Bot Protection using CAPTCHA: Gurmukhi Script

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ABSTRACT

Today several daily activities such as communication, education, E-commerce, Entertainment and tasks are carried out by using the internet. To perform such web activities users have to register regarding the websites. In registering websites, some intruders write malicious programs that waste the website resources by making automatic false enrolments that are called as bots which adversely affect the working of websites. So, it becomes necessary to differentiate between human users and Web bots is known as CAPTCHA. CAPTCHA is based on identifying the distorted text, the color of image, object or the background. In this paper a new CAPTCHA technique is proposed that focuses on the use of Gurmukhi script in the generation of CAPTCHA. The proposed scheme uses specific Punjabi font in CAPTCHA generation. Such CAPTCHA exploits the limitations of Gurmukhi OCRs in reading Punjabi text. However, many of the existing English based CAPTCHAs have some inherent problems and cannot assure the security of these websites. The proposed scheme is beneficial in Punjabi speaking countries and is very useful in protecting internet resources. The user interface for proposed CAPTCHA is both Punjabi and English. The mainstay of this project is to avoid tremendous attack from malicious computer programs, so CAPTCHA mechanism has been designed to distinguish humans and computers. A survey has been conducted to find the usability of the scheme, which was satisfactory. The results were encouraging. Moreover, a comparative study of our CAPTCHA with traditional CAPTCHAs and reCAPTCHA has shown its advancement over traditional CAPTCHAs.
Keywords: HIP, Web Bots, Turing Test, CAPTCHA, OCR, Reverse Turing Test.

1 INTRODUCTION

CAPTCHA was invented in 2000 at CMU by Luis Von Ahn, Manuel Blum, and Nicholas J. Hooper John Langford [2], [3].
CAPTCHA stands for
- Completely
- Automated
- Public
- Turing Test to Tell
- Computers and
- Humans
- Apart.

CAPTCHA technology has its foundation in an experiment called the Turing Test. Alan Turing, sometimes called the father of modern computing, proposed the test as a way to examine whether or not machines can think -- or appear to think -- like humans. CAPTCHA follows a reverse turing test in which CAPTCHA program acts like a judge and participant acts like a user. If the test is passed by the user, then he is considered as human otherwise it is a machine. Currently, in order to prevent malicious programs from issuing advertisements or other useless information recklessly, message boards of BBS, blog and wiki have widely used CAPTCHA mechanism, requiring that users must input the correct letters to leave a message. CAPTCHA also plays a significant role in limiting usage rate. For example, the automatic use of a particular service is allowed unless such use goes beyond certain [1], [4].
CAPTCHA is a defensive system that acts as a tool to prevent web bots from abusing online services on the internet including free e-mail providers, wikis, blogs etc. It is a HIP (Human Interaction Proof) system that is widely used to secure the internet based applications [6]. CAPTCHA is also called as a challenge response test which gives a challenge to the users, when the user gives accurate answer he is considered as human otherwise a web bot.
There are 3 basic properties that CAPTCHAs must satisfy [2].
- It should be easy for human users to pass.
- It should be easy for a tester machine to generate and grade.

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- It should be hard for a software robot to pass.

2 RELATED WORK

In 1997, Andrei Broder et al. designed a new system for differentiating between human users and computer programs [9]. This method is used by Alta vista website. In this method, a simple distorted English word is presented to the user and then the user is asked to submit it correctly. If a match is found, then he is considered as human otherwise a bot.

In Oct. 2007, Shirali-Shahreja, M.H. & Shirali-Shahreja, have been proposed Multilingual CAPTCHAs [9]. In this paper a method is based on basis of choice of an object shown on the screen. The user interface of this method is multilingual. At first, the user selects his/her native language. After that, all messages are shown in the selected language. All the messages are translated using an online translator. The advantage of this method is that the user doesn't need to be familiar with English language. This method has been implemented by the PHP language. This method can also implement on other devices such as mobile phone, PDA (Personal Digital Assistant), and the devices which have touch screens.

