

A Study of Audio Captcha and their Limitations

K. Aiswarya¹, K. S. Kuppusamy²

^{1, 2}Department of Computer Science, Pondicherry University, Puducherry, India

Abstract: Due to the massive development of Internet, security of web application has turned into a fundamental issue and numerous web applications confronting a danger of Internet Bots otherwise called Internet Robot is the automated program which executes over the web application and spoils valuable web space. CAPTCHA has become accepted standard for securing web applications from Internet Bots and all the application/ forms utilize this test for verification purposes. This paper is an aggregate study of work done on Audio CAPTCHA frameworks. In the accompanying segment, talked about the limitation of different audio captcha approaches and followed by evaluation of the usability and accessibility of audio CAPTCHA.

Keywords: Audio Captcha, Visually impaired user, Accessibility, reCaptcha, Usability.

1. Introduction

To exploit the World Wide Web is the distributing of information and valuable services to the internet users. With the rapid growth of World Wide Web, the security becomes a major issue. To evade that issue, CAPTCHA is used. It is the acronym of "Completely Automated Public Turing Test to Tell Computers and Human Apart" which is universally a secure scheme to distinguished human from the bots[1]. Numerous sites rely on upon Captcha, to protect the assets from the bots or dangers. A Bot is the malicious programs a software application which has the capability to perform the repeated tasks automatically over the Internet and thus creating problem in the networks.

The first inspiration for Captcha originated from the online surveys and email spam. Captcha is a sort of challenge-response test and it is otherwise called reverse turing test. It was initially developed by Atla vista in 1997, to prevent bots from "including URL" function of their search engine. The term CAPTCHA was instituted in 2000 by Luis von Ahn, Nicholas J. Hopper, Manuel Blum of Carnegie Mellon University and John Langford of IBM [2].

Captcha is the program that ensures the web assets against bots by creating and evaluating the test that the human can easily solve though it's difficult to solve for the automated program. The most well-known CAPTCHA is an image of distorted text and numbers which have a great deal of disorder and noise in background. The user is requested to type the text and numbers which are in the distorted images show up on the screen. If the correct solution is entered then the system assumes that response is generated by a human or by the bots and the access is denied. The idea is that the visual user can see through all the background clutter and noise and it's difficult for bots.

Generally, the captcha should have the following properties are

1. It should be accessible.
2. It should be non-troublesome and straightforward to the end user.
3. It cannot stigmatize or redirect from the basic role of the page.
4. It should be automated.
5. It should not put a huge strain on the server/browser.

2. Categories of CAPTCHA

The Captcha is utilized as a part of numerous sites where the authentication access is the essential concern. It is broadly classified into several categories and these are given below.

2.1 Text Captcha

Text-based Captcha is the most widely used captcha in web application. It is image of distorted text/numbers and addition to with some background noise or clutter. The content is generated randomly either text or alphanumeric. The user asked to identify the distorted letters or numbers whatever displayed in the captcha challenge and entered them. It requires a large question bank. It is uncomplicated to solve for visual user, but it's becomes very difficult to read for blind user. In text based captcha, simple asked question based on the arithmetic for example what is five plus three? Gimpy is a text-based captcha, randomly picked the words from the dictionary and are displayed in distorted and overlapped manner. The users have to type the three words from the challenge. Ez-Gimpy is a simplified version of Gimpy[3]. A single word picked from the dictionary and makes the word, more distorted and given to the user. It is anything but difficult to settle by the user furthermore effectively broken by the OCR (Optical Character Recognition) method.

2.2 ReCaptcha

The reCaptcha is a open captcha service that serves to digitize books and daily paper furthermore to shield your site from spam and ill-use[4]. The reCaptcha service give two words are randomly drawn from the books. The first word is control word and another one is a questionable word[4]. The user interprets the words and after that the framework expects that if user sorts the control word accurately, then the questionable word is likewise right[4]. They then send the outcome to the digitization projects. In 2012, reCaptcha started utilizing the photos of house number taken from Google's Street View projects, notwithstanding filtered words.

