Prime III: A User Friendly Voting System

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Abstract
Mr. Wilson never votes. He doesn't vote because he is not confident in his reading capabilities; however, he decided that he will vote this year because he heard that blind people will be able to privately cast their vote. He said, "If blind people can vote, then so can I". At the voting precinct, he shows his identification and receives a blank, numbered ballot sheet. He enters a voting booth, placing the ballot into the printer. Using a headset with a microphone, he is able to make his selections by speaking numbers, which gives him confidence that his vote is private. Before printing his ballot, he listens to a summary of his selections. He leaves the voting booth and places his printed ballot into a secure box. Like Mr. Wilson, there are millions of people that don't participate in our electoral process due to disabilities and lack of confidence in the equipment. Through usable security, Prime III aims to broaden voter participation and confidence.

Keywords
Guides, instructions, author's kit, conference publications

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous. See [3] for help using the ACM Classification system.

Introduction

America's current voting system is in need of a major overhaul. This became overwhelmingly clear as a result of the 2000 U.S. Presidential election [2, 7]. Accordingly, the federal government has allocated funds for the purchase of modern voting equipment. Many of these jurisdictions have switched to direct recording electronic (DRE) machines. However, the use of these machines has not been without controversy and met with resistance. For example, it has been widely reported that electronic voting machines pose a number of unacceptable risks such as, vulnerability to hackers, malignant workers, faulty code, lack of recount ability, and human error. Therefore, a system must be built that can address the aforementioned issues and instill voter confidence in the electronic voting process. It is no longer sufficient for such a system to simply be secure; the voter must feel confident in the integrity of the system. Additionally, it should be easy to navigate for all segments of the voter population. The system should provide security and trust while being easy to use, i.e. usable security.

The next section discusses such a system, Prime III which is a DRE developed to be usable for all voters including those with various disabilities. The preliminary study section shows the results of an initial usability study in which the majority of the subjects found Prime III easy to use and the majority of the disabled users found Prime III better than paper voting. The preliminary study is followed by the future work section which discusses upcoming studies focused toward the elderly and seeing impaired.

Solution

Prime III is a voting system that delivers the requisite system security, integrity, and user satisfaction safeguards in a user friendly, secure, electronic voting system. Moreover, Prime III incorporates the current voting process that the voter is accustomed to using and significantly improves upon it. This approach allows the voter to remain comfortable and confident while using an enhanced voting system. The design goal was to develop a robust multimodal application through user centered design principles [4, 5] that combines security with user interaction to create a usable security system that facilitates user interaction with the application, through multiple means (i.e. text-to-speech, speech-to-text, touch). This multimodal approach permits voters to hear and/or see the candidate names while they cast their votes (via voice and/or touch). After the voter confirms the vote, it is recorded in electronic format and can be printed. Therefore, the vote can be verified in a variety of ways, this accommodates multiple recount methods. The first method of voter verification is visual and/or verbal. The voter can verify their vote by looking at the screen and/or listening to the spoken response. The second confirmation method is the printed ballots. The system prints a text version of the voter's selections. Note that the printed ballot is not of the typical ballot form. It only contains the voter's selections. This will clearly communicate the voter's intent. If an official recount is required, election officials have the option of tallying votes by doing one or more of the following: using the internal database on each machine or by performing a hand count of the printed ballots. These are features

that can increase voter and election administrator confidence. The Prime III interaction model integrates well into the current voting process.

