EFFICIENT MONITORING IN ONLINE TESTS USING ESDV METHOD

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ABSTRACT

In online exams location of the proctor varies from the location of the examinees. When the distance increases, chances of doing malpractice increase. To avoid such situations, the examinee has to be constantly monitored. Many techniques were proposed for providing security during conduct of online exams. This paper proposes an Enhanced Security using Data Visualization (ESDV) for conduct of online exams. This method is a multi model technique which uses a combination of password and face authentication.

KEYWORDS

Authentication, data visualization, feature extraction, malpractice, online exam.

1. INTRODUCTION

In an online exam, due to the inability of direct invigilation by the proctor, the examinee may attempt to malpractice. To prevent this condition, the examinee has to be constantly monitored. Monitoring can be done by using authentication techniques such as providing username and password, biometric methods like face, finger prints and iris identification techniques.

Authentication is a process that permits an entity to establish its identity to another entity [1]. Authentication methods are of three types namely passwords, tokens and biometrics. With the use of passwords, only authenticated users are logged in. Conditions such as, the password should contain minimum of eight characters; one letter, one number, one special character etc are provided to make the passwords strong enough for intruder attacks. Passwords should be often changed to avoid the risk of stealing and guessing.

The second mode of authentication is the use of tokens. Some of the applications of the tokens are physical keys, proximity cards, credit cards, Asynchronous Transform Mode (ATM) cards. They

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are simple in usage and easy to produce. To avoid the risk of stealing, these tokens are used along with the Personal Identification Number (PIN).

The last mode of authentication is biometrics. In this method the user enrols by providing a sample physical characteristic, which is converted from analog to the digital form. This conversion is stored in a template, which is later verified with the new sample provided by the user at the time of authentication. If the two samples match with a slight variance then the user is authenticated. Biometrics authentication can be applied in the fields of facial recognition, finger prints, hand geometry, keystroke dynamics, hand vein, iris, retina, signatures, voice, facial thermo gram, Deoxyribonucleic acid (DNA).

There are a varying number of authentication systems namely central authentication systems, multi factor authentication system, split authentication system and message authentication system. Central authentication system authenticates users remotely using a central authority system across large number of systems. Applications of this system are Remote access dial in user service, Terminal access controller access control system, Kerberos and Diameter. The multi factor authentication system combines multiple authentication factors into a single model, thus increasing the reliability and security. Application of this system is usage of ATM card with PIN number. Split authentication system, splits the authentication among two parties. The two parties should submit their passwords or cryptographic keys to encrypt or to decrypt a message. In Message authentication system, the message is authenticated by using message authenticated code (MAC). The message authenticated code is generated by combining message with a secret key shared by both the sender and the receiver. On receiving the message, the receiver recomputed its own MAC and compares it with received MAC. If any change is found, then the message is said to be altered. Digital signatures are used to ensure authenticity and non-repudiation.

The term data visualization can be described as the graphical representation of the given data. It makes an overview of entire data, thus making the viewers to easily interpret the data. There are a varying number of techniques proposed for different dimensional database. Scatter plots, line graphs, survey plots and bar charts are used for two dimensional data [2]. Scatter plots represent the two dimensional attributes by using x-y axis coordinate system. If more number of data sets is used then for making a difference, different colours are used for each data set. Line graphs display single valued function related to one dimension. Survey plots consists of n-rectangular areas each representing one dimension. A line is used to represent each dimension, with the length proportional to the dimension's length. Bar charts represent the data by using the rectangular blocks and the represented area is filled within blocks.

Scatter plots, survey plots and animation techniques can be used for visualizing three dimensional data, by adding a third dimension orthogonal to the other two dimensions. Animation helps in the representation of the data by showing the variation of the plot with respect to time.

For visualizing high dimensional data, icon based, hierarchical, geometrical and pixel oriented techniques are used [3]. In icon based, there are a number of varying techniques namely chernoff faces, star glyphs, stick figure, shape coding, colour icon, texture. The varying number of methods in hierarchical techniques are namely dimensional stacking, fractal foam, hierarchical axis, worlds within worlds, tree map [2],[3]. The varying techniques in geometrical methods are parallel coordinates, Andrew's curves, multiple views, radical coordinate visualization, polyviz, hyper slice, hyberbox, star coordinates, table lens[2],[3]. The methods that were included in pixel oriented techniques are namely space filling curve, recursive pattern, spiral and axes technique, and circle segment and pixel bar chart [3]. Detailed explanation of these methods was given in [4].

Section 2 summarizes the methods introduced so far for providing security during conduct of online exams. Section 3 presents results of our proposed system. Section 4 discusses the experimental setup. Conclusion and future work are given in section 5 and 6.

2. RELATED WORK

For visualization of an image, the image has to be pre-processed and later the features are to be extracted from it [5]. In pre-processing step, filtering, normalization and segmentation techniques are implemented. Filtering of an image helps in noise removal, sharpening which includes enhancing the details of an image and later smoothing of an image. Normalization of the image, changes the pixel intensity values such that bringing the image to the normal senses and making it more familiar. Segmentation helps in dividing the given image into multiple parts, thus making the image to be easily analysed. By dividing the image, we can further continue the work on the required part rather than on the entire image. The second step in the data visualization is feature extraction, which is a special form of dimensionality reduction. In feature extraction, the input data is transformed into a set of features. Here features are selected in a way that, the operation on those features will yield the desired result. The set of features that can be extracted from an image are shape, texture and colour.