2.3 Image Captcha

In the graphics based Captcha, the captcha tests in which the users need to figure those pictures that have some similarity. ESP Pix is a first image based captcha and it is accessible just in English language. It utilized a bigger database of images and animated pictures of regular items. The CAPTCHA framework gave a user an arrangement of pictures all connected with the same object or idea. The user was obliged to enter the object or idea to which all the pictures fit in with e.g. the system may present pictures of Globe, Volleyball, Planet and baseball anticipating that the user should accurately relate all these pictures with the statement ball. In general, image based CAPTCHAs present a visual pattern or idea that the user needs to distinguish and act appropriately. Distinctive image based CAPTCHA method use diverse examples or ideas which are easy to differentiate by the users and troublesome for the bot to mimic. It makes an issue to users having low vision or learning inability or because of smudging of pictures.

2.4 Audio Captcha

The Audio Captcha is the sound based captcha. It is developed for visually impaired user. Audio Captcha takes an arbitrary grouping drawn from recordings of words or numbers, consolidate them and include some disturbance/noise to it and given to the user. The user listen the sound clips and after that sort the talked word in the answer box and afterward submits it. Audio Captcha is utilized to recognize the human from bots. Eco is the first audio based captcha was actualized by the Nancy Chan from the City University. Audio Captcha was gradually embraced by the sites.

2.5 Audio ReCaptcha

The reCaptcha additionally accompanies a new audio version of captcha to guarantee that visually impaired users can freely explore the website. It uses classic radio program audio, which is not able to decipher by the automated speech recognition. It exploits the human capacity to understand words through context. The audio being utilized was initially recorded with the aim that it ought to be effectively seen by people. The audio captcha is slower than the visual captcha. It takes of an opportunity time to respond in due order regarding the test. To start with listen and replied in the answer box. For no good reason[5], the ReCAPTCHA task has as of late quit utilizing the radio clip CAPTCHAs on their site and has come back to utilizing the old audio CAPTCHAs which highlight numbers and bending[5].

2.6 Video Captcha

In the video based CAPTCHA, three words were given to the client which illustrate the video. If a client's word belongs to a set of consequently created words, then the client succeeded in a test. They are the least popular because it is the hardest to give a sensible measure of features, these oblige capacity, and again – not everybody can watch and understand them.



Figure 1: Audio version of ReCaptcha

2.7 Puzzle Captcha

In puzzle CAPTCHA[6], the picture is separated into a few pieces and asked the user to join all the pieces in order to structure the complete picture into the original ones. This captcha is not simple to decipher for user in light of the fact that it takes more time to solve and distinguish the real pattern of the puzzles.

3. Related Work

I have studied the research work related to the audio captcha are given below. Audio Captcha is introduced for the visually impaired user. Because the visually impaired users can't see the visual captcha. Alternative to visual captcha, the Audio Captcha is introduced. In any case Audio Captcha is still out of reach for the visually impaired user. Since, their getting to and exploring the sites through the screen reader software. At the point when the test (audio captcha) is given to the visually impaired user, first plays the Captcha and centre the answer box to give the answer[7]. For sighted users, it is easy to solve anything but difficult to achieve the answer box by clicking the text box by the mouse though visually impaired users need to take after the direction given by the screen reader so as to achieve the answer box and to give the answers in the answer box. It is difficult and also obfuscated.

Another difficulty is the audio playback is linear[7]. The user plays the captcha and concentrate on the answer box with the assistance of the screen reader. The voice of the screen reader and Audio captcha sounds are covered with one another and it can't stop by the users. It is likewise awkward to listen the captcha sound clips. The control of the audio playback is outside the answer box. The user must leave the answer enclose request to play the captcha once again. It is time-consuming and frustrated.

In [7], another enhanced interface for solving audio captcha improved for non-visual use by permitting the user to control the playback of the audio without leaving the answer box. The control keys work just when the textbox used to answer the captcha test. These keys character won't go into the answer box and just used to control the playback. This study of 14 visually impaired members – 2 were female, 10 were male and 2 were picked not to answer that question. The outcome from this study, with the first interface just 42.9% were understood the captcha on the first attempt and 68.5% were accurately illuminated the captcha on the first attempt by utilizing the advanced interface.

