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Evolving New CAPTCHA using cognitive ability of Human through Computer Architecture

Mrs. Geeta Gandhi [1]
Research Scholar
Jaipur National University ,India

Dr. Vijay Dhaka [2]
Professor (Dept. Of Computer Science)
Jaipur National Universit, India

Abstract: As the computerization and technical development advances, the information security has become a very critical aspect of modern computing system. The users, business and organization worldwide have to live with a constant threat from hackers and attackers, who use a variety of techniques and tools in order to break down the computer system, steal information and cause havoc.

So, when we have to make the network secured from machines designed for malicious attack, we must have to be capable of distinguishing between a human being and a machine .This task is performed by CAPTCHA i.e. Completely Automated Public Turing test to tell Computers and Humans Apart which is a class of Human Interaction Proof (HIP) that have been able to effectively prevent web Bots from getting access to the web services. It is a type of Challenge Response test used in computing as an attempt to ensure that the response is generated by a person .The process involves one computer asking a user to complete a single test which the computer is able to generate and grade. It has become a significant and standard security mechanism to provide Authentication which can be utilized as a tool for defending against malicious and bot programs.

The objective of the present paper is to focus on the need of generating new CAPTCHA methods by evaluating and analyzing the limitation of present available CAPTCHA .Also, this paper utilizes the cognitive ability of human for generating CAPTCHA to achieve the goal of differentiating human and machine apart. For this we propose a framework to generate CAPTCHA using the combination of different logic gates of Computer Architecture which will open new doors in the direction of web security.

Keywords: Web Security, CAPTCHA, Evaluation and limitation, cognitive power of human, Computer Architecture.

I. Introduction :-

Nowadays, several web services use CAPTCHA as a defensive mechanism against automated web bots[1].So, The necessity of having CAPTCHA on a web form is now not a topic of debate or it is a must to keep the website up and live.[2]. The web services and applications that use CAPTCHA methods for as HIP include chat rooms, search engines ,password systems, online polls, email services for account registration ,prevention of sending and receiving spam, blogs, messaging services, free content downloading services and detecting phishing attacks[1].

The present paper focuses on the application areas of CAP-TCHA evaluating the present available CAPTCHAs emphasizing the need of new CAPTCHA generation. Also, it will provide a framework of Computer Architecture to produce CAPTCHA test randomly on the screen.

II. Literature Review:

CAPTCHA was first introduced in 1997 when Anderi Broders devised the CAPTCHA method. In the same year, AltaVista website used this method to distinguish between computer programs and human user [3].The three major properties of a good CAPTCHA are that

(i) It should be easy for a human user to pass.
(ii) It should be easy for a tester machine to generate and grade.
(iii) It should be hard for a software robot to pass[4]

So far we can categorize the available CAPTCHAs as text- based CAPTCHA, Image-based CAPTCHA, Audio–based CAPTCHA and Video- based CAPTCHA. This categorization only implies what is being presented to the user and not what is being used [5].

2.1) Text-Based CAPTCHAs:-

They typically relies on sophisticated distortion of text images rendering them unrecognizable to the state of the art of pattern recognition programs but recognizable to human eyes [6]. The E-Z Gimpy CAPTCHA, Pessimal Print

CAPTCHA [7], the Re-CAPTCHA, Baffle Text CAPTCHA (a version of Gimpy Test)[4]are some of the major examples of present available CAPTCHA[5].Various service providers on the internet like Pay Pal ,Hotmail and You Tube use their own versions of text based CAPTCHA on their websites and update them with newer versions frequently [1].

2.2) Image-Based CAPTCHA:

They typically require the users to perform an image recognition task [6]. These CAPTCHAs are introduced as a substitute of text-based CAPTCHA[8].In this CAPTCHA images are distorted to such an extent that it has minor effect on the recognizability by human , but at the same time possess great deal of difficulty for algorithmic recognition[8]. Eventually this idea was to present a more difficult challenge for spam bots as image based CAPTCHA contain colors and also have large variety of meaningful images rather than text and words [3].These CAPTCHAs include the ESP-Pix CAPTCHA(as the first image CAPTCHA developed by Carnegie Mellon University) [9],. Asirra (Animal Species Image recognition for restricting access), Multimodal CAPTCHA, Dynamic Image-based CAPTCHA (DIBC), Identipic CAPTCHA etc. [9].

