(RESEARCH ARTICLE)

# Implementation of interactive voice response voting system using wireless communication

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## Abstract

Recently, information technology has greatly impacted positively in all aspects of life, which actually with proven facts to a large extent, includes politics. The most recent method which is being adopted is the electronic voting (E-voting) system which is based on the use of mobile phone by the voters. To develop more on the electronic voting system, a secured and reliable e-voting system was put in place. This system protects the privacy of the voter, which is user friendly and can be used anywhere in the world with internet coverage during the time of election. A voice interactive voting system using the global system mobile device was developed with implementation of a dual tone multiple frequency (DTMF) decoder which makes the whole system interactive. The method adopted in this research work was the use of a program written in c-language and a microcontroller to control the whole process of voting based on DTMF technology. This method was use to overcome the problem involve in the use of paper ballots. This development came about as a result of the outcome of a study of the electoral process carried out in the electoral commission of Nigeria. Two data-bases would be created by the database administrator; the first is to keep a record of the voter's information and the second database will have information about the election parties.

**Keywords:** Accreditation; Database; Electronic Voting Machine (Evm); Validation; Mobile Phone

## 1. Introduction

The Nigerian electoral process involves the following order; the constitution of the voter register, validation of the register and the elections.The presidential election which took place in 1979 and the general elections which took place in 1983, 1999, April/May 2003 and 14 April 2007 which involves the use of electronic voting machines, all witnessed violence and all election results were contested in court [1], even the March/April 2011 general election was full of irregularities as proclaimed by the citizens [1].The general election that took place in March/April 2015 was 50% free and fair due to the use of biometric device but stealing of ballot boxes was not left out but to a minimal level. The 2019 general election in Nigeria was categorised as one of the most violent post-electoral processes ever witness in the history of the country, as more than 70 persons lost the lives during and after the exercise. Beside the loss of lives recording during and after the general election, there was snatching of ballot boxes, burning of properties including the

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Independent National Electoral Commission offices [2]. Political support, wealth and influence were acquired by politicians across Nigeria through the use of all manners of electoral violence and irregularities. Killing, rioting and stealing of ballot papers and boxes and destruction of properties were eminent. A number of the electoral verdicts were rescinded in view of evidence that results were falsified. This was as a result that the electoral system was not air- tight and reliable. There was annulment of 1992 presidential election results by the military government of General Ibrahim Babangida claiming electoral fraud, also the results of the June 1993 elections were annulled gain on June 12, 1993, thus depriving the great winner Chief Moshood Abiola of the blessed memory, the mandate of the people[3]. In some parts of the country (Nigeria) due to the nature of the terrain, which makes it especially in the South-South region, it was difficult for INEC (Independent National Electoral Commission) to carry electoral materials to these areas[3]. To put an end to these problems of election malpractices, irregularities, inaccessible areas and violence in Nigeria, we proposed a voice interactive electoral system based on wireless communication which was as a result of the development of electronic voting. This system is different from commercially available electronics voting systems. The implementation in Nigeria is feasible and other part of the world.

