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Study on Techniques for Providing Enhanced Security During Online Exams

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***Abstract*— In online exams the location of the proctor varies from the location of the examinee. Due to the increase in the distance, chances of doing malpractice increases. To avoid such situations, the examinee has to be constantly monitored. Many techniques were proposed for providing security during conduct of exams. This paper studies various authentication techniques namely unimodal, multimodal and data visualization techniques. The paper also proposes an enhanced security method Enhanced Security using Data Visualization (ESDV) for conduct of online exams.**

***Keywords*—Authentication, data visualization, malpractice, online exam, security**

I. INTRODUCTION

In online exams the location of the proctor varies from the location of the examinee. Due to the increase in the distance, chances of doing malpractice increases. To avoid such situations, 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, 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 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 enrolls 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 colors 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,

color icon, texture. Chernoff face represents a data set and each feature in the face represents a dimension. Star glyph represents data by using a single point with equally angled rays. Here each ray represents a dimension, and the length of the ray represents the value of the dimension. Stick figure maps two attributes to the display matrix and the remaining to the length, thickness, color of limbs. In Shape coding each data item is visualized by using a pixel of arrays. According to the attribute values the pixels are mapped onto a color scale which helps in visualization of the multi dimensional data. In color icon, the pixels are replaced by arrays of color fields that represent the attribute values. Texture helps to gain knowledge about the overall relation between the attributes in addition to the data items.

Section 2 summarizes the methods introduced so far for providing security during conduct of online exams. Section 3 discusses the proposed system. Section 4 gives the conclusions of the paper. Section 5 discusses the future work related to the paper.

II. RELATED WORK

There are a number of methods available in hierarchical techniques namely dimensional stacking, fractal foam, hierarchical axis, worlds within worlds, tree map [2],[3]. Dimensional stacking divides the given data into two dimensional subspaces which are stacked into each other. Later from those subspaces, only attributes are chosen for visualization. This technique is useful for discrete categorical or binned ordinal values. Fractal foam depicts the correlation between the dimensions by the usage of circles. The starting dimension is represented in the form of circle. Later other circles are attached to the first circle, which represent the other dimensions. The size of the circles represents the correlation between the dimensions. In Hierarchical axis the axis is applied in a hierarchical manner. This technique helps in plotting many attributes on one screen. Worlds within Worlds divides the given data space into three dimensional subspaces. This technique helps in generating an interactive hierarchy display, which allows the further exploration of n-dimensional functional spaces. Tree map divides the given screen into a number of regions based upon the attribute values, in a hierarchical fashion. It helps in obtaining an overview of large datasets with multiple ordinal values.

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]. Parallel coordinates makes use of the parallel axes in representation of the dimensions. A vertical line is used for projection of each dimension or attribute. Andrew's curves plot each data point as a function of data values, by using the equation:

$$F(t) = x\frac{1}{\sqrt{2}} + x2.\sin(t) + x3.\cos(t) + x4.\sin(2.t) + x5.\cos(2.t) +$$

...

….(1) [2]

Where, x= (x1, x2, , ,xn) and xn are the values of the data points for the particular dimension. Multiple views are used for the data sets that contain diverse attributes. This method reveals the correlation and disparities between the attributes thus making a visual comparison for better understanding. In Radical coordinate visualization, n number of lines extends from the centre of the circle and end at the perimeter. Each line is associated with one attribute. Data points with similar or equal values lie close to the centre. Polyviz technique represents each dimension as a line. The position of the data points depends upon the arrangement of the dimensions. This technique provides more information by giving an inner view of data distribution in each dimension. Hyper slice contains the matrix graphics representing a scalar function of the variables. This technique provides an interactive data navigation over a user defined point. Hyberbox is depicted in two dimensional data space. This technique is helpful in mapping variables to the size and shape of the box. In star coordinates technique, the data items are represented as points and attributes are represented by axis arranged on a circle. The length of the axis determines the attribute contribution. Table lens technique uses rows and columns for representing the data items and attributes. The information among rows and columns is interrelated which helps in analyzing the trends and the correlation in the data.

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]. Space filling curve provides clustering of closely related data items, thus making the user to easily understand the data. Recursive pattern follows a generic recursive scheme where, the arrangement of line and columns are performed iteratively and recursively. Spiral techniques arrange the pixels in a spiral form, depending on the distance from the query. Axes techniques improve spiral techniques, by adding feedback to the displacement. In circle segment the attributes are arranged on the segments. The data point that is assigned is available at the same location on different segments. Pixel bar chart presents the direct representation of the data values. Each data item is represented by a single pixel and is placed in the respective bars.

