Journal of Engineering and Computer Sciences
Qassim University, Vol. 9, No. 2, pp. 139-154 (July 2016/Ramadan 1437H)

Usability and Robustness Evaluation of Popular Electronic Services' CAPTCHA in Saudi Arabia

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(Received 21/8/2016, accepted for publication 17/10/2016)

Abstract. Web-based services have been utilized to facilitate many electronic government services that may be exposed to attacks based on some automated tools. In order to prevent these attacks, a method has been proposed to distinguish between humans and bots users. This method is a CAPTCHA, which stands for Completely Automated Public Turing test to tell Computers and Humans Apart. It is a mechanism which is widely used nowadays for protecting web-based services from malicious users and automated spammers. A good CAPTCHA should be usable and robust. Since electronic services (e-services) have recently been released in Saudi Arabia, this paper investigates the usability and robustness aspects of CAPTCHAs that are applied in a number of these services. The results showed that several applied CAPTCHA schemes in some e-services in Saudi Arabia need an improvement in terms of both usability and robustness aspects.

Keywords—*CAPTCHAs; Text-based; Usability; Security; Electronic Services; Evaluation*

1. Introduction

Nowadays, there are many services that governments provide for their populations to help them in many domains such as education, health, employment and so on. However, with the development in technologies and the trend of people to use these technologies anywhere, most countries turn services to be provided electronically. Electronic services (e-services) are the online services available on the Internet. Since there may be such attacks against these services, several security techniques have been proposed. One of these techniques is a CAPTCHA (Completely Automated Public Turing test) to tell Computers and Humans Apart [1]. It is a technique used in a number of website by providing some challenges.

To date, the most popular type of CAPTCHAs is the text-based type; because it has many advantages, such as it is easy for different ages to solve [2]. As a result, this paper focuses on this type only and all CAPTCHAs that will be evaluated in this paper are text-based CAPTCHAs.

The usability and robustness are the fundamental requirements for CAPTCHA design, where the usability is the ease for humans to pass the presented challenges, while the robustness is the difficulty for computers to pass [3]. Hence, evaluating the usability and robustness aspects of an applied CAPTCHA periodically would boost the applied CAPTCHA to be usable for normal users as well as robust against attackers.

A set of e-services in Saudi Arabia has recently been released such as Jadarah, Assurance and Ahwal services. Also, several ministries have used e-services such as Ministry of Commerce, Labor, Education, Health and Foreign Affairs. Due to the importance of evaluating the usability and robustness aspects of an applied CAPTCHA, this paper aims to evaluate the usability and robustness of applied CAPTCHAs in these services.

By analyzing the usability of all applied CAPTCHAs, several usability issues have been observed, such as the applied CAPTCHA in Ministry of Labor. Moreover, by developing a segmentation algorithm, the robustness of all applied CAPTCHAs in the aforementioned e-services is evaluated. The results of this evaluation showed that the design of several applied CAPTCHAs need such improvements in terms of the resistance against such attacks. This is the case for the applied CAPTCHA in the Assurance's website. On the other hand, a number of these CAPCHAs demonstrate robustness against the developed algorithm. This is the case for the applied CAPTCHA in the Ahwal's website. Afterwards, all segmented CAPTCHAs are fed into Neural Network technique in order to recognize them. The results of this recognition step showed that most of the segmented CAPTCHAs have been recognized with more than 93% success rate.

The main contributions of this paper are as follows. Firstly, we evaluated the usability level of the applied CAPTCHA schemes in the aforementioned e-services. Secondly, we developed a segmentation algorithm as well as a recognition method

for evaluating and analyzing the robustness level of applied CAPTCHA schemes in several well-known e-services in Saudi Arabia.

The rest of this paper is organized as follows. Section 2 discusses some related works to evaluate the usability and robustness of text-based CAPTCHAs. Section 3 gives an overview about the targeted CAPTCHA schemes. Section 4 discusses the usability evaluation of targeted CAPTCHA schemes, while Section 5 demonstrates the robustness evaluation of targeted CAPTCHA schemes. Section 6 discusses the results. Section 7 concludes the paper with future work.

