IADIS International Journal on Computer Science and Information Systems Vol. 1, No. 2, pp. 63-75 ISSN: 1646-3692

PERSIAN/ARABIC CAPTCHA¹

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ABSTRACT

Nowadays, many daily human activities such as education, trade, talks, etc are done by using the Internet. In such things as registration on Internet web sites, hackers write programs to make automatic false registration that waste the resources of the web sites while it may also stop it from functioning. Therefore, human users should be distinguished from computer programs. To this end, this paper presents a method for distinction of Persian and Arabic-language users from computer programs based on Persian and Arabic texts. In this method, the image of a Persian or Arabic word chosen from a dictionary is shown to the user and he is asked to type it. Considering that the presently available Persian and Arabic OCR programs cannot identify these words, the word can be identified only by a Persian or Arabic-language user. The proposed method has been implemented by the Java language.

KEYWORDS

Completely Automated Public Turing test to tell Computers and Human Apart (CAPTCHATM), Persian and Arabic Text, Optical Character Recognition (OCR), Internet Security, Turing Test.

1. INTRODUCTION

Many aspects of human life have been affected by the expansion of the world-wide web, so that, in industrial countries, many daily affairs from daily shopping to education and commerce are all carried out on the Internet.

One of the common actions in most web sites, esp. commercial and administrative ones, is to fill out registration forms for certain purposes. After filling out the forms by entering the

¹ CAPTCHA is a trademark of Carnegie Mellon University.

required information, the individuals will be allowed to connect to that web site to carry out certain jobs.

Unfortunately, however, there are individuals nowadays who break the law by doing such vandalistic acts as writing programs to make automatic false registration in the web site. These programs automatically fill out a form with incorrect information to enroll in the site. This wastes a large volume of the resources of the site in favor of the profit-seeking programmers or reduces the performance of the system. Such attacks are known as 'Denial of Services' or DoS.

Various methods have been presented in order to prevent such attacks, aiming at distinguishing human users from computer programs. The main characteristic of these methods should be their automaticity so as to be implemented only by using the computer because examination of a large bulk of registration on the Internet web sites by human forces requires a great deal of time and expense and in some cases, such as web sites providing email services, using human force for examining the registration forms is practically impossible. Therefore, it is necessary to use automatic systems to distinguish human users from computer programs.

In the discussions of artificial intelligence (AI), a test known as the Turing test is used for providing the intelligence of a computer. In this test, a human person and a computer are put in two different rooms and a human interrogator in a third room asks them questions. If the interrogator cannot recognize which room the computer is in and which room the human, it is said that the computer has passed the Turing test.

A similar method to the Turing test should be used to distinguish human users from computer programs with the difference that the human interrogator should be replaced by a computer, which should ask questions to distinguish the human user from the computer program. This method is called CAPTCHA (Completely Automated Public Turing test to tell Computers and Human Apart). The main focus of this method is, therefore, on questions that the human user can easily answer but which the present computer programs are hardly likely to be able to answer.

Among the other methods used for distinguishing human users from computer programs is the use of pictures of words. It is a method based on the weak points of optical character recognition (OCR) programs.

OCR programs are used for automatically reading the texts, but they have difficulty reading texts printed with a low quality or reading manuscripts and can only recognize highquality typed texts that use common standard formats. So, this defect of the OCR programs can be taken advantage of by changing the picture of a word so that it can be recognized only by a human user but not by any OCR program. Section 2 will further elaborate on the methods used for this purpose.

The CAPTCHA method is now used in big web sites such as the Yahoo! or Hotmail for registration of users. Besides this method, in recent years, methods have been proposed for overcoming CAPTCHA methods and automatically recognizing such word images (Mori and Malik, 2003; Moy et al, 2004).

By considering the special characteristics of the Persian and Arabic scripts, this paper proposes a new method for distinguishing Persian and Arabic-language users from computer programs by using images of words written in Persian or Arabic. In this method, a Persian or Arabic word is saved in an image format and, after undergoing some changes, is shown to the user while asking him to type the shown word. Since the present Persian or Arabic OCR programs cannot recognize the word, it is only the human users who can type the word correctly.

The structure of this paper provides for: a review of the work done in this regard, in section 2; an introduction to the specific characteristics of the Persian and Arabic scripts which make it difficult to recognize their characters, in section 3; the proposed method in section 4; the experimental results of implementation of this method in section 5; and the final conclusion in Chapter 6.

