Emoji Captcha: A secured Picture Character approach against OCR Attacks

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***Abstract*—Captcha is acronym for completely automated public turing test to tell computers and humans apart. Captcha is an online test determines whether the user on a website is human or automated software known as bots. Captcha typically ask the user to perform some task which is easy for humans to complete but difficult for bots to complete. Thus Captcha act as a protective arrangement to prevent bots, in gaining access to the sensitive information of web sites and abuse their online services. Bots imitate the behavior of humans and perform malicious activities such as gathering e-mail addresses for spamming, blocking bulk number of tickets for an event. Text based Captcha are very simple and easy to use, besides experience OCR attacks. Image based Captcha are visually appealing and more immune to any type of attacks. The proposed Emoji are picture characters visually perceived as an image and internally function as a character, therefore insusceptible to any type of OCR attacks and ensures hassle free transmission, easy process as similar to text based Captcha. Emoji Captcha is a novel method provides enhanced security for the web applications.**

Keywords-Emoji, OCR, Image Captcha, security, virtual keypad

I. INTRODUCTION

Security is the most important feature in Internet applications. Web applications such as online banking, search engine submissions, Internet polls, web registrations and E-mail registrations need an increased level of security and should ensure that the services are utilized by humans and not by any automated bot programs. Captcha a Human interactive proof designed to ensure the security of web sites, which automatically verifies the presence of human in the web applications. Captcha implementations have been found more than 3.5 million sites globally, and humans solve more than 300 million Captcha every day.

Various types of Captcha challenge response tests has been implemented in web applications which are basically categorized as;

- Text Based Captcha: The text based Captcha are easy to accomplish. It typically features a series of text, usually made up of words in the dictionary. To supersede OCR based attacks, the text are wrapped and then displayed as an image. The user is required to type the text in the input textbox and submit to prove him a human. The user is allowed to use the website services only if the typed text matches the displayed text. Gimpy, Ez-Gimpy, baffle text, MSN Captcha, Arabic Captcha is some of the popular text based Captcha methods.
- Image based Captcha: The image based Captcha uses simple images, visual pictures and puzzles as a challenge response test. The user need to identify the image or match the images or solve the puzzle. The image Captcha needs a large pool of images to display. The images should be explicit and easy to understand. Bongo, ESP-PIX, Assira, cartoon Captcha are the popular image Captcha methods.
- Audio based Captcha: The audio based Captcha are initially designed for the visually impaired people. An audio clipping consists of numbers and character, is played in a noisy background. The user has to identify and enter the number or character from the recording to get authentication.
- Video based Captcha: In the video based Captcha randomly generated Captcha words are played in the middle of the video. The users need to watch and enter the correct words for authentication.

A Captcha test should ensure the following important characteristics [1]:

- Automated : It should be easy for server to generate and evaluate
- Usable : It should be easy for human users to pass the test
- Secure : Test should be difficult for the bots to complete

Different types of Captcha techniques are designed and implemented to provide secured access in the following important applications [2]:

- E-ticketing: This can be everything from booking a train ticket or buying a concert ticket. Web scrapers can bulk book almost anything that is available for online booking if Captcha service is not enabled.
- E-mail protection: Various amenities are freely available to the humans such as email services. Unless security arrangement such as Captcha is used, bots can sign up to thousands and thousands of these free email accounts which cause network problems and unavailability to genuine users.
- Protecting online polls: Online polls can be influenced by bots. This may lead to a fabricated result as bots voting instead of humans, rendering the poll useless**.**

- Prevent spam in blogs and Mails: Random comments can crop up in the comments section of blogs if they are not protected. Captcha prevents email spam and protect emails from web scraping.
- Search Engine Bots: Captcha act as protective arrangement to keep the web page un-indexed.

II. RELATED WORK

An immense variety of research has been in progress on text and image based Captcha for the secured authentication of web applications.

