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Article

Fake Biometric Detection Based on Image Quality Assessment Application to Iris Face & Fingerprint

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Abstract: Biometric is a technological system that utilises the data for an individual to distinguish it. This technology stores particular information for one of the kinds of organic properties to operate in a workable way. It can be utilized in biometric frameworks by government, organizations, and associations for security reasons. An airplane terminal checking gadget, a "bio-secret key" framework are examples of a biometric system utilizations of the recognizing information for a security result. Be that as it may, we require security for this data and also verification of that individual. This novel software-based technology help to look at the data of an individual is genuine or counterfeit because of that the last aftereffect of validation can be got. Therefore, the major aim of this piece of work is to improve the well-being of the biometric acknowledgement system that includes image quality evaluation to make fast, simple to comprehend and minimal effort. Three applications of data were utilised here which are fingerprint, iris, and face detection. The proposed approach uses features of overall image quality derived from a single image to differentiate with both true and fake samples. It gives efficient protection against different spoofing attacks.

Keywords: Image quality assessment, biometrics, security, attacks, countermeasures.

1. Introduction

The biometric framework is a computer framework which is utilized to investigate human characteristics. The biometric framework comprises detecting, matching modules, and feature extraction. This approach introduces a multi-biometric system. Using Image Quality Assessment, we shield the biometric framework from counterfeit attacks. The term Biometric system related to technology. It will be dealing with human characteristics:

A. Physiological characteristics

The body parts will describe the Physiological features, e.g., iris, fingerprint, face, etc. Fingerprint Recognition: Every fingerprint of every individual unique, even twins have different fingerprints. Identification of fingerprints is by far the most accepted technique of biometric recognition. Fingerprints were being used to distinguish between people for a long time. Recognition of Iris: A computerized biometric strategy for identification makes use peoples' eyes irises; whose random patterns are different and could be differentiated from a distance. Iris is the colour ring surrounding the pupil of every person. Every person has a unique iris. Face Recognition: which is the system that distinguishes between the face and its background. It is most effective if a face within an audience must be recognized by the framework. The framework after this examines the characteristics of the person's face-their main highlights and the terrains and landmarks of his face and treats them as references and compares them to those stored in the system database.

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B. Behavioural characteristics

Characteristics of behaviour are associated with the individual's behaviour, for example, voice, signature, keystroke, and so on. The biometric framework separates in detecting, feature extraction, and matching modules.

C. Liveness detection methods

Generally, these methods are categorized into each of 2 groups. (i) Hardware-based techniques: This approach works by attaching the sensor to a specific component to recognize particular characteristics of a living object, like blood pressure, fingerprint sweat, or clear eye reflections. (ii) Software-based techniques: For this situation the falsified attribute is spotted once it has been gathered with a regular sensor, i.e. features used to define real and false attributes are derived from the biometric sample rather than the object itself.

These two techniques will give each other a few advantages and disadvantages and, generally, the combination of both may be the most effective security technique for through the biometric systems safety. Hardware-based strategies typically implement a greater falsified rate of recognition as a coarse contrast, whereas software-based schemes generally cost lower than hardware-based because there is no need for an additional device, but far less demanding as the consumer is straightforward in their application. Besides that, since they straightly can work at the gathered sample, not on the biometric attribute on its own. Software-based schemes can be incorporated into the function extractor module, which allows them ready to detect certain forms of illegitimate break-in tries that are not generally known as spoofing attacks [3].

Literature Review

In 2010, J. Galbally, C Mcool, J. fierres the face variety framework with the slope climbing algorithm, for that slope climbing calculation is utilized. In that calculation is legitimate thinks about and streamline information, which gives the consequence of an 85% achievement rate. Rather than utilizing individual distinguishing proof like numerical passwords, designs we utilize the biometric framework. Utilizing the computation of the Bayesian incline climbing, the method is led between the circuitous attack and the measurement matcher parameter. It analyzes roundabout assault and gives a score by matcher, so this calculation is created to use genuine people data. The value of this framework is, it will think about every single outcome, so there is no probability of missing the test. Consequently, the proficient outcome is taken at yield. The disadvantage of that system is the handling of calculation requires some time.

