WEB 2016

The Fourth International Conference on Building and Exploring Web Based Environments

ISBN: 978-1-61208-485-5

June 26 - 30, 2016

Lisbon, Portugal

WEB 2016 Editors

Daniela Marghitu, Auburn University, USA

Jaime Lloret Mauri, Polytechnic University of Valencia, Spain

WEB 2016

Foreword

The Fourth International Conference on Building and Exploring Web Based Environments (WEB 2016), held between June 26 - 30, 2016 - Lisbon, Portugal, was the inaugural conference on web-related theoretical and practical aspects, focusing on identifying challenges for building web-based useful services and applications, and for effectively extracting and integrating knowledge from the Web, enterprise data, and social media.

The Web has changed the way we share knowledge, the way we design distributed services and applications, the way we access large volumes of data, and the way we position ourselves with our peers.

Successful exploitation of web-based concepts by web communities lies on the integration of traditional data management techniques and semantic information into web-based frameworks and systems.

We take here the opportunity to warmly thank all the members of the WEB 2016 Technical Program Committee, as well as the numerous reviewers. The creation of such a high quality conference program would not have been possible without their involvement. We also kindly thank all the authors who dedicated much of their time and efforts to contribute to WEB 2016. We truly believe that, thanks to all these efforts, the final conference program consisted of top quality contributions.

Also, this event could not have been a reality without the support of many individuals, organizations, and sponsors. We are grateful to the members of the WEB 2016 organizing committee for their help in handling the logistics and for their work to make this professional meeting a success.

We hope that WEB 2016 was a successful international forum for the exchange of ideas and results between academia and industry and for the promotion of progress in the field of Web-based environments.

We are convinced that the participants found the event useful and communications very open. We also hope that Lisbon provided a pleasant environment during the conference and everyone saved some time for exploring this beautiful city.

WEB 2016 Chairs:

Irina Astrova, Tallinn University of Technology, Estonia
Zhe Wu, Oracle, USA
Mariusz Trzaska, Polish-Japanese Institute of Information Technology, Poland
Maria Del Pilar Angeles, Universidad Nacional Autonoma de Mexico - Del Coyoacan, Mexico
Davide Rossi, University of Bologna, Italy
Adriana Martin, National University of Austral Patagonia (UNPA), Argentina
Daniela Marghitu, Auburn University, USA

WEB 2016

Committee

WEB Advisory Committee

Irina Astrova, Tallinn University of Technology, Estonia
Zhe Wu, Oracle, USA
Mariusz Trzaska, Polish-Japanese Institute of Information Technology, Poland
Maria Del Pilar Angeles, Universidad Nacional Autonoma de Mexico - Del Coyoacan, Mexico
Davide Rossi, University of Bologna, Italy
Adriana Martin, National University of Austral Patagonia (UNPA), Argentina
Daniela Marghitu, Auburn University, USA

WEB 2016 Technical Program Committee

Ahmad Abdel-Hafez, Queensland University of Technology, Brisbane, Australia
Rajendra Akerkar, Western Norway Research Institute, Norway
Maha Alabduljalil, University of California - Santa Barbara, USA
Mohammed Alodib, Qassim University, Saudi Arabia
Diana Andone, Politehnica University of Timisoara, Romania
Margherita Antona, Foundation for Research and Technology - Hellas (FORTH) | Institute of Computer Science (ICS), Heraklion, Greece
Leandro Antonelli, Lifia | Facultad de Informatica | UNLP, Argentina
Remi Arnaud, AMD, France
Irina Astrova, Tallinn University of Technology, Estonia
Sofia Athenikos, IPsoft, USA
Judie Attard, University of Bonn, Germany
Dirk Bade, University of Hamburg, Germany
Karim Baïna, ENSIAS / Ecole Nationale Supérieure d'Informatique et d'Analyse des Systèmes - Rabat, Morocco
Henri E. Bal, Vrije Universiteit, The Netherland
Khalid Belhajjame, Paris Dauphine University, France
Carlos Bobed, University of Zaragoza, Spain
Ludovico Boratto, University of Cagliari, Italy
Christos Bouras, University of Patras | Computer Technology Institute & Press «Diophantus», Greece
Tharrenos Bratitsis, CrInTE Lab | University of Western Macedonia, Greece
Miroslav Bureš, Czech Technical University in Prague, Czech Republic
Marcin Butlewski, Poznan University of Technology, Poland
Coral Calero Muñoz, University of Castilla-La Mancha, Spain
Elena Calude, INMS Massey University Albany-Auckland, New Zealand
José Laurindo Campos dos Santos, National Institute for Amazonian Research | Ministery of Science, Technology and Innovation, Brazil
Irene Celino, CEFRIEL, Italy
Sunil Choenni, Research and Documentation Centre / Ministry of Security and Justice, The Netherlands
Paolo Ciancarini, University of Bologna, Italy
Christophe Claramunt, Naval Academy Research Institute, France

Copyright Information

For your reference, this is the text governing the copyright release for material published by IARIA.

The copyright release is a transfer of publication rights, which allows IARIA and its partners to drive the dissemination of the published material. This allows IARIA to give articles increased visibility via distribution, inclusion in libraries, and arrangements for submission to indexes.

I, the undersigned, declare that the article is original, and that I represent the authors of this article in the copyright release matters. If this work has been done as work-for-hire, I have obtained all necessary clearances to execute a copyright release. I hereby irrevocably transfer exclusive copyright for this material to IARIA. I give IARIA permission or reproduce the work in any media format such as, but not limited to, print, digital, or electronic. I give IARIA permission to distribute the materials without restriction to any institutions or individuals. I give IARIA permission to submit the work for inclusion in article repositories as IARIA sees fit.