In May 2007 Ahn et al. created system called reCAPTCHA that channels the necessary cognitive work associated with human verification into a useful purpose: correcting ambiguous portions of text scanned from books using optical character recognition (OCR) software [5]. It overcomes the drawbacks of existing implementations. reCAPTCHA works by showing a user two words: a control word and an unknown word. The control word is used to validate that the user is human, as in a standard word-based implementation. If the user is validated as human, the unknown word is also assumed to be valid, pending agreement from other users.

In October 2007 Elson et al. developed an image-based authentication system called Asirra that relies on a large database of images of pets from various animal shelters [7]. In order to pass the CAPTCHA, the user must select all images depicting either cats or dogs from a set of random images from both categories. The system takes advantage of the fact that users can easily differentiate between semantically different visual content, while the problem is difficult for computers.

In Dec. 2011 Yadava P, Sahu C and Shukla S. introduces a new TIME-VARIENT CAPTCHA [10]. In this paper the focus is not on the effective development of CAPTCHA but targeting a display of CAPTCHA over the webpage for a fixed time, CAPTCHA replaces itself until the final CAPTCHA is filled by user. Refresh process just work with CAPTCHA and don't affect the web page. So, now, automated program has to cover one more area to breach the CAPTCHA: to determine the final entered CAPTCHA.

In March 2011 The paper "Cyber Security Using Arabic CAPTCHA Scheme" is proposed by Bilal Khan et al [8]. The proposed scheme uses Arabic script to generate an image. The image is distorted by adding various types of noises in the background in the form of dots, lines and arcs. The background and foreground colors are selected so that the overall CAPTCHA image is attractive for the user. The varying number of characters, font types and font sizes make it extremely hard for the OCR to read our CAPTCHA. The Algorithm is efficient and the user does not have any problem while interacting with the system. To evaluate the readability rate of CAPTCHA images, a survey was conducted consisted of over one hundred and fifty individuals. Those survey participants were from Arabic speaking countries as well as non-Arabic South Asian countries who can understand the Arabic script. It was found from the survey that the overall readability rate of the images was high. So this proposed CAPTCHA scheme can be used in non- Arabic speaking countries where languages use Arabic script such as Urdu, Pashto and Persian etc.

In August 2011 Sushma Yalamanchili and Kameswara Rao proposed a DevaCAPTCHA that is highly usable as it is easy for humans to successfully provide the response [11]. Since they use words from books and newspapers or an assortment of characters that are non-words, it is not difficult for humans to visually perceive these characters despite the distortions and noise due to their superior visual capabilities and cognitive abilities to make connections with words that they have encountered in some context. Distorted images containing random strings are still easy for humans to read while computers spend endless time processing information. The implementation of DevaCAPTCHA and the participation in OCR testing efforts related to Indian language scripts is to be taken up as future research work. Handwriting recognition and testing for Devanagari script is another future research activity.

3 PROBLEM FORMULATION

Networking and the use of World Wide Web (WWW) has increased multiple folds in the last few years. The internet is easily available these days at cheap rates and used for by all for various purposes. Also, along with this, way of life has also changed. E-business along with electronic transactions has led us to an era of improved technology. Despite improvement in the technology, not all the means of information exchange are safe. Thus there is a need of security measures for the use of websites and other software so as to provide a relatively safer environment to use the available sources. CAPTCHA is once such security application which is used for this security. The use of these different CAPTCHA`s and their importance in today's networking led to research and study them. A lot of work though implemented and researched in this area, a lot still remains to be done.

The purpose is to design a CAPTCHA in Punjabi language that exploit the difference in the reading proficiency between human and computer programs to defend cyber services against bot attacks. In this proposed method,

CAPTCHA is generated as an image which consists of sequence of characters in Punjabi that are shown to the user and with each character there is an appropriate sound attached to it. The proposed method is beneficial in Punjabi Speaking Countries and can be useful in protecting internet resources. The user interface for proposed CAPTCHA is both Punjabi and English. The mainstay of this project is to avoid tremendous attack from malicious computer programs, so CAPTCHA mechanism has been designed to distinguish humans and computers.

4 OBJECTIVE

The main objective of choosing/selecting Punjabi language for use in CAPTCHA is, as large population uses Punjabi language. This type of CAPTCHA can be used to enhance the security of Punjabi language based content based applications. In the Punjabi language users are basically involved in content generation and access of applications in Punjabi language. Custom keyboards are already used by the users that facilitate keyboard input in that language so that the aspect is taken care of.

