

# An Enhanced Intellectual CAPTCHA Based on Intrinsic Situation Reaction Turing Test



Ayushi Thakur, Shikha Agrawal, Rajeev Pandey

**Abstract:** Completely Automated Public Turing test to tell Computers and Humans Apart (CAPTCHA) is a challenge response tactics for identifying whether intervened user is human or bot. It is a benchmark task in the field of artificial intelligence that acquires capabilities to secure a webpage or database from programmed loop. There are various ways to attempt such tests i.e. distorted text recognition, motion text recognition, picture identification, mathematical calculation and AI problems as gaming CAPTCHA. Nowadays CAPTCHA is well thought-out as a broadly employed technique which is exploited by web services to prevent their system from unusual relay attacks. It is basically a Turing test required to differentiate whether the accessed client is either a human being or a robot. CAPTCHA is a trending approach where user needs to play an artificial game which is based on some logics that can be understood by human and almost impossible for robots. Gaming CAPTCHA is trending now where user is required to understand the task and perform as it required. But dragging an object towards target area on the basis of object recognition is not a big deal either for human or bots. It is required to put some intellectual efforts that automated programs do not understand. Proposed system is able to provide highly secured technique that easily differentiates human and bots. Proposed CAPTCHA is based on situation reaction test where user is required to take fundamentally correct decision as per the situation. Situation reaction based CAPTCHA is a new and effective approach where hard AI problem proposed that only possible for human and almost impossible for bots. Robot is always weak in correct decision making especially in real life situations that is why situation reaction CAPTCHA plays an important role in the field of turing test.

**Index Terms:** AI Problems, CAPTCHA, Situation Reaction Test, Turing Test, Text Recognition, Web Security.

## I. INTRODUCTION

CAPTCHA were invented to chunk spamming machines from posting junk entries. In the modern era where digitalization grows, CAPTCHA plays an important role for securing server from malicious attacks. The traditional CAPTCHA is in the form of distorted string where user will have to recognize that and type over there. Then the system

becomes advanced and 3D CAPTCHA has been proposed that possesses high complexity for users to understand. Furthermore it has been upgraded to moving letters which belongs to poor security in front. Then graphical CAPTCHA arrived that proposes sequences of similar images and user will have to click over similar kind of images but there is no penalty for wrong clicks which leads system towards less secured premises. Gaming CAPTCHA is a trending approach where user needs to play an artificial game which is based on some logics that can be understood by human and almost impossible for robots. Some gaming CAPTCHA may have penalty and some does not have. There are so many gaming CAPTCHA possesses simple logics where user solves it by dragging object to the target place and some of them are often difficult for human to solve because of its difficulty level. A CAPTCHA should be as simple as that human can answer within few seconds. Game files may consume spaces that increase the loading time, so that is why game should be fewer in storage that requires less time to reach client ends. Game should require less time to achieve it and does not bother user interest [1-2].



Fig.1. Gaming CAPTCHA [3]

In fig.1 user is required to identify fishes and drop them in the ocean by dragging. There are various games proposed till now that comprises distinct solutions with hard AI problems. Game may be based on color recognition, object recognition, picture identification or solving puzzle. Puzzle consumes time and irritates user to proceed with the game effectively.

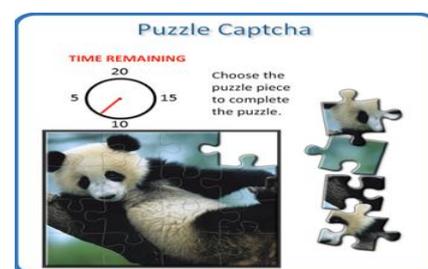


Fig.2. Puzzle CAPTCHA [4]

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Fig.2 represent the puzzle CAPTCHA where user is required to drag & drop puzzle pieces to complete the puzzle correctly.