In 2016, Sarvesh Manav Meena, Prof. Arun B. Nandurbarkar proposed a liveness evaluation at multimodal biometrics through the picture quality appraisal. In that picture quality parameters are utilized to separate genuine and fake pictures. The picture quality appraisal having two sections initially is subjective part, in that information is contrasted and positioning of parameters after that outcome is shown in five classes of extremely poor, poor, great, great, and magnificent. And afterwards, this procedure aims to offer placement to test if the most severe element matches a different view, then provides a brilliant rank or if there are lesser matches between the information and the special example, it provides the reference implementation an extremely poor rank. Another is objective, which comprises two pictures one is a reference, and another is test pictures. It expresses some writing review on paper as it takes after 1) "Iris liveness discovery given value related highlights", by J. Galbally, J. Fierrezin 2012 proposed picture quality-related parameters which are programming-based answer for iris recognition. Iris can be distinguished a few properties like concentration, impediment (which identify the structure of eyelashes). 2)"Universal picture quality record", by Zhou Wang proposed a new all-inclusive picture quality list which is anything but difficult to material different picture preparing the application. It comprises parameters like loss of connection (It

measures the level of straight relationship between X and Y) and luminance blending. The preferences are minimal effort and quick reaction.

In 2014 J Galbally, Sebastian marcels, inquire about a quality appraisal for counterfeit biometric identification: application to iris, unique impression of the finger, and face acknowledgment by utilizing 25 picture characteristics are looked over one picture. Those characteristics are contrasting and a counterfeit picture or testing picture. The parameter depends on full reference and no reference. It utilizes MATLAB programming. This framework is having multitasks and multi-biometric insurance techniques. This paper utilizes the general picture quality parameter to recognize genuine and counterfeit examples. With the assistance of picture quality evaluation, the distinctive highlights are motivated to contrast with distinguishing unique examples. Its ways to deal with make activity quick, not destructive, easy to use.

In 2015, Yujia Jiang & Xin Liu proposed a fake unique finger impression identification given co-event grids. In this paper co-event framework or novel programming is for the most part utilized. It comprises falsely counterfeit unique marks made utilizing a material like gelatin or silicon. It is having diverse strategies like sweat pores-based technique, sweat based strategy, skin flexibility technique, and surface strategy. It likewise has a highlight extraction process, in which preparing strategy (used to make a judgment) another is trying procedure (for a look at the picture). In the include extraction, picture pixel esteems are right off the bat quantized. Quantization activity will cause loss of data this is the weakness of this task.

In 2015, S Chinthu, C Dhanabal proposed counterfeit distinguishing proof in the finger, iris, and face utilizing appraisal of picture quality. In that novel programming is utilized to catch unique pictures to improve quality. Catch pictures are imprinted on paper utilizing a business printer, accessible at the sensor. By utilizing this, the framework handles distinctive sorts of assaults and giving abnormal state assurance. Framework engineering comprises diverse modules for a location like liveness recognition and assault on the biometric distinguishing proof framework. The assault on a framework like unique pictures is caught for better quality, imprinted on pares used for the business printer. Utilizing this data or printed pictures displayed on the sensor of the biometric framework this framework is catch and contrast by programming and diverse parameters and identify the framework that data is genuine. This framework uses distinctive techniques like histogram leveling (modifying picture forces to improve differentiate), diminishing pictures (it is the change of an advanced picture into a streamlined), multi-point recognition, and execution measure. By breaking down this parameter the last discovery result is made. It gives an abnormal state of security over various sorts of assaults. For parameter examination, it needs a high caliber of the picture.

In 2015, Tija Thomas, Helice K Babu, Ambikadevi Amma T. proposed a novel fake identification framework for biometric modalities. By utilizing novel programming multi-biometric counterfeit identification, we get a genuine and counterfeit examination. It comprises picture quality evaluation having full reference use to test, and no reference database data isn't utilized. Exploring a collection of different highlights was the main part of procedure, A rational classifier will be provided that provides the likelihood of images. A novel parameterisation that use 30 general measures of image quality is taken into account in these 30 proposed frameworks. This framework utilizes just a piece of single information, a biometric check to be called genuine or counterfeit with a clear end goal to ensure its rationalization and efficacy. This strategy considers the entire picture as opposed to considering any attributes particular properties, no preparing steps are done preceding the figuring of IQ highlights. In the wake of registering all highlights, it will be a diminished figuring load. The fundamental highlights are chosen to utilize principle component analysis (PCA). Because of this, it is quick and easy to use.