5 RESEARCH METHODOLOGY

In this section a new method is proposed for distinguishing between human and computer programs. In this method, CAPTCHA is generated as an image which consists of sequence of 5 to 6 characters that is shown to the user and with each character there is an appropriate sound attached to it.

There are two abilities to respond to this type of CAPTCHA:

1. The user can enter the CAPTCHA code by recognizing voice or speech of concerned sequence of characters.
2. The user can enter the CAPTCHA code by interpreting the shown sequence of characters.

Thus if the match is found correct, it means the test is passed by the user. These two operations cannot be done by the computer appropriately, so this method can resist the computerized attacks efficiently.

5.1 Implementation of CAPTCHA

This section explains the implementation and Algorithmic details of our CAPTCHA scheme with its advantages.

➢ http://localhost:1032/anju/Default.aspx is the address of website as shown in figure 1.

Figure 1: Front Page of website

➢The front page of website is designed using language C# with Dot Net Framework, like a login form which directs user to go to next page, when correct code is entered by the user during the login procedure as shown in following figure 2.

Figure 2: LogIn Form for CAPTCHA

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➢ In the Web page, substantially the noisy and distorted image is displayed containing the chosen text string randomly for GUI image display area. The background color of GUI image display area of CAPTCHA Code is white with noise in the form of tiny dots and lines with light blue color. The color of distorted string of Punjabi characters is also blue. A text input box is provided where the user can type in the characters in sequence as they appear in the distorted image. Also sound symbol is provided to so that user can enter the code by listening it by pressing play and stop button. A submit button is to be pressed to signal completion of input. Also reset button is provided to refresh the CAPTCHA Code.

➢ There are many fonts to write the text in Punjabi and in this CAPTCHA Method, Punjabi font gurbanilipi is used to generate CAPTCHA code in Punjabi Language.

➢ The database consist of 41 Punjabi characters in the form of image as shown in following figure 3 with appropriate sound attached to it. The program is generated that picks any 5 to 6 Punjabi characters randomly at a time.

Figure 3: Gurmukhi Alphabet Set

➢ The user interface of this method is both English and Punjabi. The idea is to prevent spammers from using web bots to automatically post form data in order to create email accounts (for sending spam) or to submit feedback comments or guestbook entries containing spam messages.

➢ If user enters correct CAPTCHA code, then message displays " Data Saved Successfully" as shown in figure 4.
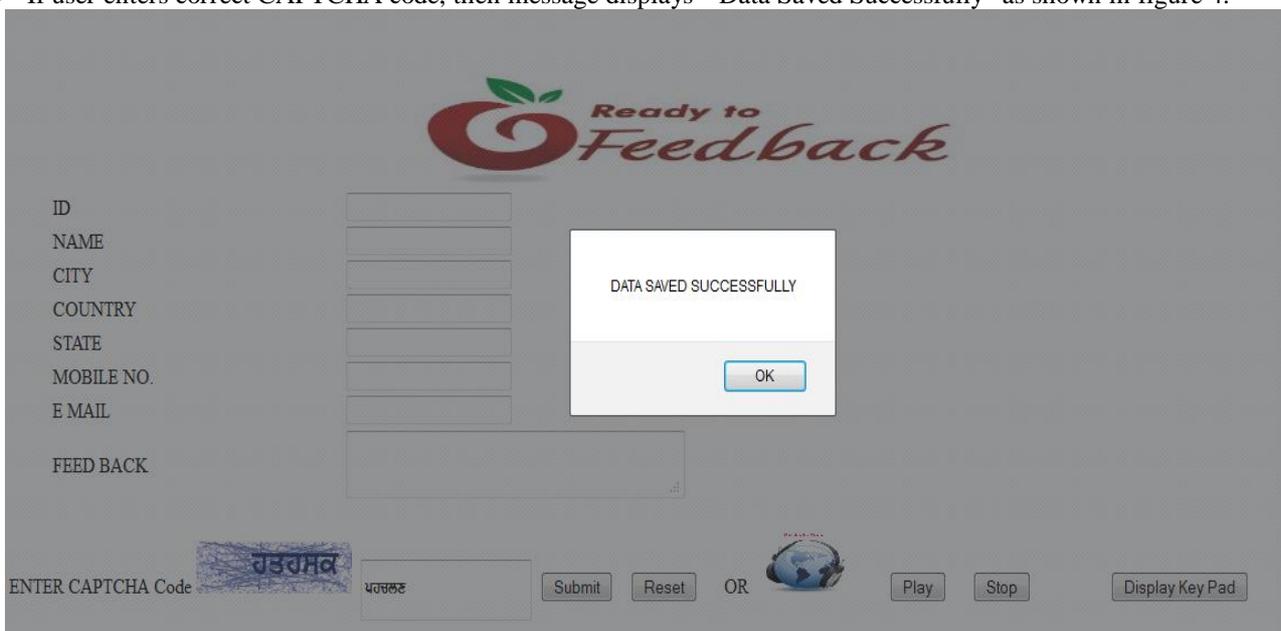