2.3) Audio-based CAPTCHA:

These kinds of CAPTCHAs typically require users to solve speech recognition task [6].They are designed firstly because of disability of vision and the problems related to eyes and so on. So, it came into existence due to the visual disability of human being to recognize the distorted text CAPTCHA [3].

2.4) Video-based CAPTCHA:

In video-based CAPTCHA, three words (tags) are provided to the users which describe a video. If a users tag belongs to set of automatically generated ground truth tags than a challenge is passed [1].

III. Result and Discussion*:*

On the basis of present study of different types of available CAPTCHAs, we conclude that the present available CAPTCHAs are associated with some limitations which can be summarized below:

(i) Registration to a specific website got dropped about 70% with the introduction to CAPTCHA.
(ii) As text-based CAPTCHA typically relies on sophisticated distortion of text images it is sometimes so complicated as it takes time to understand and type the words of CAPTCHA image which makes the user annoyed.
(iii) Some CAPTCHAs protection systems can be by passed without using OCR symbols by reusing the session Id of a known CAPTCHA image [10].
(iv) CAPTCHAs residing on shared servers can also present a problem as a security issue of another virtual host may leave the CAPTCHA issuer's site vulnerable [10].
(v) Some CAPTCHAs are easily solvable by the machine using segmentation as convolution neural networks were trained using machine learning to recognize characters in each of these experiments [11].
(vi) Some projects are designed to defeat CAPTCHA by machine learning techniques which make the present CAPTCHA in secured. For e.g. Mori et al. published the paper in IEEE CVPR'03 detailing a method for defeating EZ Gimpy by 92% [10].

So, on the basis of the above evaluation, we can say that a good CAPTCHA is one which intends to provide the problem easy enough for all human to solve and prevent standard automated software for filling out a form.
Thus, we can say that the present available CAPTCHA requires maintaining a balance between usability and security [12].
This motivates the requirement to perform research in this area which is also helpful to provide new challenges in the direction of Artificial Intelligence.
In this paper we are going to develop some of the designs utilizing cognitive ability of human and then display them on the screen with the help of Computer Architecture which will open new doors to Web Security.

IV. Proposed Work:

1.1 Using Cognition to develop CAPTCHA codes:

In our proposed work first of all we are going to develop some Surrogative images which will contain an alphanumeric code hidden into it. Now the user is supposed to recognize the alphabet or number which is hidden within the code. The main feature of these designs is that they are the images generated utilizing either a number or alphabet. This concept makes the alphanumeric code difficult to be detached through machine learning techniques, however on the other hand this code can be easily resembled by the user as it requires cognition ability to identify and grade. In this way we have utilized the cognition ability of human being to generate an innovative CAPTCHA which can further open new doors to the direction of Web security. So, the objective of these designs is to be utilized as a CAPTCHA code so that only human being can capture the code hidden into it utilizing his cognitive ability.Cognition means the capability to achieve knowledge which makes a human being different from a machine. using this cognition based innovative CAPTCHA our objective is to achieve an optimum CAPTCHA solution containing feature of both usability and robustness.
Some of these designs which are chosen as CAPTCHA code can be shown in the table(1) below :

	IMAGE 1	IMAGE 2	IMAGE 3
1			
2			
3			
4			
5			
6			
7			
8			
9			
0			
A			
B			
C			
D			
E			
F			
G			
G			
I			
J			
K			

L			
M			
N			
O			
P			
Q			
R			
S			
T			
U			
V			
W			
X			
Y			
Z			

Table (1) Designs of Images to be used as CAPTCHA code

As the Cognition concerns with a group of mental processes which includes attention, memory and understanding which not the feature of a machine is so this concept can be better utilized to differentiate a human and a machine. Now the Question is to display these designed codes randomly on the screen in the form of CAPTCHA. For this we are going to design a database which will contain the new numerology for random display. The working of the proposed work can be summarized in the flow chart below in Fig (1) which will choose 6 images randomly at a time to be shown as Human Interaction Proof(HIP) for the user.

