INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

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AN APPROACH FOR E-VOTING SYSTEM USING PREFERENTIAL VOTING

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Accepted Date: 15/03/2016; Published Date: 01/05/2016

Abstract: The rapid advancement in information and communications technologies has given rise to new applications that were impossible just few years ago. One of these applications is e-voting. The term "e-voting" is defined as any voting method where the voter's intention is expressed or collected by electronic means. This paper details the requirements, design and implementation of a generic and secure electronic voting system for ISTE, where voters can cast their votes for representative by giving preference to them, anytime, anywhere and using a number of electronic devices including private computer networks, web, mobile phones and voting results is being calculated by using preferential voting system.

Keywords: ISTE, E-Voting System, three tier architecture, preferential voting.

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How to Cite This Article:

Swapnil Dhangare, IJPRET, 2016; Volume 4 (9): 1207-1218

PAPER-QR CODE

INTRODUCTION

"While democracy must be more than elections, it is also true it cannot be less" former United Nations Secretary General, Kofi Annan once said. Democracy is a form of government in which the supreme power is vested in the people and exercised directly by them or by their elected members under a free electoral system. Election on the other hand is a process in which citizen (voters) choose their representatives and express their preferences for the way that they will be governed. Democracy and elections have more than 2500 years of history. However, technology has always influenced and shaped the ways elections are held. In past, different voting systems that are based on traditional paper ballots, mechanical devices, and electronic ballots were developed for elections. However, these voting systems have history with example of elections being altered in order to influence their results. Allegations of violence, intimidation, ballot stuffing, minors and multiple voting, error in counting, complicity of the security agencies and the absence or late arrival of election materials often trail elections conducted using these systems of voting. In Africa, most elections are conducted using paper ballots. However, there have been numerous reported cases of eligible voters being unable or prevented from using their right to vote as stated in the Universal Declaration of Human Rights of the United Nations, sometimes due to violence, lack of information on physical location of voting poll sites, social discrimination; and by other natural causes like advanced age, physiological disability, floods, and poor communication infrastructure. Therefore, there is the need of symbolic alternative to this conventional system in the delivery of trusted elections. The advancement of information and computer technologies has allow for a fully automated online computerised election process whereby vote counts are done in real that by the end of elections day, the results are automatically out. This type of election process is known as electronic voting (e-voting). E-voting is any voting method whereby at least the voter's intention is collected by electronic means. The term e-voting is being used from tabulating the votes by electronic means to integrated electronic systems of voters' and candidates' enrolment to the publication of election results. In general, two important types of e-voting can be identified: e-voting supervised by the physical presence of representatives of governmental authorities, usually known as Direct Recording Electronics (DRE); and e-voting within the voter's sole influence, not actually supervised by representatives of governmental authorities, e.g. voting from one's own personal computer via the internet, by mobile phones (SMS), or via digital television. The emergence of e-voting will definitely permit voters to cast their vote from a place other than the poll booth in their voting district, facilitate the casting of the vote by the voter, help the participation in elections by those who are entitled to vote, widen access to the

voting process for voters, those having other difficulties in being physically present(having disabilities) at a poll site, increased voter turnout by providing extra voting channels, reduce overtime, the overall cost to the electoral authorities of organizing an election, deliver voting results accurately and more quickly amongst many other benefits. This paper details the requirements, design and working of a generic e-voting system, where voters can cast their votes anytime, from any place and using a number of electronic devices including web and mobile phones. Section 2 details a high-level set of general requirements that an e-voting system must satisfy. Sections 3 describe Literature Reviews on E-voting System. The architecture of an e-voting system that clarifies the stated requirements is presented in section 4. Section 5 outlines description and the implementation of a prototype for the e-voting system. Section 6 describes how preferential voting result is being calculated with example. Finally, section 7 presents some concluding remarks.

II. REQUIREMENTS DEFINITION FOR THE E-VOTING SYSTEM

The process of any voting system, whether electronic or traditional paper ballots or mechanical voting system must satisfy a number of competing criteria. These requirements are divided into two groups, namely, generic and system-specific. The system is to satisfy the following generic requirements:

i. *Privacy*: After casting a vote, no one should be able to link the voter to this vote;

ii. *Authenticity:* Only eligible voters can cast their votes;

iii. Integrity/accuracy: Once a voter cast a vote, no alternation to this vote is permitted. Moreover, all valid votes must be counted, whereas all invalid votes must not be discarded;

iv. Security: Throughout the voting process, a vote can't be tampered with;

v. Democracy: All eligible voters must be able to vote, one person - one vote and no one can vote more than once or vote for others.

vi. Verifiability: Voters can independently verify that their votes have been counted correctly and are included in the final tally.

