Accessible Voting Systems for Visually Impairments

Ruba Ghazi Alzamel[1*] and Randa Ali Obeidallah[2]

*[12]Computer Information System Department,
The Hashemite University
Ruba@hu.edu.jo[1],Randa.Ali@hu.edu.jo[2]*

Abstract

It is the time for blind people to participate elections independently. A special segment of the population, such as visually impaired voters has the right to vote and choose their representative; it is an essential part of democracy. Extant election systems do not adequately serve this goal. This paper focuses on blind people and aims to provide a new voting system to give blind and low vision voters more choices to participate the election process.

***Keywords:** Vision impairment, E-Voting, low vision, blind, audio interface, online voting system, off line voting system, braille language*

1. Introduction

The election process affords the right to every citizen of a country to elect an authentic representative who can guide the society towards development and security (Patil *et. al.,* 2013). This not only gives people a chance to choose their representative, but also to freely express their views on issues. (Ofori-Dwumfuo and Paatey, 2011).

Visual impairments people who are blind or have low vision is one of categories of the society that have right to participate in the elections as voter or even candidate. They should have an opportunity to cast their ballots independently and privately. Participate voting is one of the essential parts of Democracy (Al-Khasawneh and Obeidallah, 2014) for all people regardless of their physical conditions, who they are or where they come from (Ofori-Dwumfuo and Paatey, 2011).

Voting systems are divided into two approaches: paper voting system and electronic voting system (Chaum, 2004) (Ofori-Dwumfuo and Paatey, 2011) (Patil *et. al.,* 2013). Paper voting system is based on using a piece of paper as a ballot for every voter then collecting ballots by the administrators and counted manually (Chaum , 2004)(Patil *et. al.,* 2013). Electronic voting system is type of vote which is done through electronic systems, it is also known as E-voting system. It has different implementations and approaches (Qadah and Taha, 2007).

In this paper we will suggest an enhancement for the traditional voting systems and propose an online voting system which takes into account the blinds people participation in election and focus on issues and obstacles that face them during casting their vote, moreover, we tried to provide the E-voting systems with some features that increase its flexibility and suitability for blinds. Few blind persons can be seen casting their votes; who came with their family member, friend or caretaker.

Our suggestions and amendments will contribute to motivate blind to vote and increase the percentage of blind participation. The proposed online voting system enhances independence vote, moreover, no fear related to confidentiality of their votes.

We will highlight the benefits and obstacles of all the voting systems and the proposed online system. The paper is organized as follows: section 2 discuss the concept of visual

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*Corresponding Author

impairment and its types, section 3 presents braille language technique. Section 4 highlights the types of voting systems. The Additions and modifications on the voting systems adapting blind is discussed in section 5. The online voting system for blind is proposed in section 6. The issues related to our
proposed online voting system are illustrated in section 7, and finally conclusion is placed in section 8.

2. Visual Impairment

Visual impairment (vision impairment, vision disability) is a general term that describes a wide range of visual function, from low vision through total blindness. It can be due to disease, trauma, or congenital or degenerative conditions (Disabled World, 2015)

2.1. Visual Impairment Types

2.1.1. Low Vision: The term Low Vision, sometimes also referred to as 'Vision Loss' or 'partially sighted' or 'partial blindness', it means that even though a person may use eyeglasses, contact lenses, medication, or surgical techniques to improve their vision; they still have difficulty seeing. Low vision is more common among the elderly, but it can occur in individuals of any age as a result of some disease.

2.1.2. Total Blindness: The term Total blindness is defined as the complete lack of light and form perception, and is recorded as "NLP," an abbreviation for "no light perception."

3. Braille Language

According to (Wikipedia, 2016), Braille system was created in 1824 by a Frenchman, Louis Braille who lost his eyesight due to a childhood accident. It is a tactile method widely used by blind or visually impaired people to read and write. Each letter or number in Braille is made up of a cell that has six up to raised dots in two rows of three dots each, which means 64 possible combinations; the number and arrangement of these dots distinguish one character from another. Blind people read Braille by moving their fingers over these cells and feeling the raised dots which performed letters and numbers.
Since the various braille alphabets created as transcription codes of printed writing systems, sets of character designations vary from language to language. Therefore, different Braille codes are used to show letters in different languages.