2. Related Work

To the best of our knowledge, this paper is the first work for evaluating the applied CAPTCHAs in several Saudi Arabia's e-services. Therefore, this section discusses various works for evaluating both the usability and robustness aspects.

A study aims to understand what kind of issues that should be addressed to make CAPTCHA schemes more usable for humans [2]. The discussion of this study largely focused on text-based CAPTCHAs and Audio CAPTCHAs because they have widely been deployed, and have many advantages compared to other types. For text-based CAPTCHAs, the study discussed the usability issues such as: distortion, content, and presentation [2]. Furthermore, an optimizer that automatically enhances the usability of a text-based CAPTCHA design has been introduced in [3]. This optimizer is designed to be embedded in a text-based CAPTCHA generator, and generating schemes based on a set of rules [3]. Also, the effects of different CAPTCHA distortion techniques on human's visual system and cognitive system of different age groups are compared in [4]. A large-scale evaluation was conducted in [5] that assesses how much friction captchas present to the average user. An experiment has been run in [6] to examine which people have best efficiency and effectiveness for solving localized and Latin-based text CAPTCHA challenges. Furthermore, an empirical pilot study in [7] presented eye tracking to know the complexity of text based CAPTCHA and is it easy for humans to solve or not by using three metrics: fixation count, fixation duration and task completion. A study in [8] describes how would be possible to design a new CAPTCHA scheme for Google that focus on maximizing usability.

A groundbreaking paper for evaluating the robustness aspect of text-based CAPTCHA is by Chellapilla *et al.* [9] in 2005 where human and computer were compared in terms of their recognition abilities. The results showed that computers are as good as human or better at single character recognition even with some distortion. In 2007, Yan and El Ahmad were developed an algorithm that could break most of CAPTCHAs that are provided by Captchaservice.org with a very high successful rate. Moreover, they proposed such new insights on the design of visual CAPTCHA schemes [10]. Likewise, the same authors, in 2008, evaluated Microsoft CAPTCHA, and their attack has achieved a segmentation success rate higher than 90%. Based on

this result, several lessons have been reported regarding the design of a text-based CAPTCHA [11]. The results of this study have been improved in [12].

Moreover, researchers in [13] run experiments and found that if characters are segmented, computers could beat CAPTCHA and recognize them easily. In 2011, several text-based CAPTCHAs have been evaluated in [14] by using a sophisticated developed algorithm. The results showed that most of released text-based CAPTCHAs can be broken except Google CAPTCHA as it has such features that make attacking process difficult. Also, a study in [15] showed that a BotDetect CAPTCHA is effectively but automated program successfully extracted all the characters. Besides, a set of recommendations have been discussed for strengthen text-based CAPTCHAs [16]. Further, the first comprehensive study on e-banking CAPTCHAs deployed around the world for evaluating the robustness aspect is reported in [17].

A recent study in [18] proposes a novel approach to solving CAPTCHAs in a single step that uses machine learning to attack the segmentation and the recognition problems. This study suggests that the next evolution of solving text-based CAPTCHAs would combine the segmentation and recognition processes. In 2015, a study in [19] found important flaws and weaknesses while evaluating the robustness of a new type of CAPTCHAs based on a puzzle completion scheme by using a low-cost side-channel attack. This attack has a 65% success rate. Similarly, in 2016, a study by Gao *et al.* [10] developed a new attack that breaks a wide range of text CAPTCHAs with distinct design features, including those deployed by Google, Microsoft, Yahoo!, Amazon and other Internet actors. They used Log-Gabor filters as an approach for attacking text-based CAPTCHAs.

3. Targeted Captcha Schemes

There are numerous e-services that have recently been launched in Saudi Arabia for facilitating the government services. These e-services include: Jadarah, Assurance and Ahwal services. In addition to these services, several ministries have used e-services such as Ministry of Commerce, Labor, Education, among others. The following highlights each one of the e-services that will be evaluated in this paper with an example of the applied CAPTCHA.

