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Persian/Arabic Baffletext CAPTCHA[1]

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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. Our proposed algorithm is based on adding a background to the image of a meaningless Persian/Arabic randomly generated word. This method relies on the difficulty of automatic separation of background from Persian/Arabic writing, due to the presence of many diacritical dots and signs.
In this method, the image of a random meaningless Persian or Arabic word 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. This method also can be used to prevent program attacks, resource waste and performance reduction. The proposed method has been implemented by the Java language. The generated words are tested, using ReadIris and Omnipage OCR systems. These OCR systems were unable to recognize these words.

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

Categories: I.5.4, I.4.0

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.

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[1] This paper is an extended and improved version of "Persian/Arabic CAPTCHA" which appeared in proceedings of the IADIS International Conference on Applied Computing 2006 (AC2006), San Sebastian, Spain, 25-28 February 2006, pp. 258-265.
CAPTCHA is a trademark of Carnegie Mellon University.

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 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.

Also there are many other reasons for automatically distinguishing human users from computer programs. Automatic systems attempt to create email accounts for the delivery of SPAM, the systems try to extract content by automatically registration for new users in order to provide added value without compensation. These systems also attempt to fraudulently vote in online polls, etc.

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 automation 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 proving 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. Luis von Ahn, Manuel Blum, Nicholas Hopper, and John Langford from Carnegie Mellon University, called it as CAPTCHA™ (Completely Automated Public Turing test to tell Computers and Human Apart) [Blum, 00]. 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 automatic 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 in reading texts printed with a low quality or reading manuscripts and can only recognize high-quality 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, 03], [Moy, 04].

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 random meaningless Persian or Arabic word is generated and 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 is as follows, the next section is a review of previous works done in this regards. Section 3 explains the specific characteristics of the Persian and Arabic scripts which make it difficult to recognize their characters by OCR systems. In section 4 we present our proposed method. Section 5 shows the results of implementation of this method. We conclude our work in section 6.

2 Previous Works

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 first method for automatically distinguishing human users from computer programs. The problem was defined by Altavista, because people were trying to register their web sites in Altavista search engine under multiple addresses in order to score higher. Therefore, Altavista web site used this method to tell computer programs and human apart and stop that problem. 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, 02a].

Figure 1: An Altavista CAPTCHA word [Baird, 02a]

Luis von Ahn, Manuel Blum, Nicholas Hopper, and John Langford from Carnegie Mellon University, called these systems as CAPTCHA™ (Completely Automated Public Turing test to tell Computers and Human Apart) [Blum, 00]. These systems are now used in most well-known web sites such as Gmail, Yahoo! and Microsoft. Below we further elaborate on these methods.

2.1 The Gimpy Method [Blum, 00]

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 850 words, it can easily be broken in [Mori, 03].

Yahoo! have been used a simple version of this method, known as EZ-Gimpy for recognizing human users from computer programs in preventing consecutive definition of user accounts by destructive computer programs until 2004. The new CAPTCHA method which is used by Yahoo! is shown in Figure 2.

Figure 2: Some new Yahoo! CAPTCHA words [Yahoo!, 06]

2.2 The Baffletext Method [Chew, 03]

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, 04]

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 low quality, some of which are hard to recognize even for human users.

2.4 The PayPal Method [PayPal, 06]

The PayPal 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, 06]

2.5 Using Dynamic Visual Patterns [Liao, 04]

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 shown 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, 06]

In the Hotmail email service registration, which belongs to Microsoft Corporation, another CAPTCHA method is used. In this method, a string of 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 (figure 4). 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.

Figure 4: Some Hotmail CAPTCHA words [Microsoft, 06]

2.7 The Scatter Type Method [Baird, 02b]

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, 01]

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, 03].

2.9 Non OCR Based CAPTCHA Methods

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. But there are also some CAPTCHA methods which are not based on OCR systems such as Implicit CAPTCHA [Baird, 05], picture recognition method (PIX) [Blum, 00] and Text-to-Speech method [Chan, 03].

In the Implicit CAPTCHA method, 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.

