Accessible Voting Systems Usability Measures

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Abstract

It is critical that all adults be able to successfully and independently engage in the voting process. In order to ensure that this is possible, individuals with disabilities must be included in usability evaluations of accessible voting systems, and the present paper defines standardized evaluation criteria and benchmarks for including blind, visually impaired, and dexterity limited individuals in testing. While voting accuracy is always the most important measure of any voting system, additional factors disproportionately impact individuals with disabilities, which can make the voting process difficult and painful if not properly controlled. As a result, the authors propose the use of revised Voluntary Voting System Guidelines and Voting Performance Protocol measures for total completion score, voter inclusion index, and perfect ballot index, as well as two new measures, voting time and interactions, to determine whether a system should be considered acceptable for people with disabilities. These new measures are necessary to ensure that the voting process can be successfully and reasonably completed by individuals with disabilities.

Keywords

Voting; accessibility; voting metrics; accessible voting systems; usability

Introduction

Usable voting systems are essential to the democratic process for all people, but are especially important for persons with disabilities. Electronic voting systems, which are used in local, state, and federal elections in the United States and other countries, need to be designed so that all users can independently and effectively interact with them in a reasonable amount of time and without discomfort.

The Voluntary Voting System Guidelines, or VVSG (U.S. Election Assistance Commission), has standards for voting system accessibility and usability as mandated in the Help America Vote Act, or HAVA. While there are extensive design requirements and associated tests for conformance to these requirements in the VVSG for both accessibility and usability, usability testing requirements for both the general population and people with disabilities are still under development. Human performance tests that include consideration for accessibility requirements (i.e., testing the usability of these systems for people with disabilities) are crucial to ensuring a satisfactory and successful voting process.

There is very little published research on accessible voting metrics; however, the present work builds on prior research for developing a methodology for conducting usability test for accessible voting systems, including Laskowski, et al. and the U.S. National Institute of Standards and Technology (NIST).

Discussion

Usability and accessibility experts at Michigan State University (MSU) were tasked by NIST with developing a suitable, rigorous test protocol that a Voting System Test Laboratory could follow to conduct usability conformance testing of accessible voting systems with persons

who are blind, have low vision, or have dexterity impairments, in order to ensure that they can vote accurately and independently with a particular voting system. The MSU researchers developed a testing methodology for determining whether voting systems are usable and accessible for persons with disabilities, including consideration for whether they are able to cast ballots as they intend without causing serious discomfort (Swierenga and Pierce). The test recommendations are aimed at making pass/fail judgments for voting system certification to the VVSG.

After developing and refining the tests and protocols to make them appropriate for the selected demographic groups, dry runs of the test protocol were conducted using multiple voting systems to obtain expert timings and performance benchmarks to refine pass/fail metrics (user testing was outside the scope of the project). Dry run data were collected by having usability researchers go through the voting protocol with each system while using specific accessibility features, while a second researcher recorded the time required and counted the number of button-presses/interactions. Unfortunately, most systems required too much time and too many interactions (e.g., button presses, screen-touches, sips/puffs, etc.) when assistive technologies were used to be reasonably completed under our constraints (limitations imposed by disabilities or the use of assistive technologies). Individuals with disabilities and experts confirmed our findings when given the opportunity to interact with the systems and evaluate the protocol. One outcome of this research was to recommend two additional pass/fail measures to determine system conformance and to help ensure an equitable experience for all voters (Swierenga et al.).

Draft Measures

The most important measure of the success of a voting system is the accuracy of a voter's selections. As a result, the use of revised Voting Performance Protocol measures for

effectiveness (total completion score, voter inclusion index, and perfect ballot index) is recommended to determine whether a system is acceptable for people with disabilities (Swierenga and Pierce 36-37). For Total Completion Index and Perfect Ballot Index, it is recommended that a system's uncorrected mean score must exceed a benchmark value in order to pass. The recommended benchmark is 92.5% for Total Completion Score and 2.00 for Perfect Ballot Index. Voter Inclusion Index should be calculated across all groups, and a 95% confidence interval should exceed a benchmark of 0.35 to pass. Additionally, two new metrics, voting time and interaction counts, should also be used as criteria for system acceptability for individuals with disabilities (Swierenga and Pierce 37-39).

Voting Time

Voting time, while not considered for conformance in the standard Voting Performance Protocol, becomes more critical for individuals with disabilities for a number of reasons. First, the time required is significantly longer; Swierenga et al. (“Impact of visual impairments”) found that, as a rule of thumb, users who are blind or have low vision typically take up to 4 times as long as users with normal vision in usability studies with computers. While variation between 5 and 20 minutes may not be considered problematic in voting session duration, for users who are blind or have low vision, that would translate to variation between 15 and 80 minutes.