## 2. Related works

The first electronic based voting system which was held in Indian, using electronic voting machines, was held between April 20 to May 10 2004,[4].The electronic voting machines are a reusable carry pack which can operate on battery power source in remote areas. Each electronic voting machine can record nearly 3,000 votes in a polling unit in a day, but there is still the limitation of the polling officers to be present at the polling unit for voters to be able to cast their votes and this can lead to a long queue in a polling unit. Brazilian government converted to fully electronic voting and deployed over 400,000 kiosk-style machines in elections in year 2000, the voting machines feature an integrated screen and keyboard. The voting machine, produces both digital and printed reports of the number of votes given to each candidate, but these electronic voting systems was a paper-trail machine [5]. In May, 2002, the UK (United Kingdom) launched Electronic Voting Machine (EVM), testing for various technology improvements on voting or counting votes, which involves touch-screen voting machines, while others tested remote voting techniques, some jurisdictions authorized electors to vote using electronic methods, such as interactive voice response (IVR), computerized systems, and portable mobile devices using the Short Message Service (SMS). Some of these jurisdictions allowed electors to vote using personal computers or kiosks in public places like shopping malls. Based on the report of the Electoral Commission in UK on the review of electronic voting tests, it was observed that the hardware and software functioned well and without significant problems. It also found no evidence of fraud during the pilot projects, although he expressed concerns regarding potential security and privacy breaches [6,7], Future research on e-voting in developing countries should be focused on drawing the holistic image of reciprocal relationships between social and technical aspects of the technology, also, future studies must perceive e-voting not as a mere technological means but rather as a complex socio-technical agent that plays an important role in social and political reforms. They need to be more critical of the motives behind e-voting initiatives and conservative in following established development frameworks[8]. In order to eliminate electoral irregularities in Nigeria[3] an automated election system algorithm was developed using biometric data. The system designed incorporated the use of a central database server at the INEC's national headquarters in Abuja and stand-alone servers in each state headquarters and geopolitical zones. The central database server which has a Web-based application will be communicated, from the client computer system which has no database installed, this is done to achieve information query and request during voting. The system was based on the false assumption of a high level of infrastructure, literacy and computer awareness of the electorates. Also an online voting system (OVIS) was propose as a result of the findings of a study of the electoral process of the Electoral Commission of Ghana[9]. It was meant to phase out the traditional means of voting. Due to OVIS's infrastructural requirements made it most inappropriate for the Electoral Commission of Ghana, also the low level of internet accessibility and Ghana's literacy level are similar to Nigeria. The development of a semi-automated electoral system which involves the use of the fingerprint biometric technology was proposed and was used because of its reliability, correctness and accessibility [10]. In the proposed system, the electoral process is categorized into three sub-processes viz; the constitution, validation of the voter register and the elections proper. Interactive and Voice Response based Voting system (IVRS) and DTMF based was proposed [11] this system collates voter's database such as voter's name with voter's ID (identification) and generate a password. The voter calls a toll-free line in which the response directs the user on how to vote by entering his/her unique password. This system performs creditably as expected, but an Arduino board was used in this implementation. This is similar to our proposed system in this research work, but in our research work a Printed Circuit Board (PCB) was used. It is important to note that even though e-voting systems appear to be the best alternative to paper-based and other mechanical systems, they must be used with caution because experts believe that some of such systems could have challenges ranging from software engineering, auditing pitfalls, to insider threats, thereby undermining their integrity. Based on the analysis of related work above a secured interactive voice response voting system will be developed. This research thesis aims to present a new voting system employing the use of a peripheral interface controller (PIC), to coordinate and use a modem and DTMF technology to implement an interactive voice response based voting system in

order to avoid rigging and to enhance the accuracy and speed of voting process. A micro-SD card will be used to store the result and serve as the system database, but in real application of the system a computer system is used in place of the SD card.

## 3. Problem statement

For a voter to cast his/her vote they have to physically visit at the polling booth and then cast their vote, but if a person is out of the country or is unable to visit the polling centre due to any reason then he is deprived of fundamental right of voting. So, with the use of Interactive voice response voting system (IVRS) technology we can overcome this problem. From this application we can connect to the voting system by dialling the response number for voting so that everyone who is an identified registered voter can vote from anywhere.

## 4. Methodology

The proposed system – Interactive voice response-based voting system is made up of the following essential parts:

- Initiating device – Mobile phone
- Control device –PIC microcontroller
- Filter circuit-used to convert the pulse wave modulation signal to voice output signal (Analog).
- Controlled devices – Micro-SD card, MODEM and dual tone multi-frequency decoder
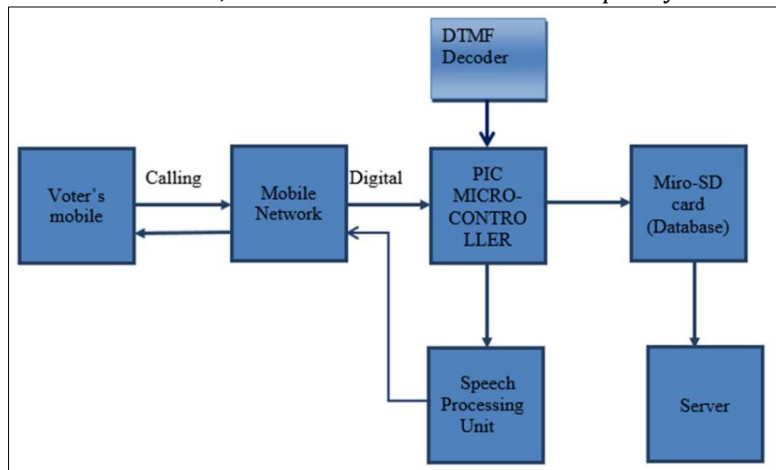