A. Jadarah Website

Jadarah website is an approved service by the Ministry of Civil Service in Saudi Arabia. This website is a special service for citizens applying for the government sector positions [21]. Figure 1 shows a sample of the applied CAPTCHA in this website.

Fig. (1). A Sample of the applied CAPTCHA in Jadarah website [21]

B. Assurance Website

Assurance website is an established service to take care for people who work in private manufacturers and a group of workers in public sector in order to help them after leaving the work due to the retirement, disability or death [22]. Figure 2 shows a sample of the applied CAPTCHA in this website.

Fig. (2). A Sample of the applied CAPTCHA in Assurance website [22]

C. Ahwal Website

Ahwal website is a service that is responsible for registration of citizens and residents in Saudi Arabia [23]. Figure 3 shows a sample of the applied CAPTCHA in this website.

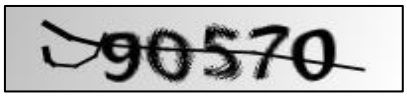


Fig. (3). A Sample of the applied CAPTCHA in Ahwal website [23]

D. Ministry of Commerce Website

Ministry of Commerce website provides commercial services such as emission of commercial regulations and necessary licenses to establish chambers of commerce and all matters related to commerce in Saudi Arabia [24]. Figure 7 shows a sample of the applied CAPTCHA in this website.

Fig. (4). A Sample of the applied CAPTCHA in Ministry of Commerce [24]

E. Ministry of Labor Website

Ministry of Labor website aims to regulate the use of the workforce through the implementation of the regulations, and settlement of labor disputes in the private sectors [25]. Figure 5 shows a sample of the applied CAPTCHA in this website.

Fig. (5). A Sample of the applied CAPTCHA in Ministry of Labor [25]

F. Ministry of Education Website

Ministry of Education website provides various e-services such as Noor system and others that are related to the education in Saudi Arabia [26]. Figure 6 shows a sample of the applied CAPTCHA in this website.

Fig. (6). A Sample of the applied CAPTCHA in Ministry of Education [26]

G. Ministry of Health Website.

Ministry of Health website provides health care for populations in Saudi Arabia, set out regulations for both public and private sectors and monitor their performance. In addition, it provides several e-services such as medical licensing service and search for health facilities in Saudi Arabia [27]. Figure 7 shows a sample of the applied CAPTCHA in this website.

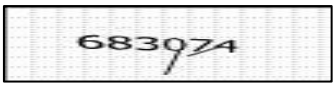


Fig. (7). A Sample of the applied CAPTCHA in Ministry of Health [27]

H. Ministry of Foreign Affairs Website.

Ministry of Foreign affairs website provides different services such as the passport issuance and ratification documents service and so on [28]. Figure 8 shows a sample of the applied CAPTCHA in this website.

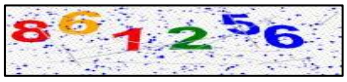


Fig. (8). A Sample of the applied CAPTCHA in Ministry of Foreign Affairs [28]

4. Usability Evaluation

In this section, the targeted CAPTCHAs are evaluated in terms of the usability aspect. The evaluation methodology that is proposed in [2] is followed

here. By analyzing the collected samples manually, it seems that the common issue is the confusion characters [3], as summarized in Table 1.

Table (1). Results of analyzing usability issues in targeted schemes.

Applied CAPTCHA scheme in	Usability Issue
Jadarah website	• Interfering some numbers with each other. • Using incorrect rotation degree with some numbers, e.g. "7" can resemble ">" • Using incorrect vertical shifting size, *e.g.* leading to present some numbers outside the bond of the image as shown in Figure 11.
Assurance website	• No usability issues are observed.
Ahwal website	• No usability issues are observed.
Ministry of Commerce website	• Using incorrect background distortion.
Ministry of Labor website	• Using confusing numbers, e.g. "6" may resemble "9" when using vertical shifting. • Hiding some numbers by each other, e.g. Figure 13. • Hiding some number's shape, e.g. Figure 14.
Ministry of Education website	• No usability issues are observed.
Ministry of Health website	• No usability issues are observed.
Ministry of Foreign Affairs website	• No usability issues are observed.