Colour is the widely used feature in the feature extraction process [5]. The following are the advantages of using colour feature namely robustness, effectiveness, implementation simplicity, computational simplicity, low storage capability. The colour of an image is represented through colour model. A colour model is specified in terms of 3-D coordinate system and a subspace within that system where each colour is represented by a single point. There are three colour models namely RGB, HSV, Y C_b C_r. RGB colours are called primary colours and are additive. By varying their combinations, other colours can be obtained. In HSV, the representation of the HSV space is derived from the RGB space cube, with the main diagonal of the RGB model as the vertical axis in HSV. As saturation varies from 0.0 to 1.0, the colours vary from unsaturated (gray) to saturate (no white component). Hue ranges from 0 to 360 degrees, with variation beginning with red, going through yellow, green, cyan, blue and magenta and back to red. HSV is calculated by using the formula $H = \cos^{-1}\left\{\frac{\left(\frac{1}{2}[(R-G)+(R-B)]\right)}{\sqrt{(R-G)^2+(R-B)(G-B)}}\right\}$ $S = 1 - 3[\min(R,G,B)]/V$

$V=1/3(R+G+B)$ (1)

YC_bC_r is a colour space used in the JPEG and MPEG international coding standards. Formula used in calculation is

$Y = 0.299R+0.587G+0.114B$
$C_b = -0.169R-0.331G+0.500B$
$C_r = 0.500R-0.419G-0.081B$ (2)

The second feature that can be extracted from an image is texture [5].Texture has been one of the most important characteristic which has been used to classify and recognize the objects and have been used in finding similarities between images in multimedia databases. Texture alone cannot find similar images, but it can be used to classify textured images from non-textured ones and then be combined with another visual attribute like colour to make the retrieval more effective. There are 4 methods in texture extraction namely statistical, geometrical, model based, signal processing methods [6].

Statistical methods help in defining the qualities of texture in the spatial distribution of gray values.

Geometrical methods are characterized by their definition of texture as being composed of "texture elements" or primitives. Once the texture elements are identified in the image, there are two major approaches in analyzing the texture. First type computes statistical properties from the extracted texture elements and utilizes these as texture features. The geometrical method comes under the second type, which tries to extract the placement rule that describes the texture. Geometrical methods are further classified into voronoi tessellation features, structural methods [7]. Voronoi tessellation helps in defining local spatial neighbourhoods, because the local spatial distributions of tokens are reflected in the shapes of the voronoi polygons. Texture tokens are extracted and then the tessellation is constructed. Tokens can be points of high gradient in the image or line segments or closed boundaries. The structural models of texture assume that textures are composed of texture primitives. The texture is produced by the placement of these primitives according to certain rules.

Model based texture analysis methods are based on the construction of an image model that can be used not only to describe texture, but also to synthesize it [7]. The model parameters capture the essential perceived qualities of texture. Model based methods are further divided into random field models, fractals, autoregressive, Markov random models. Random field models have been popular for modelling images. They are able to capture the local (spatial) contextual information in an image.

Basing on Signal Processing Methods, the psychophysical research has given evidence that the human brain does a frequency analysis of the image [7]. Most techniques try to compute certain features from filtered images which are then used in either classification or segmentation tasks. Signal processing methods are further divided into spatial domain filters, Fourier domain filtering, Gabor and wavelet models. Further discussion on these methods was given in [4].

Shape is another important visual feature and it is one of the primitive features for image content description [5]. This feature helps in measuring the similarity between the images represented by their shapes. There are two steps in shape based image retrieval namely, feature extraction and similarity measurement between extracted features. Shape descriptors are used for feature extraction in shape. They are of two types in shape descriptors namely region based which use whole area of the object and contour based that use information present in the contour of an object. Features calculated from object contour are based on circularity, aspect ratio, discontinuity angle irregularity, length irregularity, complexity, right-Angularness, sharpness, directedness.

Region based shape descriptor utilizes a set of Zernike movements calculated within a disk centred at the centre of the image [5]. Following are the advantages in using Zernike movements namely rotation invariance, robustness, expressiveness, effectiveness, multilevel representation. Zernike polynomials are an orthogonal series of basic functions normalized over a unit circle. These polynomials increase in complexity with increasing polynomial order. To calculate the Zernike moments, the image (or region of interest) is first mapped to the unit disc using polar coordinates, where the centre of the image is the origin of the unit disc. Those pixels falling outside the unit disc are not used in the calculation. The coordinates are then described by the length of the vector from the origin to the coordinate point.

One of the techniques, used in the feature extraction is Discrete Cosine Transform [8]. This feature extraction technique is useful in extracting proper features for face recognition. After applying Discrete Cosine Transform (DCT) to entire face, some of the coefficients are selected to construct feature vectors. This technique helps in processing and highlighting signal frequency features. Whenever an input image is given, features are extracted and are stored along with the input image in the database. Now, when a query image is given it is first normalized then converted into a block image. Later from the block image, DCT based feature extraction is done. Then these features of the query image are compared with the features of the input image.