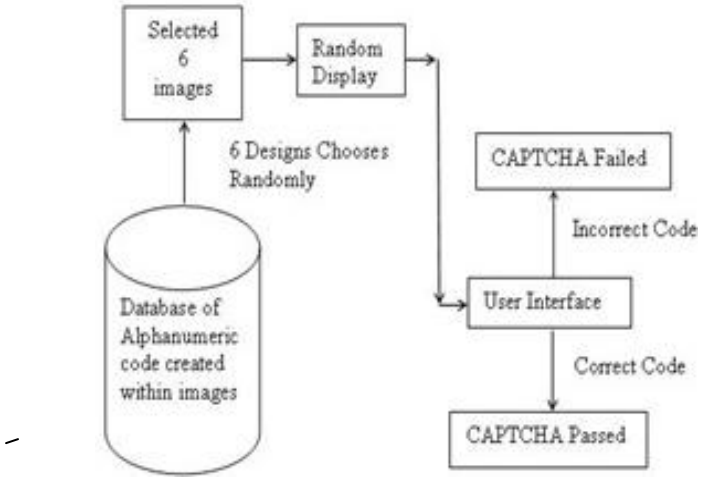


Fig (1): Diagram showing working of proposed work.

1.2 *Technical Implementation* :

After developing the Surrogative images mentioned above, now our goal is to produce these designs randomly on the screen. For this we will use some of the Integrated circuits, Combinational Circuits and Sequential circuits of Computer Architecture to achieve the mentioned goal.

Proceeding in this direction we first explain the working of each of the component of Computer Architecture which we are going to use in our circuitry and then explain the design and working of the proposed circuit.

1.2.1 : *Elements of the proposed Circuit* :

(i) The N:1 Multiplexer :

A multiplexer is a digital circuit where the output depends on the current input provided .This is a type of combinational circuit where to select one of 2^n inputs we only need n lines to "select "the input. The basic block diagram of N: 1 Multiplexer is shown in Fig. (2)

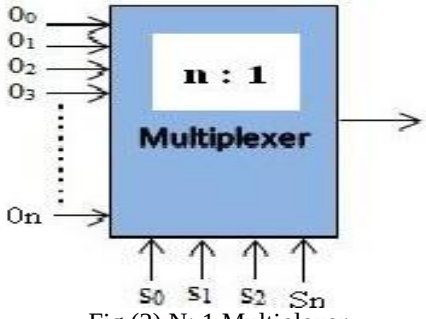


Fig (2) N: 1 Multiplexer

(ii) *D Flip Flop* :-

The D flip flop is one of the synchronous type of storage element utilized for sequential logic. It employs signals that affect the storage element employed in clocked Sequential circuit.

The D flip-flop is designed utilizing the SR flip flop by inserting an Inverter between S and R assigning the symbol D to the single Input. The D input is sampled during the occurrence of a clock transition from 0 to 1.

If D=1, the output of the flip flop goes to state 1

If D = 0, the output of the Flip flop goes to the 0 state.

The graphic symbol and characteristic table of the D flip flop are shown in Fig (3):

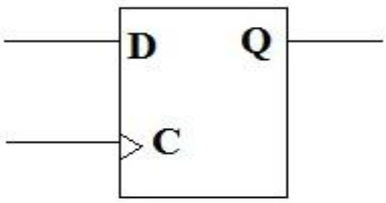


Fig (3) D-Flip flop

(a) Graphic symbol

D	**Q(t + 1)**
0	0 clear to 0
1	1 set to 1

(b) Characteristic table

From this characteristic table we note that the next state Q (t+1) is determined from the D input. The relationship can be expressed by a characteristic equation

Q (t+1) = D

This means that the Q output of the flip flop receive its value from the D input every time that the clock signal goes through a transition from 0 to 1.