I. Applied CAPTCHA in Jadarah website

The applied CAPTCHA in Jadarah website seems usable, but we observed several confusions as follows:

- The generated number "7" can resemble ">" as shown in Figure 9.

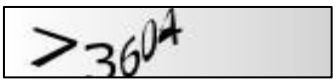


Fig. (9). A Sample of the applied CAPTCHA in Jadarah website with confusions (1) [21]

- Some numbers are hidden in the generated CAPTCHA and this can make the readability tricky for users, as shown in Figure 10 where the third number is disappeared from the top. As a result, users may assume the hidden number is "0" or "8" "6".

Fig. (10). A Sample of the applied CAPTCHA in Jadarah website with confusions (2) [21]

J. Applied CAPTCHA in Assurance website

The applied captcha in assurance website seems usable, all generated numbers are readable and no confusion can be observed. On the other hand, this applied CAPTCHA could be segmented 100%, as will be demonstrated in the next section.

K. Applied CAPTCHA in Ahwal website

The applied CAPTCHA in Ahwal website is usable and interestingly no confusions can be observed.

L. Applied CAPTCHA in Ministry of Commerce website

The applied CAPTCHA in Ministry of commerce website appears usable. However, the distortion used in the background leads to such character confusions. For example, in Figure 11, the third presented number may resemble "9" because it is overlapped with the distortion in the background. So, it is suggested that the distortion can be as lines instead of circles in this applied CAPTCHA.

Fig. (11). A Sample of the applied CAPTCHA in Ministry of Commerce with confusions [24]

M. Applied CAPTCHA in Ministry of Labor website

The applied CAPTCHA in Ministry of labor website appears usable. However, we observed several confusions as follows:

- The generated number "6" may resemble "9" and vice versa when these numbers are distorted by such rotation degrees as shown in Figure 12.

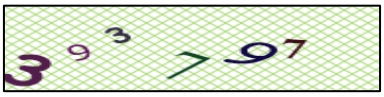


Fig. (12). A Sample of the applied CAPTCHA in Ministry of Labor with confusions [25]

• The generated numbers may be hidden by each other, and this may cause a confusion to users. For example, in Figure 13, which one is the first number in typing the generated numbers (3 or 0)?

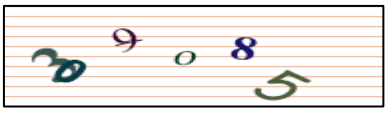


Fig. (13). A Sample of the applied CAPTCHA in Ministry of Labor with confusions [18]

• Some of generated numbers in the released CAPTCHA appear partially as shown in Figure 14, and this would make it tricky to users in order to figure out that what is this number?

Fig. (14). A Sample of the applied CAPTCHA in Ministry of Labor with confusions [18]

N. Applied CAPTCHA in Ministry of Education website

The applied CAPTCHA in Ministry of Education website seems usable for users and no confusions can be observed.

O. Applied CAPTCHA in Ministry of Health website

The applied CAPTCHA in Ministry of Health website seems usable for users and no confusions can be observed.

P. Applied CAPTCHA in Ministry of Foreign Affairs website

The applied CAPTCHA in Ministry of Foreign Affairs website seems usable for users and no confusion can be observed.

5. Robustness Evaluation

In this section, the targeted CAPTCHAs are evaluated in terms of their robustness aspect against such attacks. Since the evaluation methodology that is introduced in [10] seems practical with a very high accuracy, this methodology is followed here in this paper. However, our methodology improves the previous one [10] by using two main phases: a segmentation phase and a recognition phase, and each one of these phases is discussed as follows.

