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CHAPTCHA BASED INFORMATION SECURITY: A SURVEY

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Abstract: With the advent of internet, information is at the tip of the figure, which has raised an issue of 'Digital Humanism' for discussion. Information Security and Authentication are the key problems in the digital era. The offshoots of internet causes for hacking important information through bots, spammers, dictionary attacks while operating online accounts. These are automated destructive programs, which unnecessarily increase the damage space. The remedy to this problem is the use of CAPTCHA (Completely Automated Public Turing Test to Tell Computers and Human Apart). The present paper is an attempt to review the literature regarding existing CAPTCHA Schemes, its drawback, working, generation and their applications.

Keywords: CAPTCHA, OCR, Bots, Web Security.

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INTRODUCTION

In recent decades, web applications like email, social networking sites, blogs, e-governance sites etc. have become everybody's necessity. With the rapid growth of Internet, Security is also becoming a critical issue. CAPTCHA (Completely Automated Public Turing Tests to tell Computers and Human Apart) was developed to prevent automated bots from performing actions that meant for human users. CAPTCHA, as defensive scheme against such Web-bots. Security of CAPTCHA can be broken by OCR. There are many numbers of CAPTCHA techniques having their own advantages and limitations.

CAPTCHA is challenge response test used to determine whether user is human or not. Computer cannot understand distorted text or numbers. CAPTCHA follows reverse Turing Test based on text, image, video or audio. Web services use CAPTCHA in chat rooms, search engines, password systems, online polls, e-mail services for account registrations, prevention of sending and receiving spam, blogs, messaging services, free content downloading services and detecting phishing attacks [1]. A good CAPTCHA satisfies Automatic generation of the test, Quick and easy answer to the test, Acceptance to all human beings and Resistance to attacks with publically known protocol.

This review paper presents existing CAPTCHA Techniques and their merits, demerits and also presents current research work and scope for future work.

II. HISTORY:

It was 1996, Naor proposed framework that provide a test to check humanity automatically [1]. In 1997, AltaVista was being mistreated by the automatic submission of URLs to their "add-URL" service. Chief Scientist Andrei Broder and his colleagues devised a way to prevent bots from submitting URLs. The applied method was to generate random strings of text and distort them so Optical Character Recognition (OCR) programs would have difficult to reading them but humans would not. In 1999, slashdot.org issued an online poll asking users to pick the best computer science school in the US. Students at MIT and Carnegie Mellon University created "voting bots" to vote for their school multiple times. In September 2000, Yahoo! reported that bots were entering their online chat rooms and pointing users to advertising sites. Luis von Ahn, Manual Blum, Nicholas Harper, and John Langford developed CAPTCHA.

ReCAPTCHA: The *ReCAPTCHA* service uses the CAPTCHA interface, asking users to enter words seen in distorted text images onscreen, to help digitize the text of books, while protecting websites from bots attempting to access restricted areas. The ReCAPTCHA service supplies subscribing websites with images of words that optical character recognition (OCR) software has been unable to read.	
Gimpy: Gimpy is based on the idea of reading distorted and corrupted text by the human and not by automated programs. It works by selecting the words from a dictionary, and then appearing of those words in a form of corrupted and distorted image and then Gimpy CAPTCHA asks the user to type the words displayed in the form of distorted image.[6]	
Ez-Gimpy: EZ-Gimpy is based on the idea of reading distorted, textured background and cluttered text by the human and not by automated programs. It works by selecting the one word from a dictionary, and then appearing of those words in a form of corrupted and distorted image and then EZ-Gimpy CAPTCHA asks the user to type the word displayed in the form of distorted image.	
Bongo: Bongo is a CAPTCHA of solving a visual pattern recognition problem by a human. It displays two series of different blocks (left and right). The user is asked to find the characteristic that state the difference between two blocks	
MSN-CAPTCHA : Digits and 8 characters (upper case) are used. The foreground color is sets dark blue and background color sets grey. To produce the ripple effect and to distort the characters warping is used. MSN-CAPTCHA is broken by yan. Rotating and distortion of characters, the noise in the form of lines of the same color crossing characters.	
Baffle-Text *is* designed at California University at Berkeley by Henry Baird .It's a modified version of Gimpy. In Case of Baffle-text a random alphabets or characters are picked to form a pronounceable text. Then the user is challenged to enter the right word.	
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Lius Von Ahn presented reCAPTCHA in 2007 with: "Read a book, Stop Spam". ReCAPTCHAs challenges include two words one of them is a complex content with an obvious reply and the other is scanned from a physical book with lack of recognizing program with OCR. Through digitalization process of physical books, it is possible to increase searching facility and reducing required resources for reservation or transfer of them. When a user tries to solve a challenge and if there is a correct word for relevant image, it is assumed that the reply is also correct. If the users enter the same variety for an unknown word, the system will be ensured about their reply as well.