2. PREVIOUS WORK

So far, no work has been reported on the recognition of human users and computer for the Persian or Arabic language. Therefore, we make a review of the work done for the English language.

It was first in 1997 when Ander Broder et al devised the CAPTCHA method. In the same year, Altavista web site used this method to tell computer programs and human apart. In this method, a distorted English word was shown to the user and the user was asked to type it (Figure 1). Distortion was so that OCR programs could not recognize the word (Baird and Popat, 2002).

These systems were known as CAPTCHA systems and are now used in most well-known web sites such as Yahoo! and Microsoft. Below we further elaborate on these methods.



Figure 1. An Altavista CAPTCHA word (Baird and Popat, 2002)

2.1 The Gimpy Method (Blum et al, 2000)

The Gimpy method was prepared at Carnegie Mellon University to distinguish human users from computer programs. In this method, a word was chosen from a dictionary and, after applying such changes as adding black or white lines, making linear changes, etc, it was shown as an image and the user was asked to type it properly. As this method uses its word from a dictionary with 860 words, it can easily be broken in (Mori and Malik, 2003).

Yahoo! uses a simple version of this method, known as EZ-Gimpy (Figure 2), for recognizing human users from computer programs in preventing consecutive definition of user accounts by destructive computer programs.



Figure 2. Some Yahoo CAPTCHA words (Yahoo, 2006)

2.2 The Baffletext Method (Chew and Baird, 2003)

In the Baffletext method, words that are not provided in English dictionaries are produced, and then the picture of the word is changed with different degrees of ease or difficulty.

Although words with a high degree of difficulty can be used in this method, the produced words will also be difficult for human users to distinguish.

2.3 Using Handwritten Words (Rusu and Govindaraju, 2004)

The other method is to use handwritten words. In this method a databank of the handwritten names of American cities, extracted from letters mailed by people, is prepared. In order to tell humans and computer programs apart, the image of the name of a city is selected and shown to the user and the user is asked to type it correctly.

This method contains word images with a bad quality, some of which are hard to recognize even for human users.

2.4 The PayPal Method (PayPal, 2006)

The PavPal web site provides services for electronic payment of money. It uses distorted words, as in Figure 3, to tell human users and computer programs apart.

Unfortunately, PayPal has not published any details of the method. However, considering the large distance of the characters, it is apparently not difficult for OCR programs to recognize the characters.



Figure 3. Some PayPal CAPTCHA words (PayPal, 2006)

2.5 Using Dynamic Visual Patterns (Liao and Chang, 2004)

In this method, words are printed on a background of visual patterns, e.g. the text is printed on a background of black circles and then show for recognizing human users from computer programs. In spite of the fact that it is difficult for computer programs to recognize these words, they are difficult for human user to read as well.

2.6 The Hotmail Method (Microsoft, 2006)

In the Hotmail email service registration, which belongs to Microsoft Corporation, another CAPTCHA method is used. In this method, as in Figure 4, a string of eight English characters is randomly selected and, after making some changes to the characters, their images are shown to the user and he is asked to type them.



This method has employed researches on OCR systems. These researches show that character segmentation is the most difficult task of an OCR system. Therefore, attempt has been made to change the words so that they cannot be easily separated from each other. This attempt has been made by using some curves to make it separation of the words as difficult as possible. As a result, although separation of these characters is simple for human users, this cannot be done by the present programs.

In this method, because of putting curves in between characters, sometimes some of the characters are read differently and sometimes additional characters are created.

2.7 The Scatter Type Method (Baird and Riopka, 2005)

Similarly to 2.6, this method mainly emphasizes the separation of characters, i.e. the characters are tried to be changed so that they cannot be separated easily. For this purpose, each of the characters is broken into pieces and then the pieces are moved. This makes it difficult for the present OCR systems to separate the characters because the characters in this method are broken into a large number of pieces. On the other hand, the characters are randomly selected so that a dictionary cannot be used to predict the words.

2.8 The Pessimal Print Method (Coates et al, 2001)

This method is based on one of the major weaknesses of the present-day OCR systems, i.e. their inability to recognize characters printed with a low quality. Therefore, it has been attempted to lower the quality of the printed characters artificially so as to prevent the activity of destructive programs.