In PIX Recognition method, usual pictures (instead of pictures of words) are used to tell human users and computer programs apart. A library of pictures with different subjects is prepared for this method and a number of these pictures that have a similar subject is selected and shown to the user while asking him to select the subject of the picture from among the subjects shown. However, this method requires a large space for keeping the pictures and the library should also be very extensive, which requires large expenses.

In Text-to-Speech method, instead of showing an image, a sound is played which has been obtained by converting text to speech by certain programs. The user must recognize and type the word. Considering the many complexities of speech, it is very difficult for computer programs to recognize the played words. Similar to PIX Recognition method this also requires a great deal of space and expense. This method is also used by PayPal [PayPal, 06].

In general these non OCR CAPTCHA methods seem to be easier methods for the users although they are costlier.

2.10 Comparative Study

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, 05].

As we said, many CAPTCHA methods are OCR based. Among these methods, Hotmail and Yahoo! methods seem to be more powerful though they are easy to use for human users. In table 1 the main characteristics of these methods are listed.

Method Name	Meaningful Words	Rotation	Non-linear Deformation	Background	Two Color Only	Various Fonts	Use Numbers
Old Altavista	No	Yes	No	No	Yes	Yes	Yes
Gimpy	Yes	No	Yes	Yes	No	Yes	No
New Yahoo!	No	Yes	Yes	No	Yes	Yes	Yes
Handwritten	Yes	Yes	Yes	Yes	No	Yes	No
PayPal	No	No	No	Yes	Yes	No	Yes
Dynamic Visuals	No	No	No	Yes	No	Yes	Yes
Hotmail	No	Yes	Yes	No	Yes	No	Yes
Scatter Type	No	No	No	No	Yes	Yes	No
Pessimal Print	Yes	No	No	No	Yes	Yes	No
Baffle Text	No	No	No	No	Yes	Yes	No

Table 1: Main characteristics of OCR based CAPTCHA methods

3 Characteristics of Persian/Arabic Scripts [Shirali, 96]

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 /g/ (گ), /ch/ (چ) /p/ (پ) and /zh/ (ژ), which exist in Persian script but not in Arabic.

3.1 Main Characteristics of Persian/Arabic Scripts

In this subsection the main characteristics of Persian/Arabic scripts are introduced. The first characteristic is right-to-left writing. Persian and Arabic are written in a right-to-left direction unlike English, which is written in a left-to-right direction, or other languages that are written from the top to the bottom. Therefore, Persian/Arabic characters must be recognized also from the right to the left.

The other important feature of these languages is cursive writing. In Persian and Arabic, letters are connected during writing both in printed and handwritten texts, as opposed to English, in which the letters are written cursively in handwritten texts only.

A letter in the Persian or Arabic script may be written in up to four different forms. The form of each letter may vary depending on where in the word it is used. For example the forms of the letter named *Ein* can be either "عـ", "ـعـ", "ـع", or "ع", 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.

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

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 2 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.

ک گ	ف ق	ع غ	عـ غـ	عـ غـ	ع غ	ط ظ	صـ ضـ	ص ض	سـ شـ	س ش	ر ز ژ	د ذ	جـ چـ حـ خـ	ج چ ح خ	ب پ ت ث ـب ـپ	ب پ ت ث

Table 2: Similar Persian letters

3.2 Other Features of Persian/Arabic Scripts

There are also some other features in Persian/Arabic scripts which make recognition of these scripts more difficult. One of these features is the 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.

The other feature is the present of 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* "ـَ", *zamma* "ـُ" and *kasra* "ـِ", 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.

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 "**امّا**" for *tashdid*, "**حتماً**" for *tanvin*, "**قرآن**" for *madd* and "**سؤال**" for *hamza*, Another sign is the shortened "**ی**" which is put on top of "**ه**" as in "**خانهٔ دوست**".

There are also some writing tips in these languages. One of these tips is 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 "**باشد**" which can be written "**بـــــاشد**".

The other tips is overlapping characters. 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 "**را**" in

which "ا" overlaps with "ر". This also makes recognition of Persian and Arabic characters difficult.

4 Our Proposed 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 and Background to the Image

One of the most effective methods in preventing recognition of characters by OCR programs is to add noise and background to the image. To this end, doing such things as adding some background to the image, the OCR programs will have difficulty in segmenting and 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 background to the image while the human users can recognize the characters.