Comparison is done with the use of Euclidean distance measure. The formula used in DCT based feature extraction for two dimensional images is
The 2-dimensional DCT of an image f(I,j) for I,j=1,…….N
is

$$f(u,v) = \frac{1}{\sqrt{2N}} c(i)c(j) \sum_{x=1}^{n} \sum_{y=1}^{n} f(x,y) \cos\left[\frac{(2x+1)i\pi}{2N}\right] \cos\left[\frac{(2y+1)j\pi}{2N}\right]$$

(3). The formula used for the Euclidean distance measure is $D(I_q, I_d) = \frac{\sqrt{\sum(I_{q_i} - I_{d_i})^2}}{N}$ (4)

Where D is the distance between the feature vector I_q and I_d and N is the number of blocks. A detailed survey and comparison of works can be found in [4].

3. PROPOSED SYSTEM

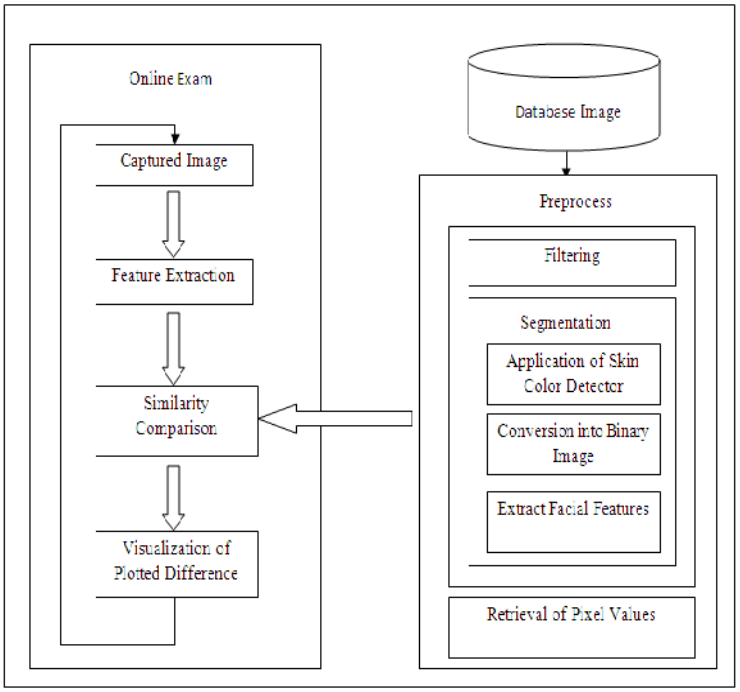

Figure 1. Architecture of Enhanced Security using Data Visuailization (ESDV) System

A multimodal technique is proposed for providing security [4]. This includes authentication of the examinee at the beginning of the exam and later continuous monitoring of the examinee through information visualization techniques. The detection and comparison of the examinee's face and behaviour is done in two phases. Phase 1: During the registration phase in "Fig 1", image of the examinee is stored in the database. The registration phase is shown in "Fig 2", where the examinee has to provide username, password and a recent photograph. Only the authenticated user can login and write the exam. Now the stored photograph of the examinee undergoes the pre-processing step. In pre-processing step, filtering and segmentation are done. In filtering, either of the red, green, blue filters is used. This filtered image is submitted to segmentation phase. In segmentation phase there are three steps namely Application of skin colour Detector, Conversion into binary image and extraction of facial features. Skin Colour Detector helps in finding faces as shown in "Fig 3". The skin colour detector can easily differentiate skin regions from the non-skin regions in the given image. YC_bC_r is applied as the skin colour detector in the proposed system as shown in "Fig 4". After identification of skin region from the image, only that part of the image is

taken for further process thus removing the entire background of the image. Now the second step in the segmentation phase is conversion into binary image. In this step for retrieving the face of the examinee, the skin region image is converted into binary image. With the help of the binary image, the system can detect and extract the examinee's face as shown in "Fig 5"and "Fig 6". The image containing the examinee's face is sent as the input to the third step of the segmentation. This step helps in retrieval of the facial features such as left eye, right eye and lips as shown in "Fig 7". From these extracted features, pixel values are retrieved and stored in the database.