In 2015, Aleena T. A, Chithrak, R. Ramachanran proposed security for the biometric framework. In that Gaussian separating is utilized with Fourier change. The proposed framework demonstrates it can be performing a multilevel task while looking at gadgets then it gives 90% of accurate result is from the biometric framework. By using extricated picture quality measures, the input picture is named genuine or counterfeit. use of full reference of database data contained in it to be analyzed, no reference (database data is missing, some methods are being used), methodological approaches to bending, JPEG quality file and High-Low incidence file are two distinct disfigurement features that are delicate to photo sharpness, arrangement-based method, display ready to use clean and invalid images and characteristic static strategy to scene group recognized data with Gaussian channel1. It turns out to be a proficient security upgrading innovation for the biometric framework.

In 2015, Anju. M. I, G. Sheeba, G. Sivakami proposed a multimodal biometric acknowledgment security framework, with various calculations. Additionally, it comprises the best biometric framework contrasting given data as far as precision, time, or highlight extraction. The consolidated technique will lessen preparing time and increment proficiency. The security and verification of people are vital for various parts of our lives. The vast majority having confirmation their personality on everyday bases incorporate ATM secured to ID cards and passwords to conquer a considerable lot of the shortfalls of this technique, it recognizes an individual based their identity as opposed to what they are recollected. Improving the well-being of biometric recognition methods is the aim of the suggested system through the inclusion of liveliness assessments. These ways to deal with various calculations for iris, unique mark, and face acknowledgment.

In 2012, Maria Martini a picture quality appraisal in light of edge conservation. For Picture pressure, the transmission edge discovery technique is utilized. It precisely speaks to the subjective nature of proposed pictures that are signed for the plan and appraisal of a picture pressure. It is critical to figure the nature of getting pictures with the least reference to the transmitted one. For the transmission framework, picture quality measures can be assessed at collectors and gave as criticism data to a implementation Controller on the aimed quality metric info side which require no reference or needs the least reference to a unique image. Human eye understanding is extremely precise to edge and the image's design of data supports the proposal of a lower reference quality metric. Determination of Sobel filtering brings about low many-sided quality metric, have high estimation speed, and give continuous execution. The impediment of this framework is the lower limit estimations causes to higher affectability to edge. The high appraisal of the limit are too small, considerable components of the image are viewed as edges which are unimportant for quality assessment.

Mojtaba Sepasian, Wamadeva proposed for helping to identify ridiculing assaults related to unique marks. It guarantees the input picture of the finger is genuine or fake. There is equipment and additionally, programming procedures are utilized to distinguish parodying assault, likewise, they say willful and non-deliberate systems. The deliberate system incorporates passwords, shrewd cards for signs-in data, it depends on the reaction of the client. For non-intentional procedure beat, circulatory strain and pulse are incorporated. This discovery depends on the client consequently reacting to jolt. In any case, these procedures have a few impediments of inadequacy for giving genuine outcome which causes increment preparing time, cost, and the absence of demonstrated of the right outcome. There are no reasonable criteria for sensors to identify the properties of the human body as a unique finger impression of sweat. It can't give data identified with additional properties for considering particular or common properties related to the individual in an evolving climate. So, it just distinguishes the manufactured unique mark of an individual.

2. Methodology

Using image quality assessment, we assume that the utilised image quality used for spoofing attacks has different qualities as compared to the real image. The difference includes colour, the sharpness of that image. The primary issue here is to discover the set of functions was using to categorize a picture as fake or real . It is shown in figure 1.

The major issue of fake biometric identification could be viewed as a two-class classification issue where an input sample should be allocated to one of two classes: real or fake. A novel parameterisation was proposed in this work using "25 general image quality measures". A general diagram of the suggested protection method will be illustrated in fig. 3.1. Since the approach works on the whole image without trying to find any attribute-specific properties, no pre-processing steps such as segmentation of fingerprints, iris identification or face reclamation are needed. These features restrict its computation complexity. When the feature vector was already extracted, the sample is classified into two major types: "real, generated by a genuine attribute, or fake, produced synthetically, using some essential classifiers". The parameterisation suggested in this procedure includes 25 reference and blind image quality measures. The selection process for the initial characteristics to assess the set of 25 IQMs was completed under five basic measures. The 4 criteria of selection are:

- **Performance:** Only commonly utilized methods of quality related to the image that already were accurately assessed proposing superb implementation for various applications that were viewed.
- **Complementarity:** for the purpose of generating a as general framework as possible for the attacks that have been identified and supporting biometric modalities, main concern was given to IQMs based on additional image properties such as sharpness, entropy or structure.
- **Complexity:** To maintain this method as simple as possible, features of low complexity were chosen over those that includes a higher computational burden.
- **Speed:** So as to guarantee an easy-to-use non-nosy application, clients ought not to take long for a distinguishing proof framework reaction. Subsequently the element extraction time has been given the most elevated need, which has an extremely noteworthy effect on the all-out speed of the face acknowledgement calculation.