I, the undersigned, declare that to the best of my knowledge, the article is does not contain libelous or otherwise unlawful contents or invading the right of privacy or infringing on a proprietary right.

Following the copyright release, any circulated version of the article must bear the copyright notice and any header and footer information that IARIA applies to the published article.

IARIA grants royalty-free permission to the authors to disseminate the work, under the above provisions, for any academic, commercial, or industrial use. IARIA grants royalty-free permission to any individuals or institutions to make the article available electronically, online, or in print.

IARIA acknowledges that rights to any algorithm, process, procedure, apparatus, or articles of manufacture remain with the authors and their employers.

I, the undersigned, understand that IARIA will not be liable, in contract, tort (including, without limitation, negligence), pre-contract or other representations (other than fraudulent misrepresentations) or otherwise in connection with the publication of my work.

Exception to the above is made for work-for-hire performed while employed by the government. In that case, copyright to the material remains with the said government. The rightful owners (authors and government entity) grant unlimited and unrestricted permission to IARIA, IARIA's contractors, and IARIA's partners to further distribute the work.

Table of Contents

Introducing Middle School Students to Basic Computer Programming Skills Using Web based App Inventor Application

Kevin Cree
CSSE
Auburn University
Auburn, USA
kmc0043@ auburn.edu

Daniela Marghitu
CSSE
Auburn University
Auburn, USA
DanielaMarghitu@auburn.edu

***Abstract*—Computer technology is one of the driving forces of the US economy. The Bureau of Labor Statistics (BLS) predicts that a 30% increase in demand for software developers by 2020 in the United States [1]. The BLS also predicts between an 18% to 31% growth in salaries in the various computer related professions. To get interest in the computer science field and fill these new jobs the Auburn University (AU) Laboratory for Education and Assistive Technology (LEAT) K12 research and inclusive outreach program developed an innovative App Inventor curriculum to teach the children basic computing skills.**

Keywords- K12 Computer Science inclusive outreach; App Inventor

I. INTRODUCTION

Computer technology is one of the driving forces of the US economy through innovations made by firms like Google, Microsoft, Apple, Facebook and Twitter. The Bureau of Labor Statistics (BLS) predicts that a 30% increase in demand for software developers by 2020 in the United States [1]. The BLS also predicts between an 18% to 31% growth in salaries in the various computer related professions, making computer science related jobs very lucrative career options and thus attractive to students. Yet, rigorous Computer Science (CS) is dramatically under-taught in US's schools. In Alabama, CS Education remained marginalized in a reflection of the situation in the rest of the country. Whereas women currently receive more than half of all the undergraduate degrees granted in the U.S, they earn only 11% of computing degrees [2]. The number of special needs girls who complete a CS undergraduate degree is particularly low; less than 6 % of undergraduate degrees are awarded to students with disabilities annually [3]. People often consider CS a boy's activity where a group of geeks play a violent game in an isolated room, and girls do not want to be considered nerdy. One way to change young women's perception about CS is to provide an engaging CS programming experience that is related to their own personal interests while they work with successful female mentors.

II. ROBO CAMP K12 RESEARCH AND OUTREACH PROGRAM

Today, a record 197 students took the CS AP exam in May 2014. It is also important to point out that Alabama was one of the nation's leaders in the rate of African-Americans who received qualifying scores on the CS AP exam – 75% of African-Americans received a 3 or better on the CS A in recently [4]. While the qualifying rate seems impressive, only 8 such students took the exam. High School women account for 47% of all AP Calculus test-takers, but only 18% of those who take the CS AP test are women. Thus, there are rapidly expanding educational resources for HS students who have an interest and basic skills for CS education, but few women, underrepresented minorities and rural students are engaged in these CS offerings, due in large part to insufficient middle school engagement in CS.

For the past seven years, the Auburn University (AU) Laboratory for Education and Assistive Technology (LEAT) K12 research and inclusive outreach program developed to introduce students (especially girls and students with disabilities) to CS and computational thinking [5]. CS Unplugged [6], Carnegie Mellon University Alice Programming System [7], Microsoft Kodu programming environment [8], Massachusetts Institute of Technology (MIT) App Inventor [9], Lego Mindstorms NXT, EV3 and Tetrix robots, 3D printing are few of the applications used to teach concepts of computer programming and robotics. LEAT team offered several successful k12 teacher development workshops. Offered each semester since 2007, the Robo Camp [10] is an AU K-12 CS outreach program designed to enhance students' knowledge in computing and robotics fields and to offer graduate students a hands-on experience in working with K12 school aged students.

III. APP INVENTOR CURRICULUM COMPONENTS

Robo Camp team has designed a twenty hours informal curriculum using App Inventor (AppI) and CS Unplugged (CSU).

A. Computer Science Unplugged

CSU is a set of non-programming kinesthetic learning activities used to facilitate understanding of CS concepts.

 ISBN: 978-1-61208-485-5

CSU-type activities can help students recognize and learn difficult concepts that may not be made explicit in a particular programming environment [11]. By providing this exposure and then discussing the concept, students can start to understand and identify CS concepts in different programming environments. As recommended in [12] this as a worthwhile investigation into how CSU activities combined with visual programming environments can facilitate deeper understanding of computation and its application.

B. App Inventor

AppI is a web-based drag-and-drop visual programming tool for designing and building mobile apps for Android. AppI promotes a new era of personal mobile computing in which people are empowered to design, create, and use meaningful mobile technology solutions for their daily lives, in endlessly unique situations. AppI's intuitive programming concept and incremental development capabilities allow the developer to focus on the app programming logic rather than the syntax of the coding language, fostering digital literacy for all [13].