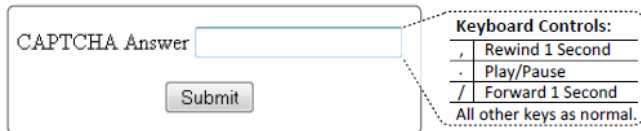


Figure 2: New improved interface for solving audio captcha optimized for non-visual use[7]

Tam et al[1]. built up the captcha that exploits the gaps between the human voice and the engineered voice. It creates the difficulties by arbitrarily select the sentences from the books. Its length is situated between 8 to 20 words. The user needs to read out the sentences. After that the system is utilized to recognize whether it is a human or bots by investigating the generated audio clips.

L. von Ahn[8] makes the new audio captcha, to make the progress rate at least 70% and that sound is not simple broken by the ASR framework. To improve the human captcha solving rate, it has the misshaped sound and the human can without much of a stretch distinguish the expressions through the connection intimations furthermore it is taken from the old fashioned radio system with low quality, it is hard to break by the ASR.

In [9], proposed a new version of captcha that are more accessible for visually impaired users and it is equally usable for both the users with and without visually impairments. The captcha is taking into account the mix of both pictures and their relating sounds. Along the side[10][11], it named as HIPUU (Human Interaction Proof Universally Usable). For cases, the captcha having a picture of elephant and elephant sound clip. The idea is that the visually impaired user utilizes the sound clips, a sighted user utilizes the non-textual picture and individual with no disability utilizes both. It is more secure in light of the fact that image-recognition and speech-recognition technology are vastly improved at perceiving the content than recognizing the pictures and positively at distinguishing the sounds[12]. This permitted HIPUU to present these pictures and sounds without needing to include any kind of distortion that may confuse a client regarding what they are listening to or seeing, yet giving the same level of security against the robotized bots.

At first, they utilized the non-textual pictures and sounds blend from the transportation, animals, weather and musical instruments[10]. A few cases incorporated a birds, dog, elephant, flute and piano. The right answer is picked by distinguishing the sounds and pictures utilizing a drop-down list where you select the appropriate choice. At first it begins with predetermined number of choices. To upgrade the security, the client allows three endeavours to recognize the picture or sound [12]. In the event that user missed, then the user shut out of the framework.

The statistics illustrates that the new version of HIPUU captcha is simpler for both sighted users and visually impaired users than the routine captcha. Rather than 46% captcha solving time in 65 seconds with an audio based captcha, with this availability adaptation of HIPUU, visually impaired users finished it effectively 90% of the time in just 35 seconds[12]. It is profoundly fulfilled by this HIPUU captcha. To enhance the strength of security included the different challenges in the same page. Option outline of

HIPUU methodology may utilize the free text entry rather than drop-down list. The free text entry methodology would require the user to sort the comparing word connected with the sound clip and picture.

Jonathan et al[5]. SoundsRight audio captcha gives the real-time audio based challenge in which every sound clip, involved arrangement of 10 sounds that are played through computer audio framework. For examples, the sound clip contains the sounds like the bell, piano, train, and so forth. This methodology develops mp3 record file and saved in the database. At the point when the user is select the audio option and they informed to press the space bar to proceed. Once the user pressed the space bar, the back-end procedure gives the audio record file to solve the test. This file involved arrangement of sounds with the delimiter as "next sound" in the middle of every sound in captcha test. This used to keep away from the decoy sounds in audio file. A few distraction sounds are same in nature and obfuscated users. The case of decoy sounds is sound of child crying and sound of cat (mewing). Every sound clip is altered of two seconds in length with the delimiter. The sound file includes which least of two and upwards of four sounds. With respect to, the successful completion time of the Sounds Right captcha is pretty nearly 45 seconds. The normal time to finish the reCAPTCHA sound test is 65.64 seconds. It is more proficient than the reCAPTCHA sound based system. Contrasted with the HIPUU approach, the undertaking execution was same on both the methodology, yet in Sounds Right captcha methodology has a superior time execution than the non-text based HIPUU. It is more secure than HIPUU approach.

In[13], they examine about Google's sound reCaptcha. They have exhibited overlapping and distorted target voices with stationary background noise by adding to a audio reCaptcha solver. The solver is built taking into account speech recognition techniques utilizing Hidden Markov models (HMMs). It is actualized by utilizing an off-the-rack library HMM Toolkit. The outcomes revealed vulnerabilities in the current version of audio reCAPTCHA with the solver breaking 52% of the study, which implies this sort of audio CAPTCHA is no more sheltered.