Figure 4: LogIn Form When Correct CAPTCHA CODE ENTERED

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➢ If user enters incorrect CAPTCHA code, then message displays " Invalid Code Inputed " as shown in figure 5.

Figure 5: LogIn Form When InCorrect CAPTCHA CODE ENTERED

➢ Also the Punjabi keypad is provided for the ease of users. To show keypad, "Display Keypad" button is to be pressed and the Punjabi keypad is displayed as shown in figure 6.
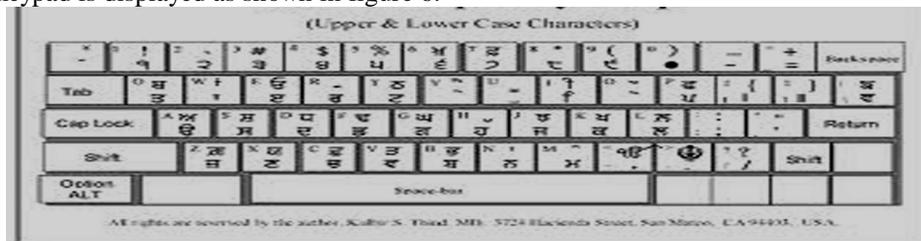

Figure 6: Punjabi Keypad

➢ Various forms of CAPTCHA Code In Punjabi language are as follows as shown in figure 7:

Figure 7: Various forms of CAPTCHA Code

5.2 Advantages

We built a browser-based client, which had several advantages over traditional client/server based applications. These include nearly unlimited client access and greatly simplified application deployment and management. The most common available technologies are Java Server Pages (JSP), Active Server Pages (ASP) and PHP. We chose Active Server Pages (ASP) in implementing our application. This CAPTCHA method has the following advantages.

✓ To pass this test, There are two abilities to respond to this type of CAPTCHA:
o The user can enter the CAPTCHA code by recognizing voice or speech of concerned sequence of characters.
o The user can enter the CAPTCHA code by interpreting the shown sequence of characters.
Thus if the match is found correct, it means the test is passed by the user. These two operations cannot be done by the computer appropriately, so this method can resist the computerized attacks efficiently.
✓ It does not require any processing and can be used on small devices and devices with limited resources such as mobile phones, PDA (Personal Digital Assistant), and the devices which have touch screens.
✓ There is a small database of 41 characters of Punjabi language so the cost of the project is reduced.
✓ Also, C# language is used that is an elegant and type-safe object-oriented language that enables developers to build a variety of secure and robust applications that run on the .NET Framework and most of the web hosting companies support it, so this method can be easily integrated to available websites with low cost.
✓ Besides its advantage of covering every age group we can also recommend it for disabled people because audio CAPTCHA is also provided.
✓ Also to pass this test, the user does not need any knowledge of Punjabi language because Punjabi Keypad is provided for the ease of user.
✓ Also our CAPTCHA method is easy to use and takes little time to pass while not bothering the users.
✓ We can change the difficulty of this method according to its situation. As a result we can make it more difficult by increasing the database, using different Punjabi fonts. This way the recognition of the characters will be more