1.2.2 : Working of the designed circuitry:

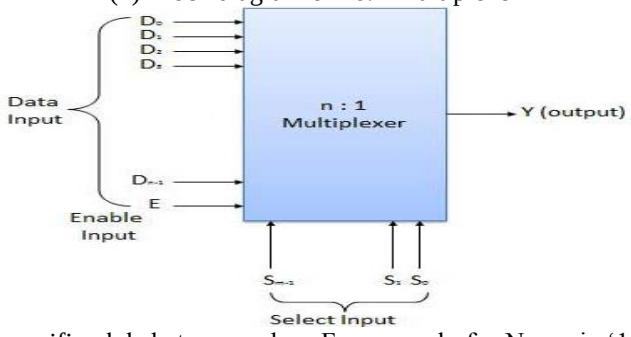
After the description of the elementary components to be utilized, in this section we will explain the architectural design of the goal to be achieved.

For this we will first create 16 images of each of the alphanumeric code to be displayed. For instance

16 images of Numeric 0
16 images of numeric 1
:
:
:
:
16 images of numeric 9;
16 images containing letter 'a'
16 images containing letter 'b';
:
:
:
:
:
16 images containing letter'z'

Now, as a whole we have 36alphanumeric codes (0 to 9, a to z) each having 16 images .So, the total number of images will be 36*16= 576.Further, we use 36 number of 16 is to 1 Multiplexer as shown in fig (4)

(4) Block diagram of 16:1 Multiplexer



Each holding the image of a specific alphabet or number. For example for Numeric '1'we use 16 images hiding 1 as input to the 16 is to 1 Multiplexer as shown below in fig(5).

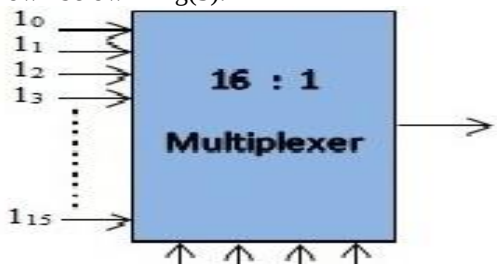


Fig (5): Block diagram of 16: 1 multiplexer containing designs for numeric1.

Similarly, we can show the Multiplexers designed to input alphabets 'a', 'b', etc as shown below in fig (6)

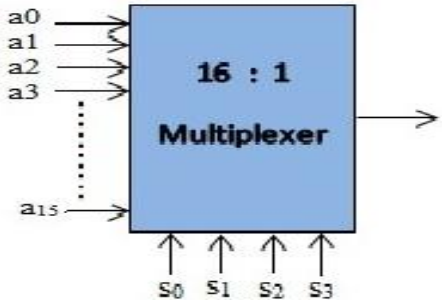


Fig (6): Block diagram of 16:1 multiplexer containing designs for alphabet 'a'.

Proceeding in the same manner we have 36 such Multiplexers totally aligned as shown in fig (7)