The Prime III Interaction Model

Prime III is easily integrated into the current voting process. This provides a degree of familiarity and allows the voter to remain comfortable and confident while using an enhanced voting system. The voting process begins when the voter enters the voting precinct and checks in with election officials. Each state has its own voter verification process, which is separate from Prime III. After the voter is verified, the voter may be handed a blank card, which is used to print the ballot. Some precincts don't require a paper trail, so this is an optional feature. The voter then takes the blank ballot card to an empty voting booth. The voting booth contains an empty single sheet printer, touch screen, and headset, (see figure 1). The voter places their ballot card into the printer. When the system begins, the voter will cast his/her vote using a multimodal (text-to-speech, speech-to-text, touch) user interface. Voters with visual, hearing or physical impairments can still participate in the electoral process using Prime III with out any additional assistance. Essentially, if you can not read, see, hear or if you have a physical disability, i.e. arthritis, you are still able to vote using Prime III in a private, secure environment. The Prime III system has an integrated ASR that is accessed through a headset with a microphone. When a voter uses the ASR, they are prompted through the choice of candidates via the headset. Each candidate is assigned a randomly generated number, from which the voter can select by simply saying the number. The first candidate is assigned a random number and incremental numbers are assigned for each subsequent candidate. This approach ensures voter privacy. Eavesdroppers will here a voter speaking numbers with no indication of the voter's choices. For example, assume two voters, Arthur and Irma, enter separate voting booths. If you were to eavesdrop on these two voters, you may hear Arthur saying "five, seven, three, eight" and Irma saying "two, five, one, nine". In this scenario, Arthur and Irma could be voting for the same officials, however, no one would know by simply eavesdropping on their conversations with the machines. Alternatively, voters can vote by touching the screen as well. After a voter finishes voting, their selections are displayed on the screen and spoken to them. At this point, the voter is required to confirm their selections using touch or speech. Upon review and confirmation from the voter, the system records the voter's selection and if the precinct is using printers, the system prints out the corresponding ballot. When used, the printed ballots provide a redundant paper trail of the vote, should there be a need for a recount. Next, the voter exits the voting booth and places their ballot card into a ballot box. This entire process is open to the public and highly visible as the voting area is surrounded by glass walls or simply no walls. The voters can view the machines, the ballot box, poll workers/guards, and each other. The only hidden aspects of the system are the actual touch screens and printed ballots as illustrated in figure 1. This open environment turns every voter into security personnel while they are in the voting area. No one is allowed to touch the actual voting machines nor is anyone left alone with the machines during the election. These are a few physical security measures; however, Prime III incorporates other electronic and software security measures as well.

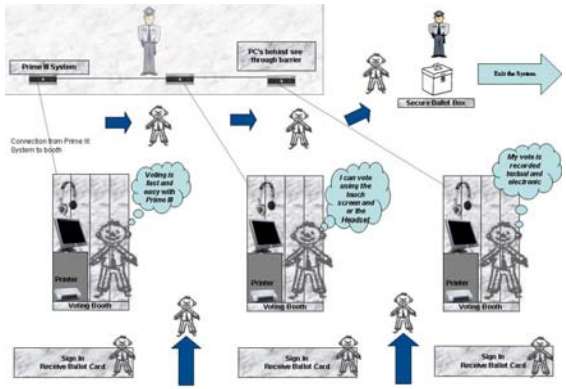

figure 1. Illustration of Prime III Voting Process.

Experimental Protocol

Approximately three hundred subjects were recruited for the preliminary study. These subjects were selected from diverse fields, age groups, ethnicity, and education background. Some of the subjects were recruited from the population, which had physical disabilities. The study was conducted in the student union on the campus of a major research institution to mimic the background noise conditions present at the time of actual voting. The main purpose of the study was to provide an initial assessment of the Prime III user interface as part of a user centered design approach to refine the user interface as needed.

Experimental Setup

Two voting booths were setup in the lobby of the union, which simulated the noisy atmosphere associated with a voting station. Each booth had a touch screen and was equipped with a headset to provide additional modality to interact with the Prime III system. The booths were also equipped with a small printer to print the vote at the end of each subject casting their vote.

Procedure

In order to protect participants' political party affiliations, the Prime III study used burgers and fries as the election candidates. Participants voted on best burger and fries from McDonalds, Wendys and Burger King. Each subject was asked to complete a pre-experiment questionnaire. An ID was assigned to keep the pre-survey and post-survey together. The participant was provided with a chair facing the touch screen, a head set and a paper ballot. The participant entered the booth and inserted the paper ballot into the printer for the final printed ballot, which is an automated task. The participant proceeded to vote using either the touch screen, voice or a combination of the two. Upon completion of the voting task, the participants would remove their printed ballot and insert it into the ballot box. After casting their vote, the participants were provided with the post-experiment questionnaire.