In this method we add some lines to the background of the image. We will explain this work in detail in section 5. But we do not add any noise to the Persian/Arabic words, because adding noise make recognition of these words difficult for human users.

4.2 Using Similar Characters

In order to make character recognition more complicated, 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 "ب،پ،ت،ث", "س،ش", etc (Table 2), which differ only in the number of dots or where in the letter the dots are put. There are other characters such as "ک،گ،ل" which are similar in appearance. In general, the number of similar words in Persian and Arabic is high. Therefore, it is difficult 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 "**می‌شود**", the small space between the two parts of the same word, i.e. "**می**" 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 "**ب**" in the word "**بـــــاخت**", 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, "**پ**" takes more space than "**د**". 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. These forms further add to the complexity of character recognition.

4.6 Using a Random Word

In some English CAPTCHA methods, a CAPTCHA word is chosen from a dictionary (as in 2.1). Although it is easy for users to type the word, it can easily be recognized by OCR programs [Mori, 03]. So we generate a random Persian/Arabic word. Consequently, versatility of OCR programs for reading Persian or Arabic texts is reduced. This method is also used in some English CAPTCHA methods like 2.2.

In view of the above factors, images of Persian and Arabic words were used for telling human users and computer programs apart. First a random meaningless Persian or Arabic word with 3 to 8 characters is generated. 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 generated word is an image. The image is then combined with a colourful background and some random lines 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 added lines 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 paper deals 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 softwares in the Java language that can be run on the World Wide Web.

In implementing this method, first an image of random meaningless Persian/Arabic word is generated. Each time a word is generated, a new random font is used. Using various fonts makes attacking to the CAPTCHA method more difficult.

The software shows this image 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 5).

For adding to the complexity of the OCR for recognition the words, a background is added to the image. This background consists of some random lines. Removing these lines is a hard task for an OCR system. Because removing these lines may destroy some dots and diacritics of the letters and change a character to another one. In cursive character recognition, the segmentation of the characters is harder than recognizing the characters. So, adding lines make the segmentation of characters a hard work for OCR programs. This is the reason that Yahoo! uses some curves and small lines to complicate the task of segmentation and recognition of the letters (see figure 2).

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, as opposed to the methods used for English, this method only adds background to the image of word. This makes it difficult for the computer programs to recognize the words. The trial version of this program is now available on www.shirali.ir/projects/bafflecaptcha.

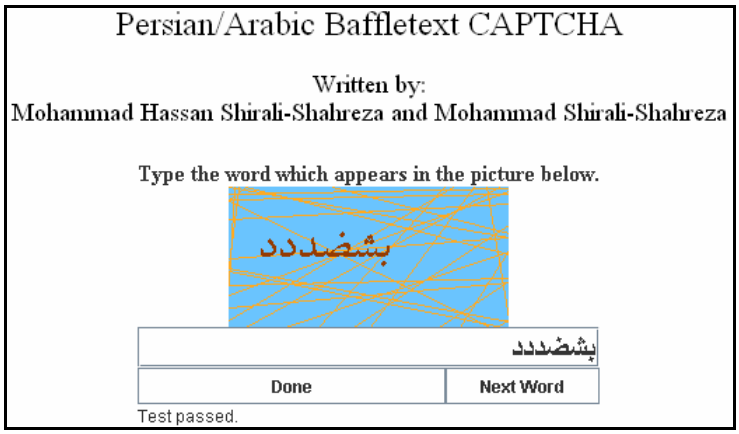

Figure 5: An example of our CAPTCHA program

We prepared 50 random words, and then tested them by two commercial Arabic OCR systems. These OCR systems were ReadIris [IRIS, 06] and OmniPage [OmniPage, 06]. Because the images were color and have backgrounds, OCR systems were unable to separate text from background. So, OCR systems did not go to feature extraction and recognition phases for these images. Therefore, all of images were unrecognizable by these OCR softwares.

We also test these words by some human users. Our human testers could recognize 90 percent of words in first attempt and 10 percent in the second or third attempt.

We analyzed the words that were difficult to recognize by human users. The main difficulty was the similarity of background color to text color. The other problem was existence of random lines which made recognition of dots impossible in some cases.

6 Conclusions

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 Slanted (*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 these methods, which require further research to be done.

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