### II. RELATED WORKS

There are a lot of researches intended to acquire better option in the form of CAPTCHA. JingSong et al. [5] proposed a method where moving alphabets along with complicated background is there. User is required to recognize that letters and it was supposed to identify characters when they are in motion. The system which has been proposed in this paper is hypothetical that is impossible for a robot to solve it. Video is a sequence of frames and frame does not possess any motion. Jing-Song et al. [6] emphasizes the weakness of motion based CAPTCHA which is often easier to recognized and machine based attack can affect it. They proposed 3D animation CAPTCHA where alphabets move over a complicated background which creates heavy confusion even for human. Ibrahim et al. [7] proposed a method where cube is presented with identical color along with respective letters. User will have to identify these colors and their alphabets on the basis of color while rotation. But color identification is a very simple task in the field of image processing. Sushma Yalamanchili et al. [8] proposed a CAPTCHA which is based on Devnagari Script i.e. Hindi language strings. Author realized that Hindi language is often difficult for a program to read or understand properly due to hindi vowels and consonants. It has been observed that devanagari script becomes more difficult when compound character and modifier characteristics are combined in 'noisy' situations.

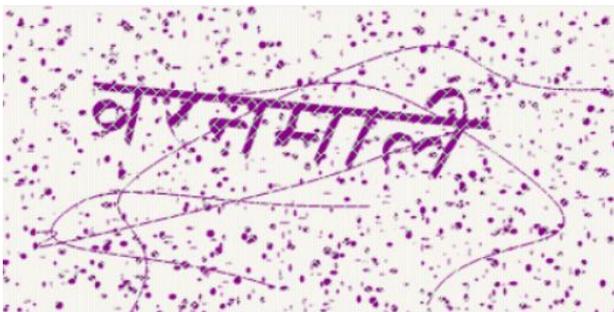


Fig.3. Devanagari String [8]

Aadhirai et al. [9] proposed a system which is based on vision where user will have to identify the object based on distance. System serves an image of real world where different kind of object relies where user is required to recognize the objects according to the distance from a particular object. There are hazy appearances in the image which leads to the difficulty level high and recognizing object w.r.t. the distance from 2-D image is also difficult. Seyed Mohammad Reza et al. [10] proposed a CAPTCHA which is one of the most accepted CAPTCHA used by some renowned organizations like Google, Yahoo, and Facebook etc is reCAPTCHA. Method used in this CAPTCHA is consists of two different words taken from old text book and to prove your identity, user needs to recognize those two words and write it on the given text box. This technique can be cracked by an intelligently trained neural network system and OCR. This CAPTCHA is time consuming and challenging at times that could be annoying for a user. Cao Lei et al. [11] proposed a

CATPCHA which is based on finger guessing game where user will have to recognize particular gesture which has been asked for. There were several images that have been shown with different kind of gestures where user will have to identify the correct gesture as per queried out. S. Ashok Kumar et al. [12] proposed a system which is based on mini games that have been designed using HTML5 and Java Script. These games are either based on clicks or drag. These games are fundamentally web based. The application designed in HTML and JAVA script can easily be extracted because of its availability in URL (Uniform Resource Locator) due to which web attacks can affect the security premises of the CAPTCHA. Fig.4 has various birds in different colors and user is required to click only those birds which belong to yellow color. Color recognition is easiest thing in image processing to recognize with high level of accuracy. The logics behind these CAPTCHA are simple and crackable.



Fig.4. Color Identification based CAPTCHA [12]

There is another way to crack the mini games based on color detection and clicks; by employing color detection algorithm which can recognize the target objects by using Image processing toolbox. These target objects either save coordinate values or layer's name, once the user click on coordinate values saved as game log or forward it to the server for further processing. Here, color detection has been applied on previously proposed system that stated a problem of finding yellow colored birds as in the fig.4.