4. Voting Systems Types:

4.1. Paper Ballot Voting System (PBVS)

Paper ballot voting system (PBVS) is a traditional voting system; still used in many countries (*e.g.,* Jordan), PBVS depends on using paper and pen, where each voter uses one unshared paper ballot and writes in the names of candidate.
In Other countries especially in governmental elections use pre-printed sheets to control the security of voting (Mayur Patil, Vijay Pimplodkar, Anuja R. Zade, Vinit Vibhute, Ratnakar Ghadge).
Using PBVS has some advantages such as Simplicity, Portable, Less cost. And in other hand it has disadvantage such as losing consuming, Booth capture, and Low tally speed.

4.2. Electronic Voting Systems (EVS)

Electronic voting system (EVS) also known as E-voting is a new type of voting system which allows voter to cast their ballots electronically, it is divided into two types: Online

via the Internet or Offline via voting machine and/or electronic polling booth (Alaguvel and Gnanavel, 2013), Use one of these system aims to make the voting process more convenience and increase the participation of voters (Tadayoshi Kohno,Adam Stubblefield,Aviel D.,Rubin Dan,S. Wallach).

Electronic voting systems should be reliable and authoritative enough to make voters and

candidates to accept the results (Kohno *et. al.,* 2004). Many studies proved that EVS has some advantages over PBVS, such as Convenience, Tally speed, Mobility. And disadvantages such as High cost, hard implementation, Software failure issue.

5. Developing Voting Systems to Serve the Blind Voting Right

As one of the essential categories in each country, people with Visual impairments have the right to cast his/her vote in election. In order to make voting accessible to blind citizens, voting areas should be prepared to be on an accessible level such as the ground floor of a building, special ramps and handrails as necessary. Adequate parking spaces near to the entrance of the polling station should be available. Employing Competencies polling, this polling station staff should be given disability awareness training to be able to help disability individuals. Low vision users may be adept at utilizing their own magnifying tools to make regular print, computer screens(Gillian E. Piner and Michael D. Byrne, Accessible Polling Places for the Visually Impaired)

Whether using Offline E-voting System or Paper Voting System (PBVS) a blind or low vision impairment has had to rely on those that are sighted(family member, friend) to read registration information and voting ballots, the Privacy security of information confidentiality of blind person's vote depends on ethics of his helper.

5.1. Amended Paper Ballot Voting System (PBVS) for Blind

To help Visual impairments individuals casting their vote independently, using the traditional Voting System PBVS as in Jordan which do use this old System, PBVS should be developed in order to adapt those people, administrators who response on organizing the election day should take in their concern blind participation, administration should supply all the ballot station with elected ballot sheet written in braille language (brailed paper) for those blind who read and write using braille language, moreover, employing extra polling staff who are familiar with braille language to tallying blind voting at the end of the election day. This staff should also be reliable and confidence in which not to manipulate the blind voting, Furthermore, help blind individuals getting into the voting stations and setting in the corresponding voting place, giving them the voting paper; adequate lighting inside the polling station and large and clearly visible signs are also

recommended. Finally, voting forms should be available in a variety of languages, with a large print option and a tactile option to view the forms, and have a simple layout familiar to the voters.

Nevertheless, some blind people can't use braille language, and unable to cast his/her own ballot, so they still need a sighted guide helps reading and writing on the traditional ballot paper to complete the voting. Never quite felt comfortable with someone marking off his/her candidates. High probability of manipulation, There was no clear way to really know if the candidate they chose was selected on ballot paper or not.

Using PBVS system increases the election expenses, employing Competencies polling is cost task and not easy to find such employer, also supplying the polling booths with enough number of brailed ballot papers before the election. In additional that PBVS is a manual system; and as mentioned before this system waste time which spends on tallying and counting the vote before announcement the result.

5.2. Amended Electronic Voting Process (Online/Offline) for Blind

Nowadays, electronic voting has become more popular around the world. United States, Brazil, Australia, Canada, Belgium, Germany, Romania, France, Venezuela, Philippines, The European Union, Switzerland, Italy, Norway, Romania and United Kingdom are some countries which uses electronic and vote online.