IV. APP INVETOR CURRICULUM

The informal AppI curriculum is usually taught in four days camps.

A. Day 1 Basic programing skills

Day 1 starts with an overview of how AppI works, which includes the My Projects Page, App Designer Window, and Blocks Editor. After reviewing the App Inventor system, students build their first application called *Hello Aubie*, which reinforces the skills needed to use MIT App Inventor. Then students go over basic programing skills which includes variables, if statements, if-else statements, methods, and loops. To reinforce these skills, students progressively add new code to the *Hello Aubie* application. While creating the application, students are introduced to basic quality assurance skills by pointing out faults and then being asked to suggest solutions to resolve each step.

B. Day 2 Accessibility

Day 2 focuses on accessibility and first introduces students to different types of disabilities (e.g. communication, hearing/visual impaired, physical, and learning) by playing a game that gives examples of some type of accessibility technology and has the children guess the disability that is assists with. Students work on a talking calculator application, which shows how a visually impaired person may interact with a calculator. Then we cover the concept of random number generation creating a dice application. Lastly we play a game called Java Jump created by Kevin Cree, which is similar to *Shoots and Ladders*, but uses Java syntax to decide the direction of each move.

C. Day 3 Robotics

Day 3 uses AppI and a Lego Mindstorm (LM) robot to reinforce accessibility. The day starts by making a standard controller for the LM robot, which includes forward, back, left, right and stop controls. This exercise shows how to program the different peripherals the LM offer, which includes 2 motors and a sonic sensor. After we complete this project, we build off of it and continue to reinforce the idea of accessibility by creating a voice controlled LM controller. This project is added to the standard controller and allows students to speak commands directly to the Android device and follow the preprogramed movements. While creating this application we sress the importance of applications like this and how the concept could assist people with limited or no mobility.

D. Day 4 Robotics and Binary Numbers

Day 4 continues robotics by adding some additional peripherals and teaching children how to convert binary numbers into decimal format. We start by explaining binary number and how they are converted to decimal numbers using the CSU Binary Numbers activity. We add an additional peripheral, the light sensor, then build an application that runs the LM robot over a set of paper tiles that are light and dark, light being 1 and dark being 0. Each time the LM steps to the next tile it reads out the new binary number. While doing this, students participate and calculate each number and use the LM to verify their calculation.

V. CONCLUSION

We are continuing to develop the AppI curriculum and we closely collaborate with the App Inventor developing team so we can implement the latest environment features. We are especially interested in new components related with Accessibility and Robotics.

REFERENCES

[1] U.S. Bureau of Labor Statistics: http://www.bls.gov/, [Accessed June 14 2016]

[2] NSF Indicators: http://www.nsf.gov/statistics/seind10/,[Accessed June 14 2016]

[3] NSF Disability Report: http://www.nsf.gov/statistics/2015/nsf15311/, [Accessed June 14 2016]

[4] Ericson, B., Guzdial M., Measuring Demographics and Performance in Computer Science Education at a Nationwide Scale Using AP CS Data, ACM SIGCSE. Atlanta, GA, 2014

[5] Marghitu, D., Fuller, M., Ben Brahim, T., Auburn University Robotics and Computer Literacy K- 12 Engineering Camps: A Success Story, ASEE-SE, SPSU, Marietta, GA, 2009

[6] CS Unplugged: http://csunplugged.org/, [Accessed June 14 2016]

[7] Alice: http://www.alice.org/, [Accessed June 14 2016]

[8] Kodu http://www.kodugamelab.com/, [Accessed June 14 2016]

[9] App Inventor: http://appinventor.mit.edu, [Accessed June 14 2016]

[10] RoboCamp:http://eng.auburn.edu/outreach/,[Accessed June 14 2016]

[11] Ward, B., Marghitu, D., Bell, T., Lambert, L., Teaching Computer Science in Scratch and Alice, The ACM Journal of Computing Science in Colleges, Volume 26, Issue 2, pp 8, 2010.

[12] Marghitu, D, Bell, T., Using Virtual Worlds to Engage Typical and Special Needs Students in Kinesthetic Computer Science Activities: A Computer Science Unplugged Case Study AACE ED-MEDIA, Honolulu, HI, 2009.

[13] Pokress, S., Veiga, J., MIT App Inventor: Enabling Personal Mobile Computing, PRoMoTo 2013 Proceedings, October 2013

 ISBN: 978-1-61208-485-5

Electronic Voting and Its Use - E-elections

Juraj Fabus
Department of Communications
University of Zilina
Zilina, Slovakia
email: juraj.fabus@fpedas.uniza.sk

Iveta Kremenova
University of Zilina

Viktoria Fabusova
University of Zilina

***Abstract*— The paper is devoted to the issue of electronic signature in the Slovak Republic. It identifies perspective area for electronic signature use - electronic voting. It discusses possible factors that are essential for the introduction of e-elections to life for citizens of the Slovak Republic.**

***Keywords*-Electrocic voting; security; national ID card.**

I. INTRODUCTION

The subject of this paper is the possibility of using an electronic signature within the concept of e-voting. The aim is to raise awareness of electronic signature, to increase interest in its use, as well as to describe the conditions necessary for the introduction of e-voting.

For example, Estonia is the only country in the world that relies on Internet voting in a significant way for legally-binding national elections — up to 25% of voters cast their ballots online. Independent evaluation [1] of the system urgently recommends that Estonia discontinue use of the system.

The reason for which e-election should be introduced is so, that the Slovak citizens, who live abroad, and the number of which is estimated at around 250,000, can also participate in elections. Today they need to handle long and difficult election by post and mainly for this reason, their voter turnout is so low.