In particular, we firstly collected 100 random samples from each targeted scheme[1]. Then, we developed an algorithm that can segment each sample vertically[1]

[1] The collection period of samples was between Jan 2016 to Feb 2016.

into several chunks. Each of these chunks may contain one or more characters. The segmentation process requires identification of the correct positions for each character. The pseudo code of the proposed algorithm is shown in Figure 15.

```
Input: C_I: CAPTCHA_Image
Output: S_C: Segmented_Character
For x axis do
   For y axis do
      Pre_segmentation (Filter, remove dots/noises, erode and
dilate, and threshold)
For x axis do
   For y axis do
      If the background color and foreground color are white && no
black color in                    background disturbs vertically
the segmentation process
      Then make a vertical segmentation in this particular pixel
Return S_C
```

Fig. (15). The pseudo code of the proposed algorithm.

As a result, based on the developed segmentation algorithm, Figure 16 shows an example of the segmentation process.

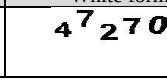
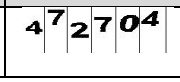
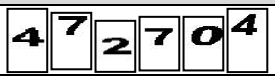
Original Image	Eliminating the background noise and Converting to Black & White format	Segmenting by vertical lines	Last format of the segmentation process
			

Fig. (16). Steps of the segmentation process

After we run the code on all targeted schemes sequentially, we achieved interesting results as shown in Table 2. In particular, all schemes have been segmented either completely or partially, except Ahwal's scheme, where 3% could only be segmented completely. Furthermore, it seems that the applied CAPTCHA scheme in Assurance website was the weakest against our segmentation algorithm, while the applied CAPTCHA scheme in Ahwal website appears the robust one against our segmentation algorithm.

Table (2). Results of segmenting all targeted schemes

CAPTCHA scheme	Number of Segmented Characters		
	Zero	Partially	All
Jadarah	0%	21%	79%
Assurance	0%	0%	100%
Ahwal	3%	80%	17%
Ministry of Commerce	0%	٣٨%	٦٢%
Ministry of Labor	0%	٦٥%	٣٥%

[1] The process of vertical segmentation is explained in detail in [10].

CAPTCHA scheme	Number of Segmented Characters		
	Zero	Partially	All
Ministry of Education	0%	٣٣%	٦٧%
Ministry of Health	0%	١٤%	٨٦%
Ministry of Foreign	0%	٦٥%	٣٥%

Once the segmentation process is done, we used Neural Network (NN), as suggested in [6] as one of the standard recognition techniques, in order to recognize each segmented character of each sample. The recognition process identifies which character is in each position. For this, all samples that have been used for the segmentation phase are used in the recognition phase as a test set, while a new training set is collected (70 samples). This training set is firstly segmented, and then fed it to the NN for training. After that, each segmented character in the test set is fed it to the NN for testing. Table 3 shows the configurations that used for the NN. Consequently, very interesting results have been achieved, as summarized in Table 4.

Table (3). Configurations of the NN

Parameter	Value
Input layer	784 pixels/neurons
One hidden layer	30 neurons
Output layer	10 neurons
Learing rate	30
Mini batch size*	3
Epochs	30

*We used mini-batch stochastic gradient descent (SGD) [29]

Table (4). Results of recognizing all targeted schemes after the segmentation phase

Applied CAPTCHA scheme in	Percentage of successful Recognition
Jadarah webiste	94%
Assurance webiste	94%
Ahwal webiste	83%
Ministry of Commerce webiste	94%
Ministry of Labor webiste	98%
Ministry of Education webiste	89%
Ministry of Health webiste	83%
Ministry of Foreign webiste	99%

Although completely segmented samples of CAPTCHAs that are applied in Ministry of Foreign Affairs website were 35% as shown in Table ٢, almost all of them have recognized. Likewise, the samples of CAPTCHAs that are applied in Ministry of Labor website were almost completely recognized. On the other hand, samples of CAPTCHAs that are applied in Ahwal website were difficult to segment, and not all of them have been recognized correctly.