**Figure 1** Block Diagram of Interactive Voice response Voting System Technology

The diagram in fig.1 above shows how interactive voice response-based voting system will be implemented in this research work. In telephony, interactive voice response (IVR), is a mobile phone based technology which gives access to a computer to detect voice and touch tones using a mobile phone call. The IVR system can respond with pre-recorded or dynamically generated audio to further direct callers on how to proceed. IVR systems can be used to control almost any function where the interface can be broken down into a series of simple menu choices. As shown in figure 1, intending voters will register their mobile numbers with the mobile network, these numbers will be stored in the database and these are used as legal voters during the exercise. During registration each registered voter will be assigned a unique identification or personal identification number (PIN), which is only known to individual voter. When voters (he/she) want to vote for the candidate of choice, then he calls the toll free line from his/her mobile phone to the system mobile of the IVR system and then as shown in the diagram the process voting begins. Voter calls to the system mobile (MODEM), which is where the Subscriber Identification Module expected to receive calls, is inserted and the mobile or MODEM slot is connected to the PIC microcontroller. Then PIC microcontroller communicates with the server to ensure that the caller is a registered user of that phone number and the unique PIN will be requested from the user by the mobile network based on the interactive voice response technology, using the DTMF technology. After this is done, the database responds back to the PIC microcontroller based on the program written on the microcontroller to ascertain the caller as a legal registered voter. The microcontroller then controls the speech processing unit (voice response unit) to produce the prerecorded voice as per what the voter should do based on directing the voter to punch a particular number to vote for a particular candidate or party of choice. The selected number is then used to pick the candidate of choice and result is stored in the micro-SD card (database server).The result of the exercise can then be viewed by removing the micro-SD card and slot it into the card reader of a computer of administrator. The

administrator's system is the server. Interactive voice response systems generally scale well to handle large call volumes. A caller dials a telephone number that is answered by an IVR system. The IVR system executes an application which is tied to the number dialed. As part of the application, pre-recorded audio files explain the options available to the caller.

## 4.1. Application design

An algorithm will be presented at this point to show the process of information in the design and a flowchart will be designed as well

- Start the voting process by calling a toll-free line
- A welcome message is produced
- Voter is prompted his/her personal identification number
- Candidate and corresponding party list is produced
- If voter has already voted then the process ends immediately, else voter is allowed to vote
- Increment in the number of voters voted for the corresponding candidate
- End
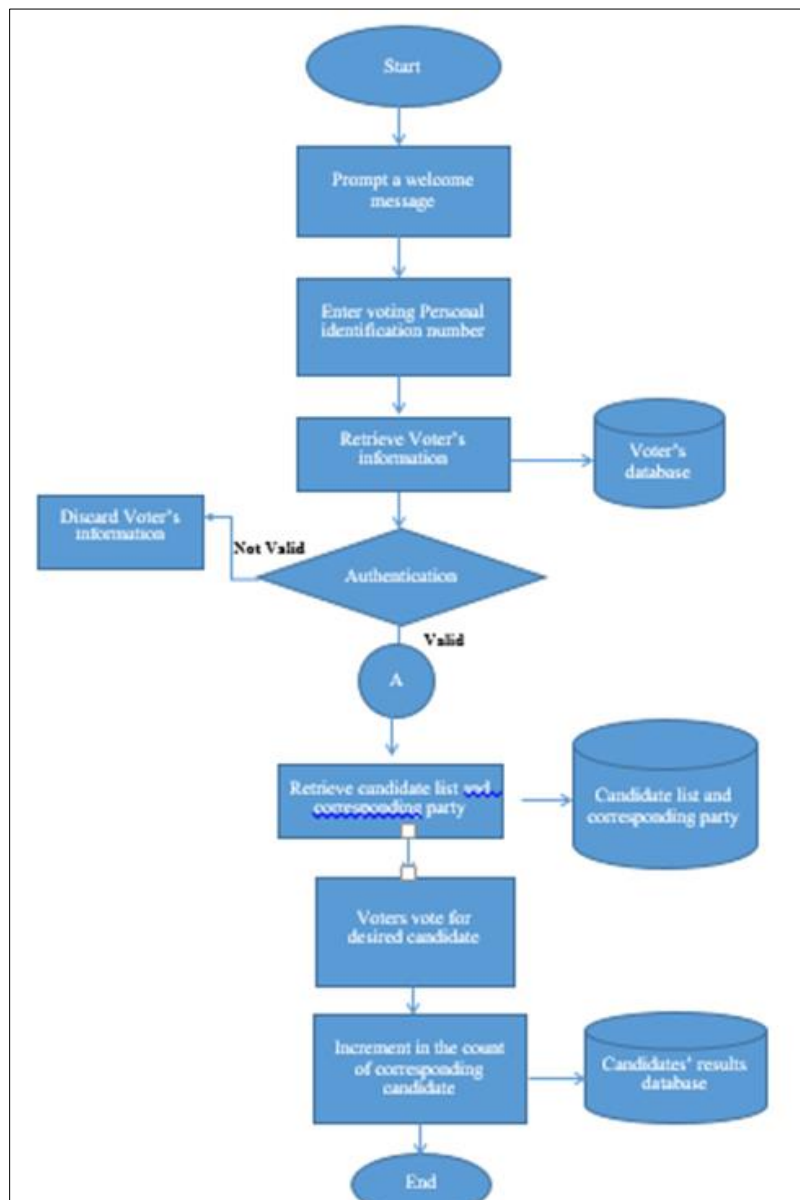