### III. PROBLEM IDENTIFICATION

It has been observed in the prior developed Gaming CAPTCHA, dragging object to the target position or clicking on desired objects do not possess any AI problems to get it solved. These mini games are designed in HTML5 and JavaScript where implementation can be visible to everyone. As in click based games employed in CAPTCHA, each object has x and y coordinates that addresses the location which could easily traced by the hackers. CAPTCHA which are relied on drag and drop based games contains different object which are assigned as layer names and hit test method has been used to identify the target area and target object through which they can easily cracked. Hybrid attack is able to crack those Gaming CAPTCHAs which are based on simple logics.



These games are called “Dynamic Cognitive Game” that can be affected by relay attack. Some CAPTCHAs are based on database; it means that if there is an entry made by game in database will authenticate the user. SQL injection is an attack that can affect the security premises of games. Attacks can be made through gameplay log that affects the server’s response. When a legitimate user ‘U’ is interacting with the web server W, the server W would send flash content to local machine. Since Stream Relay attack employs game play features, when ‘U’ successfully finishes the game, the log of U’s mouse or keyboard interactions with the game is sent to W. W then runs a detection algorithm on input for that log, and respond back by accepting (or rejecting) ‘U’. Under Stream Relay, the attacker ‘A’ obtains the gaming CAPTCHA challenge from ‘W’, just like a legitimate user. The attacker runs a streaming server and the human solver ‘S’ connects to the attacker machine through a streaming client. This streaming software is responsible for delivering the gaming CAPTCHA frames to ‘S’ and sending S’s mouse interactions, such as drag-and-drop, mouse clicks and positions, to A. A then simply forwards the log of this interaction between ‘S’ and the game to ‘W’. Finally, ‘W’ would run the detection algorithm on input for that log, and respond back by rejecting (or accepting) ‘A’. The Stream Relay attack flow diagram is shown in Fig.5.

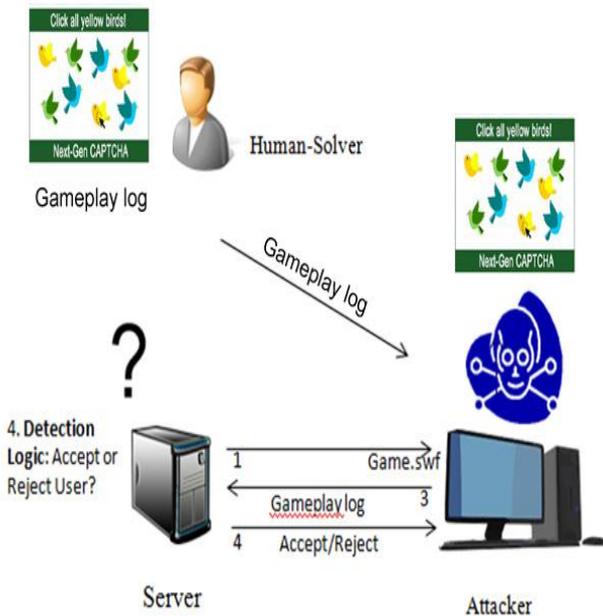


Fig.5. Attack User Gameplay

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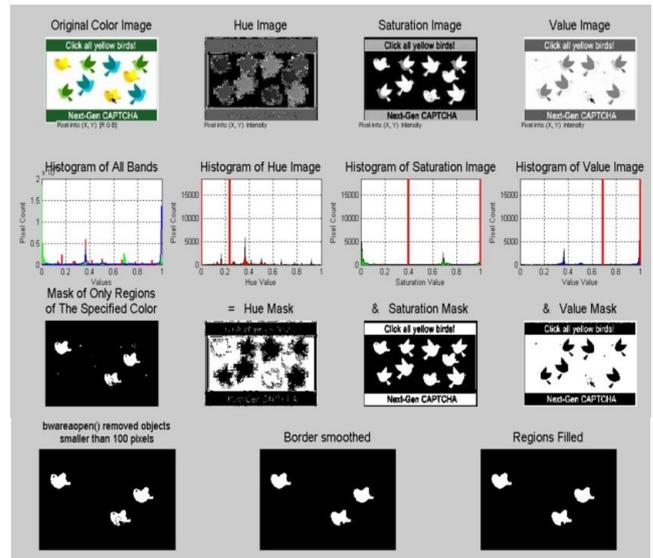


Fig.6. Attack using Color Identification [12]

#### IV. PROPOSED WORK & IMPLEMENTATION

Proposed system is able to provide highly secured technique that easily differentiates human and bots. Proposed CAPTCHA is based on situation reaction test where user is required to take fundamentally correct decision as per the situation.