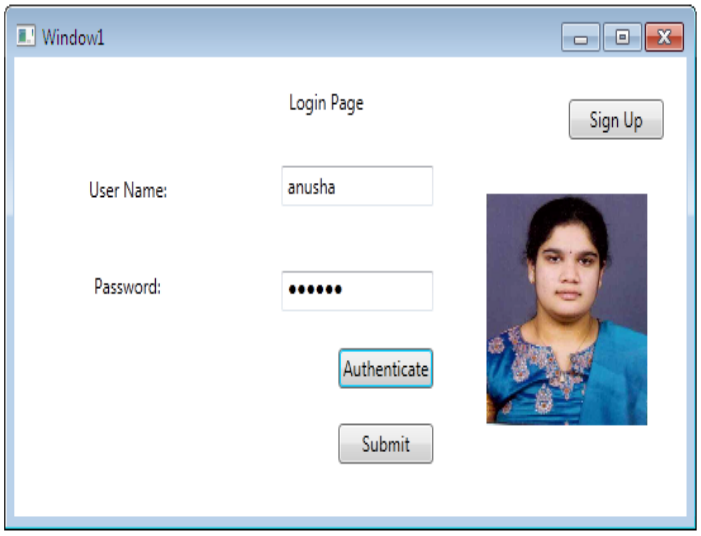

Figure 2. Registration Phase

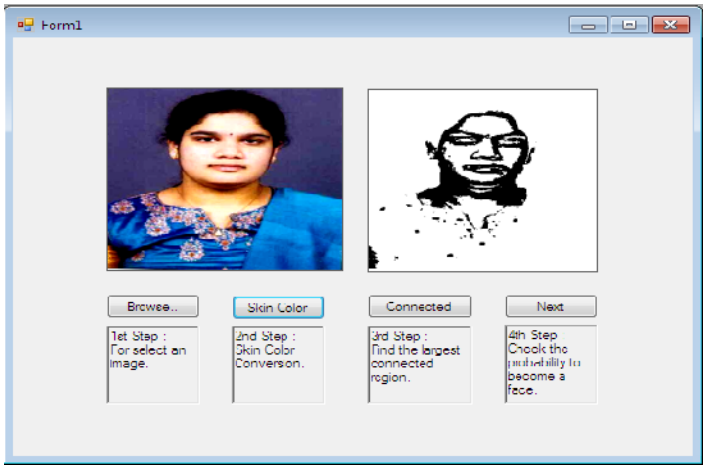

Figure 3. Application of Skin Color Detector

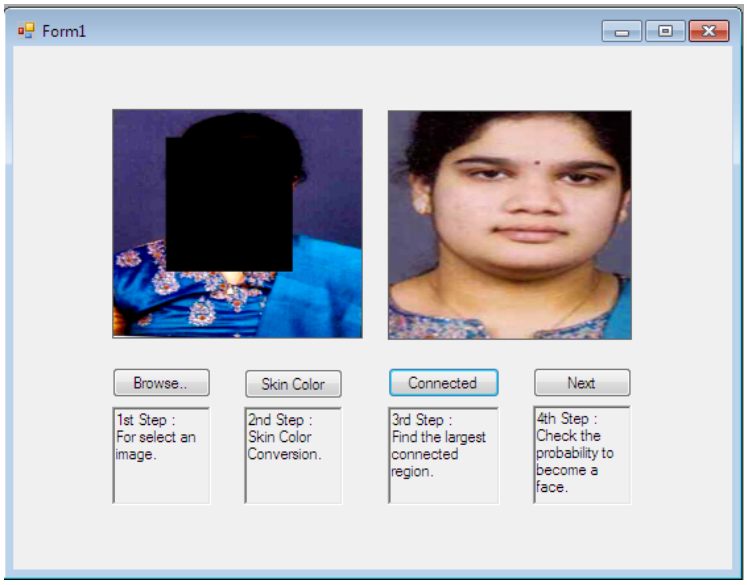

Figure 4. Extracting Skin Region from the Image

Figure 5. Conversion into Binary Image

Figure 6. Retrieval of face from the Image

Figure 7. Extraction of Facial Features

Phase 2: Examinee's images are captured at regular intervals of time. These snapshots are sent as the captured images. From captured input image, feature extraction is done based on the colour, using RGB colour model. From these features, the pixel values are retrieved. Now, the pixels of the registered image are compared with the pixels of the captured image as shown in "Fig 8". Later the plotted difference is represented by using two dimensional data visualization techniques as shown in "Fig 9". Through these plots, the proctor can easily visualize any change noted in the examinee's behaviour. This approach thus employs a full time security for online exams.