However, this method does not well resist attacks and the words may be restored to their primary quality by reversing the changes to make the words recognizable by the OCR systems (Mori and Malik, 2003).

2.9 Implicit CAPTCHA (Baird and Bentley, 2005)

The common methods to tell human users and computer programs apart usually troubles the users because he has to read a text that is usually very difficult to read and then type it. However, in the Implicit CAPTCHA methods, the user has to make a simple click. For example, the picture of a mountain is shown to the user and he is asked to click on its top or a number of words are shown in an image and the user asked to click on a specific word. This seems to be an easier method for the users although it is costlier.

In addition to Implicit CAPTCHA, other CAPTCHA methods are available witch are not using OCR systems such as picture recognition method (PIX) (Blum et al, 2000), text-to-speech method (Chan, 2003; PayPal, 2006), and Drawing CAPTCHA (Shirali-Shahreza and Shirali-Shahreza, 2006).

It can be said in brief that methods used nowadays for telling human users and computer programs apart are usually difficult for human users to use and most individuals are reluctant to use them (Baird and Bentley, 2005).

3. CHARACTERISTICS OF PERSIAN/ARABIC SCRIPTS (SHIRALI-SHAHREZA, 1996)

To use Persian or Arabic texts for telling human users and computer programs apart, some knowledge of the language is necessary so as to be familiar with the characteristics of the language in order to design the system according to the characteristics of the language. This section explains the characteristics of these languages in terms of OCR. The main difference between the Persian and Arabic scripts is in the written forms of four sounds /gaf/ ($\stackrel{<}{\sim}$), /che/ ($\stackrel{<}{\sim}$) /pe/ ($\stackrel{<}{\sim}$) and /zhe/ ($\stackrel{<}{\sim}$), which exist in Persian script but not in Arabic.

3.1 Right-to-Left Direction of Writing

Persian and Arabic are written from the right to the left despite English, which is written from the left to the right, or other languages that are written from the top to the bottom. Therefore, Persian characters must be recognized also from the right to the left.

3.2 Dots in Some Letters

Dots are very important in writing Persian and Arabic. 50% of the letters of the Persian alphabet have dots in them. Dots are important because some letters differ only in the number of dots or where the dots are put. Table 1 shows the letters which differ only in the number of dots or the place of the dots. According to this table, the letters may contain no dot or one to three dots. The major problem in recognizing the letters is that the dot may be mistaken with the noise in the image of a text. The other problem with the dots is that, since they may be connected to each other, it is sometimes difficult to distinguish whether it is two or three points.

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3.3 Lack of Space between words

In Persian and Arabic writing, words are not commonly separated by space. Therefore, it is not possible to separate words without considering the entire sentence. In recognition of characters, lack of space between words makes correction of recognized text by using a dictionary difficult.

3.4 Special Diacritics

The Persian and Arabic scripts also contain diacritics known as *tashdid, tanvin, hamza* and *madd*. Although some of them are specific to Arabic, but one can hardly find a Persian text in which none of these diacritics are used. These diacritics are put on top of letters. Examples include "موال" for *tashdid*, "حتما" for *tashdid*, "حتما" for *tanvin*, "موال" for *tashdid*, "حتما" and "موال".

3.5 Lengthening a Word

When typing Persian texts, in order to finish a sentence in the same column, sometimes a lengthening "-" sign is used for lengthening a word. The sign has no specific function and is used only for adding to the beauty of the text. An example can be the word "بالشد" which can be written

3.6 The Different Forms of the Same Letter

A letter in the Persian or Arabic script may be written in up to four different forms (Table 2). The form of each letter may vary depending on where in the word it is used as the forms of the letter named *Ein* which can be either "ع", "ع", "ع", "e" or "z", depending on whether it is written in the beginning of a word, between two other letters, in the end of a word or as a single letter, respectively.

3.7 Diacritic Vowels

Most vowels are not written in Arabic or Persian. However, if there is a possibility of mistake in reading, the vowels may be written by using the appropriate diacritics, which are the same in both Arabic and Persian and include *fatha* "—", *zamma* "—" and *kasra* "—", which are put on top or below the relevant letter to specify the exact vowel for correct reading. For OCR, it is very difficult to separate the diacritic vowels from the letters.