In Section 2 we describe why it would be good to use e-voting in Slovakia. In Section 3, the requirements for protocol used in electronic voting are introduced. Section 4 is about the up and downs of e-elections. Last section – Section 5 – is about eID card project and the possibilities of implementation of e-elections in the Slovak republic.

II. ELECTRONIC VOTING

With regard to electronic voting, the most asked question is its application in national elections. The benefits is particularly in financial savings, speeding-up of results counting, simplification of act of election and to increase participation of younger generation. The field of its use is much broader, ranging from regional elections through referendum, various selection procedures up to the polls. Such use of electronic elections in Slovakia requires the necessary legislative amendments.

On the other hand, the electronic voting as a cheap and quick way to vote could lead to the creation of new institutions. The use of e-voting could be quickly fastened in the university environment, where we can expect computer-proficient people, and where complicated legislative changes are not necessary [2].

III. SECURITY PROTOCOL OF E-ELECTIONS

Implementation of e-voting protocol consists of several phases (Figure 1), which must be performed in a prescribed order.

In the Constitution of the Slovak Republic, it is stated that suffrage is universal, equal, direct and conducted by secret ballot. Electronic voting should be able to enable citizens to realize this right. Possible election fraud and particularities of electronic voting deliver additional requirements:

- Eligibility - Only eligible voters who meet certain well-defined criteria may participate in the vote. Verification of the eligibility to participate in the elections together with mechanisms to avoid multiple counting of voters' votes, must be part of an electronic election scheme. If not, dishonest participant can manipulate with the election results.
- Election verifiability - voter should be able to verify that his vote was recorded and counted correctly in the election results. We distinguish between individual and universal verifiability. This requirement is important for the confidence of voters in the electoral system, including the results. Then, uncontrolled authorities would not be able to manipulate the election results without verification of voters or others.

 ISBN: 978-1-61208-485-5

- Repudiation of vote - Scheme should have mechanisms to deal with inconsistencies in the various stages. For example, if voter finds that his vote was not counted in the election results despite the fact that he participated in the voting, there should be a mechanism that would be able to demonstrate his legitimate complaint against the electoral authorities.
- Justice - No one should have access to partial results if the elections are still ongoing. This information can be misused in a pressure on voters who have not yet participated in the election.
- Secrecy of voting - in electronic voting envelope, the selected option must not identify the voter. Each links between the ballot and the voter has to be deleted. This requirement protects the privacy of the voter in the election, so that he cannot be penalized in any way for the vote.
- Urgency of elections – after the vote, voter would not be able to obtain the document, with which would be able to prove his choice to someone else. This requirement is to impede vote buying [2].

In technological terms, system for electronic voting could operate in different ways. To prevent abuse of the system, the system should be based on qualified electronic signatures. It is a condition for online communication between authorities and citizens.

There are two basic types of protocols in an e-election - a scheme based on blind signature, and a scheme based on homomorphic encryption [3]. Blind signature, as introduced by David Chaum [4], is a form of digital signature in which the content of a message is blinded before it is signed. A homomorphic encryption scheme is a crypto system that allows computations to be performed on data without decrypting it.

With qualified electronic signature, the voters would encrypt the vote by the public key and add the proof of the correctness of the encrypted message, i.e., it comprises a vote of one of the possible candidates only. After signing this report it will be sent to registration server. It checks the voter's eligibility to participate in the election, verifies the signature and fairness of accompanied evidence. If all is well, encrypted vote of the voter can be published.

IV. BENEFITS AND RISKS OF E-ELECTION

For young people who are accustomed to work with the Internet, e-elections would represent a more comfortable alternative that reflects their lifestyle. Any qualified voter would be able to vote from anywhere with internet access. On the other hand, especially for representatives of the older generation who are not adept in using computers, there should still be a space to participate in public affairs in classical way.

There are real technical risks of e-voting over the internet, which should not be overlooked. As a threat, we consider an attack to disrupt the election services with a consequent avoidance of the vote. It is desirable to describe the possible internal and external attacks on individual components of the electoral system. Creating and maintaining people's confidence in the accuracy and security of the electoral process is the basis for the use of electronic voting [2].

V. SITUATION IN SLOVAKIA

Implementation of e-elections in the Slovak Republic should be realized on a long-term concept of informatisation of society and should not be done quickly, because currently our country is not ready for such elections yet.

The first major step toward introducing of e-elections into practice was disclosure of the call for project on a national electronic ID card by the Ministry of Finance. This card should contain components to implement qualified electronic signature. Legal acts carried with it by a citizen, will be then unquestionable. So, the state would provide (and delivered as well) an electronic signature free of charge to every citizen to communicate with other bodies. Such identification card creates good starting conditions for the nationwide e-voting use.

The price of ID card with electronic-signature and the costs associated with its use can influence Slovaks on whether or not to use public services online, and decide whether the vicious circle will finally break, as the weak extension of the qualified electronic signature hinder the use of services. Lack of services on the other hand, inhibits expansion of e-signature [5].

By the end of April 2016, more than 804,000 Slovak citizens had eID cards. Less than 39,000 of them requested also the certificates that enable the creation of advanced electronic signature. The Ministry of Finance is responsible for the implementation of eID cards. It is not clear why people do not apply for advanced electronic signature (free for first five years). Research in this area will be needed.

In [6], the authors proposed a concept of academic election system that can provide voting services for different university applications, e.g., university information system portal, virtual collaboration, video conferencing system, etc. This election system was tested in the project “Modern European elections” [7]. Background process of e-elections is technically highly complex. But for voters casting votes it looks like a simple task. During the simulation, the students inserted the voter card into the chip reader and then entered the PIN. After that, from a desktop application, they selected a party for which they wanted to vote and with a click their choice was sent.