Furthermore, not all samples of CAPTCHAs that are applied in Assurance website were recognized correctly (*i.e.* 94%), although all of them were segmented successfully as shown in Table 2. Similarly, samples of CAPTCHAs that are applied in Ministry of Commerce website and Jadarah website were recognized with a good recognition rate 94%. Moreover, the successful recognition rates were 89% and 83% for samples of CAPTCHAs that are applied in Ministry of Education and Health websites, respectively.

6. Discussion

The evaluation studies of both usability and robustness aspects, which are conducted in this paper, demonstrate that most of applied CAPTCHA schemes in the e-services need such enhancements. In particular, the robustness level of several applied schemes needs an improvement. For example, the applied CAPTCHA schemes in Assurance website could be segmented with a 100% successful rate as shown in Table 2. Although a set of distortion mechanisms have been applied against the segmentation attack, the application of these mechanisms may not be in the right position. Thus, this could be an explanation of the ability of our algorithm to segment a large number of targeted CAPTCHAs.

Furthermore, applying the NN as a recognition technique reflects the accuracy of the developed segmentation algorithm, where most of the segmented characters have been recognized with more than 90% success rate as shown in Table 4. This combination of the segmentation and recognition methods for evaluating the robustness of a text-based CAPTCHA could support the recent study in [18], as this study suggests that the next evolution of solving text-based CAPTCHAs would be by combining the segmentation and recognition phases. In contrast, the majority of previous works for evaluating the robustness of text-based CAPTCHAs were utilizing only the segmentation phase, for example in [11, 12, 13, 14, 15].

For the usability evaluation, several usability issues have been observed as demonstrated in Table 1. For example, applied CAPTCHA schemes in Jadarah, Ministry of Commerce and Ministry of Labor websites need an optimization algorithm. This algorithm can improve the usability of generating a CAPTCHA scheme by presenting all numbers, characters or both of a generated CAPTCHA scheme inside the bond of the released CAPTCHA, and optimizing the rotation degree. The proposed optimization algorithm in [3] might improve the usability in these schemes. Moreover, it might be helpful to conduct a usability study for all targeted schemes before releasing the generated schemes in order to test the usability feature.

7. Conclusion and Future Work

This paper evaluates the usability and robustness characteristics of applied text-based CAPTCHAs in several popular e-services in Saudi Arabia such as Jadarah, Assurance, Ahwal, Ministry of Commerce, Ministry of Labor, Ministry of Education, Ministry of Health and Ministry of Foreign Affairs. The main contributions of this paper are as

follows. Firstly, we developed a segmentation algorithm as well as a recognition method for evaluating and analyzing the robustness level of applied CAPTCHA schemes in the mentioned e-services. Secondly, we evaluated the usability level of applied CAPTCHA schemes in the mentioned e-services. The results showed that the majority of applied CAPTCHA schemes in aforementioned e-services need an improvement in terms of both usability and robustness aspects. For example, the successful rate of segmenting an applied scheme was 100%, while considerable usability issues were found in another one.

Our future work would be to generalize the evolution study of both robustness and usability of applied text-based CAPTCHA schemes in other e-services.

7. References

[1] Von Ahn, Luis, Manuel Blum, and John Langford. "Telling humans and computers apart automatically." *Communications of the ACM* 47, no. 2 (2004): 56-60.

[2] Yan, Jeff, and Ahmad Salah El Ahmad. "Usability of CAPTCHAs or usability issues in CAPTCHA design." In *Proceedings of the 4th symposium on Usable privacy and security*, pp. 44-52. ACM, 2008.

[3] Alsuhibany, Suliman A. "Optimising captcha generation." In *Availability, Reliability and Security (ARES), 2011 Sixth International Conference on*, pp. 740-745. IEEE, 2011.

[4] Lee, Ying-Lien, and Chih-Hsiang Hsu. "Usability study of text-based CAPTCHAs." *Displays*, 32, no. 2 (2011): 81-86.