**Figure 2** Flowchart of the interactive voting process

## 5. Results and discussion

The results of the implementation of the voting response system are tabulated. Aspirant details are captured and stored on the IVR voting system in tabular form as shown below in table 1 was assumed that four parties where contesting for the position of presidency.

**Table 1** Aspirant Details

| Sn | Name | Party | Code |
|----|------|-------|------|
| 1 | Adetoro Ouwasegun | AGN | 1 |
| 2 | Safiriyu Hakeem | DFA | 2 |
| 3 | Jaiyeoba Lateef | RTA | 3 |
| 4 | Daramola Eniola | PSA | 4 |

**Table 2** Registration Details

| Voters Details | | | |
|----|------|------|------|
| Sn. | Name | Phone no. | Code |
| 1 | Koleayo Lukman | +2347066874022 | 1234 |
| 2 | Olaleye Emmanuel | +2347066874023 | 1235 |
| 3 | Taiwo Olayinka | +2347066874024 | 1236 |
| 4 | Oladejo Babatunde | +2347066874025 | 1237 |
| 5 | YUSUF DAMILOLA | +2347066874026 | 1238 |
| 6 | TAIWO MARY | +2347066874027 | 1239 |
| 7 | Oladipupo Karimot | +2347066874028 | 1240 |
| 8 | Ajala Hammed | +2347066874029 | 1241 |
| 9 | Sarumi Islamiyat | +2347066874030 | 1242 |
| 10 | Okunsanya Damilola | +2347066874031 | 1243 |
| 11 | Oyedele Adeyemi | +2347066874032 | 1244 |
| 12 | Yakub Murithador | +2347066874033 | 1245 |
| 13 | Ogunlete Toheeb | +2347066874034 | 1246 |
| 14 | Hammed Lawal | +2347066874035 | 1247 |
| 15 | Oleyede Ganiyat | +2347066874036 | 1248 |
| 16 | Opayomi Zainab | +2347066874037 | 1249 |
| 17 | Babatunde Ismail | +2347066874038 | 1250 |
| 18 | Dosunmu Kayode | +2347066874039 | 1251 |
| 19 | Adebayo AbdlHafeez | +2347066874040 | 1252 |
| 20 | Olabode Peter | +2347066874041 | 1253 |
| 21 | Jaiyeoba Lateef | +2347066874042 | 1254 |
| 22 | Olanipekun Seyi | +2347066874043 | 1255 |
| 23 | Daramola Eniola | +2347066874044 | 1256 |

| 24 | Akinwalere Florence | +2347066874045 | 1257 |
|----|---------------------|----------------|------|
| 25 | Atoyebi Olayinka | +2347066874046 | 1258 |
| 26 | Erinmu Peter | +2347066874047 | 1259 |
| 27 | Ayinde Abdulahi | +2347066874048 | 1260 |
| 28 | Adeniji Michael | +2347066874049 | 1261 |
| 29 | Banjo Babatunde | +2347066874050 | 1262 |
| 30 | Awomodu Idrees | +2347066874051 | 1263 |

The results were extracted via micro-SD (secure digital) card inserted on the system. The available data below was compiled and stored on the database system. However, analysis of this can be defined by the official or administrator at the back end, which gives analysis based on required result as expressed below.