A) Full-Reference IQ Measures (FR)

The IQA strategies rely on the availability of a clean undistorted reference image to appraise the quality of the test sample. In the challenge of fake detection discussed in this work, such a reference image is unidentified, since the discovery framework just has passage to the information test the information picture I (gray-scale, size N / M) is separated with a low-pass Gaussian piece ($\pi = 0.5$, size 3/3) to make a smooth variant of I. At this stage, the quality between the two pictures, I and I, is determined utilizing the full reference IQA metric.

This methodology recognizes that the loss of quality caused by Gaussian scanning varies between the actual biometric features and the fake stuff. Data from studies assert the assumption.

1) Error Sensitivity Measures

Identifying the approach for reviewing image quality relies on assessing the errors for both distorted and reference images, and helping to coordinate these errors in a manner that simulates the sensitivity of human visual error. Even though their usefulness as signal fidelity evaluations is up to date to some extent debatable, these are without suspect the most commonly used methods for IQA since they properly utilize several more known psychophysical aspects of visual system of the human, they are simple to be measured and, as a rule, their computational complexity is extremely low. A

few of those parameters were included in this work's proposed 25-function parameterization. These characteristics were classified into five special categories, as demonstrated by the image property measured.

These characteristics measure the deviation between two images depending on their differences in pixel-wise direction. This work includes "Mean Squared Error (MSE), Signal to Noise Ratio (SNR), Peak Noise Ratio (PSNR), Structural Content (SC), Maximum Difference (MD), Standardized Absolute Error (NAE) and Average Difference" (AD).

- Correlation-based measures: In contexts of correlation function the between two digital photos similarity can be analyzed. Given the angle of statistical data between the pixel vectors of the original and distorted images, a variance in correlation-based measurements can be obtained. These characteristics include Mean Angle Similarity (MAS), Normalized Cross-Correlation (NCC), and Mean Angle- Similarity of Magnitude (MAMS).
- Edge-based measures: For instance, edges and other two-dimensional highlights are likely the most enlightening pieces of a picture, which has a basic job in the human visual system and numerous PC vision algorithms along with quality assessment applications. Since an image's structural distortion is intimately associated to its angle degradation, two edge-related quality measurements were considered here: Total Corner Difference (TCD) and Total Edge Difference (TED)
- Spectral distance measures: Another standard image processing tool implemented to the field of image quality assessment is the Fourier transform. In this research IQ "spectral-related features: Spectral Magnitude Error (SME) and Spectral Phase Error (SPE), where F and F are the respective Fourier I and I transforms, and arg(F) is phase-related".
- "Gradient-based measures": Gradients contain significant visual data that could be useful for the evaluation quality. An enormous proportion of distortions that is can impacting an image are shown in its gradient by adjustment. Consequently, the use of such information can adequately assess structural and contrast alterations. The biometric protection system employs two basic gradient-based features, Gradient Magnitude Error (GME) and Gradient Phase Error (GPE).

2) Structural Similarity Measures

The prior image quality metrics depending on sensitivity to errors display a few issues, their lack of matching through "subjective human-based quality scoring systems" sometimes proves this. Through this work, a new sampling frame was proposed for image quality assessment based on structural similarity, on the presumption that the human visual system is highly modified to collect structural data from the environment of viewing. Consequently, an image distortion originating from changes in lighting, such as non-structural distortions such as changes in contrast or brightness, must be considered in a different way from structural ones. The "Structural Similarity Index Measure" (SSIM) has the most straightforward implementation among this ongoing goal perceptual measures and has increased across the board prevalence in a wide scope of useful applications. The SSIM has been included in the 25-function parameterisation given its very attractive properties.

