

# JigCAPTCHA: An Advanced Image-Based CAPTCHA Integrated with Jigsaw Piece Puzzle using AJAX

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**Abstract** – With an increasing number of automated software bots and automated programs that abuse and corrupt public web services, the user is primarily required to go through and solve a Turing test problem, before they are allowed to use web applications and web services. This Turing test is termed as CAPTCHA.

In this paper, JIGSAW puzzle based CAPTCHA ('JigCaptcha') is introduced.

The paper introduces a drag and drop image based CAPTCHA by integrating image-based CAPTCHA with AJAX and JIGSAW puzzle for the easy access of web services in lesser time.

**Keywords** – CAPTCHA (Completely Automated Public Turing test to tell Computers and Humans Apart), Turing Test AJAX(Asynchronous JavaScript and XML), IMAGINATION (Image Generation for Internet Authentication), OCR( Optical Character Recognition), XML(Extended Markup Language)

## I. INTRODUCTION

There have been lots of automated software bots and automated scripts that corrupt and affect the web applications. That is why a user (human) is commonly required to solve a Completely Automated Public Turing test to tell Computers and Humans Apart (CAPTCHA) before they access public web services.

The main goal of a CAPTCHA is to prevent the automated script attacks by raising the computation and development cost of breaking a CAPTCHA to an unprofitable level [1]. Traditional CAPTCHAs uses to ask users to write a series of alphabets and numbers that were transformed to defeat character recognition tools [2]. But Still many character recognition softwares have succeeded in deciphering plain text-based CAPTCHAs [3]. In order to overcome the weak points of text-based CAPTCHAs, Image-Based CAPTCHAs was introduced [4].

While a jigsaw puzzle is a tiling puzzle that requires the collection of plenty mini, and interlocking small images. After completion, a jigsaw puzzle produces a complete picture.

Similarly, Here Jigsaw puzzle Algorithm is implemented in a Small piece of 1xK (1 row, K columns) image based CAPTCHA using AJAX.

Captcha is a response test to ensure that the response is generated by a person and not by a automated machine In the process, the computer provides a test to the user which is graded by a computer itself. These tests are easily generated by a automated machine, but are difficult for a machine to solve, only a human can solve it easily.

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## A. Captcha.

A basic CAPTCHA requires the user to type some alphanumeric characters specially, Alphabets or digits from a distorted image that is displayed on the screen. The motive of the tests is to prevent unwanted bots from accessing websites.

### i) Application of captcha:

CAPTCHAs have several applications for practical security. Some of them are mentioned below:

- **Protecting Website Registration:** All the free services should be protected with a CAPTCHA in order to prevent abuse by automated programs like bots that would sign up for bulk of email accounts every single span of time. The solution to this problem was to use CAPTCHAs to ensure that only humans obtain free accounts.
- **Spam and Worms:** CAPTCHAs also offer a solution against spam emails and worms.
- **Avoiding Comment Spam:** Some automated programs submit bogus comments in order to raise search engine ranks. Such automated programs are termed as comment spam. CAPTCHA, ensures that only humans can enter comments on a blog.
- **Avoiding Dictionary Attacks:** CAPTCHAs can also be used to prevent dictionary attacks to secure online accounts by asking user to solve a CAPTCHA after a certain number of unsuccessful logins.

### ii) Accessibility of captcha:

If CAPTCHAs rely on only visual perception then the groups who commonly struggle with visual CAPTCHAs are[5]:

- The blind
- The colour blind or partially sighted people
- Dyslexic people
- The elderly people
- People with intellectual disabilities.

Thus the CAPTCHAs may provide an audio version of the CAPTCHA in addition to the visual method as well.