Jeremy Elson (2007) has presented ASSIRA (Animal Species Image Recognition for Restricting Access) Image CAPTCHA.

In this CAPTCHA, there are 12 images from among a database with more than 3 million of photos. Then the user is required to recognize the image of cats or dogs from among 12 images. And in 2008, Kluever & Zanibbi introduced Video CAPTCHA. This CAPTCHA uses a social video of users on Web.

III. CLASSIFICATION OF CAPTCHA:

CAPTCHAs are classified in to four types: 1. Text based 2. Image based 3.Audio based 4.Video based.

1. Text-based CAPTCHA: It is most popular type. Security of an existing text CAPTCHA is enhanced by systematically adding noise and distortion, and arranging characters more tightly [2,3]. Background color and distortion and font style are different, therefore it is tough to recognize it by OCR. This type of CAPTCHA is have the properties like, Font, Character set, Distortion, Tilting, Waving, etc.

ESP-Pix : Developed by Luis von Ahn and reCAPTCHA team. User presented with 4 distorted images and asked to identify them. It used a larger database of photographs and animated images of everyday objects. The CAPTCHA system presented a user with a set of images all associated with the same object or concept. The user are required to enter the object or concept to which all the images belonged to category e.g. the program might present pictures of Globe, Volleyball, Planet and baseball expecting the user to correctly associate all these pictures with the word ball. In general image based CAPTCHAs present a visual pattern or concept that the user needs to identify and act accordingly. Different image-based CAPTCHA scheme use different patterns or concepts which are easy to be recognized by the users and difficult for the bot programs to simulate.
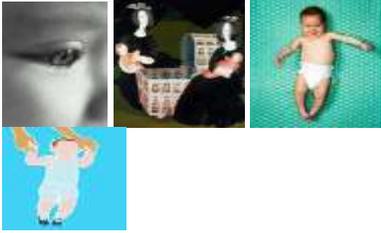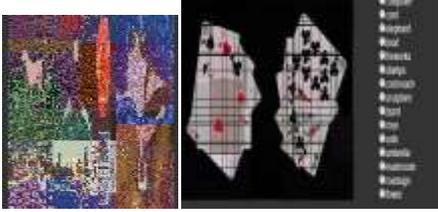
Pix: PIX is a program that has a wide database of indexed and labeled images. These images are the pictures of real time objects (a human, animal flower etc). The object is picked by the program randomly. It then finds four images of that object from the database on the random basis, distorts them and then presents them to the user and then asks the question "what kind of images are these ? or These images belong to which object".	
Asirra: Asirra is an image-based CAPTCHA. It asks user to click on the random image of any random object selected from the image database.	
IMAGINATION (Image Generation for Internet Authentication) system, produces randomly chosen distorted images and present them to the user. It uses a two step verification process - 1. The user clicks near the center of any picture in the mosaic. 2. The user is asked to identify a distorted image by selection from a select list.	
Ajax : AJAX is Asynchronous JavaScript and XML. Ajax technologies are used by Developers to build Web applications with improved performance and interactivity, as well as responsive user interfaces. It can also be said that AJAX is the technology of exchanging data with a server, and updating of a web page without reloading/refreshing the whole page. Ajax introduces a mediatory engine (written in JavaScript) between the user and the server.	

Image based CAPTCHA: Requires user to identify labeled images or rotated images.

Audio based CAPTCHA:

The first audio based CAPTCHA was implemented by Nancy Chan to provide an alternative to text based CAPTCHAs for visually impaired people. Audio CAPTCHAs [10] take a random sequence drawn from recordings of simple words or numbers, combine them and add some disturbance and noise to it. This recording is played when the user clicks a button provided on the web page. The CAPTCHA system then asks the user to enter the words and/or numbers in the recording. Audio CAPTCHAs are more difficult to solve and more demanding in terms of

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time and efforts in comparison to text and image CAPTCHAs. However, audio based CAPTCHA tests have become an alternative for visually impaired people. Most Web services include it in addition to text and image CAPTCHAs.

Video based CAPTCHA:

NuCAPTCHA is a first-of-its-kind CAPTCHA technology that uses video to determine if users are human, not bots.

Question based CAPTCHA:

Math Questions

Instead of a graphical code, the user has to answer a simple math question. A common example would be "2 + 2". The user then has to enter the answer and if it is correct, the system loads the succeeding page. This option is good for most people. Math questions may cause difficulties for persons with cognitive disabilities.

Simple Questions

Apart from math questions, developers have tried using simple questions. An example of this is a question such as "What is the second letter of the English alphabet?" Simple questions generally work well for Internet users. But problems may still arise for certain people. For instance, the above example may be difficult for non-English speakers to quickly provide the answer.