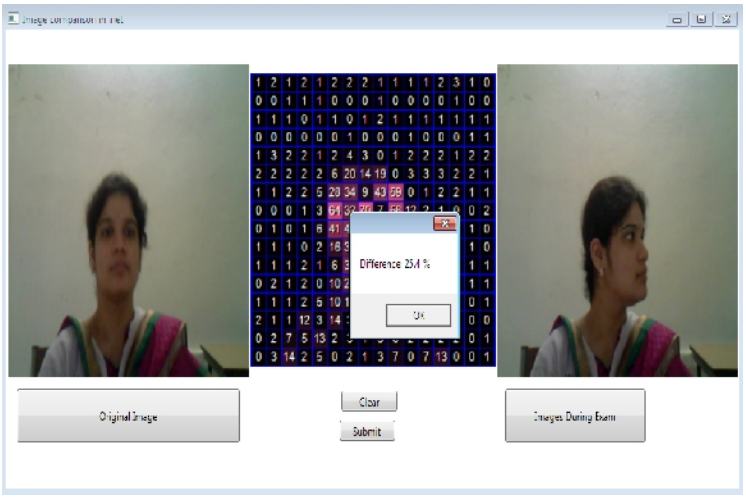

Figure 8. Comparison during the examination

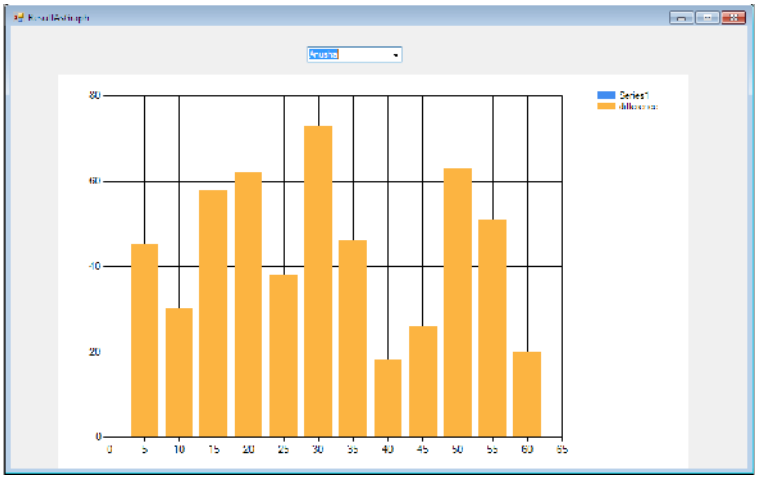

Figure 9. Plotting of the difference using Data Visualization Technique

3.1 Advantages of the Proposed System

3.1.1 Memory

Existing system [9], records and stores video of the examinee during exam which occupy more space and requires more network bandwidth for communication. In the proposed system the snapshots of the examinee are taken at regular intervals of time and are compared with the registered image. The plotted difference which is a two dimensional data is considered for authenticating the examinee. As a result of this storage, memory and bandwidth requirements are reduced.

3.1.2 Network Overload

Video transfer becomes hectic when the examinees' number increases. Even the compressed video takes much time to get transferred. The proposed system overcomes this problem, by reporting the behaviour of the examinee through graphs X, Y (Coordinates) that reduces time complexity of transferring data.

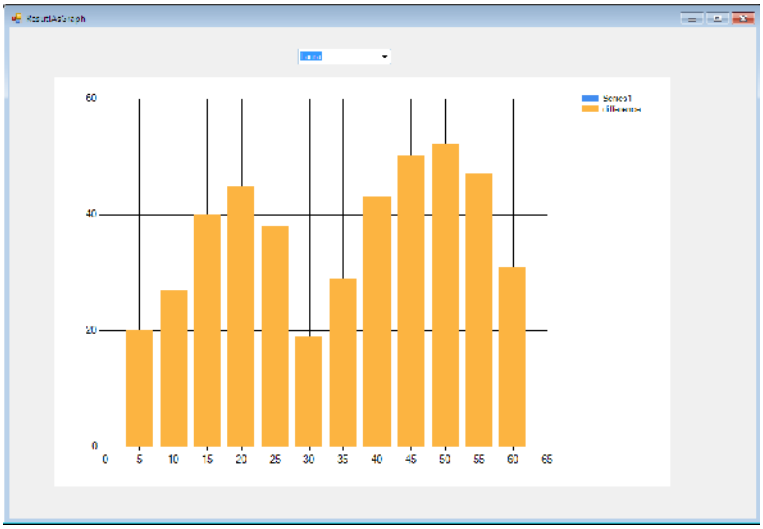

Figure 10. Overall Behaviour of an examinee

3.1.3 Problem of Monitoring

In the existing system [9], video of each examinee in the exam is sent to the proctor. The proctor should continuously monitor to avoid the concept of beguile. The problem arises when the examinees' number increases. The proctor alone cannot identify the malpractice from multiple videos. To avoid such situation, the proposed system introduces the concept of two dimensional visualization techniques. With the help of these techniques, plotting can be done for multiple examinees and the result is portrayed in the same graph as shown in "Fig 10".

Examinee behaviour can be analyzed by plotting the different behavioural values as shown in "Fig 11", "Fig 12", "Fig 13" and "Fig 14".

3.1.3.1 User Graph

This graph gives the information about the overall behaviour of all the examinees.

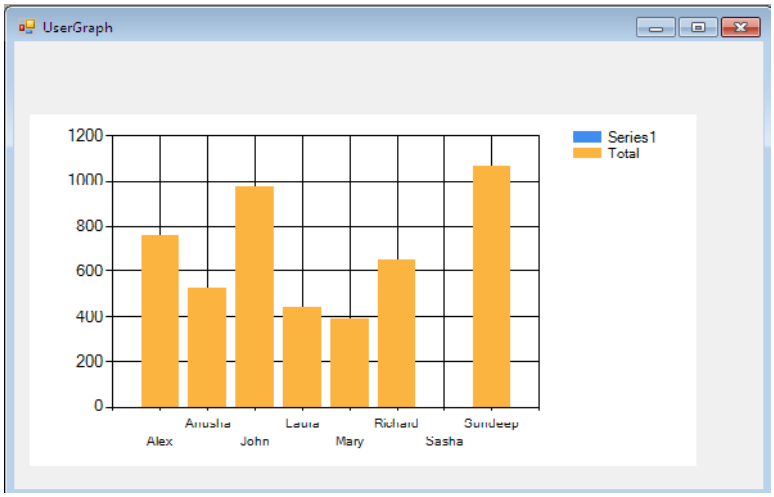

FIGURE 11. Cumulative behaviour of all the examinees

3.1.3.2 Timer Graph

With the help of the timer graph, the proctor can identify the behaviour of the examinees at a particular time interval.