Amalia Rusu et al [3] proposed a novel Captcha approach based on human handwritten. It is one of the challenging approaches against OCR attacks. It displays a handwritten word from the database. The users should identify and enter the characters to get authentication. Neha C. Mutha et al, [4] proposed a 3D Animated Handwritten Captcha, to increase the challenge level. The Captcha will show only few characters at a time and hides the remaining characters by animation, also a set of images related to the text is displayed. The user needs to predict the answer image from the text. Achint Oommen Thomas et al [5] proposed Synthetic handwritten Captcha. In this the characters are generated as close as possible and as similar to human handwriting, which pose a great challenge to the bots, distortion also applied to create more confusion to the bots. Divyashree et al [6] proposed a thread Captcha as challenge response test. The text emerges like a handwritten text using a long thread in free style. The thread which creates text can also be used to create noise in the background to confuse bots. The user should identify and enter the thread text which is hard for bots.

Mohammad Shirali-Shahreza et al [7] proposed collage Captcha method. Some known object images are chosen randomly. The images are rotated and tilted in random angles and presented to the user. Now the user is requested to identify the particular object to prove him as human. Haichang Gao et al [8] proposed Jigsaw puzzle Captcha. In this method the image is divided into n number of pieces and only two pieces are swapped from their original place. The users need to identify and rearrange the images correctly to get authentication. Rituraj soni et al [9] proposed an improved Captcha method. In these images of animals, persons and furniture are displayed in left hand side and the names of these images are displayed in the right hand side. The user has to select an image on left hand side first and then select the corresponding name of the image from the right hand side. If both are correct then he has to enter the name in the text box for authentication

Aziz Barbar et al [10] discussed the character image semantic Captcha. A simple question will be generated and displayed to the user based on the image displayed. The user has to enter the correct answer for authentication. Rahual saha et al [11] proposed a combo Captcha based on the images of animals, plants and other objects. An image with combination of two objects is displayed to the user. The user should identify the name of two objects and click from the given option to prove him a human. Chen-Chiung Hsieh et al [12] proposed an image based Captcha for distinguishing human and computer by embedding versatile characters in the image. A randomly generated five alphanumeric characters are embedded in the images. The user needs to identify and click the character in sequence as per the Captcha image to complete the test.

Peter matheus et al [13] proposed a scene tagging Captcha. In this a multiple object image is displayed to the user. The user need to understand all the objects in the image and their relationship and should answer for the simple question based on the scene. Vikram et al [14] proposed a semantically matching image technique. The user need to select semantically related images from the given set of images and also identify the semantic relationship between them for authentication.

III. EMOJI

Emoji are tiny pictures used in texts to communicate a feeling or a concept. Emoji are picture characters originally associated with mobile phones. It is very popular in social networking sites, worldwide. Emoji can be pictures. Emoji can be codes. An Emoji is a single picture that is used like a character of text. They represent things such as faces, weather, vehicles and buildings, food and drink, animals and plants, icons that represent emotions, feelings, or activities.

Words are processed by our short term memory. Images, on the other hand, go directly into long-term memory where they are indelibly impressed. 90% of information transmitted to the brain is visual, and visuals are processed in the brain at 60,000 times the speed of text. Emoji pictures have the benefit of image as well as text. Humans only can understand and identify the emotions and actions, hence able to complete this Captcha test actively. Thus Emoji poses a real challenge for the OCR software and other automated programs.

Unicode consortium has approved as many as 1,851 Emoji characters. All modern operating systems support Emoji characters. The Emoji characters are categorized in 8 different groups namely Smileys & People, Animals & Nature, Food & Drink, Activity, Travel & Places, Objects, Symbols and Flags. Emoji tender the opportunity to use images along with or instead of words. Emojis are supported on iOS, Android, Mac OS, Windows, and Linux. In Windows 10, Windows 8 and Windows RT, a touch keyboard that can be enabled for direct Emoji input. At present Emoji characters vary slightly between platforms within the limits in meaning defined by the Unicode specification. The benefits of using Emoji are;

- Emoji allowed users to send picture messages without congestion in the network.
- Emoji are used like characters in a font, it means that the Unicode for a particular Emoji is sent across the network, and not the image itself.
- The receiving computer hardware and software interprets the Unicode and displays the appropriate image.
- The validation is based only on Unicode of Emoji and not by images.