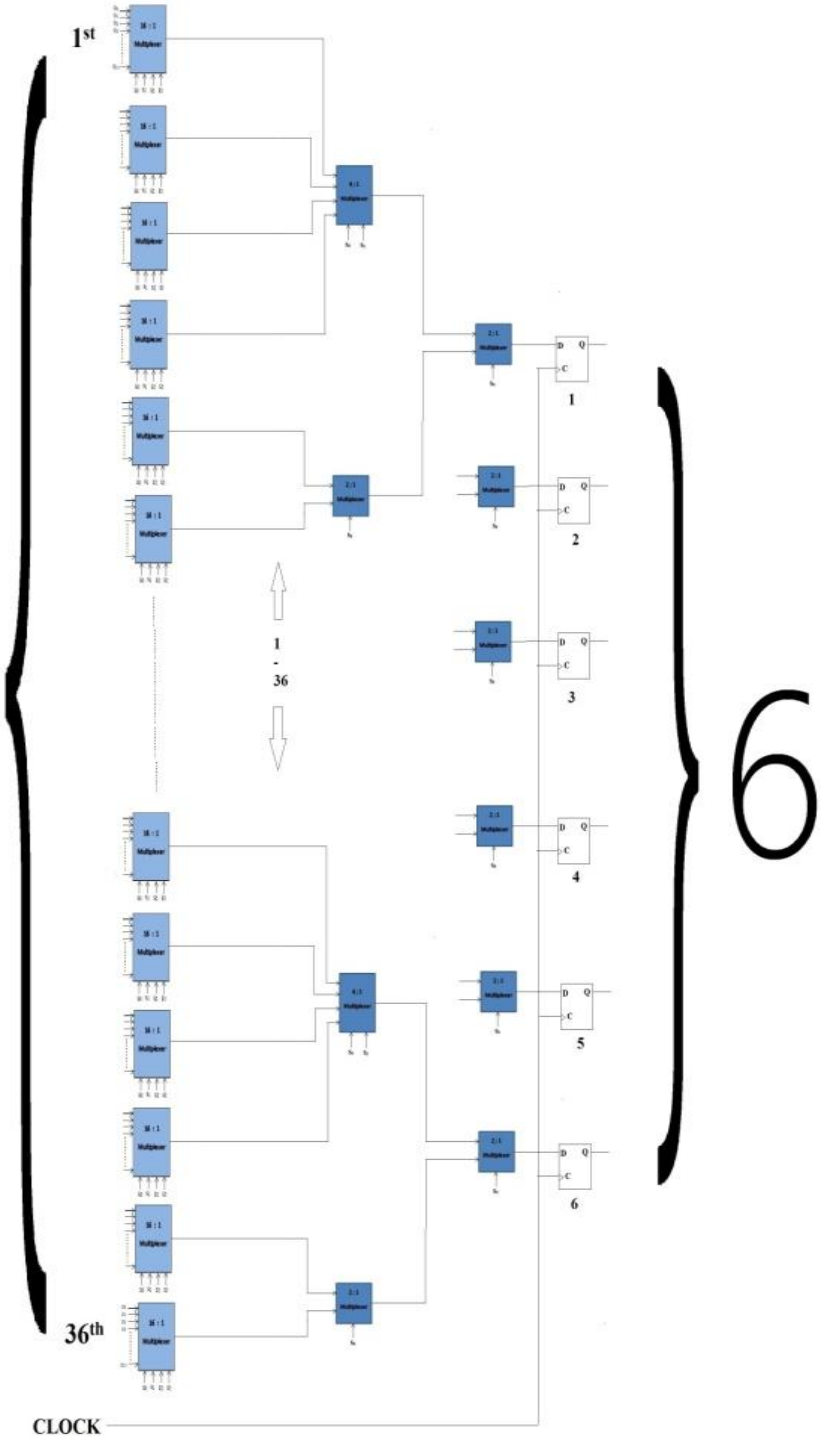


Fig (7): Architecture for random display of CAPTCHA

Now our goal is to choose 6 digits at a time from these Multiplexers.
For this, we make a set of four 16 is to 1 Multiplexer to be associated with one 4 is to 1 Multiplexer then taking next two 16 is to 1 Multiplexers joined with one 2 is to 1 Multiplexer as in fig(7).
By again binding both of the outputs with one 2 is to 1 Multiplexer as shown in our circuitry.
This complete combination will provide a single image randomly selected to be displayed on the screen.
Now, as we have to generate 6 images to be displayed at a time, we require 6 sets of the above mentioned combination.
Again, to store these codes for a single clock pulse we will use 6 D Flip flops available with a common synchronized clock. This common clock input triggers all the Flip flops on the rising edge of each pulse and the data available at the 6 inputs are transferred into the 6 bit register. These 6 outputs then can be sampled at any time to display the generated CAPTCHA.The advantage of using D flip flop register here is that the clear input goes to a special terminal in each flip flop and when this input goes to 0 all flip flops are reset asynchronously which makes the selected pattern to show for a small span of time . This time variant technique strengthens our CAPTCHA by reducing the chances of machine hit.
The implementation of our work will follow the steps below:

(i) Create design / patterns using alphanumeric codes.
(ii) Generate the database
(iii) Randomly choose the pattern with the combination of multiplexers.
(iv) Display the pattern through combination of D flips flop.
(v) Obtain the user input
(vi) Compare and evaluated the CAPTCHA entered by the user.
(vii) Permit or deny the access to the user according to the result.

V. Conclusion:

The proposed work suggests a new technique to display CAPTCHA on the screen which can open new doors to the web security which has become a critical aspect now days. Also it will provide new challenges to the field of Artificial Intelligence.

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