Other, not less important conditions are legislative changes, expanding the availability of broadband Internet, the political will and other factors. Also it is appropriate to establish an expert commission which will assess the social, technical and legal aspects of the use of computerized elections in Slovakia in the context of the development of eGovernment. In view of all the conditions to be met, it seems unrealistic to put the nationwide elections into practice prior 2017 [2].

VI. CONCLUSION

Current state of the electronic signature has positive and also negative effect on the situation in the Slovak Republic.

 ISBN: 978-1-61208-485-5

The electronic signature is not exerted nowadays because of the small extension. It is assumed that these problems will soon be removed, and the competent authorities will pursue the main idea of an electronic signature. Research projects, such as the "Academic election system" and "Modern European elections", which are initiated from bottom, can help to gain the necessary experience with the creation and use of electronic elections. They open public discussion on the future of e-voting in Slovakia.

REFERENCES

[1] D. Springall, T. Finkenauer, Z. Durumeric, J. Kitcat, H. Hursti, M. MacAlpine. J. Halderman, "Security Analysis of the Estonian Internet Voting System", In Proceedings of the 21st ACM Conference on Computer and Communications Security (CCS '14), November 2014.

[2] M. Novotný, "Electronic voting - a sci-fi or near future?", Available from: http://www.itnews.sk/tituly/infoware/free-clanky/2009-11-09/c130130-iw-elektronicke-volby-sci-fi-alebo-blizka-buducnost, [retrieved: may, 2016].

[3] R. Sampiegethaya, R. Poovendran, "A Framework and Taxonomy for Comparison of Electronic Voting Schemes", Elsevier Computers & Security, vol. 25, 2006.

[4] D. Chaum, "Blind signatures for untreaceable payments", Crypto 82, 1982.

[5] G. Jarosova, "Online election at the earliest in 2014", Available from: http://fwd.etrend.sk/vsetko/online-volby-najskor-v-roku-2014.html, [retrieved: may, 2016].

[6] M. Novotny, "Design and analysis of a practical e-voting protocol", in the Proceedings of FIDIS/IFIP Internet Security & Privacy Summer School 2008, Springer IFIP, vol. 298, 2009.

[7] Modern European elections Project Website. Avaliable from: http://ics.upjs.sk/evolby, [retrieved: may, 2016]

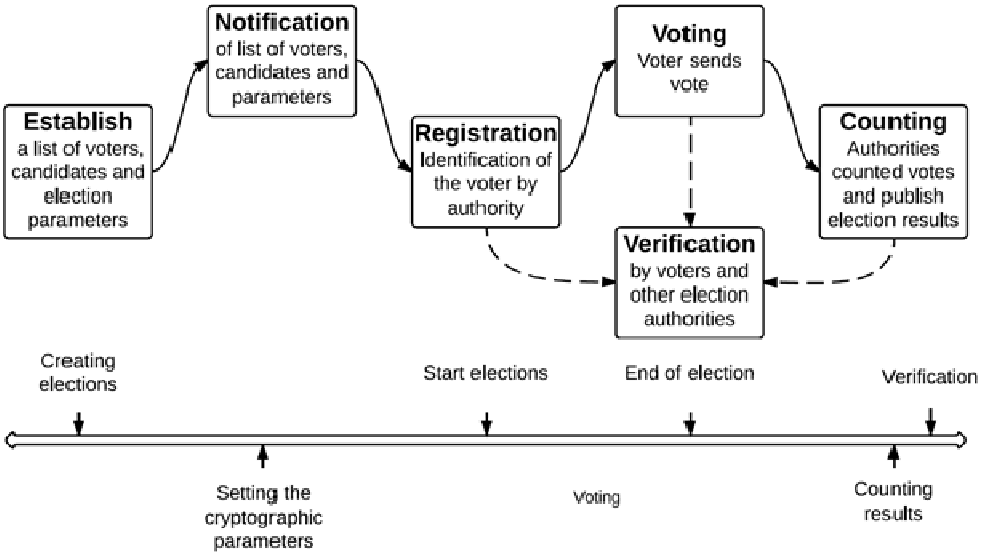

Figure 1. Phases of an implementation of security protocol in electronical election implementation (Source: own processing).

Challenges to Enhancing Web Accessibility in Saudi University Websites: An Exploratory Study

Asmaa Alayed, Mike Wald, E. A. Draffan
School of Electronics and Computer Science
University of Southampton, Southampton UK
E-mail: {asia1g14, mw, ead}@ecs.soton.ac.uk

Abstract—This paper aims to provide an exploratory study of challenges in enhancing web accessibility faced by web developers of the Arabic language version of university websites in Saudi Arabia. The number of challenges encountered were wide ranging from a lack of accessibility knowledge and negative attitude upon disability issues. In the light of the study findings, this paper presents some recommendations for improving the accessibility status in Saudi university websites.

Keywords- web accessibility; Saudi Arabia; disability; challenges; university websites.

I. INTRODUCTION

The number of government universities in Saudi Arabia has increased dramatically in the last two decades from 7 to 28 [1]. As a result the number of their websites has also increased without any clear guidelines in place regarding accessibility, which may hinder some users from benefiting from their content. University websites in Saudi Arabia are in need to address the barriers that might exclude people with special needs from participation in online educational, social and professional activities [2].

Although 65.9% of the population of Saudi Arabia uses the Internet [3], web accessibility has remained a problematic issue for Arabic websites in terms of the accurate assessment of whether those with disabilities are able to enjoy their use on equal terms with their non-disabled peers.

