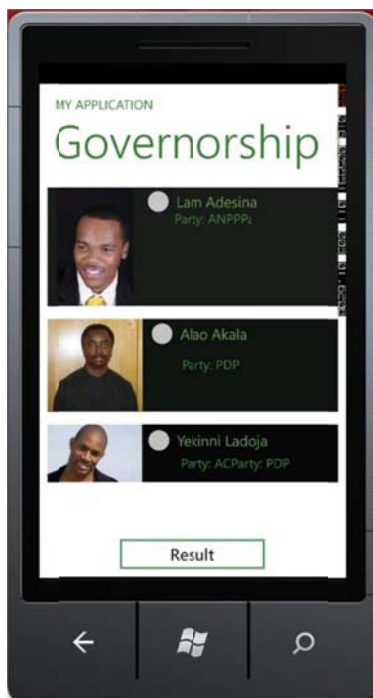


Figure 5: Figure showing the list and Pictures of Governorship election aspirants.

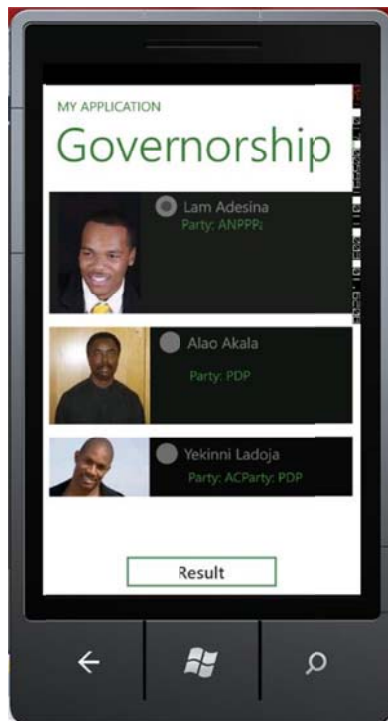


Figure 6: Figure showing the list and pictures of presidential election aspirants

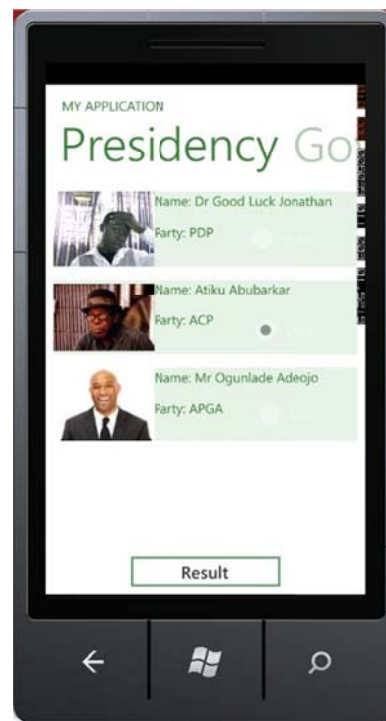


Figure 7 Governorship election vote casted by a voter

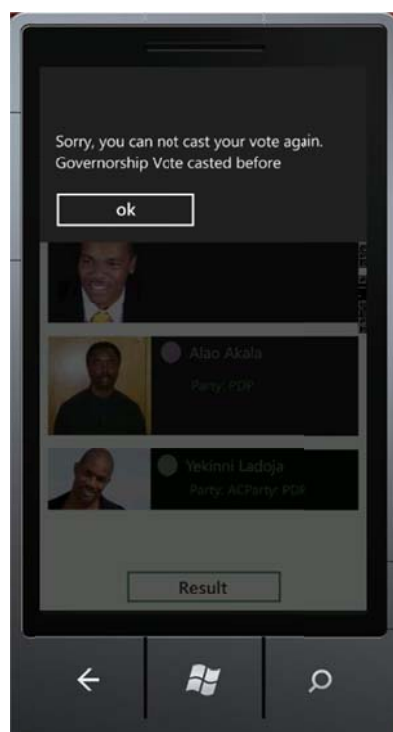


Figure 8: Presidential election vote casted by a voter

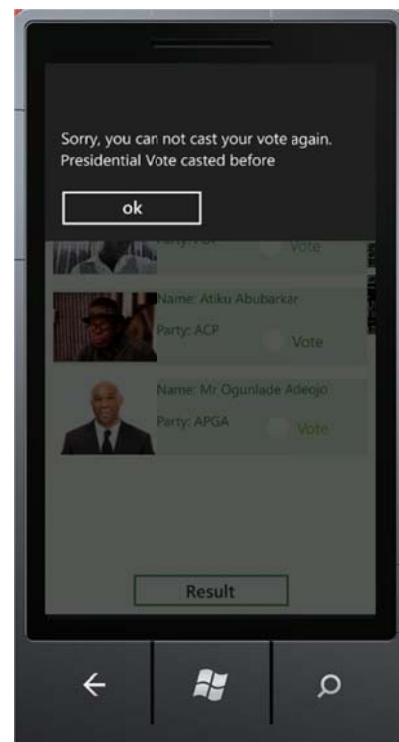


Figure 9: A prompt dis-allowing the user from voting twice during the Governorship election

Figure 10: A prompt dis-allowing the user from voting twice during the Presidential election

The final part of this work has to do with the display of the result. After each election has been conducted, the application can view the election result as soon as it is published or released by the electoral commission. Figure 11 captures the result page of the application.



Figure 11: The result page of the application

5.0 Conclusion and Recommendations

This work presents the development of a Mobile application for electronic voting. The application developed in this system tried to circumvent the challenges attached to the conventional way of voting. It was designed on the assumption that the users have been registered and authenticated by the electoral commission. The coding was done from scratch using the .NET Framework (C Sharp Programming Language) as the frontend and MySQL Server as the database backend. The developed application was deployed and tested using the Windows phone emulator (version 7).

In lieu of the insights gathered from embarking on this work as well as considering the rate of proliferation of ICT infrastructures (especially mobile devices) in this present age, the following recommendations are put forward;

- Further work should be done by the academia and industry to make available standard electronic voting applications that can run on most common and widely used mobile platforms
- The Government of developing countries should embrace electronic voting at different levels of their democratic development.

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