Clickable CAPTCHA:

Clickable CAPTCHA combines several textual CAPTCHA into grid, only determination of grid elements which satisfy some given requirement. The selection is done by mouse or touch screen, no keyboard required. So this is more secured and its usability is also more that is used in mobile devices.

Substitute to CAPTCHA: Verification via SMS

In this option, the site asks for the user's mobile number. After the user has provided this information, the site will send an SMS containing the verification code to the mobile phone. The user then can enter the code in the specified field. The main problem of this option is that every person doesn't have mobile phone. In addition, a blind person, for example, may have a mobile phone but it doesn't have the needed screen reading software.

IV. CURRENT RESEARCH WORK

The challenging task is to generate the CHAPTCHA in local language. Numerous research work is being carrying out for different Indian Scripts and Languages. Sushma Yalamanchili and Kameswara Rao [15] proposed using Devanagari script. OCR for printed Devanagari text are developed but to recognize distorted or noisy text is yet to be achieved. Bilal Khan et al [18] presented Arabic Language CAPTCHA Scheme. M. Hassan Shirali-Shahreza and Mohammad Shirali-Shahreza [4] proposed a "Multilingual CAPTCHA". S. Ravi Kiran,Y. Rama Krishna [20], presented a new approach to protect user's password against spyware attack. From a security viewpoint, this exploration is expected to advance the development of graphical passwords. Mandeep Kumar and Renu Dhir [23] have presented new Image based CAPCTHA technique by creating large database of different labeled colored images. All of these images are pictures of concrete objects (a car, a table, a fan, a flower, a computer etc) but within only one color or it be a colored image only. Rituraj Soni and Devendra Tiwari [24] proposed "Improved CAPTCHA method". In their work, they have proposed method on left hand of screen display the images and right hand side of screen display names of images appeared on left hand side. Program asks to select image from left hand side and select its name from right hand side of image. Then enter correct name of image selected in text box below. It is pass by human only not by computer bot. This method is suitable for any age group and used also on PDA and mobile devices. It is like a matching pairs. Juraj Rolko, Zilina, Slovakia (2010) proposed "3D CAPTCHA, CAPTCHA based on spatial perspective and human imagination". Authors have provided information on a new technology named 3D CAPTCHA. This CAPTCHA system is based on

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human imagination and spatial perspective. Test solution requires from user to find the correct observation point. It is a point which makes 3D image displayed in the CAPTCHA meaningful. The user is looking for a proper solution by rotating the 3D model in a simple and well arranged user environment. When creating the technology the emphasis was put on the use of innovative and untraditional methods. Many users find the most widespread text-based CAPTCHA systems unfriendly, so in the case of 3D CAPTCHA the authors tried creating a simple user interface and providing users with the best possible comfort in solving CAPTCHA test.

V. WORKING OF CAPTCHA:

A Web server may be holding both public and protected resources that may be in the form of web pages, data stored in a database or files or some other service intended to be used by human users on the client. User request for a resource is send by the client computer to the server, which is granted to it if the resource is not protected. In case the resource is CAPTCHA protected, the access is granted to it only after passing CAPTCHA test.

The server uses some CAPTCHA image generation algorithm to generate a CAPTCHA image. Different CAPTCHA techniques use different algorithms for image generation which may employ use of images stored in an image database. The state information along with Global Unique Identifier (GUID) of the client and the CAPTCHA solution is stored in the State Information Database (SID) at the server. Storing GUID of the client ensures that only client that received CAPTCHA can produce a valid solution. Instead of storing the CAPTCHA solution and other state information on server in SID, it be may stored in hashed or encrypted form in a cookie on the client. A web page containing the generated CAPTCHA image and the cookie is posted to the client which renders it in a web browser to the user. A human operator responds to CAPTCHA test and the response is passed by the client to the server. The server verifies the authenticity of CAPTCHA solution by comparing the stored GUID and the GUID of the client sending the solution. The solution provided by the client is next compared with the solution stored in SID or cookie and accordingly either access is granted or denied. In case access is denied, a message is posted to the client and the process starts afresh. A CAPTCHA implementation may temporarily block access for a client if it repeatedly fails to respond to a number of CAPTCHA tests. Further, for a particular session once a CAPTCHA challenge has been passed by a client, subsequent accesses to protected resources on the server may be granted to it without putting it to further tests [22].

VI. CAPTCHA GENERATION:

It is not possible to generalize the algorithm for generation of CAPTCHA image; however, the steps listed below provide a guideline for creation of a basic text-based CAPTCHA image:

1. Create a CAPTCHA image of desired dimension sufficient to hold the text or numeric string.

2. Set the background color for the CAPTCHA image. Instead of choosing a solid background color, a pattern or a stored background image may be used. Some CAPTCHA tests use a simple white background while others fill the image with some form of noise.