For visualization of an image, the image has to be pre-processed and later the features are to be extracted from it [4]. 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.

Color is the widely used feature in the feature extraction process [4]. The following are the advantages of using color features namely robustness, effectiveness, implementation simplicity, computational simplicity, low storage capability. The color of an image is represented through color model. A color model is specified in terms of 3-D coordinate system and a subspace within that system where each color is represented by a single point. There are three color models namely RGB, HSV, Y C_b C_r. RGB colors are called primary colors and are additive. By varying their combinations, other colors 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 colors 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) (2) [4]. YC_bC_r is a color 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 (3) [4]

The second feature that can be extracted from an image is texture [4].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 color to make the retrieval more effective. There are 4 methods in texture extraction namely statistical, geometrical, model based, signal processing methods [5].

Statistical methods help in defining the qualities of texture in the spatial distribution of gray values. We use {I(x,y),0<=x<=N-1,0<=y<=N-1}to denote N*N image with G gray levels. In statistical methods we have 2 types namely co-occurrence matrices and auto correlation features. In Co –Occurrence Matrix, Spatial gray level co-occurrence estimates image properties related to second-order statistics. The gray level co-occurrence matrix P_d for a displacement vector d = (dx, dy) is defined as follows. The entry (i,j) of P_d is the number of occurrences of the pair of gray levels of i and j and which are a distance 'd' apart. Formally, it is given as: $P_d(i,j) = |\{((r,s),(t,v): I(r,s) = I, I(t,v) = j\}|$ (4) [5] where, (r,s), (t,v) € N*N, (t,v) = (r + dx, s+ dy), and $|\ .\ |$ is the cardinality of a set. The second type is the auto correlation feature, which is used to assess the amount of regularity as well as the fineness/coarseness of the texture present in the image. Formally, the autocorrelation function of an image I (x,y) is defined as follows:

$$\frac{\sum_{u=0}^{n}\sum_{v=0}^{n}\left(I(u,v)I(u+x)(v+y)\right)}{\sum_{u=0}^{n}\sum_{v=0}^{n}I^2(u,v)} \quad (5) \quad [5]$$

Consider the image function in the spatial domain I(x,y) and its Fourier transform F(u,v). The quantity $|F(u,v)|^2$ is defined as the power spectrum where |.| is the modulus of a complex number.

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 [6].

Voronoi tessellation helps in defining local spatial neighborhoods, 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. Structural texture analysis consists of two major steps. One is extraction of the texture elements and the other is inference of the placement rule. Structure methods represent the texture by well defined primitives (micro texture) and a hierarchy of spatial arrangements (macro texture) of those primitives.

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 [6]. 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 modeling images. They are able to capture the local (spatial) contextual information in an image. These models assume that the intensity at each pixel in the image depends on the intensities of only the neighboring pixels. Fractals are known for modeling roughness and self-similarity at different levels in image processing. Given a bounded set *A* in a Euclidean n-space, the set *A* is said to be self-similar when A is the union of N distinct (non-overlapping) copies of itself, each of which has been scaled down by a ratio of r. The fractal dimension D is related to the number N and the ratio r as follows:

$$D = \frac{\log N}{\log\frac{1}{r}} \quad (6)\ [6]$$

Autoregressive (AR) model assumes a local interaction between image pixels, where the pixel intensity is a weighted sum of neighboring pixel intensities. A Markov random field (MRF) is a probabilistic process in which all interactions is local; the probability that a cell is in a given state is entirely determined by probabilities for states of neighboring cells. Direct interaction occurs only between immediate neighbors.

Basing on Signal Processing Methods, the psychophysical research has given evidence that the human brain does a frequency analysis of the image [6]. 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. Spatial domain filters are the most direct way to capture image texture properties. Earlier attempts at defining such methods concentrated on measuring the edge density per unit area. Fine textures tend to have a higher density of edges per unit area than coarser textures. In Fourier domain filtering, the frequency analysis of the textured image is done. As the psychophysical results indicated, the human visual system analyses the textured images by decomposing the image into its frequency and orientation components. The multiple channels tuned to different frequencies are also referred as

multi-resolution processing in the literature. Gabor filter is a linear filter that is used in edge detection. They are appropriate for text representation and discrimination. Gabor filters are self similar filters that are produced from one parent wavelet. A wavelet is a wave like oscillation that starts at the amplitude zero, increases and then decreases to zero. Wavelets are combined with an unknown signal by using a technique called convolution, to extract the information from the unknown signal.