Situation will be based on real world problem where only human can intervene correctly and bots definitely get confused. Every wrong attempt will be recorded and system will deny the user and consider him as bots and whenever reload or reopen that page then another distinct situation will be shown.

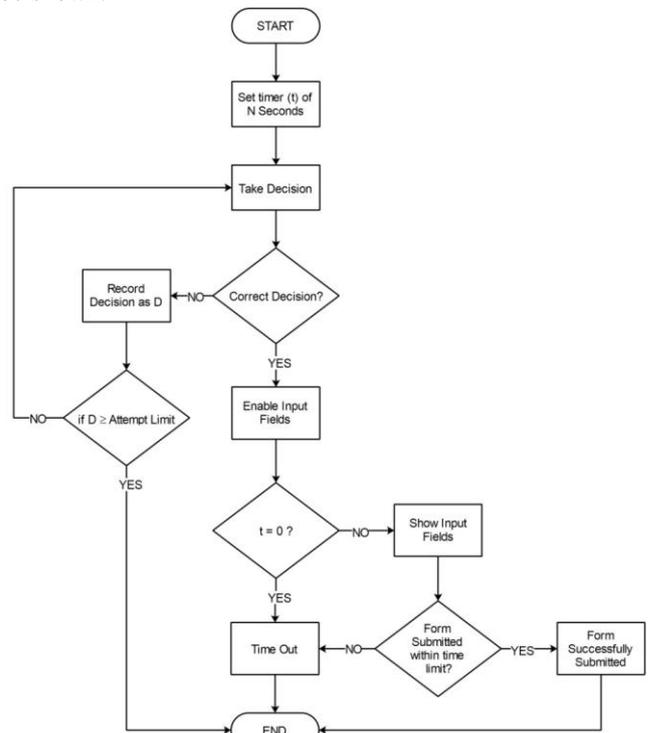


Fig.7. Flow Chart

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At the very first phase, a timer has been initiated after that user will have to understand the appeared situation and take action accordingly. If taken decision is correct then input fields will get enabled and till timer does not reach to 0. If action is performed within time limit then server will accept the input credentials otherwise validation will be failed because of time out. If wrong decision is attempted then it will be recorded and if it is performed again then CAPTCHA will get expired and another situation will get appeared as shown in fig. 7.



**Fig.8. Situation Reaction Test**

System is implemented under game theory concepts and game theory is “the science of strategy,” a branch of mathematics that studies the strategy, rules, and statistics of decision making games and applies it to other fields. The data gleaned from studying games can be related to back to economics, political science, social science, business in general, or even biology to better understand decision making and behavior in that field. The term “game” is in the title, but it is more a branch of complexity science than a study of games. The game is a kind of mathematical model to understand decision making and the interaction between decision makers.

### Arbiter’s Dilemma Algorithm:

Require: The incorrect decision set  $D_n$ , correct decision layer  $T_n$ , subjects  $S_1, S_2..S_n$ , time  $t$ , valid move  $m$ , invalid move  $n$ .