There are two types of Electronic voting: the first type is known as offline E-voting which is supervised physically by independent electoral authorities or governmental representatives and using the machines at polling stations. The second type is known as online E-voting which is remote electronic voting; where the vote is not physically supervised by government or independent representatives, it will be wherever via the internet from a personal computer, or mobile phone.

Although Electronic voting has many advantages, such as reducing the time taking to count votes and provide results, there are some obstacles face visual impaired voters, the equipment used should feature proper accessibility for the benefit of individuals with visual impairments.

E-voting systems are frequently inaccessible to blind people because of the nature of the process requiring a sighted assistance. Moreover, the environment in which the voting system takes place can cause problems for people with vision disabilities. The use of small controls, like push buttons or touch screens, and insufficient reach or strength to use a voting machine will impair them when it comes to casting a vote using electronic machines. For example, individuals with low vision experience trouble accessing voting systems due to small print, or the inability to clearly see the position of text blocks on the screen.

People with Visual impairments require electronic voting systems to contain a combination of auditory, visual and cognitive features to be able to keep their independence when exercising the right of voting. they comfortable with listening to text-to-speech computerized voices like those that are used in screen readers and be able to listen to them at a rapid pace that would be unintelligible to those with no experience with speeded up audio.(Gillian E. Piner and Michael D. Byrne, Accessible Polling Places for the Visually Impaired)

5.2.1. Accessible Offline E-Voting Machine: Offline Electronic Voting is very accessible for individuals with disabilities. A Voting machine has electronic equipment which includes its software, firmware and the required documentation to program control and support equipment which is used to count and cast votes, to display or report election result and to produce and maintain audit trail information. This machine has different levels of security, usability, accuracy and efficiency.

Accessible voting machine would allow a blind or low vision person to vote secretly and verifiably without using the absentee ballot in the past. These voting machines must be easy and quick to understand and use by all voters, from the most computer intelligence to those whose experience with technology goes no further than the telephone.

Blind should ask for the accessible voting machine when enter the polling place. The offline electronic voting machines should be available at local polling locations. The machines look very similar to a traditional machine, except that it has a headset attached so that the visually impaired person can listen to their options for candidates. The machine should be set up and functioning before the Election Day, furthermore, the poll workers should have training to be able to use this technology, explain the process, assist people with disabilities, so they can answer questions and solve any problems.

To use these machines, blind people need to have the ability to use joysticks, earphones, foot pedals, *etc.,* This machines have touchscreens such as (vote- truckker, eSlate, AVC edge) which can display the information in several languages and voting choices in audio, Audio Interface can be a recorded human voice or synthesized text-to-

speech program (Gillian E. Piner and Michael D. Byrne). These features make voting easier and comfortable for people with vision disabilities.

Once the person is standing at the machine, a blind person should put the headset, a button is pressed, the voice will prompt with instructions and enable blind to review the ballot via speech output through headphones, and then it is just a matter of pressing the appropriate number to select the candidate. The most important accessibility features that should take in the perspective are Speech output quality and clarity (Gillian E. Piner and Michael D. Byrne), and the Clarity of both printed and spoken instructions should be multi languages, blind can choice the proper language before vote, Proper and active headset, Controls that are identifiable tactilely or have braille, such as braille keyboard with keys covered with transparent caps which has braille on it.

However, electronic voting brings a new set of risks and drawbacks as well as advantages. In additional to machine high cost; Offline E_voting machine may not set up well or may not be in place and ready to go, the voting machine extremely heavy and needs time to be setup before the election day. Sometimes people with disabilities have to be advocates and speak up to get the things they need. Blind May still need assistance to help standing at the machine and put the blind finger on the correct button, put the headset and Makes sure it works correctly, and correct the headset voice volume this needs to employing extra polling staff. Furthermore, this part of the voting process will make voting less independent and private for those who are blind.

5.2.2. Online Voting: Vote online is a type of remote voting which can be done using the Internet through a web browser (Armen, C. and Morelli, R, 2005), using a mobile phone or personal computer. The voters will directly vote from anywhere in the world without visiting to voting booths in highly secured way, which makes voting a fearless of violence and that increases the percentage of participations, Online Election voting system helps people with different disabilities vote without any assistance (Abu-Shanab E., Knight M. and Refai H., 2010). So using online electronic voting will be the proper choice for blind individuals.