3. Generate n random characters from the designated character set and/or digit set. Generally upper and lower case English alphabets are used as character set and 10 numerals are used as digit set. A CAPTCHA test which is case insensitive and uses both alphabets and numbers thus has total combinations of 36 characters while as the one which is case sensitive, has a total combination of 62 characters. The character generation algorithm is made to generate those characters which are similar to one another in some manner and will make the string complex to be understood by the OCR techniques.

4. Choose the font, font size, font style, font color and other related attributes. Most CAPTCHA implementations make   use of personalized fonts and apply twist to characters so as to make OCR techniques to fail. Some CAPTCHA tests use different fonts and styles for different characters to make the test more secure.

5. Select a random spacing between each generated character. The spacing is chosen in a manner that some characters partially overlap one another. The text string is then placed on the CAPTCHA image.

6. Optionally, generate lines and arcs or other objects with desired parameters and place it on the CAPTCHA image to make the characters inseparable by the OCR programs.

7. Finally, apply a distortion to the generated CAPTCHA image by using some mathematical transformation. The application of the distortion makes characters within the image to twist and thus increases the difficulty for the OCR programs to decode it [11].

VII. MERITS OF DIFFERENT TYPES OF CAPTCHA:

Sr. No	Types of CAPTCHA	Merits
1	Text based CAPTCHA	1) Text-based CAPTCHA is simple to implement so it's mostly used in websites. 2) Battle Text-based CAPTCHA is used to defeat dictionary attacks. 3) Re-CAPTCHA Text-based CAPTCHA uses new dictionary words that cannot read using optical character recognition.
2	Images based CAPTCHA	1) Over the text-based CAPTCHA it increases the security. 2) Simple click based system so no need of typing. 3) Using Image-based CAPTCHA pattern recognition of image is difficult.
3	Audio based CAPTCHA	1) It is used for people that have visual impairment. 2) Friendly to peoples.
4	Video based CAPTCHA	1) It cannot break using Optical Character Recognition (OCR). 2) It cannot effect by laundry attacks. 3) In some cases it provides greater security than Text-based CAPTCHA and Image based CAPTCHA.
5	Puzzle based CAPTCHA	1) It seems like a fun. 2) It helps the user to monitor their brain. 3) It's like a game so user can more interact with this CAPTCHA system.

VIII. DEMERITS OF DIFFERENT TYPES OF CAPTCHA

Sr. No	Types of CAPTCHA	Demerits
1	Text based CAPTCHA	1. In text images, user has some problem to identify the correct text or characters. i. Multiple fonts, ii. Font size, iii. Blurred Letters, iv. Wave Motion. 2. It can be easily identified by OCR techniques.
2	Images based CAPTCHA	Some users face problem of image identification who have low vision or due to blurring of images.
3	Audio based CAPTCHA	1.It is available in English therefore end user must have a comprehensive English vocabulary. 2. Character that have similar sound.
4	Video based CAPTCHA	Due to large size of file, users face problem to download video and find correct CAPTCHA
5	Puzzle based CAPTCHA	The task is not easy for users because puzzle based CAPTCHA take more time to solve.

IX. APPLICATIONS OF CAPTCHA:

Protecting online polls: CAPTCHA can be used to make sure that only humans will participate in an online poll and preventing the possibility of biased poll results.

Protecting Email addresses from spammers: Spammers crawl the web in search of email address. Asking user to solve captcha can provide an efficient way to hide our email address from web crawlers.

Web registration protection: CAPTCHA can be used to ensure only genuine users and humans can obtain accounts and prevent websites from bot attacks.

Preventing dictionary attacks: CAPTCHA can be used to prevent dictionary attacks in password system. CAPTCHA can be used to terminate or block the loop after specified number of unsuccessful attempts.

Search engine bots: To provide guaranteed prevention of bots from webpages captchas are required.

X. CONCLUSION:

CAPTCHA system are used to distinguish between human user and computer programs. The existing text based CAPTCHA are not safe as computer-vision techniques develop rapidly. But for higher level security from spyware and bots, use of regional language is an essential factor. Multilingual CAPTCHA is also efficient and secured technique. Recognition of color is also new innovative idea. Selection of object and its corresponding name from the left and right side of window is also good image based CAPTCHA but author does not implemented the concept. Matching the pair concept may work better. CAPTCHAs increase load on servers because of requirement for image database and huge server processing. Audio based CAPTCHA are mostly suitable for visual impaired people. Video CAPTCHA requires more memory on server and better speed of internet if both are increased then it is efficient method. In this paper, an attempt is made to review the literature based on CAPTCHA, its drawback, working, generation and applications.

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