[5] Bursztein, E., Bethard, S., Fabry, C., Mitchell, J. C., & Jurafsky, D. "How Good Are Humans at Solving CAPTCHAs? A Large Scale Evaluation." In*IEEE Symposium on Security and Privacy* (pp. 399-413), 2010.

[6] Fidas, Christos A., and Artemios G. Voyiatzis. "An empirical study on efficiency and effectiveness of localized vs. Latin-based CAPTCHA challenges." In*Proceedings of the 17th Panhellenic Conference on Informatics*, pp. 91-97. ACM, 2013.

[7] Al-Khalifa, Hend S. "An Empirical Pilot Study of CAPTCHA Complexity Using Eye Tracking." In *Proceedings of the 16th International Conference on Information Integration and Web-based Applications & Services*, pp. 175-179. ACM, 2014.

[8] Bursztein, E., Moscicki, A., Fabry, C., Bethard, S., Mitchell, J. C., and Jurafsky, D. "Easy does it: more usable CAPTCHAs." In *Proceedings of the 32nd annual ACM conference on Human factors in computing systems* (pp. 2637-2646). ACM, 2014.

[9] Chellapilla, K., Simard, P., and Czerwinski, M. "Computers beat humans at single character recognition in reading-based human interaction proofs (HIPs)." *In Proceedings of the Second Conference on Email and Anti-Spam (CEAS)*, Palo Alto, CA, July 21–22, 2005.

[10] Yan, Jeff, and Ahmad Salah El Ahmad. "Breaking visual captchas with naive pattern recognition algorithms." In *Computer Security Applications Conference, 2007. ACSAC 2007. Twenty-Third Annual*, pp. 279-291. IEEE, 2007.

[11] Yan, Jeff, and Ahmad Salah El Ahmad. "A Low-cost Attack on a Microsoft CAPTCHA." In*Proceedings of the 15th ACM conference on Computer and communications security*, pp. 543-554. ACM, 2008.

[12] Huang, S. Y., Lee, Y. K., Bell, G., & Ou, Z. H. (2010). "An efficient segmentation algorithm for CAPTCHAs with line cluttering and character warping." *Multimedia Tools and Applications*, *48*(2), 267-289.

[13] El Ahmad, Ahmad Salah, Jeff Yan, and Lindsay Marshall. "The robustness of a new CAPTCHA." In*Proceedings of the Third European Workshop on System Security*," pp. 36-41. ACM, 2010.

[14] Bell, Graeme Baxter. "Strengthening CAPTCHA-based Web security," *First Monday* 17, no. 2 (2012).

[15] El Ahmad, Ahmad Salah, Jeff Yan, and Wai-Yin Ng. "CAPTCHA design: Color, usability, and security," *IEEE Internet Computing*, 16, no. 2 (2012): 44-51.

[16] Bursztein, Elie, Matthieu Martin, and John Mitchell. "Text-based CAPTCHA strengths and weaknesses," In *Proceedings of the 18th ACM conference on Computer and communications security*, pp. 125-138. ACM, 2011.

[17] Li, S., Shah, S., Khan, M., Khayam, S. A., Sadeghi, A. R., and Schmitz, R. "Breaking e-banking CAPTCHAs," In *Proceedings of the 26th Annual Computer Security Applications Conference*(pp. 171-180). ACM. 2010.

[18] Bursztein, Elie, Jonathan Aigrain, Angelika Moscicki, and John C. Mitchell. "The end is nigh: generic solving of text-based CAPTCHAs," In *8th USENIX Workshop on Offensive Technologies (WOOT 14)*. 2014.

[19] Hernandez-Castro, Carlos J., María D. R-Moreno, and David F. Barrero. "Using JPEG to Measure Image Continuity and Break Capy and Other Puzzle CAPTCHAs," *IEEE Internet Computing* 19.6 (2015): 46-53.