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complicated and more difficult for a computer. These operations will make the work more difficult even for a human user.
✓ This method is very beneficial in Punjabi speaking countries and can be useful in protecting internet resources.
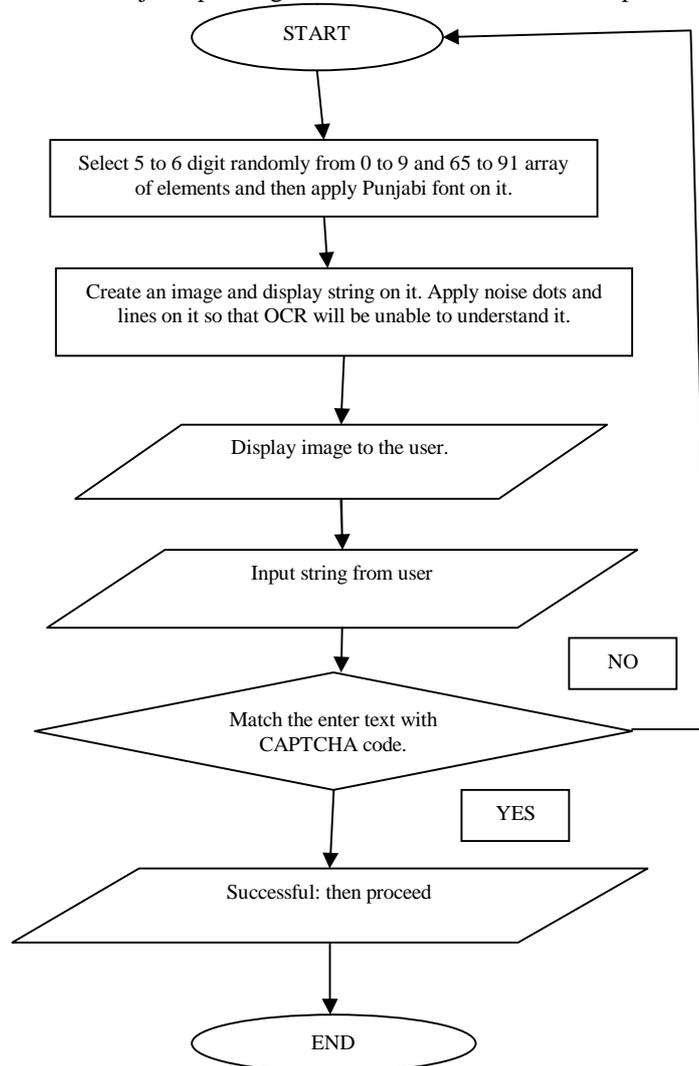
Figure 8: Flowchart Representation of CAPTCHA in Punjabi language

5.3 Algorithm for designing Web Page with CAPTCHA Code
1. Set text_length = select a number randomly in the range of 6 to 7.
2. For a=1 to text_length do
Select letters from a collection of already specified A-Z letters with attached sound files.
3. End for
4. Select a fixed size rectangle.to generate an image within the rectangle.
5. Set background color = white
6. Randomly generate points with random horizontal and vertical coordinates in the image.
7. Set Font type=gurbanilipi.ttf
8. Draw the input text within selected points (coordinates).
9. Set foreground color = blue
10. Set ID = Generates new Challenge ID and Store it in DB
11. Challenge Block = Encrypt(Text, ID)
12. Display Challenge Block.
13. IF Block.Text ≠ User Input then
14. Return False and displays a message "Code not Matched, Please Type Again".
15. Else
16. Return True and displays a message "Data Saved Successfully".
17. End If.
4. End.

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6. RESULTS AND DISCUSSION

We implemented this project in C# with ASP.NET platform. We have taken few fields in the form just to show the impression of the registration form. The fields in the form are provided just to show the impression of the registration form are ID , NAME CITY, COUNTRY, STATE, MOBILE NO., E-MAIL-ID and Submit button is to be pressed to submit the entered code.

We had successfully implemented this project and run the system for nearly 50 students of our college and all the times it generated a new CAPTCHA with Punjabi characters and the system does work as per the specifications.