I suggest an online voting system with multiple languages which will be feasible for blind people; this system will motivate blind to exercise their voting right wherever they were. Registering and voting in few second. They need to have smart mobile phone, or computer (lab top or desktop) and have the ability to use these devices, and of course internet connection.

6. Proposed Online E-Voting Framework for Blind

The system has some features that increase its security. This online voting system depends on voice voting, Before the Election Day blind must call or go to the election center to register before deadline put by the government. The staff will locate the blind on the electoral roll, the blind must state that he/she is blind or has low vision and can't fill in a ballot yourself. Blind will be asked to choose a password and username and record these information by his/her voice. Once the blind has these information he/she can vote in the Election Day.

The system should be set up on the computer device or smart phone correctly enough time before the Election Day or at any time during the Election Day before the end of the election specific time.The government has to provide all the blind with this system sending a technical employee to their home to setup the application with proper language for free and teach the blind voter all the vote instructions using this online voting system correctly, Alarm should be set on the date of the Election Day to remind the blind. The blind should be able to use this application and make trainings before the election.

In the Election Day, after the alarm ringing, the blind voter opens his device and uses the audio interface to start the process, first the system will tells the user the current

country name, the current date and time, in the next step the system will ask the voter assign User name and password using their voice, matching(voter voice tone ,correct password, correct username) with the ones recorded previously, if not match the system will ask the user to try again, give the voter three attempts before stop his/her vote.

Next, The system starts quietly reading the candidate's number with the corresponding name and give brief about each candidate (name, age, education, skills, and job), then gives one minute before moving to the next candidate waiting from blind if need repeating the information .once the system finishes from reading all the candidates, it will ask the blind to choose one candidate by saying his/her eligible candidate number and name with high and clear voice. The system will ask the blind to repeat his/her choice two time for confirmation. At the end, the system will tell the blind voter that he/she has voted successfully and so the process ended

7. Proposed Online Voting System Issues

Out of all advantages of the Online Voting system in general, especially give the blind chance to vote from anywhere independently without any intrusion. There are many related issues mayface blinds when using our proposed framework, I will mention few issues related my proposedframework, these issues are illustrated as follows:

- Internet issues, such as: availability of internet for all blind in all countries, especially in poor countries, May has no internet connection or low internet connection, insecure access of internet and also voter should be familiar with internet. (Anand Ankit, Divya Pallavi, 2012)
- Staff issues: lack of unqualified programmers and staff members and poll worker training with accessible technology.
- Blind financial status: availability of smart phone or personal computers (laptop, tablet, desktop) and subscribe and access to internet. Most of blind people are poor individuals, with no or limited job, government in some countries provides blind with small amount of money enough to their basic life requirements (food, medication, house), therefore own smart phone or any computer device may be difficult .
- Software failure issues, such as: Error in installing the voice audio-interface system. Or the online voting application.
- Availability of electricity in some poor places
- Blind computer skills issues: some blind find it difficult to use computer device.
- Error set alarm time, or time different between countries especially for those blind who live aboard.
- Blind health status in the Election Day: some disease like (flu, cold) may effect on the blind voice and change the voice tone, so no matching with the recorded voice. And this willdeprives from voting.

8. Conclusion

Blinds are an essential part of citizens in all countries; their ballots are important and affect the elections results. Many voting systems are available but may not serve blind people to cast their voting ballots. In this paper, we are looking to improve the old and traditional voting systems, and design new online-voting system to motivate blind exercise their voting right, and to enhance blind participation in Election Day. Relying on the financial possibilities of countries, each country must provide at least one of voting system mentioned above to help its blind citizen casting their ballots freely. However, the initial cost of implementing some of these systems is relatively high; the infrastructure for online voting system and the offline voting system must be well equipped and systematize

by professional staff. Availability of some requirement equipment such as: braille keyboard, braille voting paper smartphone, joystick, *etc.,*

In this paper, we mentioned for each voting systems number of advantages and some issues that must be considered in the future

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