Over 700,000 people with disabilities live in Saudi Arabia which represented around 8% of its citizens in 2015 [4]. Among them, are those interested in or who need to access university websites, for example prospective students, undergraduate students or those pursuing lifelong courses. With a low level of web accessibility the number of people excluded from obtaining the benefits of accessing university websites would definitely increase. This is an important issue to be taken into account when developing websites, services and content.

Therefore, this paper contributes to this area by exploring the challenges in designing and developing accessible university websites in Saudi Arabia. A better understanding of these challenges would help to inform suggestions and solutions for improving access. The contribution of this research will be to enhance the accessibility of university websites in Saudi Arabia.

The rest of this paper is organised as follows. Section II describes studies on accessibility of Saudi websites. Section III presents the research methodology. Section IV presents the results. Section V discusses the results and Section VI concludes the paper.

II. RELEVANT STUDIES

Based on a literature review and to the best of the researchers' knowledge, limited work has been reported on identifying the challenges of designing and developing accessible Arabic language university websites in Saudi Arabia. The study conducted by [2] was the only one found to evaluate the accessibility of university websites in Saudi Arabia, however, it focuses on the English version of these websites not the Arabic one. A few studies, however, have been conducted to evaluate the accessibility of websites in Saudi Arabia. The very first study in this regard was conducted to evaluate the accessibility of e-government websites in Saudi Arabia and Oman [5]. One of the stages of this study was to survey the webmasters of the e-government websites to explore the reasons behind the lack of accessibility in their websites. Since then, there has been limited research to assess web accessibility of Saudi websites, such as [2], [6]-[10]. Generally, there has been strong agreement regarding the poor accessibility of the examined websites and a lack of awareness of its importance. The main violations found were: text alternatives for non-text content, no keyboard accessibility, compatibility and no identification of the language. Moreover, it was reported that a number of accessibility evaluation tools have raised a problem since they do not recognise Arabic language.

Although each of these studies has its significant impact and contribution on accessibility of Saudi websites, it can be seen that little work has been conducted in identifying the challenges of designing and developing accessible Arabic websites in general and university websites in particular. In the USA, for example, there have been studies to explore the same perspective, such as [14] and [15]. Therefore, and to contribute towards this issue, we present our exploration of such challenges in terms of design and development of accessible university websites in Saudi Arabia.

III. RESEARCH METHODOLOGY

Usually, interviews are used to conduct an exploratory study. The interview research method was chosen here

 ISBN: 978-1-61208-485-5

because it enables in-depth discussion and exploration. Experts were chosen for interview at this exploratory stage to ensure the findings would have more credibility than those from a sample of non-experts [16]. When recruiting experts, the choice is based on their knowledge and experience in the area being studied. Therefore, in this type of sampling, sample size depends on saturation, which can be reached when no new knowledge or information can be gathered [17]. Based on the above recommendations, in this study, 15 experts from various Saudi universities were interviewed. Since this paper concerns the perspective of web developers on challenges faced when improving accessibility of university websites, a person was considered an expert if they had at least two years' experience of university website development in Saudi Arabia or were Saudi university researchers with at least two published papers in this area of research.

An invitation was sent by email that requested experts' participation. After sending the invitation emails to the experts, 15 of them from 9 universities responded by agreeing to participate and informed us of their preferred method of communication. The interviews were conducted face-to-face, over the phone and online, according to the availability and location of each expert. Most of the experts (12) were developers or designers, and the remaining three were researchers in the area of web accessibility. Moreover, 60% are from long-established universities and the remainder is from newly emerging universities.

In each interview, the expert was presented with a consent form to sign and then given a brief explanation of the study. After that, open ended questions regarding their opinions on accessibility of their websites and challenges they faced in enhancing their accessibility were asked and the responses audio recorded by the researcher, after obtaining permission.

All the interviews were conducted in Arabic and audio recorded, then transcribed. Afterwards, the transcripts were translated from Arabic to English by a professional bilingual native Arabic translator. Different techniques including back-translation and bilingual committee approach suggested by [18] and [19] were followed in this study. The Arabic version was then checked by three bilingual PhD students in Electronics and Computer Science and Linguistics at the University of Southampton. Upon a satisfactory review, the Arabic version was back translated into English by another translator. The final copy was compared to the original transcripts to check validity of the translation. Minor variations were detected but did not alter meanings.

To analyse experts' responses to the interview questions the interviews were transcribed and saved into NVivo. NVivo is a software tool used to manage and understand textual data, and allow for in depth analysis. Experts' responses were tagged using NVivo according to analysis themes, collected together into groups and then synthesised.

IV. CHALLENGES TO ENHANCING WEB ACCESSIBILITY IN SAUDI UNIVERSITY WEBSITES

Experts were asked to identify challenges they face (or may face) in enhancing the accessibility of university websites. After qualitative content analysis of the question responses, Figure 1 was constructed to show the challenges and the percentage of experts who pointed out the challenges. The challenges were as follows:

A. Negative Attitude Toward People with Disability

It is clear from Figure 1 that the main challenge admitted by the experts was the negative attitude toward people with disability. This attitude was reflected by university websites and web developers, as they are part of society. Therefore, people with disabilities are usually neglected when designing university websites in Saudi Arabia as explained by **Expert C:**

"*When we develop the website, we do not think of users with different abilities or special needs at all. I think this needs to be changed not only in terms of developing accessible website but also in all aspects of our lives.*"

B. Lack of Guidelines for University Websites in Saudi Arabia

The experts mentioned the need for guidelines for all aspects of the websites including the accessibility, usability and organisation of web pages, especially the home page, and consistency in the layout across all Saudi university websites. Responses from all experts indicated that no guidelines, either international or local, were used for web accessibility.