3) Information-Theoretic Measures

Through an information theory point of view, review of the information is viewed as reliability issue, instead of signal reliability. The basic thought behind these strategies is that a source of images connects with a receiver via a channel that restricts the amount of data that may travel through it, thus it introduces distortions. The objective is to incorporate the visual quality of the test image into the amount of information given between the test and the reference signals, that is, the common information between the test signals. Two of those information-theoretical features were considered in this work:

"The Visual Information Fidelity (VIF) and the Reduced Reference Entropic Difference index (RRED)". The two parameters are dependent on IQA's information-theoretical perspective, nevertheless each necessitates a local or global method to the actual problem. The VIF metric predicts the quality fidelity as the ratio in between total entropy information calculated from the the whole distorted image optimally derived by the brain and the total information contained in the full reference image. Otherwise, the RRED metric approaches the QA problem from the point of view of calculating the quantity of limited information difference between the reference image and the estimation of the distorted image into the normal image space, for a provided wavelet domain sub-band. Basically, the RRED calculation quantifies the normal distinction in dispersed style between scaled local entropies of wavelet reference coefficients and projected distorted images in distributed fashion. All through this in opposition to the VIF highlight, it isn't adequate for the RRED to have passage to the entire reference picture yet just to a little piece of its data.

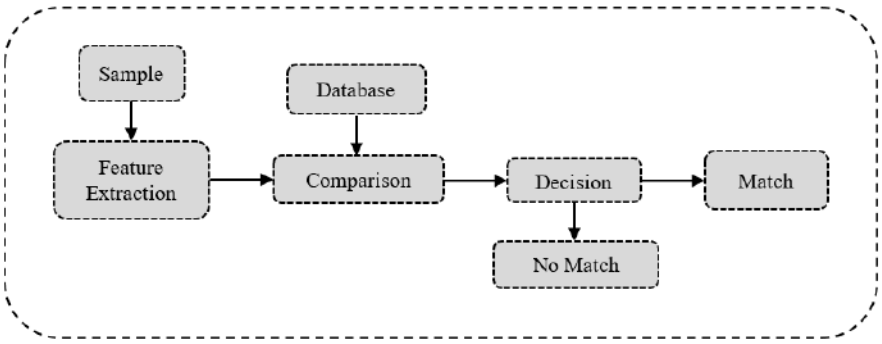


Fig. 1. General block diagram of the proposed biometric system

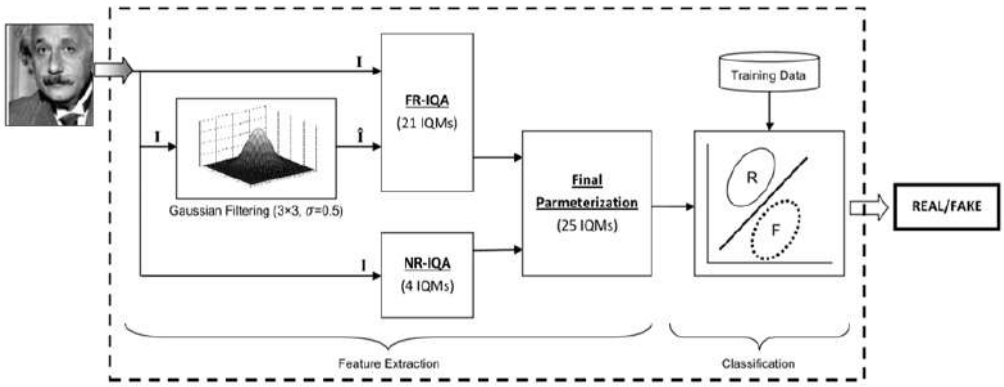


Fig. 2. General block diagram of the biometric protection scheme based on Image Quality Assessment (IQA).

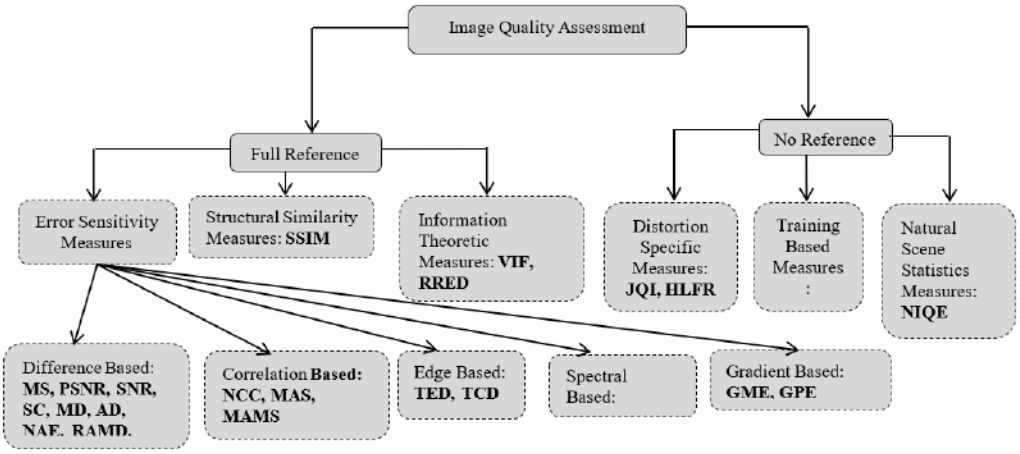


Fig. 3. Implemented 25 image quality measures classification in this work.