Shape is another important visual feature and it is one of the primitive features for image content description [4]. 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 centered at the centre of the image [4]. 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 [7]. 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 image is:

The 2-dimensional DCT of an image f(I,j) for I,j=1,…….N is

$$f(u,v) = \frac{1}{\sqrt{2N}} c(i)c(j) \sum_{x=1}^{n} \sum_{y=1}^{n} f(x,y) \cos\left[\frac{(2x+1)i\pi}{2N}\right] \cos\left[\frac{(2y+1)j\pi}{2N}\right] \quad (7) \quad [7]$$

The formula used for the Euclidean distance measure is: $D(I_q, I_d) = \frac{\sqrt{\sum (I_{q_i} - I_{d_i})^2}}{N}$ (8) [7]

Where D is the distance between the feature vector I_q and I_d and N is the number of blocks.

[8] Proposes 3G smart phone technologies, which is helpful in the collection of the user data. Basing on this data, it can depict the contact distance between the users. Then this technology predicts the spread of infectious diseases among persons through contact and visualizes it through the use of the line graph method. This method can be later used in our approach for representation of the calculated difference between the pixels.

[9] Came up with a solution, for identifying the malicious attacks from inside the organization. Visualization of the attacks is done by the use of the bipartite graphs. Bipartite graphs help in the visualization of the unauthorized behavior of the persons inside the organization. By using the same visualization method, we can depict the unauthorized behavior of the student. Some forms of the unauthorized behavior can be of accessing questions prior to the exam, accessing unauthorized documents, changing system time and changing answers after the exam

[10] Proposes a web usage mining technique that helps the merchants to know the trends in buying pattern of the customers. This helps them to increase their business options. From the data that is stored based on purchasing, user behavior is noted basing on the navigation of screens and choice of buying items. Different patterns are mined from this behavior and later these are plotted using coordinate graphs. With the use of the same coordinate graphs, we can plot the student behavior in answering questions with response to the time.

[11] Proposes a stream line visualization tool that helps in the visualization of the lab work done by the biologists. This technique also provides visualization for any stream in the course selected that is of the number of class hours, assignment schedules, meetings, group projects etc. It helps the user, to view the data according to a temporal format. With the use of this concept, the student behavior in the exam can be visualized according to the change in time. Bar charts are used for the visualization of the student behavior.

[12] Proposes a unimodel technique that provides a method for security in online exams by the use of the face recognition techniques. They use Discrete Cosine transform (DCT) and Karhunen-Loeve Transform (KLT) methods for the feature extraction from face images and later compare these results for face identification. This technique can be further extended by comparing faces with the stored image.

[13] Proposes a unimodel security technique by using the biometric web authentication. This technique uses bio tracker software that is useful in recognizing the images on the client side. It visualizes the student images and is useful in tracking student behavior. Disadvantage with this technique is, it needs powerful servers for executing this software.

[14] Proposes a unimodel technique that implements one-time password authentication scheme. This scheme provides separate passwords basing upon the time and location of the mobile device. By using only that password, the user

can access the applications in the mobile device such as online banking. This helps to reduce the risk of intruders. This technique can be used in the paper, during authentication process of the student.

[15] Proposed a machine learning approach which prevents the theft, impersonation during online exams. This technique visualizes the student behavior during the exam, thus preventing him from further malpractice.

[16] Came up with a unimodel technique. In this technique, transparent authentication method is used. In this technique, the student has to make digital signatures by using stenography with voice sample at regular intervals of time. By comparing the samples, system ensures that the same student is writing the exam throughout the exam period.

[17] Proposes a multi model approach by providing authentication methods for the student login and later monitor the student during the exam period. For authentication the password, face recognition or tokens can be used. Later the student is constantly monitored through webcam. If any high risk is found then, the student is again asked to re-authenticate. This helps in identification of the student that is currently before the system.

[18] Proposed a multi model technique, where a framework is designed for conducting online exams in a secure environment. For this, they provide username and password during the registration process and later the student is monitored through webcam. This helps in tracking of the student behavior during the exam.