6.1 User Study

A test was performed in which about 50 (students) users participated. The objective of the user study was to obtain a usability estimate. In other words, we wanted to know how difficult it was to pass the test. Also, as Time is an important metrics for any CAPTCHA as a CAPTCHA is an overhead for any user. Hence the time to solve a CAPTCHA should be as small as possible so that the user spends more time on his/her intended work rather than proving his/her identity as a human being.

Several goals were kept in mind for the test:

- Average time taken by the users to solve the Punjabi CAPTCHA and Audio CAPTCHA.
- Which the users would prefer to solve if this is provided as a CAPTCHA to them.
- The enjoyment factor of this CAPTCHA as compared to the traditional CAPTCHAs.
- The difficulty level of the CAPTCHA compared to traditional CAPTCHAs.
- Any difficulty faced by the users.

The test was conducted on a web browser and the user response was taken in the form a feedback form. Each student was asked to solve 7 questions of Questionnaire. The results were as follows:

- After completing the whole process we found that, only 74% of participants indicated that they found Punjabi CAPTCHAs easy, while 26% of participants indicated that they found Punjabi CAPTCHAs very easy.
- 80% of participants indicated that they found Punjabi CAPTCHAs enjoyable while 20% found more enjoyable.
- 78% of participants are satisfied, while 35% are more satisfied while attempting this test.
- However, 70.9% of participants indicated that they prefer Punjabi CAPTCHA while 59.8 % prefer our audio CAPTCHA.
- The average time to solve Punjabi CAPTCHA is 14.07seconds, while the average time to solve Audio CAPTCHA is 15.05 seconds.

The average success rate was 75% as shown in figure 9. The result is above the average compared to other CAPTCHAs where user success rates are usually above 82%.
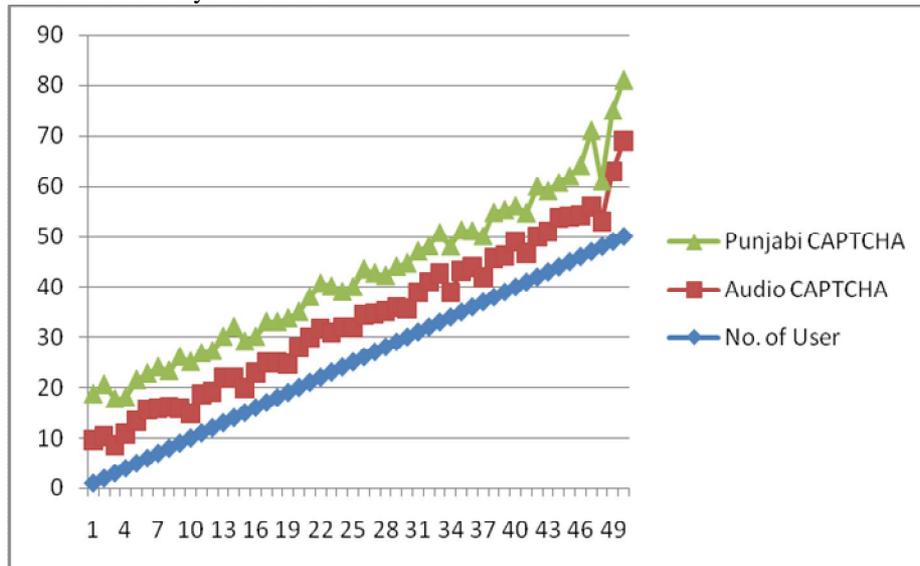

Figure 9: Success Rate of Our CAPTCHA

- Furthermore, our results indicate that our CAPTCHAs have comparable usability and security to many existing CAPTCHAs. These results are encouraging and suggest that providing this CAPTCHA as an alternative to other CAPTCHAs may be a viable and user-friendly option.

There are several factors contributing to this result. These are:

1. Language difficulties also contribute to average success rates since users may not immediately know the characters in Punjabi to describe the displayed image.
2. Some users reported that having to look up Punjabi keypad before guessing, takes more time.

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3. Likewise, context and personal experience play a large role.