### iii) Overview Of Captcha Solutions:

The Overview of the existing Captcha solutions is given as follows[6]

CAPTCHA NAME	CAPTCHA CATEGORY
ReCaptcha	Character Recognition, Sound
Gimpy	Text Based
EZ-Gimpy	Character Recognition

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BONGO	Image Recognition
PIX	Image Recognition
PICATCHA	Image Recognition
ASIRRA	Image Recognition
IMAGINATION	Image Recognition

➤ *Recaptcha*

The *reCAPTCHA* service uses the CAPTCHA interface, of 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



Fig 1 : An Example of ReCaptcha

➤ *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.



Fig 2 : An Example of Gimpy Captcha

➤ *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 (at each time of access by the user) 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.



Fig 3 : An Example of EZ-Gimpy Captcha

➤ *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 [7].

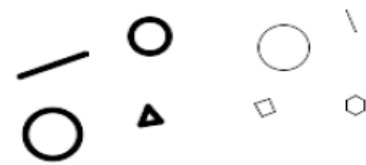


Fig 4 : An example of Bongo

➤ *PIX*:

PIX is a program that has a wide database of indexed and labelled 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 belongs to which object?" [8].



Fig 5 : An example of PIX

➤ *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.



Fig 6 : An example of ASIRRA

➤ *Imagination*:



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.



Fig 7 : An example of Imagination

2. The user is asked to identify a distorted image by selection from a select list.

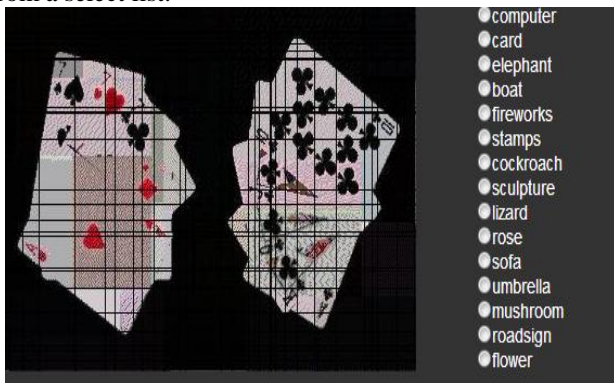


Fig 8 : An Example of Step 2 Of Imagination

## B. 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.

### i. Working of AJAX:

A Sequence of Action:

- A user action triggers an event and this results in calling of the associated event handler, which is very often a javascript function
- Inside the handler, a XMLHttpRequest object is created. `XmlHttp = new XmlHttpRequest( );`
- XMLHttpRequest will make a asynchronous Http Request to Web Server for a specified resources.
- Resource is typically a server side program (written using JSP, ASP etc). It receives the request then it retrieves parameter and then access the database (if needed) and process the data.
- The server then returns the data to the client in the form of XML document.

- XMLHttpRequest object receives the XML Data and invokes the call back function (A call back service routine or a piece of Javascript code which is executed as a part of this interrupt).
- A Javascript callback function catches the data, process them and update the HTML DOM representing the page with the new data.

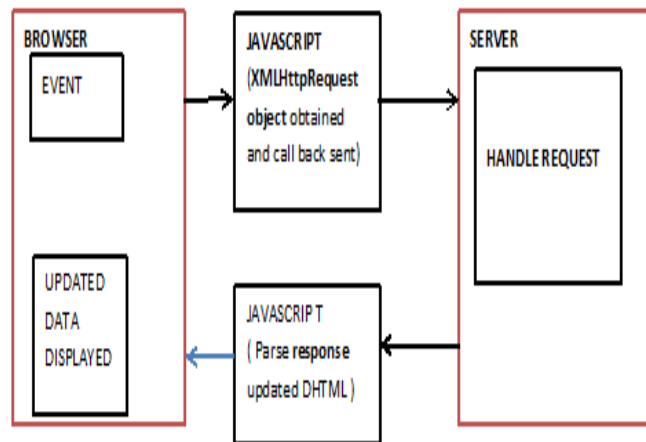


Fig 9 : Working of Ajax

### ii. Uses of Ajax:

- Login Forms
- Registration Forms
- Forms validation and submission
- Updating with user content
- Auto Complete for search suggesting tool (Search engines)
- Voting and rating the online sites
- Chat rooms
- Instant messaging
- Light boxes in place of pop-up boxes

## C. JIGSAW PIECES PUZZLE:

A **jigsaw puzzle** is a tiling puzzle with the collection of numerous small pieces of picture of size (KxK).