Only when all the "scaled entropy terms in the chosen wavelet sub-band are considered in one block, this important information may even be diminished in one scalar".

B) No-Reference IQ Measures

overall, visual arrangement of the human requires no reference test to determine the quality degree of a picture rather than the target reference IQA methods continuing to follow this equivalent hypothesis, in the absence of a reference, "automatic no-reference image quality assessment NR-IQA algorithms" attempt to address any challenging and difficult issue of image quality assessment. At present, "NR-IQA methods estimate the quality of the test image by some pre-trained mathematical analyzes".

- **Distortion-specific approaches:** These strategies rely on background data of the sort of loss in visual quality that a particular distortion caused it. The final quality measurement is calculated using a model that have been taught by clean image usage and images which are influenced by this special distortion. 2 of measures were connected to the biometric strategy for security suggested in this piece of work. The "JPEG Quality Index" (JQI), which assess the quality of images strongly impacted by common block artifacts found in many low-bit compression algorithms, such as the JPEG. The High-Low Frequency Index (HLFI) is highly affected by past work that looked at regional gradients as a blind metric for the noise and blur identification. Similarly, the HLFI function is sensitive to image sharpness by calculating the difference between lower and upper frequencies of the Fourier Spectrum power.
- **Training-based approaches:** Based on the prior NR-IQA methods class, a system is built using clean and distorted images in this kind of techniques. The quality score is then calculated on the basis of several functions has been derived of the test image and has been linked to the typical model. However, these metrics, in contrast to the earlier methods have a tendency to give a particular score of quality has no relation to a particular distortion. The statistical model was qualified to this final stages with images that are influenced by various types of distortion. This is the circumstance with the Blind Image Quality Index (BIQI) some portion of the 25 list of capabilities appeared in this study. The BIQI follows a two-phase structure in which the different bending explicit specialists' individual measures are joined to create one worldwide quality score.
- **Statistical approaches to natural scene:** All such blind IQA methods utilize information obtained from distortion-free natural scene of images to educate the initial model. The reasoning of this trend is different depending on the theory that undistorted natural environment images present specific frequent properties of all probable images that fall within that subspace. Differences from the natural statistics consistency can, if accurately evaluated, assess the conceptual image quality. This procedure is adopted by The "Natural Image Quality Evaluator" (NIQE) utilized in the current investigation follows this research. The NIQE is a totally blind image quality analyzer depending on the development of a quality-aware collection of statistical features linked to a statistical model of the multi-variety Gaussian natural scene. Result Analysis and Discussion

1) Quality Parameters

During conducting the watermarking scheme on the cover image, various quality parameters such as Peak Signal to Noise Ratio (PSNR), Correlation Factor, and Total Time Elapsed in Second have been taken into account.

Peak-Signal to Noise Ratio (PSNR): Differences from the natural statistics consistency can, if accurately evaluated, assess the perceptual feature of a picture. This procedure is adopted via "The Natural Image Quality Evaluator (NIQE)" utilized in the

current investigation follows this research, in certain circumstances, thusly, one reconstruction may appear to be closer to the past model form than another, and regardless of whether it has a lower PSNR (a higher PSNR would typically recommend that the recreation is of more prominent quality). It is depicted by for the most part methods for MSE (mean square error). PSNR is shown in the logarithmic decibel scale.

The PSNR (in dB) is defined as:

$$\text{PSNR} = 10.\log_{10}\left(\frac{\text{MAX}_I^2}{\text{MSE}}\right) \quad (1)$$

Where, $MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2$

Where MAXI is the maximum possible pixel value of image I(i,j).MSE is a mean square error. I(i,j) is an original cover image. K(i,j) is a reconstructed cover image. m is the number of rows and n is the number of columns.