[20] Gao, Haichang, Jeff Yan, Fang Cao, Zhengya Zhang, Lei Lei, Mengyun Tang, Ping Zhang, Xin Zhou, Xuqin Wang, and Jiawei Li. "A Simple Generic Attack on Text Captchas," In *Proc. Network and Distributed System Security Symposium (NDSS). San Diego, USA*. 2016.

[21] Mcs.gov.sa, "Employment", 2016. [Online]. Available: http://www.mcs.gov.sa/ Employment/ Pages/default.aspx. [Accessed: 26- Feb- 2016].

[22] Gosi.gov.sa, "GOSI", 2016. [Online]. Available: http://www.gosi.gov.sa/portal/web/guest/home. [Accessed: 03- Mar- 2016].

[23] Moi.gov.sa, "Civil Affairs", 2016. [Online]. Available: https://www.moi.gov.sa. [Accessed: 03- Mar- 2016].

[24] "Ministry of Commerce and Industry", *Coc.cr.sa*, 2016. [Online]. Available: http://coc.cr.sa. [Accessed: 09- Mar- 2016].

[25] "Ministry of Labor Saudi Arabia", *Mol.gov.sa*, 2016. [Online]. Available: https://www.mol.gov.sa. [Accessed: 09- Mar- 2016].

[26] "Ministry of Education", *Moe.gov.sa*, 2016. [Online]. Available: http://www.moe.gov.sa/ar/Pages/default.aspx. [Accessed: 13- Mar- 2016].

[27] "Kingdom of Saudi Arabia - Ministry of Health Portal", *Ministry of Health*, 2016. [Online]. Available: http://www.moh.gov.sa. [Accessed: 13- Mar- 2016].

[28] "Kingdom of Saudi Arabia - Ministry of Foreign Affairs", *Mofa.gov.sa*, 2016. [Online]. Available: http://www.mofa.gov.sa. [Accessed: 13- Mar- 2016].

[29] Roux, Nicolas L., Mark Schmidt, and Francis R. Bach. "A stochastic gradient method with an exponential convergence _rate for finite training sets."*Advances in Neural Information Processing Systems*. 2012.

تقييم متانة وقابلية الاستخدام للكابتشا المطبقة في أشهر الخدمات الإلكترونية في المملكة العربية السعودية

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(قدم للنشر في ٢٠١٦/٨/٢١؛ وقبل للنشر في ٢٠١٦/١٠/١٧)

ملخص البحث. لقد تمّ إدراج الخدمات الإلكترونية على شبكة الإنترنت لتسهيل العديد من الخدمات الحكومية والتي قد تتعرّض لهجمات باستخدام بعض البرمجيات الآلية. من أجل منع هذه الهجمات، تم اقتراح طريقة لتمييز مستخدم الخدمة بين المستخدم البشري والكود البرمجي. إنّ هذه الطريقة هي الكابتشا (CAPTCHA) وهو اختصار لـ "اختبار تورينغ العام المؤتمت" والمستخدم للتمييز بين الكمبيوتر والبشر. إنّ هذه الطريقة أصبحت مستخدمة بشكل واسع هذه الأيام لحماية الخدمات الإلكترونية من إساءة الاستخدام بواسطة الأكواد البرمجية المصمَّمة لهذا الغرض. ويجب على الكابتشا الجيدة أن تكون متينه بحيث تقاوم الهجمات المحتملة و قابلة للاستخدام بحيث يستطيع المستخدم البشري استخدامها. وبما أن الخدمات الحكومية الإلكترونية تم اعتمادها في المملكة العربية السعودية مؤخراً، فإنّ هذه الورقة تقيّم مدى متانة وقابلية الاستخدام للكابتشا المطبقة في أشهر الخدمات الإلكترونية في هذا البلد. وقد أظهرت النتائج أنّ عدداً من الكابتشا المطبّقة تحتاج إلى إعادة تصميم لكي تكون مقاوِمة لبعض الهجمات المحتملة، بالإضافة إلى أن بعضاً منها يحتاج أيضا إلى إعادة تصميم لكي تكون قابلة للاستخدام من طرف المستخدم البشري.