When time= 10

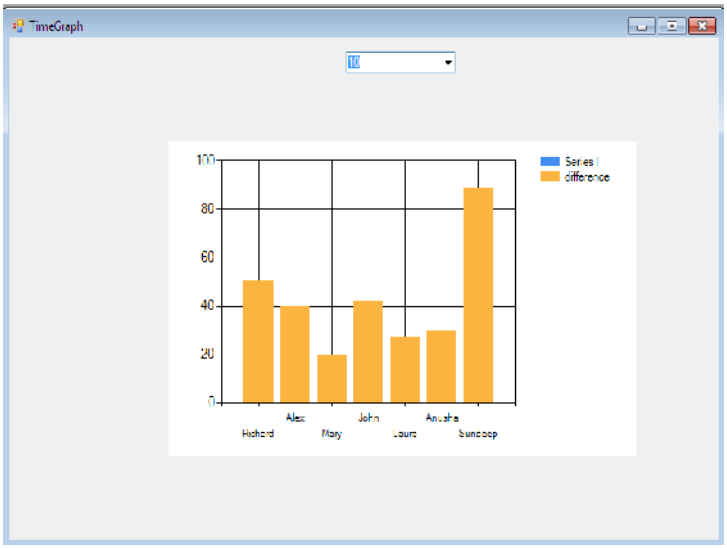

Figure 12. Cumulative behaviour of all the examinees at specific time interval

When time= 25

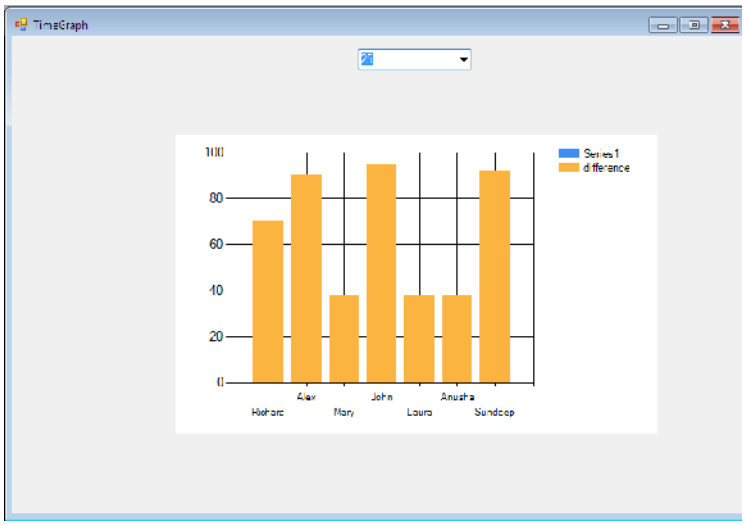

Figure 13. Cumulative behaviour of all the examinees at specific time interval

When time = 50

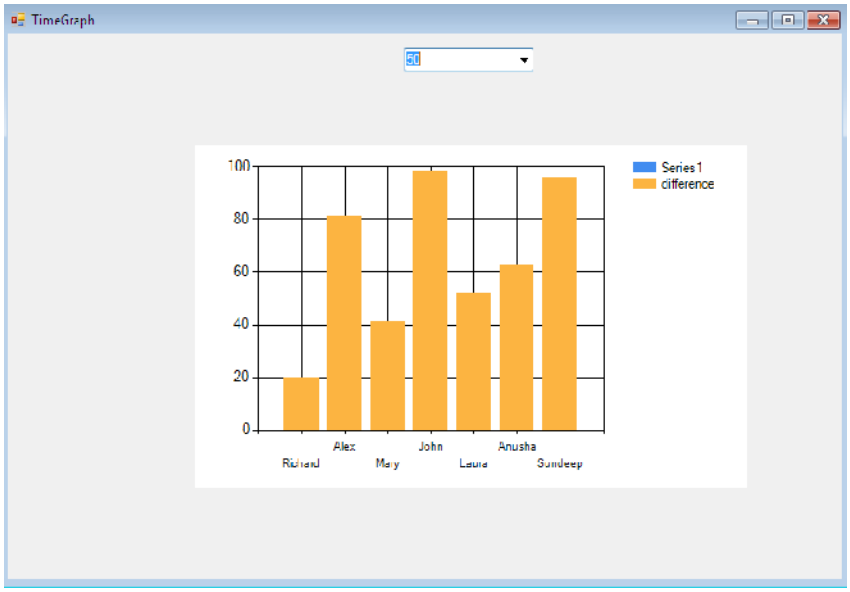

Figure 14. Cumulative behaviour of all the examinees at specific time interval

3.1.3.3 Threshold Graph

"Fig 15" and "Fig 16" gives information about the list of examinees whose cumulative misbehaviour satisfies the threshold condition