Mean Squared Error (MSE): "The mean squared error MSE of a measure is the squares average of the errors, that the variation between both the estimator and estimated value". The equation is given by,

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2 \quad (2)$$

Structural Content (SC): "It is defined as the ratio between the square of the sum of the original image and reference image". The equation is given by,

$$SC(I,K) = \frac{\sum_{i=1}^{N}\sum_{j=1}^{M}(I(i,j))^2}{\sum_{i=1}^{N}\sum_{j=1}^{M}(K(i,j))^2} \quad (3)$$

Average Difference (AD): Absolute difference image average value is estimated for every pixel (original image is detracted to the reference image). The equation is given by,

$$AD(I,K) = \frac{1}{NM}\sum_{i=1}^{N}\sum_{j=1}^{M}(I_{(i,j)} - K_{(i,j)}) \quad (4)$$

Normalized Absolute Error (NAE): It is defined "as the ratio between the sum of absolute difference image and absolute of the original image". The equation is given by,

$$NAE(I,K) = \frac{\sum_{i=1}^{N}\sum_{j=1}^{M}|I(i,j) - K(i,j)|}{\sum_{i=1}^{N}\sum_{j=1}^{M}|I(i,j)|} \quad (5)$$

Signal to Noise Ratio (SNR): Signal-to - noise ratio (demonstrated as SNR or S / N) is a way of measuring used in business and science that differs the required level of signal with that of background noise. It is the signal-to - noise ratio, expressed in the decibels, a ratio higher than 1:1 (significantly higher than 0 dB) indicates a signal greater than a noise. An electrical signal is a form of a signal applied to an SNR. The Shannon – Hartley theorem connects the SNR, a channel communication capability, and the channel bandwidth. The signal-to - noise ratio is seldom used in a discussion or exchange to refer to the ratio of useful information to false or unrelated data. In online discussion councils as well as other online communities, for example, junk is considered a "noise" that prevents the "signal" of correct

conversation.$$SNR\ (I,K) = 10log\left(\frac{\sum_{i=1}^{N}\sum_{j=1}^{M}(I_{(i,j)})^2}{N.M.MSE(I,K)}\right) \quad (6)$$

Maximum Difference (MD): The maximum value of the absolute difference image (the original image is detracted from the reference image) is approximated. The equation is provided by,

$$MD(I,K) = \max\left[I_{i,j} - K_{i,j}\right] \quad (7)$$

Blind Image Quality Index Measurement (BIQI): Blind IQA strategies have been using a previous data obtained from alteration-free natural scene pictures to prepare the original model. The aim was behind this propensity depends on the hypothesis that unmistakable world pictures normally present certain standard attributes that fall inside

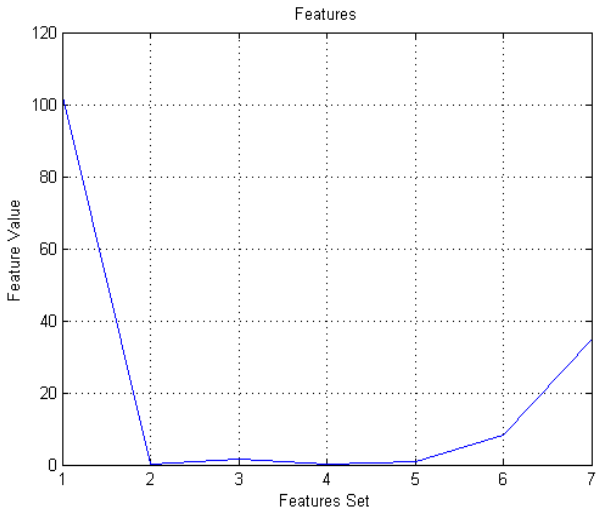
a safe subspace of every single imaginable image. Deviations from the consistency of regular review information can appraise the perceptual nature of a picture if appropriately registered.

2) Result for Iris

We can compare iris parameters of the input image with database information.

For first sample:

a) b)



c)

Fig. 4. Result analysis of the figure of iris (a) Input Image (b) Gaussian image (c) Graphical representation of Quality Parameters.