TABLE 1: AVERAGE TIME TAKEN TO SOLVE CAPTCHA

Average time (In Seconds)		Total Average Time
Punjabi CAPTCHA	14.07	14.56
Audio CAPTCHA	15.05	

6.2 Comparison with traditional CAPTCHAs
In this section, our CAPTCHA Method is compared with the traditional CAPTCHAs as well as with reCAPTCHA on the basis of success rates and usability rates.

[1.] In case of Traditional CAPTCHAs, the average time for solving a regular Google CAPTCHA (we chose 8 letter words) with a computer screen and keyboard was 4:3 seconds for subjects familiar with English, and 4:4 for subjects not familiar with English. In comparison, the average time for solving a regular Google CAPTCHA with a cell phone screen and keypad was 15:9 seconds for subjects familiar with English and 2.7 for subjects not familiar with English.
A final experiment showed no difference between the time required to solve a CAPTCHA displayed on a computer screen and on a cell phone screen, when in both cases the solution was input with a computer keyboard.
Whereas this CAPTCHA method takes, the average time to solve Punjabi CAPTCHA is 14.07seconds, while the average time to solve Audio CAPTCHA is 15.05 seconds. That is total average time is 14.56 secs., that shows an improvement over traditional CAPTCHAs.

[2.] Luis von Ahn in his world-wide deployed reCAPTCHA system [26] has observed an average success rate of around 97% and 93% for passing reCAPTCHA tests in daytime and at night (both US time), respectively. According to IP addresses of service requests that reCAPTCHA has received, more users from outside of the US (e.g. those in Asia) access this service at night than in the daytime (both US time).
In Case of reCAPTCHA, Four character words have a success rate of 93.7%; five character words, 95.7%; six character words, 96.4%; seven character words, 96.7%; etc. This can be explained by longer words providing more contexts for the users. The same relation holds when restricting attention to countries where the native language is not English, but to a lesser extent (consistent with our explanation that knowledge of the English language helps with longer words.
The fact that both standard CAPTCHAs and reCAPTCHAs take roughly the same amount of time to solve should not be surprising, because English words have patterns to which human users are accustomed. In addition, the time taken to solve reCAPTCHAs varies more widely because English words vary in length (15).
Whereas in our CAPTCHA method, success rate is 75%, it is more than 90% in reCAPTCHA. Besides this, our method is more secure than reCAPTCHA, because it takes less amount of time.

7 CONCLUSIONS AND FUTURE SCOPE
7.1 Conclusion
This scheme uses Punjabi font to generate an image. The image is distorted by adding noise in the background in the form of dots. The background and foreground colors are selected so that the overall CAPTCHA image is attractive for the user. The Algorithm is efficient and the user does not have any problem while interacting with the system.
The average success rate was 75% as shown in figure. The result is above the average compared to other CAPTCHAs where user success rates are usually above 82%. After survey, we found that, only 74% of participants indicated that they found Punjabi CAPTCHAs easy, while 26% of participants indicated that they found Punjabi CAPTCHAs very easy. 80% of participants indicated that they found Punjabi CAPTCHAs enjoyable while 20% found more enjoyable. 78% of participants are satisfied, while 35% are more satisfied while attempting this test. However, 70.9% of participants indicated that they prefer Punjabi CAPTCHA while 59.8 % prefer our audio CAPTCHA. And, the average time to solve Punjabi CAPTCHA is 14.07seconds, while the average time to solve Audio CAPTCHA is 15.05 seconds. The only problem that is faced by the initial users who are not familiar with Punjabi characters reported that most time is spent for looking up characters from the keypad.

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Furthermore, our results indicate that our CAPTCHAs have comparable usability and security to many existing CAPTCHAs. These results are encouraging and suggest that providing this CAPTCHA as an alternative to other CAPTCHAs may be a viable and user-friendly option. As a whole our method is versatile and flexible and can be adjusted and modified for various purposes.

7.2 Future Scope
The results of this thesis work point to following directions of research that are likely to be needed for further improvement.
- This CAPTCHA scheme can be devised, developed by using varying number of fonts, font sizes, and font colors.
- Handwritten CAPTCHA in Punjabi can be generated to expand the search space.
- This CAPTCHA scheme can also be devised, developed by implementing 3D CAPTCHAs.

A study can be done to find out the possible weak points of the system and hence to overcome them and make the system more secure.

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