Expert C stated:

"*The focus is on different issues such as aesthetic and security of the website. No attention has been paid to accessibility issues.*"

Expert D added:

"*No accessibility guidelines are followed at all. What our boss asks us to do is copying what other local and international universities do in their websites.*"

Expert G explained:

"*No specific web accessibility guidelines are used in our website. We are connected to a website for evaluating university websites (www.webometrics.info). It puts different criteria for the evaluation process and being accessible is not one of these criteria. In addition, our university is an emerging university established five years ago. The population in our region and university students are low compared to other long-established universities. Consequently, university members with special needs are extremely low."*

Expert H, I and **M** mentioned that although they do not follow any web accessibility guidelines, they are at least committed to consistency across their website by applying a single theme to all its pages.

C. Lack of Training for Developers

Around 60% of the experts have pointed out that the third challenge was the lack of training for developers. This has an

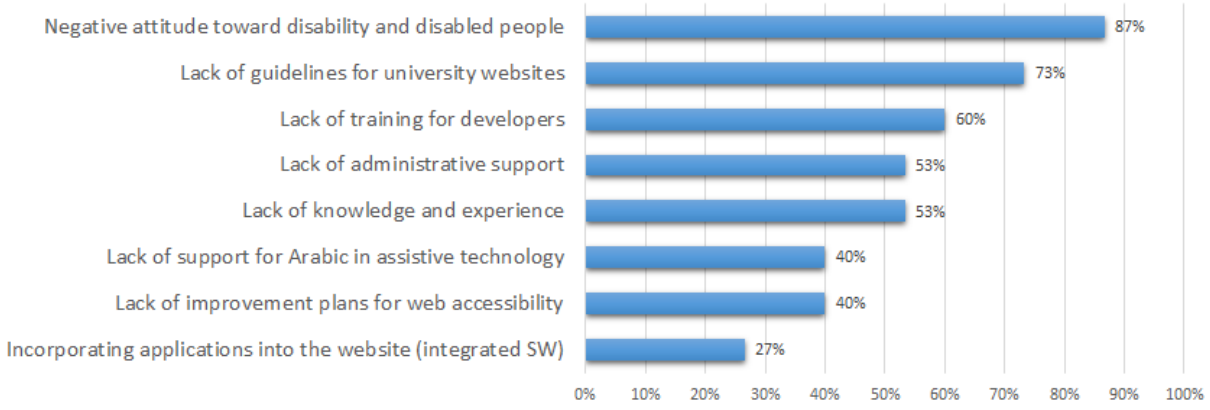

Figure 1 Challenges to Enhancing Web Accessibility Identified by Web Developers of Saudi University Websites

impact on the development of their skills and adaptation to new technologies and techniques.

D. Lack of Knowledge and Experience

The fourth challenge was the lack of knowledge and experience regarding web accessibility, as experts face difficulties when looking for resources they need in Arabic. As stated by **Expert L**:

"*Due to difficulties to find technical resources in Arabic, we tend to limit ourselves to what we can find in Arabic.*"

E. Lack of Adminstrative Support

Around 53% of the experts cited the lack of support from their bosses as one of their challenges. For example, **Expert D** stated:

"*My boss does not want me to produce accessible web elements such as, text alternative for images."*

F. Lack of Improvement Plans for Web Accessibility

Lack of plans for improvement of university websites was another challenge. **Expert H** mentioned:

"*It is not easy to introduce web accessibility in a university website, therefore a clear and realistic improvement plan is needed.*"

G. Lack of Support for Arabic in Assistive Technology

Lack of support for the Arabic language in assistive technology was an issue raised by 40% of the experts. They claimed that in Arabic they do not work, as well as in languages, such as English. Despite the accessibility techniques provided on websites, assistive technology would hinder disabled users from accessing the website. An example was given by **Expert E** for the poor performance of Arabic screen readers, which affects the experience of the blind people who use them. **Expert M** agreed on this matter and added:

"*An Arabic screen reader was added in some of the pages of our website, but the quality of reading is much lower than it should be.*"

H. Incorporating Applications into the Website (Integrated SW)

The last challenge, identified by around 27% of the experts, was integrating software applications into a website. The poor level of accessibility of some of these applications would have an influence on the whole website.

V. DISCUSSION

From the previous findings, it is apparent that the requirements of disabled people are largely ignored when developing university websites in Saudi Arabia. Different challenges and obstacles which contribute to this problem and hinder the implementing of accessibility have been identified by researchers and web developers in these universities. In general, these challenges vary as they concern different issues, such as awareness, technical and administrative issues.

A number of studies have discussed disability in Saudi Arabia, such as [11] and [12]. They have reported the negative attitude of the community toward people with disability as a challenge in conducting research involving the disabled or improving services for them. Our findings agreed with this aspect since around 87% of the experts cited this issue as a main challenge in enhancing web accessibility. As reported in [13], the main reason for negative attitudes is the lack of knowledge about those with disabilities which could be improved by an increased level of knowledge and education about disability issues.

Lack of guidelines for university websites in general and accessibility issues in particular is another obstacle that needs to be addressed by developing guidelines appropriate for university websites in Saudi Arabia and/or adapting the existing web accessibility guidelines to the local context. In addition, legal enforcement by decision makers to follow the guidelines in these universities is needed.

Other issues regarding lack of training, knowledge and experience show a pressing need to raise the developers' skills by training them on up to date technologies. Moreover, technical Arabic resources need to be enriched by translating the resources into foreign languages. Lack of knowledge was a common finding between the current study and [15].

 ISBN: 978-1-61208-485-5

Lack of training was also pointed out as a challenge faced by web developers and webmasters in the USA [14].