- Emoji are extensively used to make great effect in internet mode websites resulting in visually appealing yet very fast loading pages, often less than 1KB.
- The rapid spread of Emoji usage in recent years is due to their inclusion in the Unicode Standard.
- Standardization through Unicode solved the problem of interoperability, simplified application development, Web compatibility and Multi-lingual applications. Emoji are now usable across different carriers and different operating systems.
- The Random Guess or Brute force attack [15] will not influence on Emoji picture characters which is almost 1851 characters now and many more to be recognized in future.

IV. PROPOSED WORK

The proposed Emoji Captcha has been designed with 6 Emoji characters. The individual images of the Emoji characters are wrapped and converted as a single Captcha image, for transmission to the client side. The conversion of captcha as image in the server side is to protect any pixel count attacks which are one of the prime threats in captcha design. The bandwidth required for Emoji is very meager when compare to other image based Captcha. Since the Captcha image is the combination of six individual Emoji character images it pose a real challenge to the pixel count attacks as well as edge detection algorithms. Noise and clutters may also be added in background to increase the challenge level. The proposed Emoji Captcha is shown in fig.1. Each Emoji character may be selected from different category randomly. Cognition plays an important role in the identification of Emoji characters. The user by visual perception should identify the individual Emoji from Captcha image and enter the same using the Emoji keyboard.

Fig.1. Emoji Captcha

The proposed Emoji Captcha has been implemented in the following three methods:

- Emoji with Built in Touch keypad (EWBK)
- Emoji with virtual keypad (EWVK)
- Emoji with category button virtual key pad (EWCB)

A.Emoji with Built in Touch keypad (EWBK)

The Emoji Captcha has been experimented in windows 8 platform. The Login screen of a web page is displayed to the user along with Emoji Captcha. The user needs to enter the login credentials such as user name, password by physical keyboard or touch key pad. But the Emoji characters are not available in the physical keyboard and it should be entered through touch key pad only. In the touch keypad a smiley symbol key is available for Emoji input. By cognition activity the user needs to activate the Emoji keypad for the selection of Emoji characters. Different categories of Emoji picture characters can be obtained by switching over the category buttons at the bottom of touch keyboard. Fig.2. Shows the screen shot image of login screen with Emoji Captcha and Fig.3 shows the screen shot image of Emoji virtual keypad in windows 8.

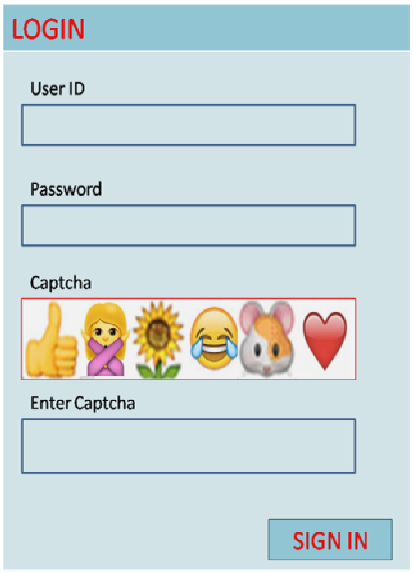


Fig.2. Screen shot of Login screen with Emoji Captcha

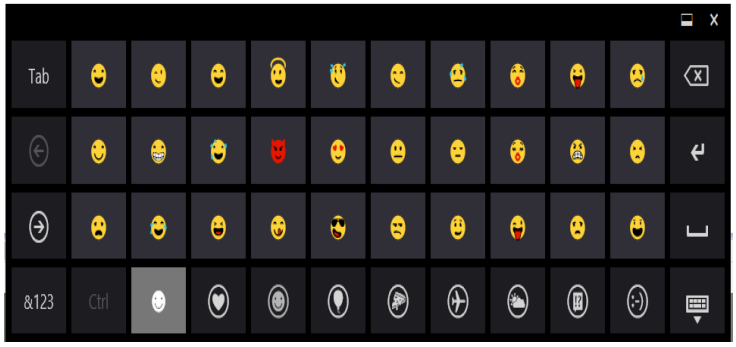


Fig.3. Windows 8 Emoji keypad

B.Emoji with Virtual keypad (EWVK)

There are as many as 1851 Emoji characters and many more will be added in future. Identifying the correct Emoji among the different group will be a clumsy work for users. Captcha entry using in built windows touch keypad will be tedious for many users. Hence to increase the usability, specially designed virtual Emoji keypads with required number of keys are uploaded to the client. The users need to click and activate the virtual Emoji keyboard for Captcha entry. The

virtual keypad is designed with random Emoji characters from different groups of Emoji. The Captcha image should also be generated among the Emoji characters in virtual keypad only. The virtual keyboard may be designed with 'n' number of keys depending upon requirement. The screen shot image of login screen and virtual Emoji keypad is shown in fig 4.