**Table 3** Extracted Result

| Exported File from SD Card | | | | | |
|------|------|------|------|------|------|
| Sn | Name | Phone no. | Code | Candidate | Party |
| 1 | Koleayo Lukman | 2347066874022 | 1234 | Adetoro Ouwasegun | AGN |
| 2 | Olaleye Emmanuel | 2347066874023 | 1235 | Safiriyu Hakeem | DFA |
| 3 | Taiwo Olayinka | 2347066874024 | 1236 | Jaiyeoba Lateef | RTA |
| 4 | Oladejo Babatunde | 2347066874025 | 1237 | Daramola Eniola | PSA |
| 5 | YUSUF DAMILOLA | 2347066874026 | 1238 | Adetoro Ouwasegun | AGN |
| 6 | TAIWO MARY | 2347066874027 | 1239 | Safiriyu Hakeem | DFA |
| 7 | Oladipupo Karimot | 2347066874028 | 1240 | Jaiyeoba Lateef | RTA |
| 8 | Ajala Hammed | 2347066874029 | 1241 | Daramola Eniola | PSA |
| 9 | Sarumi Islamiyat | 2347066874030 | 1242 | Adetoro Ouwasegun | AGN |
| 10 | Okunsanya Damilola | 2347066874031 | 1243 | Safiriyu Hakeem | DFA |
| 11 | Oyedele Adeyemi | 2347066874032 | 1244 | Jaiyeoba Lateef | RTA |
| 12 | Yakub Murithador | 2347066874033 | 1245 | Daramola Eniola | PSA |
| 13 | Ogunlete Toheeb | 2347066874034 | 1246 | Jaiyeoba Lateef | RTA |
| 14 | Hammed Lawal | 2347066874035 | 1247 | Daramola Eniola | PSA |
| 15 | Oleyede Ganiyat | 2347066874036 | 1248 | Jaiyeoba Lateef | RTA |
| 16 | Opayomi Zainab | 2347066874037 | 1249 | Daramola Eniola | PSA |
| 17 | Babatunde Ismail | 2347066874038 | 1250 | Jaiyeoba Lateef | RTA |
| 18 | Dosunmu Kayode | 2347066874039 | 1251 | Daramola Eniola | PSA |
| 19 | Adebayo AbdlHafeez | 2347066874040 | 1252 | Jaiyeoba Lateef | RTA |
| 20 | Olabode Peter | 2347066874041 | 1253 | Adetoro Ouwasegun | AGN |
| 21 | Jaiyeoba Lateef | 2347066874042 | 1254 | Safiriyu Hakeem | DFA |
| 22 | Olanipekun Seyi | 2347066874043 | 1255 | Adetoro Ouwasegun | AGN |
| 23 | Daramola Eniola | 2347066874044 | 1256 | Safiriyu Hakeem | DFA |

| 24 | Akinwalere Florence | 2347066874045 | 1257 | | |
| 25 | Atoyebi Olayinka | 2347066874046 | 1258 | Safiriyu Hakeem | DFA |
| 26 | Erinmu Peter | 2347066874047 | 1259 | Adetoro Ouwasegun | AGN |
| 27 | Ayinde Abdulahi | 2347066874048 | 1260 | Safiriyu Hakeem | DFA |
| 28 | Adeniji Michael | 2347066874049 | 1261 | Adetoro Ouwasegun | AGN |
| 29 | Banjo Babatunde | 2347066874050 | 1262 | | |
| 30 | Awomodu Idrees | 2347066874051 | 1263 | Adetoro Ouwasegun | AGN |

**Table 4** Result Based on Parties

| Party | Count of Voters |
| --- | --- |
| AGN | 8 |
| DFA | 7 |
| PSA | 6 |
| RTA | 7 |
| Grand Total | 28 |

**Table 5** Result Based on Candidate

| Candidate | Count of voters |
| --- | --- |
| Adetoro Ouwasegun | 8 |
| Daramola Eniola | 6 |
| Jaiyeoba Lateef | 7 |
| Safiriyu Hakeem | 7 |
| Grand Total | 28 |

From table 5 it can be seen that Adetoro Oluwasegun, candidate for AGN won the election.

## 6. Conclusion

This new method of voting enables a voter to cast his/her vote through a mobile phone without going to the polling booth. Double or bogus voting is not possible, faster access, higher degree of security, ease of maintaining all the information of voting, highly efficient and flexibility are the advantages of this system. This will increase the percentage of population participating in voting exercise and kind of human error can be eliminated by using such a system. Reliability and scalability for large elections goes hand in hand here. Such a voting system is also an excellent mechanism because physical presence is not mandatory. The performance of the system depends on the components used and their compatibility. Thus, we conclude that the voting which will be developed is quite convenient and easy to implement for its usage. Such a system will be appreciated for our country today, where election proper is very essential.

## Compliance with ethical standards

*Declaration of Competing Interest*

The author(s) declare that they have no conflicts of interest.

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