Each piece usually has a small part of a picture on it. After completion a jigsaw puzzle produces a complete picture[9].

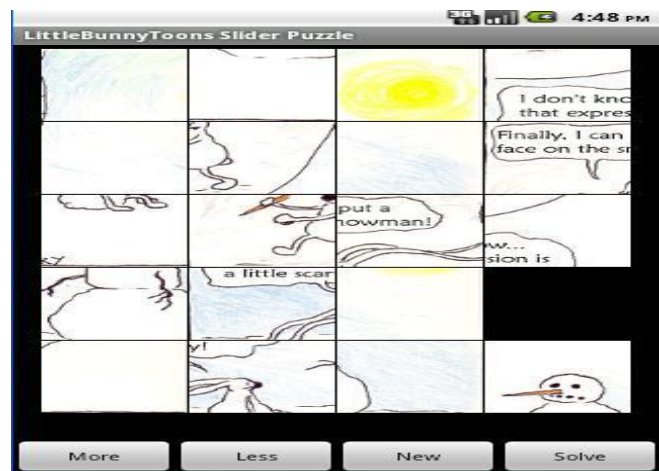


Fig 10 : An example of Jigsaw pieces puzzle

## II. METHODS AND METHODOLOGIES:

The methods and methodologies used are :

- ✓ Understanding the role of Captcha.
- ✓ Understanding the use & working of Ajax.
- ✓ Understanding Jigsaw puzzle Engine.

### 1. Role of Captcha:

Captcha is a response test to ensure that the response is generated by a person and not by a automated machine.

### 2. Role of Ajax:

AJAX exchanges data with a server, and update parts of a web page without re-loading the complete web page.

Ajax is a integration of various technologies all together, each exploring in its own right. Ajax is using XHTML and CSS. It uses dynamic update and interaction using the DOM and exchanges data using XML and XSLT and can access data asynchronously XMLHttpRequest. Ajax binds all these technologies together using JavaScript.

### 3. Jigsaw Piece Puzzle Engine:

Jigsaw piece puzzle Engine is primarily use for creating and solving of the image-based puzzle.

*How to construct a jigsaw puzzle engine?*



**Fig 11: Construction of a Jigsaw Puzzle engine.**

With the help of ActionScript 2.0 Language Reference we can use readymade class as a tool[10]

- The *MovieClip* class, provides a drag & drop methods and drawing API's.
- The *Math* class helps in randomization.
- The *EventDispatcher* class provides a way to dispatch events.

### ➤ Steps:

1. Masking, randomizing, and assigning of drag event handlers is performed on a given picture.
2. The pieces are fitted in the Stage.

3. The image is verified to ensure that its location is within the bounds of the Stage.
4. After the Jigsaw slicing, the mask is drawn and applied to the current piece.
5. The area of the completed puzzle is outlined.
6. The Sliced pieces of the original images are then jumbled by randomized the location of the pieces.
7. Pieces drag and drop is managed by event handlers.
8. The distance between the coordinates of source and destination of the piece of the puzzle is calculated.
9. Each piece is compared against a single pair of coordinates to test whether it has been dragged to the right place.
10. After the sequence of drag and drop, when the original image is again formed , the completion of the puzzle is signaled.

## III. PROPOSED MODEL

In this approach 'JigCaptcha' model is proposed for CAPTCHA that produces a set of random jumbled images that can be solved by sorting them by using drag and drop method.

CAPTCHA is integrated with the JIGSAW puzzle with a difference that the images in this model are not sliced in fact the image piece will be all different , representing a digit or alphabet. And images will be in linear fashion size 1xK (one rows and k columns)

After each move , the webpage will be updated by sending request to the server and after that updating the webpage. This results in reloading of webpage after each move.