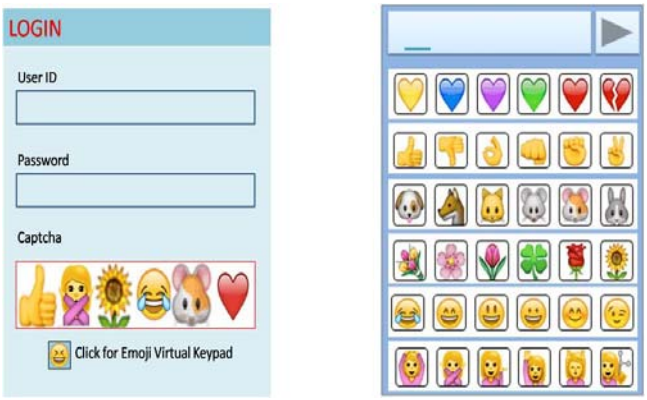


Fig.4. Screen shot of Login screen and Emoji virtual Keypad

C. Emoji with category button virtual key pad (EWCB)

This method is designed to increase the security level. An Emoji virtual key pad with category buttons are generated and uploaded to the clients. The virtual keypad consists of Emoji characters category wise and the category buttons are provided in the bottom of virtual key pad. The users need to switch in between the different categories, to find the Emoji Captcha characters. All the 8 categories may be designed with 'n' Emoji characters randomly according to the requirement. The screen shot of virtual Emoji key pad with category button is shown in Fig.5.

Fig.5. Virtual Emoji keypad with Category buttons

V. EXPERIMENTATION

In the experimental phase, 10 different age group users were selected and a prototype web session with Emoji Captcha has been structured. The users are asked to complete the Emoji captcha test in all three methods. The Response time for the completion of each session has been calculated and noted in Table I.

TABLE I. RESPOSE TIME OF EMOJI CAPTCHA IN SECS

User	Captcha Method		
	EWBK	***EWVK***	***EWCB***
User 1	63.85	11.16	20.92
User 2	60.34	17.03	20.42
User 3	62.62	11.34	28.11
User 4	67.92	11.41	25.72
User 5	60.03	18.49	21.24
User 6	60.65	17.87	28.25
User 7	67.39	16.02	25.57
User 8	61.26	12.82	23.94
User 9	64.56	14.16	29.61
User 10	62.61	15.07	24.22

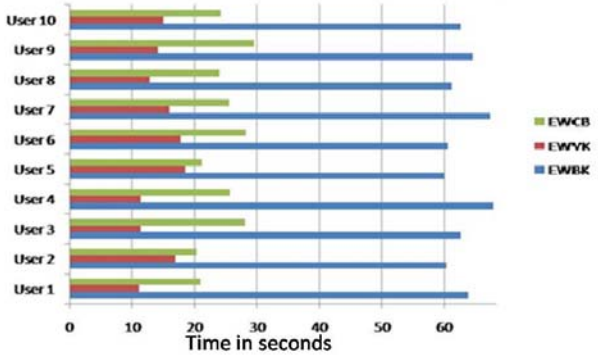


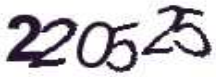
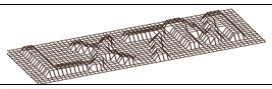
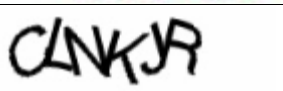
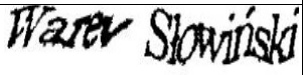
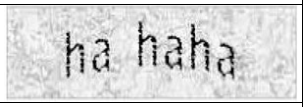
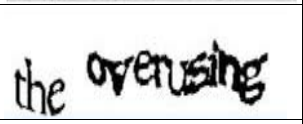
Fig.6. Response time curves of Emoji Captcha