The preliminary study conducted was a controlled experiment. To reduce the effect of the casual factors, the following controls were applied:

- All participants used the same two computing devices, sat in the same chairs and worked in the same work area.
- All tasks were the same for each participant.
- The delay time for each participant to start each task and fill out each survey was the same. The surveys were started immediately upon completion of each task.

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Each participant was instructed to not discuss the experiment with anyone to ensure that all participants had equal knowledge of the experiment.

Preliminary Results

The preliminary results are very promising. There are several major trends suggested by the initial data. First, a significant portion of the participants in the usability study preferred Prime III to the conventional paper electoral ballot. Second, the participants agreed that the features of the system are very easy to use. Specifically, the users were given three questions that pertained to the ease of use of the system. All three of the questions were asked using a 5-point Likert scale, with 1 being the best. On average, the users stated that the overall ease of use of the system was a 2, with 76% of the participants selecting a 2 or lower when rating the ease of use of the system. That question was further broken down into the ease of use of each modality of the system. The users rated the touch-feature as 1.4, with 93% of the participants selecting a score from the top 2. The speech-feature was rated, on average, as less than 1, with 73% of the participants selecting a score from the top 2. Subsequently, the users felt it was easy to complete the voting task. Specifically, a score of 1.4 was given as the average rating for the touch-modality. The majority of the participants, 89%, rated this question in the top 2. Likewise, the users gave an average rating of less than 1 for being able to easily complete the task with speech. Additionally, there were several additional items that the users gave an excellent rating for. When asked how wonderful the system was, a score of 4 was given. This rating is out of 5-points with 5 being the best. When asked how satisfying the system was, a score of 3.8 was given, using the same scale. The average rating for the usability of Prime III is 2.1, on a 5-point scale with 1 being the best. Using the same scale, a score of 1.9 was given for the trustworthiness of the system, with 75% of the participants selecting a score from the top 2. The participants overwhelmingly preferred using touch to complete the assigned task. The participants were given the option of using only speech, only touch, or a combination of both speech and touch to vote. This choice was not formally presented to the participants. The participants performed the task using his/her natural inclination for a particular modality. With that said, 88% of the users decided to use touch only, while 11% decided to use only speech. A very small number, 1%, decided to use a both speech and touch to cast their vote.

There were 6 participants who listed disabilities. Those disabilities were back injury, dyslexia, visual impairment, and diabetes. The majority of the disabled users indicated that they prefer Prime III to paper voting. Regardless of computer literacy, age, race, gender, education level, disability, or chosen modality, the participants would use the system again. The average rating for how likely it is that a participant would like to vote again using Prime III is 1.8, on a 5-point scale with 1 being the best. This corresponds to 86% of the users giving a score in the top 2.

This initial study showed some promising results, but additional research studies are needed to test the security and further test the usability among various populations.

Future Work

Additional studies are planned with various segments of the population. Currently two studies are planned for Spring 2007. One study will explore the usability of Prime III amongst the elderly and a second study scheduled for late Spring 2007 will test the usability of the system amongst a seeing impaired voting population. A third study that is planned for 2007 will be conducted at a small town in Alabama where the Mayor has agreed to participate in this research. All of these studies will explore the usability of Prime III, voter's confidence in the system, completion time, etc. amongst the elderly, visually impaired, those who are considered legally illiterate and other voting segments.

In the upcoming elderly study Prime III will explore the issue of voter confidence. Prime III will be used to test whether or not voter confidence in a system is dependent upon a paper trail. This study will have voting systems set up to print a paper ballot and voting systems that will not. As part of the post questionnaire given to the voters there will be a number of questions that will explore whether or not the voter felt confident in the recording of their vote.

Conclusion

Prime III has the requisite capabilities to provide the nation with a private, secure and usable electronic voting system. The shortcomings in today's electronic voting systems such as vulnerability to hackers, malignant workers, faulty code, lack of recount ability, and human error have been addressed in the development of Prime III. Prime III can broaden voter participation in the electoral process by enabling people with various impairments to vote, i.e. visual, auditory, and/or physical, just as any other member of society [1]. Prime III addresses usable security by providing voters with increased confidence that their votes are actually counted and privacy while casting their vote. Prime III started as a research project [3]; however, it is growing into a viable solution to the nation's woes in electronic voting.

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