Therefore AJAX is used to implement this model as AJAX exchanges data with a server asynchronously, and update parts of a web page by updating the HTML DOM without reloading the whole page.

With the use of AJAX, the proposed model can be successfully implemented.

To make this model easily accessed and time savy , it would be better if image pieces are used in linear fashion with the number of images (K) greater than equals to 2 and less than 4' with one extra stage for swapping the images.

The value of K cannot be equals to 1 , as if there is only one piece of image then there is no need to solve it as it is already sorted, In such cases bots can respond successfully to the challenge- response test of captcha.

*Proof (Result Analysis ):*

### ➤ Captcha Example A:

Arrange the following captcha in series

1 2



**Fig 12: Example A**

When the number of images are 2 then it can be Sorted in 1 move.

➤ *Captcha Example B:*

Arrange the following captcha in series

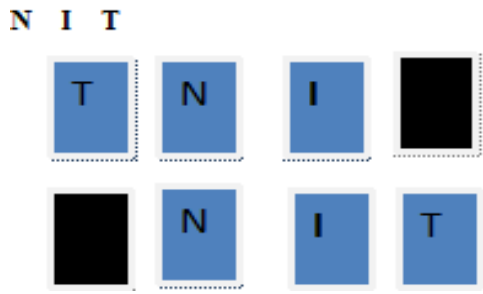


Fig 13: Example B

When the number of images are 3 then it is can be Sorted in 1 or more move. For above example it is sorted in 1 move.

➤ *Captcha Example C:*

Arrange the following captcha in series

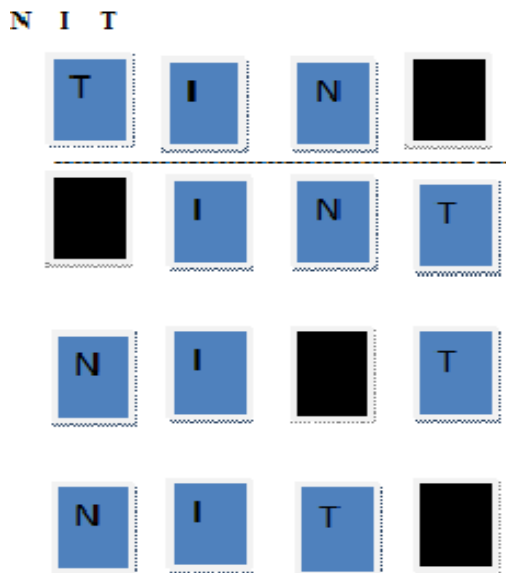


Fig 14: Example C

For the above example it is Sorted in 3 move.

If the number of pieces of images is increased then the number of moves to solve the puzzle can also be increased.

Pictures can be a combination of digits and alphabets as well. What assumption would be taken to generate a random set of images in which digits and alphabets displayed could represent the image piece and could matches a string. Then those images are jumbled and user is asked to solve it.

✓ *Steps for the Proposed Model:*

Steps for the proposed model of JigCaptcha:

- Random images are selected in a linear fashion by the image-based captcha generating software according to the string generated for users to solve the Captcha. (we prefer if number of images are greater than equals to 2 or less than 4)

- Jigsaw puzzle based, randomizing and assigning of drag event handlers is performed on a given image.
- The image or pieces are fitted in the Linear Stage with one extra blank stage for swapping the images.
- The image is verified to ensure that its location is within the Stage limit.
- The area of the completed puzzle is outlined.
- The random original images are then jumbled by randomized the location of the pieces.
- Pieces drag and drop is managed by event handlers.
- The distance between the coordinates of source and destination of the piece of the puzzle is calculated.
- Each move is handled by AJAX.
- Each piece is compared against a single pair of coordinates to test whether it has been dragged to the right place.
- The location of each piece should match the location of the String generated for solving of Captcha.
- AJAX exchanges these details of each move and location with a server asynchronously, and update CAPTCHA embedded in a web page by updating the web page without even re-loading the whole page each time after the move.
- After the sequence of drag and drop, when the sequence of the image is matched with the randomly asked String, the completion of the puzzle is signalled.
- The Captcha is solved and it is proved that the entry to a webpage is made by a human, not by a automated program like bots.