It is observed that all the different group users completed the EWVK method with the minimum time period. The response time of EWCB also relatively low, when compared to EWBK. The response time curves are shown in Fig.6

VI. USABILITY ANALYSIS

Usability means generating Captcha test easy for use, easy for understand and easy to implement. The design of Captcha needs a perfect compromise between the robustness and usability. Most of the popular websites listed in Table. II, use text based captcha only in their web services because of the usability issues. Most of the cognition based captcha methods also suffers implementation issues hence they were not implemented practically. Very few websites only uses image Captcha, audio Captcha and video Captcha for authentication. The proposed Emoji Captcha is a cognition based picture character method very easy to use, understand and implement.

TABLE II. CAPTCHA USED IN POPULAR WEB SITES

Website	***Captcha***	***Type***
E bay		Text
Rediff		Text
Yahoo*		Text
Gmail		Text
Amazon		Text
Face Book*		Text
You Tube*		Text
Twitter*		Text
Wikipedia		Text
Microsoft		Text
*Captcha in other format of text/Image/Multimodel also used		

- Matrix Matching: Matrix matching converts each character into a matrix pattern, and compares the pattern with an index of known characters.
- Fuzzy Logic: Fuzzy logic allows intermediate values in between the two values, true and false used in digital systems. The attribute is like human way of logical thinking in programming computers. Fuzzy logic is been used when uncertainly involved.
- Feature Extraction: This method defines each character by their key features such as height, width, density, loops, lines, and traits. Feature extraction is mainly used in magazines, laser print and high quality images.
- Structural Analysis: Structural Analysis identifies characters by their sub feature, shapes of the image, sub vertical and horizontal histograms. It is useful in low quality text and newsprints.
- Neural Networks: This is based on human neural system. It compares the pixels of an image and matches them with the known index of character pixel patterns. The main application is processing stock market data in finding trends with graphical patterns.

The OCR identifies the Captcha characters by:

- Scanning – it is the process of capturing the image
- Segmentation - it is the process of isolating lines, words and characters in an image and then separates the various letters of a word.
- Preprocessing – it removes the noise introduced during the scanning process by smoothing and normalization.
- Feature extraction - Features are the characteristics of individual elements. Extraction matches the pattern of characters and eliminates unimportant attributes
- Recognition - identifying and recognizing the characters in foreground pixels known as blobs.

VII. SECURITY ANALYSIS

Optical Character Recognition shortly known as OCR is the main threat to the text based Captcha. The online attackers use the latest OCR softwares to break the Captcha image and to intrude the web services. Almost text captcha in any format including handwritten Captcha are broken frequently by the attackers. The OCR is text recognition software that enables to convert the scanned paper documents, PDF files or images from digital camera into editable and searchable data. OCR makes information in documents more readily accessible for faster, more accurate data analysis. The OCR [16] function is the combination of pattern recognition, artificial intelligence and machine vision.

There are various techniques in the design of optical character recognition [17] are

Simple OCR, Top OCR, Free OCR, Best OCR, Tesseract and MeOCR are some of the popular OCR softwares which recognize text in any form. But the proposed Emoji Captcha is image by appearance; hence any of the above OCR softwares are unable to recognize it. Hence 100% security is ensured.

VIII. CONCLUSION

Cognition is a term referring to the mental processes and physical actions involved in gaining knowledge and comprehension. It includes thinking, knowing, remembering, judging, problem solving and motor skill activities. Cognitive actions are performed with the higher level functions of the brain which include language, imagination, perception, and planning. The Emoji Captcha design is based on human cognition activity to increase the security of web applications.

The physical activity of human with the intent to perform a specific task will differentiate them from the automated bots.

The proposed Emoji Captcha involves the following human cognitive activities,

- Identification of Emoji characters from Captcha image
- Identification of category to which the character belongs
- Activation of touch keypad
- Activation of Emoji keypad
- Switching between different Emoji categories
- Selection of Emoji characters

These Cognition based physical actions cannot be performed by any bots. Humans only can complete this Captcha test and get access to the web applications. Hence the proposed Emoji Captcha ensures more security, more usability and more immunity from any type of OCR attacks.

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