Sitting and concentrating for an hour or more to complete a ballot at the polls is not reasonable, and individuals with disabilities are more likely to suffer from physical and mental strain and discomfort in a voting session lasting that long. Furthermore, with a limited number of accessible voting systems at any given polling station, long voting times severely limit the number of people who can vote, and make it extremely inconvenient to find enough time to vote (especially for individuals who come as a group).

Calculating the average number of minutes needed to successfully complete the NIST Test Ballot for each user group (i.e., users who are blind, users with low vision, and users with dexterity impairments) is recommended. For each group, the maximum allowable average time should not exceed 40 minutes. Mean time for a single-group greater than this benchmark would constitute a failure for the voting system. This value was calculated after expert review and benchmarking of multiple voting systems with and without assistive technologies; however, it was primarily based on reasonable expectations for individuals with disabilities to be engaged in a single task of this type, regardless of current system abilities.

The researchers completed the NIST Test Ballot according to the instructions that would be followed by individuals in the usability tests to determine best-case times, i.e., no deviation from the instructions or confusion about how to use the machine, with three existing systems (see Table 1).

Table 1 Best case times for completing the standard NIST ballot using various alternative input devices.

		Silent	Audio
System 1	Touchscreen	10:00	
	Button Panel	11:00	17:00
	Jelly Switch	23:00	
System 2	Touchscreen	7:00	
	Button Box	18:00	37:00
	Jelly Switch	24:00	52:00
System 3	Buttons	6:00	32:00

Interactions

"Interactions" are button-presses, screen-touches, sips/puffs, and any other physical actions taken by a user to interact with the voting system. Individuals with dexterity limitations are significantly impacted by the number of interactions that they must initiate. For a button-press, the amount of strain depends on the amount of pressure applied, the size of the button, and the number of presses required. While pressure and size can be easily controlled by appropriate physical specifications in the VVSG, user data are needed in order to determine the average number of interactions that are made by users when using the NIST Test Ballot on the system.

We recommend calculating the average number of interactions needed to successfully vote for each user group and for each input device across groups. For individuals using a one- or

two-button device (such as a dual rocker switch) or using a touchscreen or full keyboard, the average should not exceed 400 interactions. For individuals who use multi-button inputs (more than two buttons/options, but less than a full keyboard), the number should not exceed 600 interactions. User groups with dexterity limitations should never exceed 400 interactions. Exceeding these limits would constitute a failure for the voting system. These values were calculated based on the number of interactions required to complete the NIST Test Ballot according to the instructions used in this study; they include a significant margin for error and allow for variation due to user interface and interaction differences between systems. The observed values for the voting systems tested often greatly exceeded this benchmark, but most could be reduced and therefore comply with only minor software or hardware revisions.

When the instructions were piloted using the NIST Test Ballot on actual voting systems to determine best-case counts (i.e., no deviation from the instructions or confusion about how to use the machine), it was found that all of the systems required a large number of button presses to complete the ballot voting task.

- System 1 touchscreen, silent: 142 button presses
- System 1 button panel, silent: 597 button presses
- System 1 dual-rocker switch, silent: 872 button presses
- System 2 dual-rocker switch, audio: 1200 button presses

Conclusion

Usability performance tests for accessible voting systems require additional and revised measures in order to successfully determine whether they can be successfully and reasonably used by individuals with disabilities. The present study proposes two new measures, voting time

and interactions, as well as modifications to existing measures (total completion score, voter inclusion index, and perfect ballot index).

Future work is needed to determine the proposed benchmarks are adequate, based on usability tests with persons with disabilities using the pilot testing protocol developed by Swierenga and Pierce. Critically, they must also take into account reasonable expectations for individuals with disabilities to be engaged in a ballot voting session, regardless of current system abilities. It is important to note that the voting time and interaction benchmarks must be set as low as possible to avoid causing injury or pain to voters, and to try to ensure that they can successfully complete the voting task in one sitting. The ultimate goal is to significantly enhance the usability of voting systems for all users, including those with disabilities, so that voters can vote independently in elections.

It is clear that voting system designers and manufacturers will need to modify their products in order to make them usable for individuals with disabilities, once subjected to more stringent user-testing protocols. Consideration given to the number of interactions and amount of time required to vote under a variety of conditions will likely result in broad changes to interaction designs which will improve the systems for all users.

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