When threshold > 480

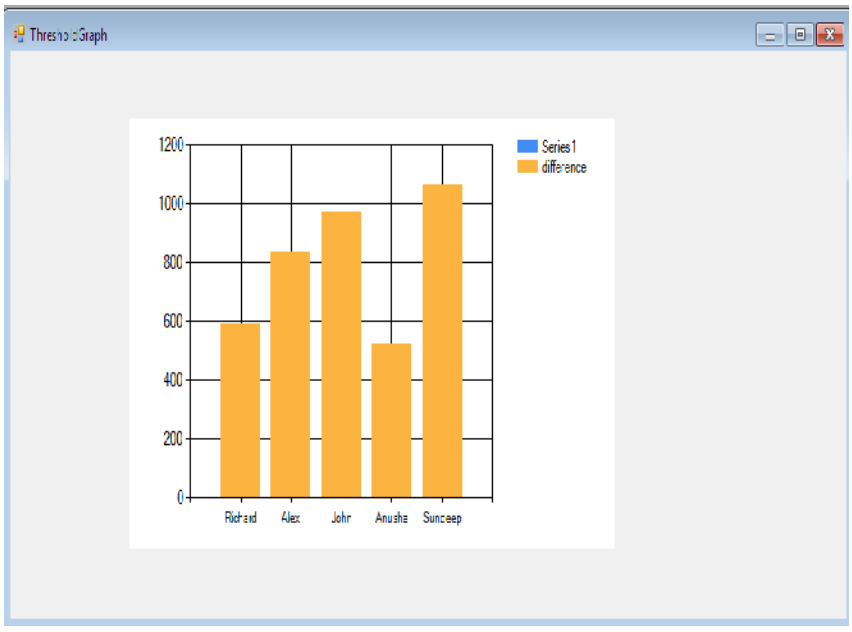

Figure 15. Cumulative behaviour of all examinees satisfying a specific threshold value

When threshold < 480

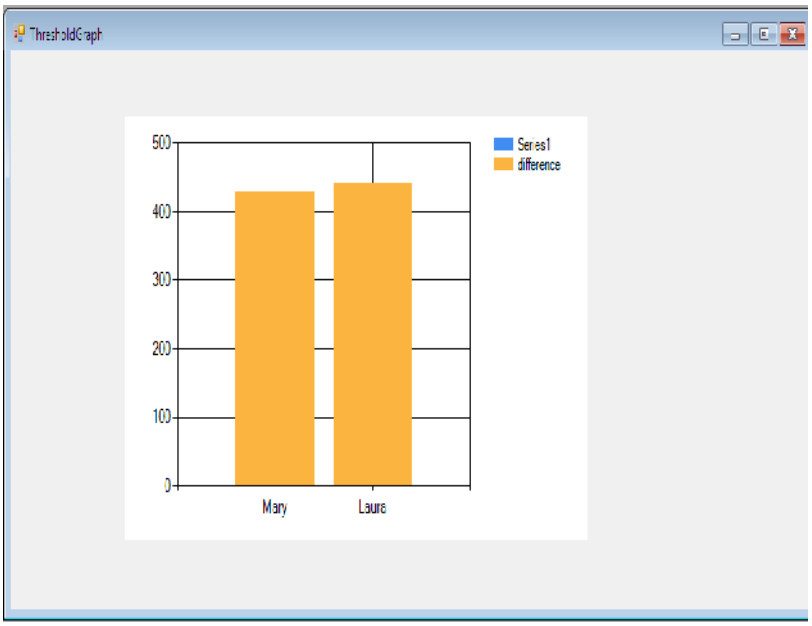

Figure 16. Cumulative behaviour of all examinees whose misbehaviour falls in the accepted range (< Threshold value)

3.1.3.4 Overall Result Graph

The proctor can also view the continuous behaviour of all the examinees writing the exam through the “Fig 17”. This helps the proctor to compare the behaviour of the examinees at different time intervals

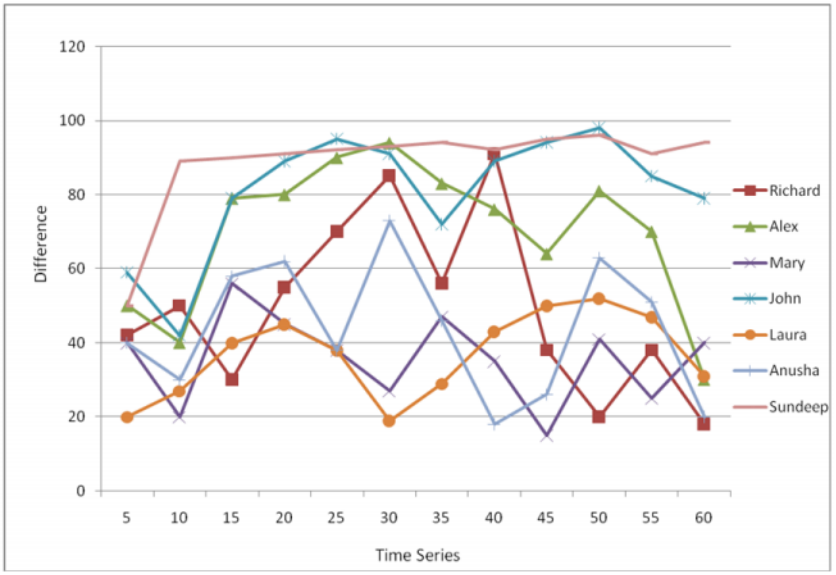

Figure 17. Continuous behaviour of all the examinees across the time series

3.1.4 Problem of Dishonesty

In the existing system [9], the examinee's behaviour is monitored by the proctor. If the proctor is dishonest, that is if he/she overlooks the malpractice done, then the concept of beguile is not eradicated permanently. The above mentioned problem can be removed in the proposed system. Here each image is compared with the original image and the result is represented in the form of a graph that can be saved onto secondary memory for further analysis by higher officials. In this way, the proctor cannot overlook malpractice.