Input: Drag & Drop

Output:  $S_1, S_2..S_n$  dropTarget  $T_n$

Step 1:  $t \leftarrow 60$  // Seconds

Step 2: Drag  $D \leftarrow$  False

Step 3: Drag  $S_1, S_2..S_n \leftarrow$  True

Step 4: **for all**  $S_1, S_2..S_n \in m$

**if**  $S_1, S_2..S_n$  dropTarget  $T_n$  **then**

formLayers.visible  $\leftarrow$  true //Correct Decision Achieved

otherLayers.visible  $\leftarrow$  false

**else if**  $S_1, S_2..S_n$  dropTarget  $D_n$  **then**

disabledLayers.visible  $\leftarrow$  true //Incorrect Decision

Achieved

**end else if**

**end if**

**end for**

**end if**

Step 5: **while** ( $t > 0$ ) **do**

Drag  $S_1, S_2..S_n \leftarrow$  True

**end while**

Step 6: **if**  $t = 0$  **then**

disabledLayer.visible  $\leftarrow$  True

reloadButton.visible  $\leftarrow$  True

**end if**

Step 7: End

Algorithm explores the methodology behind the situation reaction based game where incorrect decision layers are there and a single wrong decision can turn expired the valid CAPTCHA and user will have to solve another distinct problem for further attempt. Only fundamentally correct decision can lead to accomplish game successfully. The total time to understand and solve the situation is 60 seconds and after successful attempt a form turns visible and all other layer get disappeared. A single form can be submitted after every successful attempt. The space complexity is bit lower than the usual gaming CAPTCHA. The challenge is often difficult for bots to achieve or to understand. It is the most promising CAPTCHA till now which is based on human based intellectual situation reaction where only human can intervene successfully. The implementation has been done over adobe flash professional cs5 by using action script. There are so many advantages of “Action Script” as it has been used for directing game intellectually. Flash exports .swf (shock wave flash) file extension that cannot be edited later or reverse engineering cannot be applied.

Through java class files PHP variables can be submitted from flash to database. Proposed game does not possess load on server. Time complexity of an algorithm signifies the total time required by the program to run till its completion. The Time complexity of a function (or set of statements) is  $O(1)$  because it doesn’t contain loop or recursion. Time will be constant for single statement which is stated as  $O(1)$  and for  $N$  number of statements it will also be stated as  $O(1)$  because  $N$  number of statements do not affect the time complexity. The space complexity is  $O(1)$  which is constant because algorithm uses a fixed amount of space which doesn’t depend on the input. For every size of the input the algorithm will take the same (constant) amount of space.

## V. RESULT ANALYSIS

In table 1. there are 30 participants that intervene with the CAPTCHA and time has been recorded accordingly without failure. The result calculation is as follow with standard deviation, mean time, variance, minimum time recorded, maximum time recorded and the frequency table.

**Table No. 1. Data Collection**

S.No	Name	Time Recorded	Result
1	alka tiwari	7	Success
2	parag mishra	9	Success
3	akansha jain	6	Success
4	saif ansari	5	Success
5	binish khan	8	Success
6	sapna sahu	7	Success
7	ayushi Thakur	5	Success
8	aditya singh	10	Success

9	apoorva mudgal	12	Success
10	shubham rathi	8	Success
11	namrata	9	Success
12	vishakha tiwari	6	Success
13	adarsh tripathi	11	Success
14	akash shrivastav	10	Success
15	ruhi singh	9	Success
16	sonali Thakur	7	Success
17	swati gupta	5	Success
18	hritwik bairagi	6	Success
19	pragati mittal	8	Success
20	mayuri buchke	8	Success
21	shraddha rajput	5	Success
22	sanskriti Thakur	12	Success
23	akansha singh	15	Success
24	ayushi more	14	Success
25	priyanka	10	Success
26	shruti gurjar	8	Success
27	akshita verma	7	Success
28	aditya jasuja	7	Success
29	ravi ranjan	5	Success
30	sandhya diwan	8	Success