3.8 Overlap

When typesetting or typing Persian or Arabic texts, some letters are put on top of the other or, more precisely to say, there is some overlap between the two letters in terms of space, as in the Persian word "'u' in which "'" overlaps with "u". This also makes recognition of Persian and Arabic characters difficult.

3.9 Different Sizes of Characters

Characters in Persian and Arabic writing are not similar in terms of size. For example, the letter "---" occupies more space in printing than the letter "--". Different character sizes add to the complexity of recognition of Persian and Arabic characters.

3.10 Cursive Writing

In Persian and Arabic, letters are connected during writing, despite English, in which the letters are written cursively in handwritten text only.

Name	Posit	ion in a wo	rd	isolated]	Name	Posit	tion in a wo	isolated	
	beginning	middle	end				beginning	middle	end	
alef			L	١		sad	<u>مـ</u>	<u>مـ</u>	ے	ص
be	÷	÷	Ļ	ļ		zad	ضہ	ضر	ۻ	ض
pe	ļ		<u>ب</u>	Ĵ		ta	ط	h	Ь	ط
te	ت	<u></u>	ت	ت		za	ظ	ä	ظ	ä
se	<u>.</u>	*	<u>ث</u>	ڷ		ein	ع	ع	بح	٤
jim	÷	÷	ę	ى		ghein	à	غ	فح	Ė
che	- `	- ţ	Ş	ş		fe	ف	ā	ف	ف
he	د	<u>ح</u>	で	۲		qaf	ق	ä	ـق	ق
khe	خ	÷	خ	Ċ		kaf	ک	ے	_ى	ک
dal			۲	د		gaf	گ	ے	_گ	گ
zal			Ŀ	ć		lam	۲	1	ل	J
re			ىر	٦		mim	~	~	م	م
ze			بز	ر.		nun	Ľ	<u> </u>	ن	じ
zhe			ڔۛ	ر پ		waw			و	و
sin	ہد_	<u>_</u>	س	٣		he	<u>~</u>	+	٩	٥
shin	شب	يثب	ے	ش		ye	÷	÷	ى	ى

Table 2. Persian Alphabet (Far, 2006)

4. SUGGESTED ALGORITHM

This paper proposes a method for distinguishing of Persian and Arabic human user from computer programs by using the characteristics of Persian and Arabic writing.

In order to describe the suggested algorithm and its characteristics, in each step we will describe the actions taken for English and then compare them with the algorithm proposed for Persian and Arabic.

4.1 Adding Noise to the Image

One of the most effective methods in preventing recognition of characters by OCR programs is to add noise to the image. To this end, doing such things as adding some background to the image, the OCR programs will have difficulty recognizing the characters. Nowadays, however, some ways of removing such noises from images of English words have been found. In Persian and Arabic however, because of the three factors of dots, special signs and diacritic vowels, it is very difficult to separate noise from image because elimination of noise will eliminate the dots and small lines around the text while half of the letters in Persian and Arabic have dots in them and some words have such signs as *tashdid* or *hamza* and, finally, sometimes diacritic vowels are written in order to provide for correct reading. These dots and signs may be removed while eliminating the noises and thus result in false recognition of the characters by the OCR program. As a result, in the suggested algorithm, recognition of characters by OCR programs is made more difficult by adding noise to the image while the human users can recognize the characters.

4.2 Using Similar Characters

In order to make character recognition more complex, usually words are used which have similar forms such as "w, m", "g, q", "i, j" etc. There is a large number of such characters in Persian and Arabic. This strong similarity in characters is usually the result of the characters that differ only in the number of dots, such as "س, "ش", "س, "ش", etc (Table 1), which differ only in the number of dots or where in the letter the dots are put. There are other characters such as "ك، كَ، لَـ. الله eresult for OCR programs to recognize them.

4.3 Connected Characters

One of the most difficult things for OCR programs to do is to separate characters from each other. Considering that characters are written separately in English, CAPTCHA systems try different ways such as reducing the space between the characters, connecting the characters to each other using lines and curves (as in 2.6), etc.

In Persian and Arabic unlike English, letters are connected in writing. Therefore, none of the above actions is needed. As this is done naturally, problems that are created for human users while reading connected letters in English, such as wrong reading of the letters and creating additional letters, are not created.