The system-specific requirements of the framework allow:

i. Multi-user: A number of voters can vote simultaneously;

ii. Accessibility: The system can be accessed by voters from any location using secure Internet and/or mobile devices;

iii. Availability: The system must have high-availability during an election campaign.

III. LITERATURE REVIEW

Sr. No.	References	Evaluation Approach
1.	Malkawi M., Khasawneh M., Al-Jarrah O., (2009)	In this paper authors present a simulation model for a multifaceted online e-Voting system. The proposed model is capable of handling electronic ballots with multiple scopes at the same time.
2.	Okediran O. O., Omidiora E. O., Olabiyisi S. O., Ganiyu R. A. and Alo O. O., (2011)	In this paper author discuss the security issues associated with remote internet voting. In particular, they examine the feasibility of running national elections over the Internet.
3.	Okediran O. O., Omidiora E. O., Olabiyisi S. O., Ganiyu R. A. and Alo O. O., (2011)	This paper details the requirements, design and implementation of a generic and secure electronic voting system where voters can cast their votes anytime, anywhere and using a number of electronic devices including private computer networks, web and mobile phones.
4.	G.O. Ofori-Dwumfuo and E. Paatey (2011)	The aim of this study is to design an electronic voting system based upon the electoral process adopted in Ghana.

IV. ARCHITECTURE OF THE E-VOTING SYSTEM

To accommodate the requirements presented in section 2, an architecture presented in Figure 1 below, for the e-voting system was developed. The e-voting system was modelled around the three tier architecture: client tier, server tier and database tier.

4.1 Client tier

The client tier is made up of the following components:

i. Mobile terminal voters and the mobile network operator: Voting is done through mobile App from which voters can vote to their favourite candidate. Communication between the mobile terminals and the database server is through Web Service provided by Android.

ii. Remote clients' computers: Remote internet voting is done on the clients' computers in locations outside the poll sites. The clients' computers connect to the web server to load the web application over the internet via HTTP. The e-vote is sent to the poll site server via TCP/IP.

iii. Registration Centre and Poll Site Computers: The Registration Centre/Poll Site Computers in practice should be special-purpose computers for voters' registration and poll site voting. Communication between the Registration Centre/Poll Site Computers and the Poll site server is by TCP/IP.

4.2 Application server tier

The application server tier is made up of

i. Voters use the Mobile App for Voting and also to access the e-voting system. At the lowest level, the SMS server interfaces to GSM modem(s) that Sends notification about election dates, details of candidate, etc. to voter through SMS messages using SMS service provider (mobile operator).

ii. The web server which interfaces the e-voting system to web voters. In addition, it stores the different web page(s) containing the code required to interact with the user as well as the database system.

4.3 Database server tier

Database server is the core service for storing, processing and securing data. The database server provides controlled access and rapid transaction processing to meet the requirements of the client tier. The voters' records, candidates' record and election results database resides on this server. This server is also responsible for authenticating voters and administrators' authorisation.