[19] Proposed a multi model biometrics solution for security in online exam. The student should provide fingerprints during the examination login and later he is constantly monitored using the webcam. If any abnormal behavior is found then he is prevented from writing the exam.

[20] Proposed a multi model system for authentication of the students during examination by using the concept of multi model biometric technology. This technology provides combination of the finger prints and the mouse dynamics. Finger prints of the student are taken at the beginning of the login. The mouse movements made by the student during examination period are recorded and later verified for tracking the student behavior.

[21] Proposed a multi model technique for conducting a secure online exam. This technology authenticates student, by using group key cryptography and later the student is continuously monitored through webcam. The proposed cryptographic technique can be used in our system for student registration and authentication.

[22] Proposed a unimodel approach that tracks the answering pattern of the student through data visualization techniques. This approach helps the administrator in evaluation of tests and assignment of the grades to the students. These data visualization techniques can be used in our system for tracking the student behavior.

III. PROPOSED SYSTEM

In this paper a multimodal technique is proposed for providing security. This includes authentication of the student at the beginning of the exam and later continuous monitoring of the student through webcam as shown in Fig 1. The detection and comparison of the student's face and behavior is done in two steps. Firstly pre-processing is done to the image through filtering, normalization and segmentation. Later in the second step, feature extraction is done based on the color, texture and shape of the obtained image. The technique that is implemented in the feature extraction is Discrete Cosine Transformation method. Then these obtained features of the input image are compared with the features of the database image through Euclidean distance measure. Later the plotted difference is represented by using two dimensional data visualization techniques. Through these plots, the proctor can easily visualize any change noted in the student behavior. This approach thus employs a full time security for online exams.

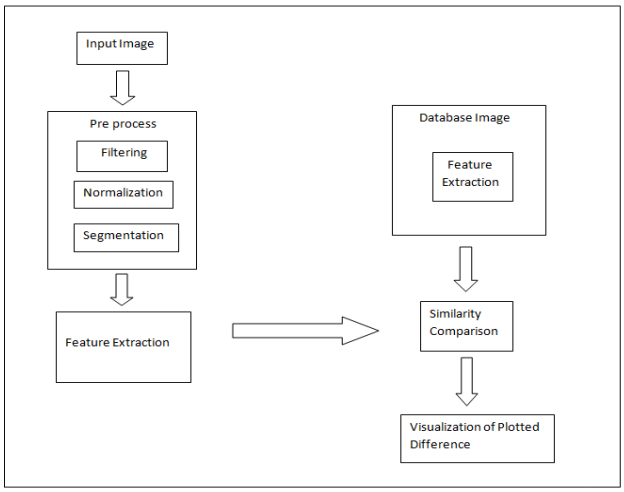

Fig 1: Architecture for enhanced security using data visualization (ESDV)

IV. CONCLUSIONS

In this paper, a set of authentication techniques are discussed. They include passwords, tokens, and biometrics. Special conditions are involved, to make the techniques to be strong enough to the intruder attacks. Varying authentication systems are discussed namely central authentication system, multi factor authentication system, split authentication system and message authentication system. This paper discuss a multi model authentication technique, that helps in continues monitoring of the student. The behavior of the student is visualized by using different visualization techniques.

Different data visualization techniques are discussed, for varying dimensional data. Scatter plot, survey plot, line graph and bar charts are used for visualizing two dimensional data. The same techniques are used in visualization of three dimensional data, by addition of the third dimension perpendicular to the remaining two dimensions. Icon based, hierarchical methods, geometrical methods and pixel oriented techniques are used for visualizing high dimensional data. By usage of these techniques, tracking of the student behavior is done and continues monitoring is provided thus implementing an enhanced security in online exam.

V. FUTURE WORK

Our Proposed system should be validated using a face database set provided in [23]. The dataset consists of 1521 images. For each image, twenty manual points are taken basing on right eye pupil, left eye pupil, right mouth corner, left mouth corner, outer end of right eye brow, inner end of right eye brow, inner end of left eye brow, outer end of left eye brow, right template, outer corner of right eye, inner corner of right eye, inner corner of left eye, outer corner of left eye, left template, tip of nose, right nostril, left nostril, centre point on outer edge of upper lip, centre point on outer edge of lower lip, tip of chin. These points of each image are to be calculated by using Discrete Cosine Transform technique and later comparison is to be made through Euclidean distance measure. Also visualization technique can be used for tracking student behavior during exam.

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