✓ *Proposed Algorithm for JigCAPTCHA:*

1. Generate the 'K' pictures randomly (we prefer if  $2 \leq K < 4$ ).  
If generated successfully then
2. Assign drag event handlers on image.
3. Images are fitted in linear Stage with one extra blank stage for swapping of the images and the location is verified to be within bounded limits.
4. Randomizing the locations of the image and forming of linear puzzle.
5. Drag and drop moves of a image is managed by event handlers.
6. The distance between the coordinates of source and destination of the piece of the puzzle is calculated.
7. Each image is compared against a single pair of coordinates to test whether it has been dragged to the right place according to the location of the String generated for solving of Captcha.
8. Each move is handled by Ajax Engine (Javascript function) and the moves made in captcha embedded in webpages are updated.
9. If the sequence of the image is matched with the randomly asked String, the completion of the puzzle is signalled.
10. Else  
Error: Problem in loading Image Captcha.

✓ *Flow Chart:*

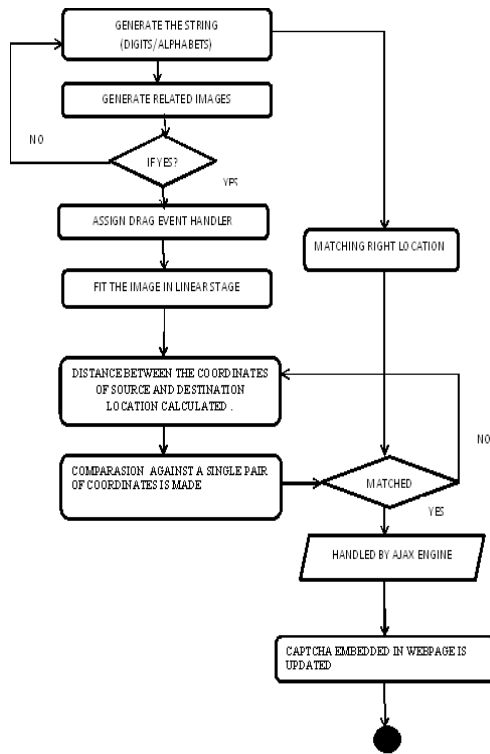


Fig 15 : Flow Chart of Proposed Model

## IV. CONCLUSION

Proposed model is a image-based Captcha that uses a dragged image technique of Jigsaw piece puzzle. To execute each and every moves on a webpage by dragging images to the correct location without reloading the page again and again, Ajax technology is used.

This technique would be more efficient if the number of pictures to be dragged and sort are greater than or equals to 2 and should be less than 4 .

It is observed that, if there is only one image then in that case there is no need to sort it as it is already sorted and even a bot or automated program can pass the turing test. Computer will not be able to differentiate between the bots and humans.

With the increase in number of images to be dragged and sorted the number of moves to sort them will also increase so it would be ideal if the number of images generated are either 2 or 3.

Drag and drop methods are found to be of much interest rather than that of writing the matching text by using intellectual mind. Sometimes the text based captchas are so complex (not understandable) due to clutters and other techniques used to avoid it to be read by OCR (to prevent bots), that user takes much time to solve it.

Unlike other existing captcha we believe that this suggested approach will proves out to be more interactive as it can be user friendly, time savy.

There is no need of using keyboard for solving it . It is solved by dragging images using mouse.

This approach as observed will comes out to be a user friendly and time savy as within atmost two- three the turing test can be solved. Even user with less intellectual can solve the test. This JigCaptcha will be more like that of a game.

The proposed system is in progress phase. The evaluation of result and performance on the basis of its result calculation will be implemented as a future work.

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