In[14], concentrates on improvement of an alternative aural CAPTCHA innovation taking into account an open- domain speech transcription task. The important objectives are to give a enhanced excellence of service, as a symptom of CAPTCHA utilization, collect meaning data, such as transcriptions of speech found in online audio streams, and convey the CAPTCHA openly to expand the general attention to openness concerns on the web for individuals with inabilities.

With this approach, a user is played a short portion of sound and must perceive and decipher any speech they listen. Open domain speech recognition is significantly more troublesome for programmed systems to handle, so less noise must be added to a given sound clip to bewilder programmed procedures. In the meantime, recognition of open domain speech is arguably a more characteristic errand for people than recognition of random spoken digits, as it permits people to apply their insight into dialect and the world

everywhere to support recognition. Another motivating factor for a test taking into account open domain speech recognition is the potential for reuse of any information gathered amid CAPTCHA assessment.

The investigation result demonstrated that open-domain speech transcription represents a feasible alternative aural CAPTCHA mechanism. In addition, the nature of the open-domain speech transcription errand fits gathering of helpful information[14], satisfying the included necessity of any reCAPTCHA arrangement. Utilities were made to encourage fast production of sound clips from source audio streams, taking care of different sign transforming undertakings and information administration.

Michitomo et al[15]. propose the new method of captcha, creates the test taking into account a verbal-style. It is not constrained in particular perceptual channels. The difficulties made out of a few expressions and it's created from the online sources. The users has two sorts of difficulties are the users attempt to recognize an expressions of strange meaning from others and to distinguish the common word among them. This methodology does not turn into a barrier for visually impaired users.

Test of detecting machine-synthesized semi-random phrases:
Q. Which phrase is generated by computer?
A) The world will little note, nor long remember what we say here.
B) Now we are dedicated in a larger people.
Test of detecting common topic:
Q. What is the topic common to the following sentences?
– Twitter is an social networking service.
– Vector processors are used for parallel computing.
A) Computer, B) Sports, C) Culture.

Figure 3: Simple Example of Our Verbal Turing Tests

4. Difficulties in existing audio captcha approaches

The table shows some limitation in the existing audio captcha approaches.

Table 1: Difficulties in various audio captcha approaches

No.	Audio Captcha Approaches	Limitations
1.	Existing Audio Captcha Interface	- Spoken digit Captcha might be difficult for humans to solve is due to the randomness of the generated sequences of digits. Because any digit is equally likely to precede or follow any other digit, there is little contextual information humans may leverage to complete the task. - It is available in English therefore end user must have a comprehensive English vocabulary [16]. - Characters that have similar sound. - Audio based CAPTCHAs are more troublesome than visual CAPTCHAs, particularly for visually impaired users who utilization screen-reader software. These software have a tendency to talk over the audio CAPTCHA as the user explores between the sound playback

		controls and answer box, disappointing the user's capacity to hear the CAPTCHA. Audio captcha playback is linear[7].
2.	HIPUU (Human Interaction Proof Universally Usable)	- The use of single, well-defined audio files creates the possibility using of checksums or signatures to defeat the CAPTCHA [5]. - Not safe. - This scheme needs to collect a myriad of pictures and sounds data.
3.	SoundsRight	- The limited choice of sounds that is easily recognizable by human users [5]. - Not fully universally usable and not safe - Time-consuming to create. - The sounds may be too similar to each other and can confuse the users.
4.	Google's audio reCaptcha	- Solver can crack 52% of the audio reCaptcha question and it is not safe [13]. - Non-Continuous audio captcha depends on the difficulties on segmentation stage.
5.	Open Domain Speech Transcription Task	- In the speech transcription, human responses to even 5 seconds of speech are liable to show huge variety because of contrasts in spelling (or incorrectly spelled words), punctuation, incorporation of "filler" words (e.g. "ah", "um"), representation of numbers and amounts, abbreviations, and so forth [14]. - This type of CAPTCHA language understanding is crucial. Performance of human users on this task is highly dependent on their fluency. This means younger users whose language skills are not well developed, non-native speakers, or users with language or learning disabilities may not perform well on [14].