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \mu)^2}$$

Where  $\mu$  is mean,  $N$  is total no. of dataset,  
 $x_i$  is an individual value  
variance ( $S$ ) =  $\sigma^2$

$$S = \frac{1}{N} \sum_{i=1}^N (x_i - \mu)^2$$

Data set - {7, 9, 6, 5, 8, 7, 5, 10, 12, 8, 9, 6, 11, 10, 9, 7, 5, 6,  
8, 8, 9, 12, 15, 14, 10, 8, 7, 7, 5, 8}  
N = 30

Mean,  $\mu = 8.36, \sigma = 2.52, S = 6.36$

Table No. 2. Frequency Count

Value	Frequency
5	4 (13.34%)
6	3 (10%)
7	5 (16.67%)
8	6 (20%)
9	4 (13.34%)
10	3 (10%)
11	1 (3.34%)
12	2 (6.67%)
14	1 (3.34%)
15	1 (3.34%)

Table No. 3. Comparative result

Scheme	S. Ashok Kumar [12]	Proposed
Total Participants	30	30
$\infty$ (Mean Time for Completion)	4.33	8.36
$\sigma$ (Standard Deviation)	0.79	2.52
$\sigma^2$ (Variance)	0.63	6.36
Minimum Time Recorded	2.9	5
Maximum Time Recorded	5.2	15

Table No.3. shows the result comparison on the basis of computation time and success rate, the Ashok Kumar [14] proposed simple games that do not possess intellectual efforts that is why the computation time is less as compare to the usual one. But situation reaction based test is bit harder for bots and simpler for human to take fundamentally correct decisions.

The hard AI problem consumes bit higher time as compare to the simpler one; that is why the proposed game requires bit higher time which is usually normal and does not irritate human. Here less computation time means fewer efforts made by human that can be cracked by machine effortlessly.

Table No. 4. Result Comparison II

Scheme	S. Ashok Kumar [12]	Proposed
Attack	Affected by color detection	Failed to understand problem
Game Play Log	Gameplay log can be saved and forward by attacker from its own Machine	No Gameplay log is required to accept or reject the request, Only for m data can send only a fter successful game pl ay
Complexity Level for bots	Low	High
Game Type	Click / Drag & Drop	Drag & Drop
Database used for accept or reject response	Yes	No

Table No. 4. shows the study of comparative result between base paper S. Ashok Kumar [12] and proposed system. This comparison is done on the basis of attacks faced by the systems, game log, complexity level, game type and database used. Here the system is able to challenge bots and no attack can harm the system feasibility because there is no pattern base target or object identification, system is total based on intrinsic situations where only human can understand it and solve it accordingly.



The best decision will acquire the game otherwise it will reject the user and a new challenge get appeared. Real life situation is hard to understand by bots or a program with good decision making, only human tendency can achieve it. According to the result comparison, the previously proposed system gets affected by color detection method in image processing, that is able to recognize yellow colored target very easily and security base has been broken. But no attacks affected the proposed system. Previously proposed system may also affected by game play log where illegitimate user can forward game log to the server and get approval from there. Overall, the proposed system is better than the earlier one in the field of Turing test.

## VI. CONCLUSION & FUTURE SCOPE

Here the system proposed a new technique of CAPTCHA that provides most effective method which is better able to differentiate human and robots. It is a next generation CAPTCHA where users enjoy it along with best security motives. System is based on intrinsic situations where only human can intervene with fundamentally correct decisions which gives a realistic challenges for bots. No attacks can affect the security premises of proposed system, thus the system is enough suitable for proposing enhanced level of protection in the field of gaming CAPTCHA. Game is simple for human but there is no clue for bots to understand the target of the games. The current proposed concept of intrinsic situations based gaming CAPTCHA can be enhanced in future with more intellectual efforts that can be easily solved by human but almost impossible for bots. The CAPTCHA can be implemented in future with the more intellectual problem or situation that can be solved within few seconds which may be fewer than the proposed one. Time and space complexity can be reduced in future for better outcomes. Proposed CAPTCHA is applicable in various fields such as- digital transaction where human latency is often important, big data optimization and many more.

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