4. EXPERIMENTAL SETUP

Our proposed system is implemented on a 2.2GHz Core 2 Duo T7500 processor having Santa Rosa chipset with 2GB DDR2-667 SDRAM running Windows Vista. Integrated 2.0 megapixel webcam is used for capturing images. Images are captured for every 5 seconds, at a resolution of 318*344 pixels. For each examinee 3.65 Kilo Bytes (KB) of data is used. A buffer of size 140KB is used for passing data packets to proctor. Each fragmented packet carries 4608 bits of data. For each examinee approximately 7 packets of data are transferred. With this packet size, the proposed system can send 38 examinees data without any congestion. This result is greater when compared to the result given in existing system [9], which can send up to 30 examinees data without any congestion as shown in "Fig 18". As long as the buffer contains enough memory to transfer data, occurrence of time delay is null. In proposed system, the time delay occurs during transfer of data at 39 examinees which is 0.000372 seconds. This result is less, when compared to the time delay of packets in existing system as shown in "Fig 19".

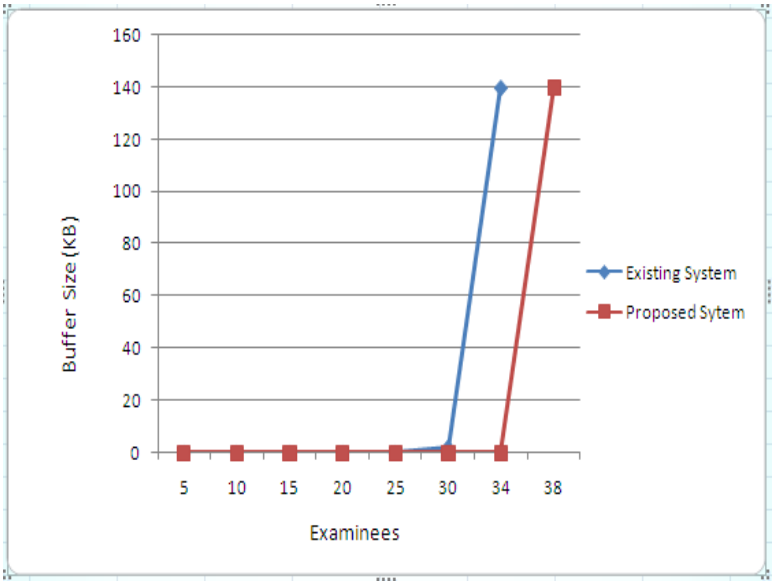

Figure 18.Buffer Requiremnets at the Gateway of Nodes

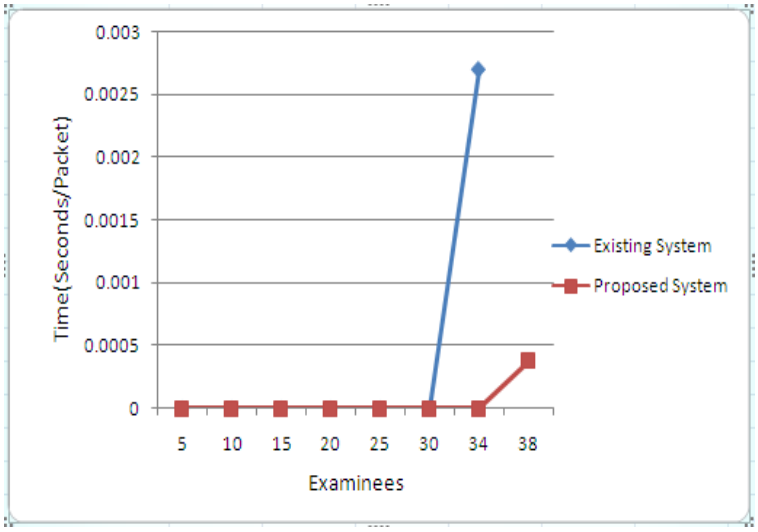

Figure 19. Node Delay per Packet

5. CONCLUSION

This paper presents a multi model authentication technique, which helps in continuous monitoring of the examinee. The behaviour of the examinee is visualized by using different visualization techniques. By usage of these techniques, tracking of the examinee behaviour is done and continuous monitoring is provided thus implementing an enhanced security in online exam.

6. FUTURE WORK

Further we wish to explore more deeply the problem of cheating detection by using facial detection techniques like edge based face detection, neural network based classification, Eigen value face recognition and distribution based modelling. Also, we can cluster the similar behaviour of students by using data mining algorithms for pattern recognition.

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