It is obvious that the lack of awareness about web accessibility and its importance comes from the administrative level which adds to accessibility problems. Spreading awareness about this issue should start from the managers who then can spread it to their developers. Lack of managerial support was also an issue for American webmasters as discussed in [14].

Lack of improvement plans was another challenge that needs to be overcome by developing strategic, stepwise and realistic plans for adoption of web accessibility. In addition, more work in the area of assistive technology is needed to support Arabic language as most of the technologies do not satisfy their users. The investigation of the accessibility of integrated applications is another issue that would be resolved by early investigation before integration into a website.

Accessibility of integrated applications is another issue that would be resolved by investigating them before integrating them into the website.

We note that lack of time and budget was revealed as a finding from [14] and [15]; however, it was not revealed as an obstacle in this study. This indicates that the financial and time resources are available and would help improve the accessibility situation.

VI. CONCLUSION

In this exploratory study, a number of challenges and obstacles in enhancing the accessibility of university websites in Saudi Arabia have been identified by web designers and developers in these universities. A number of them were found similar to findings from other studies investigating the perspective of web developers. They are: lack of training and lack of managerial support.

Similar to any other exploratory study, this study has some limitations. These include the number of experts involved in the study (15 experts) and their spread across government universities in the Kingdom (9 universities). Further in-depth research is necessary by recruiting participants from all government and private universities which might lead to reveal further accessibility challenges.

In order to enhance the accessibility in Saudi university websites, the identified challenges and obstacles in this study need to be overcome. The successful implementation of accessibility of university websites would allow people with disabilities and special needs to be involved in more activities as are their nondisabled peers and to benefit from the services offered by these websites.

REFERENCES

[1] https://www.mohe.gov.sa/ar/studyinside/Government-Universities/Pages/default.aspx. [retrieved: May, 2016].

[2] M. Rana, M. Fakrudeen, and U. Rana, "Evaluating Web Accessibility of University Web Sites in the Kingdom of Saudi Arabia," International Journal of Technology, Knowledge & Society, vol 7 (3), 2011, pp. 1-16.

[3] Internet Usage in the Middle East, http://www.internetworldstats.com/middle.htm. [retrieved: May, 2016].

[4] http://rs.ksu.edu.sa/82739.html. [retrieved: May, 2016].

[5] A. Abanumy, A. Al-Badi, and P. Mayhew, "E-Government Website Accessibility: In-Depth Evaluation of Saudi Arabia and Oman,". The Electronic Journal of e-Government, vol 3(3), 2005, pp. 99-106.

[6] M. A. Khan and K. A. Buragga, "Effectiveness of Accessibility and Usability of Government Websites in Saudi Arabia," Canadian Journal of Pure and Applied Sciences, vol 4(2), 2010, pp. 1227-1231.

[7] H. S. Al-Khalifa, "Exploring the Accessibility of Saudi Arabia E-Government Websites: A Preliminary Results," In Proceedings of the 4th International Conference on Theory and Practice of Electronic Governance, ACM, Beijing, China, October 25 - 28, 2010, pp. 274-278.

[8] H. Al-Khalifa, et al., "A Pilot Study for Evaluating Arabic Websites Using Automated WCAG 2.0 Evaluation Tools," In International Conference on Innovations in Information Technology (IIT), IEEE, April 2011, pp. 293-296.

[9] H. S. Al-Khalifa, "The Accessibility of Saudi Arabia Government Web Sites: An Exploratory Study," Universal Access in the Information Society, vol 11(2), 2012, pp. 201-210.

[10] A. Al-Faries, H. S. Al-Khalifa, M. S. Al-Razgan, and M. Al-Duwais, "Evaluating the Accessibility and Usability of Top Saudi E-Government Services. In Proceedings of the 7th International Conference on Theory and Practice of Electronic Governance, ICEGOV '13, ACM, New York, NY, USA, 2013, pp. 60-63.

[11] S. I. AlGain and S. S. Al-Abdulwahab, "Issues and Obstacles in Dsability Research in Saudi Arabia," Asia Pacific Disability Rehabilitation Journal, vol 13(1), 2002, pp. 45-49.

[12] M. S. Al-Jadid, "Disability in Saudi Arabia," Saudi Medical Journal, vol 34 (5), 2013, pp. 453-460.

[13] S. S. Al-Abdulwahab and S. I. Al-Gain, "Attitudes of Saudi Arabian Health Care Professionals towards People with Physical Disabilities," Asia Pacific Disability Rehabilitation Journal, vol 14(1), 2003, pp. 63-70.

[14] J. Lazar, A. Dudley-Sponaugle, and K. D. Greenidge, "Improving Web Accessibility: A Study of Webmaster Perceptions," Computers in Human Behavior, vol 20(2), 269-288.

[15] S. Trewin, B. Cragun, C. Swart, J. Brezin, and J. Richards, "Accessibility Challenges and Tool Features: An IBM Web Developer Perspective," In Proceedings of the 2010 International Cross Disciplinary Conference on Web Accessibility (W4A), 2010, pp. 32:1-32:10 .

[16] A. Bhattacherjee, "Social Science Research: Principles, Methods, and Practices," Textbooks Collection. Book 3.

[17] G. Guest, A. Bunce, and L. Johnson, "How Many Interviews are Enough? An Experiment with Data Saturation and Variability," Field Methods, vol 18(1), 2006, 59-82.

[18] R. Brislin, "Back-Translation for Cross-Cultural Research," Journal of Cross-Cultural Psychology, vol 1, 1970, pp. 185-216.

[19] R. Brislin, "Translation and Content Analysis of Oral and Written Materials," Handbook of Cross-Cultural Psychology, vol 1, pp. 389-444.

 ISBN: 978-1-61208-485-5