On the other hand, in Persian and Arabic, in addition to the space that is provided between words, in some words such as "مىشود", the small space between the two parts of the same word, i.e. "مىشود" and "شود" make character recognition more difficult. There are cases that the space between two words is not provided in Persian or Arabic, and this adds to the difficulty of character recognition.

In addition to the above two considerations, the phenomenon of overlap in Persian and Arabic, i.e. overlap of some letters with the previous letter, makes character recognition more difficult.

4.4 Different Letter Sizes

English characters have similar sizes while in Persian and Arabic, for purposes of beauty, one or more letters of the same word may be written longer, as in the case of "بالفن" in the word "بالفن", which has been lengthened. This makes OCR system unable to recognize the letters of a word correctly.

In Persian and Arabic, all letters are not of the same size. For example, "ب" takes more space than "ب". This makes character recognition more difficult.

4.5 Cases

In English, letters have two upper and lower cases while in Persian and Arabic, because of the connection, letters in different positions may take different forms and each letter may have up to four forms depending on its position in the word (Table 2). These forms further add to the complexity of character recognition.

4.6 Using a Dictionary

In English, dictionaries are used in order to complete the recognition of words. Unfortunately there are no appropriate dictionaries for Persian or Arabic and this technique cannot be used for Persian or Arabic character recognition. Consequently, versatility of OCR programs for reading Persian or Arabic texts is reduced.

In view of the above factors, images of Persian and Arabic words were used for telling human users and computer programs apart. First a Persian or Arabic word with 3 to 8 characters from a data base is selected. Although selection of longer words will make it more difficult for OCR programs to recognize the word, it will also be more difficult for the human users to type them.

The selected word is an image file. The image is then combined with a black and white background and some noise is also added so that, as it was mentioned in section 4.1, character recognition will be more difficult for OCR programs. The selected background and the amount of added noise are indeed so that the word can be easily read by a human user.

In the end, the image is shown to the user and he is asked to type the word. If the typed word is the same as the one shown in the image, the user will be allowed to carry out the operation.

5. EXPERIMENTAL RESULTS

This article dealt with providing a method for telling human users and computer programs apart using Persian and Arabic texts. The proposed method was implemented practically with the Java programming language. This software was embedded in a website in the Java Applet format and, after being put on our website, it was tested. Java Applets are software in the Java language that can be run on the World Wide Web.

In implementing this method, a bank of the images of words written with the *Naskh* font was prepared in the PNG (Portable Network Graphics) format (Figure 5).



Figure 5. Some of our CAPTCHA words

The software selects one of the images randomly and shows it to the user. Then the user is asked to type the word. If the typed word is the same as the one shown in the image, the software will notify the user with an appropriate message (Figure 6).



Figure 6. An example of our CAPTCHA program

The word attributed to each image is kept in a separate file, to which the program refers in order to verify the typed word. Because of the complexities of the Persian and Arabic scripts and the inability of the OCR programs in recognizing Persian and Arabic texts even in their simplest form, original images were used here and, despite the methods used for English, the image was not distorted at all. In other hand, due to novelty of CAPTCHA in Persian and Arabic languages and unfamiliarity of Persian and Arabic users with this method, in implementation of our method, noise or distortion are not added to the image of words. This makes it easier for the users to recognize the words. But in future and in next implementations after familiarity of Persian and Arabic users with this method, we will add noise and distortion to the image of words. The trial version of this program is now available on www.shirali.ir/captcha.

For testing this method, we showed the image of words to some users and ask them to recognize and type these words. Their ages were between 15 to 50. In 98 percent, the users were able to recognize the words in first attempt. The source of error was difficulty to recognize the number of dots for some letters. The other problem was mistyping the letters.

6. CONCLUSION

This paper provided a method for telling human users and computer programs apart in the case of Persian and Arabic texts.

The Arabic language is the religious language of all Muslims throughout the world. Therefore, this method covers a wide spectrum of Internet users.

In Persian, in addition to the *Naskh* font, which is used in books and newspapers, there are also other types of font including *Nasta'liq* and the *Shekasteh* font, which are much more complex than *Naskh*. Some of them are difficult to read even for humans. Therefore, these fonts can also be used for telling human users and computer programs apart.

As the method to tell human users and computer programs apart in Persian and Arabic texts is for the first time provided in this paper, there are still many opportunities for development and improvement of this method, which require further research to be done.

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PERSIAN/ARABIC CAPTCHA1

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