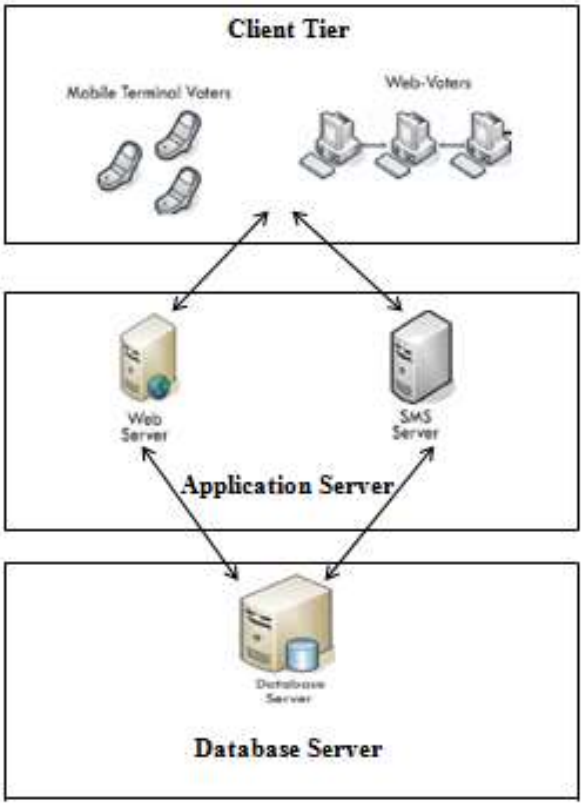

Fig. 1 Architecture of E-Voting System

V. EVOLVING THE OVERALL SYSTEM ARCHITECTURE

The system architecture defines the key components of the proposed system together with the interactions between these components. The overall functional structure of the framework is summarised as follows: an eligible electorate registers with E-voting System by filling register form. The person identifies by administrative body of election and activates or de-activate voter by checking all their information, all information of voters is stored in the database. The registered electorate will be given a unique voter identification number and a unique voting code which he/she is expected to keep confidential. A remote internet voter (client) runs the Uniform Resource Locator (URL) for the e-voting system through a web browser. The voting application runs remotely on the client's computer. Voting is done via the voting application by giving preference to the participated candidate. A remote mobile terminal voter votes via mobile App by giving preferences. Poll site voters cast their electronic ballots at designated Poll sites. The voters give preference to participating candidate on the voting interface. The developed e-voting system was designed to allow many voters to voting simultaneously while

ensuring highly availability during the electioneering process. Voters authenticate themselves by login into system with provided username and password. A voter ID and voting code sent to a particular SIM after registration cannot be used on another SIM for voting. The system ensures only one-person, one-vote (democracy) property of voting systems. Voter's SIM, voting ID and voting codes of a voter intending to cast his/her ballot are matched at every voting attempt to prevent multiple voting. The overall system was developed base on the derived system requirements and on the .NET framework using Visual C#. Web applications were developed using ASP. NET while the data tables at the backend in the database server were developed using MS SQL Server 2012.

The following flowchart shows client side task and functionality of e-voting system,

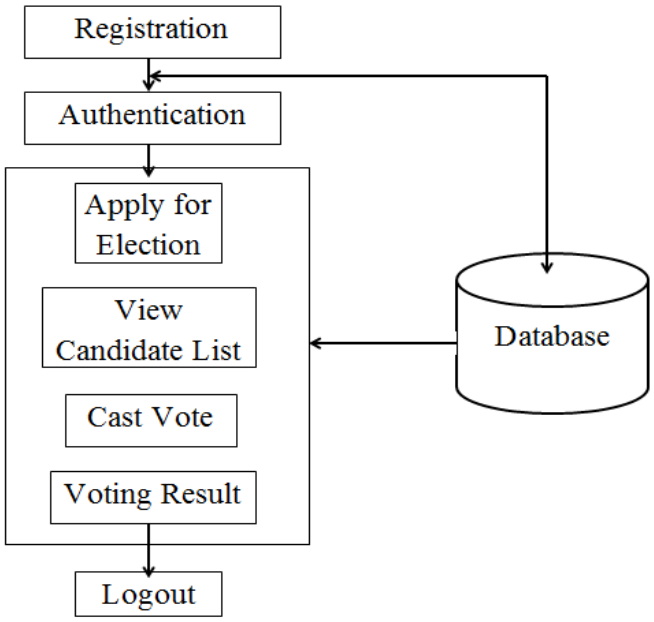

Fig. 2 Client Side Flowchart

VI. PREFENCE VOTING SYSTEM

In the proposed approach system uses preferential voting system to vote to the preferable representatives. In past, process of voting is too easy i.e. person gets maximum votes is elected but this is not the case in the preference voting system. In the preference voting system, voters give preference to the all representatives which are standing in the election. Following are the few conditions for voters which are keeping in mind at the time of voting,

- Voters must give preference to the all representative.
- If voter skip to give preference to one of the candidate then their vote get consider.