5. Captcha Accessibility and Usability

5.1 General Captcha Accessibility to the Visual Impaired

The basic idea is that the web content ought to be utilized and open by everybody. Captcha security acquaints its own particular with keep away from the automatic form submission, on the grounds that it is deliberately intended to be difficult to translate to machines. It is special openness difficulties are for the most part available website pages will be planned that ought to be as machine readable, so assistive technology can change them into exchange designs open to disabled individuals. Notwithstanding, the availability and ease of use are genuinely influenced by at present most utilized visual Captcha as they utilized stance issues to blind and visually impaired.

It is essential to solve the captcha in order to submit the form/comments in web pages, yet the visual captcha presents an unsolvable obstruction to the blind or visually impaired users. Since most people with such inabilities search the web utilizing assistive technology in view of sound (e.g. screen reader which can read the web pages). For example, attributed "alt" text for image tag, which passes on the data and can be perused by assistive technology to the individuals with disabilities.

Not only fully blind users use screen readers to access web content[17], low vision users can likewise peruse the web with the assistance of elevated amounts of browser zoom, screen magnifiers, or user characterized templates which grow the content enough to make it readable to them. Visual Captcha is uncalled for snags to the low sighted users. Colour-blind user additionally has the issue of solving the captcha which is taking into account shading/picture. Case in point, in the image based captcha, select the green shading apple in the gathering of apple pictures.

5.2 Audio Captcha Accessibility Issues

Audio elements can add to the general claim of internet learning materials while making them more open to the individuals who are print-weakened learners, for example, those with visual impairments. Some common audio accessibility problems include [18]:

- Poor sound quality.
- Inability to control volume.

5.3 Audio Captcha Usability Issues

In audio CAPTCHAs, letters are talked as opposed to being shown in an image/graphic. Typically[19], noises/sounds are deliberately added to prevent such audio schemes from being broken by current speech recognition software or bots.

5.3.1 Distortion

Background noises adequately distort sounds in sound based CAPTCHAs [3]. There is no exact research of what kind of noises will introduce satisfactory sound distortion. In any case, it is passing that distortion methods and levels, pretty much as in visual CAPTCHAs, can have a huge effect on the convenience of audio CAPTCHAs. Because of audio distortion, befuddling characters can likewise happen in audio CAPTCHAs. Case in point, we trial that it is difficult to distinguish one from the other 'p' and 'b'; 'g' and 'j', and 'an' and '8' [20]. Whether a plan is amicable to non-native speakers is an alternate ease of use sympathy toward sound CAPTCHAs.

5.3.2 Content

The content of the audio CAPTCHAs are commonly is in sound-based and in English language. Digits and letters read in English are frequently not justifiable to individuals who talk in English, in light of the fact that the voice slang is distinctive and it is hard to see at some point[3]. Consider who don't know to speak in English, it gets to be more confused and not able to understand. Thusly, localization is a noteworthy issues that audio CAPTCHAs scheme.

5.3.3 Presentation

The way for exhibiting the content i.e. style, formatting is not an issue in audio CAPTCHAs, however the mix with website pages is still a stress. For instance, there is no standard graphical image for representing an audio CAPTCHA on a website, even though numerous schemes such as, Microsoft and reCAPTCHA uses a speaker image[3]. All the more vitally, what truly matters for blind users is that the html image tag alternative text appended to any of the above image ought to unmistakably demonstrate the need to solve an audio CAPTCHA [20].

At the point when embedded in website, audio CAPTCHAs can likewise cause compatibility issues. For instance, numerous such schemes require JavaScript to be empowered. Then again, a few users may want to disable JavaScript in their browser. Some different schemes can be far more detestable. For instance [20], we found that one audio scheme require Adobe Flash support. With this scheme, vision-hindered users won't even notice that such a CAPTCHA test exists in the page, unless Flash is introduced in their browser - clearly, no text alternative is associated to the speaker-like Flash object, either.

6. Conclusion

In this paper, we have studied over the various types of CAPTCHA have grown yet. A brief review has been carried out on the Audio Captcha and list out the limitation in sound captcha in diverse methodologies. A huge scope for research exists in outlining new and novel CAPTCHA procedures that are easy to use, require less server handling and offer enhanced security control against bots.

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