At any election where one or more seat is to be filled, every valid ballot paper shall be deemed to be the value of 100, and quota sufficient to secure the return of a candidate at the election shall be determined by using following formula,

$$\text{Quota} = \frac{\text{Total number of votes}}{\text{Number which exceeds by 1 the number of vacancies to filled}} + 1$$

Following section describe how preference voting system works,

- Voters can write a “1” in the box of the option they prefer most. Then voter can put a “2” in the box of the option they prefer next, and so on.
- Voter can rank as many or as few options as they wish, but he/she shouldn’t skip a number or use the same number more than once.
- If one representative option gets votes equal to or more than quota of all the first preference votes (that is votes marked "1"), he/she will be selected on the first count.
- If no option gets votes equal to or more than quota of the first preference votes, the option with the fewest number “1” votes is dropped and its votes go to the other representative each voter ranked next.
- This continues until one representative gets votes equal to or more than quota of the valid votes cast in the first option referendum.

This system of voting is called Preferential Voting (PV) and is used for elections to the House of Representatives in Australia and to elect some mayors in New Zealand, including in Wellington and Dunedin.

Examples:

In this example,

$$\text{Quota} = \frac{\text{Total number of votes}}{\text{Number which exceeds by 1 the number of vacancies to filled}} + 1$$

= (100 / 2) + 1 = 51

Example 1:

The Aubergine flag (with 53 votes marked "1") gets more than quota i.e. 51 for the 1st preference votes and is selected.

Flag option	1st count	
Aubergine	53	Selected
Corn	8	
Carrot	20	

Tomato	14
Broccoli	5
Total	100 votes

Example 2:

The Aubergine flag (with 45 votes marked "1") leads after the first vote count but does not have votes equal to or more than quota i.e. 51 of the 1st preference votes. So the flag with the fewest votes marked "1" – the Tomato flag – is dropped and its 11 votes go to the flag options marked "2" by these 11 voters. Aubergine gets seven of Tomato's 2nd preference votes for a total of 52 votes and is selected as the alternative flag option for the second referendum.

Flag option	**1st count**	**2nd count**	
Aubergine	45	45+7=52	**Selected**
Corn	19	19+2=21	
Carrot	12	12+1=13	
Tomato	11	**Eliminated**	
Broccoli	13	13+1=14	
Total	100 votes	100 votes	

Example 3:

The Aubergine flag (with 40 votes marked "1") leads after the first vote count but does not have votes equal to or more than quota i.e. 51 of the 1st preference votes. So the flag with the fewest votes marked "1" – the Tomato flag – is dropped and its five votes go to the flag options marked "2" by these voters. Aubergine gets two of Tomato's 2nd preference votes for a total of 42 votes, Corn gets one for a total of 39 votes, Carrot gets one for a total of eleven votes, and Broccoli also get one for a total of eight votes.

There is still no flag option with 50% or more of the votes. So the flag with the fewest votes – Broccoli – is dropped and its eight votes go to the flag options each voter ranked next. Aubergine receives two of Broccoli's next preference votes for a total of 44, Corn gets four of these votes for a total of 43 votes and Carrot gets two for a total of 13 votes.

There is still no flag option with votes equal to or more than quota i.e. 51. So the flag with the fewest votes – Carrot – is dropped and its 13 votes go to the flag options each voter ranked next. The Corn flag receives nine of these votes, enough to overtake Aubergine and be selected with 52 votes.

Flag Option	1st Count	2nd Count	3rd Count	4th Count
Aubergine	40	40+2=42	42+2=44	44+4=48
Corn	38	38+1=39	39+4=43	**43+9=52**
Carrot	10	10+1=11	11+2=13	Eliminated
Tomato	5	Eliminated		
Broccoli	7	7+1=8	Eliminated	
Total	100 votes	100 votes	100 votes	100

CONCLUSION

Online voting offers convenience to the voter and considerable ease to election administrators as they can get election results out more quickly than conventional methods of manual voting. Even though computerized voting systems have a number of advantages over manual ones, there a few challenges that must be overcome in order that their benefits may be fully realized. First of all, there is the high initial cost of implementing such a system, as is typical of all computerized systems. Secondly, there is the challenge of voter education. The electorate needs to be educated adequately on the use of online voting.

A third concern is the voting system security at national level; how the system could be attacked by hackers and fraudsters, including system administrators Finally, electronic voting systems should be allowed to be scrutinized by experts in systems analysis and design, computer programming and computer system security. This would be the only way to ensure public confidence in such systems.

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