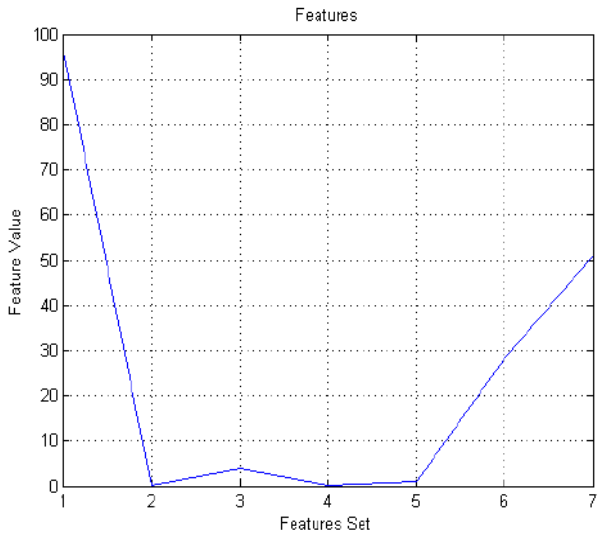
Table 1. Calculations of values for different parameters

Sr. No.	Parameter	Value
1	Peak Signal to Noise Ratio (PSNR)	102.985
2	Mean Square Error (MSE)	1.4996
3	Structural Content (SC)	1.00104
4	Average Difference (AD)	0.0799574
5	Normalized Absolute Error (NAE)	0.0005414
6	Signal to noise ratio (SNR)	8.10403
7	Maximum Difference (MD)	35
8	Training Based Measure (BIQI)	3.03668e-05

The result obtained for the above image is: It's a Fake Biometric

For Second sample:

a) b)



c)

Fig. 5. Result analysis of the figure of iris (a) Input Image (b) Gaussian image (c) Graphical representation of Quality Parameters.

Table 2. Calculations of values for different parameters

Sr. No.	Parameter	Value
1	Peak Signal to Noise Ratio (PSNR)	96.7474
2	Mean Square Error (MSE)	4.0869
3	Structural Content (SC)	1.00137
4	Average Difference (AD)	0.150274
5	Normalized Absolute Error (NAE)	0.0006768
6	Signal to noise ratio (SNR)	28.1557
7	Maximum Difference (MD)	51
8	Training Based Measure (BIQI)	8.2524e-05

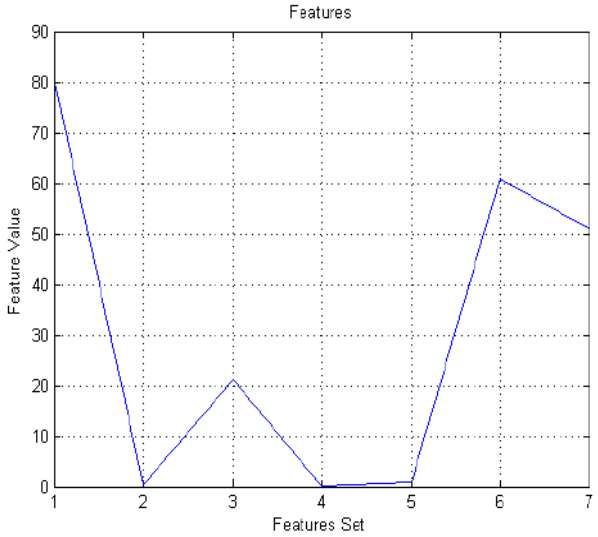
The result obtained for the above image is: It's a Real Biometric

3) Result for Fingerprint

We can compare the thumb parameters of the input image with database information.

For Second sample:

a) b)



c)

Fig. 6. Result analysis of the figure of iris (a) Input Image (b) Gaussian image (c) Graphical representation of Quality Parameters.

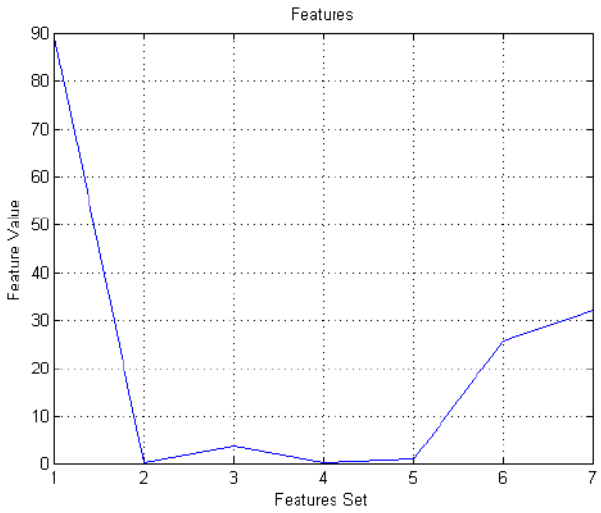
Table 3. Calculations of values for different parameters

Sr. No.	Parameter	Value
1	Peak Signal to Noise Ratio (PSNR)	80.3138
2	Mean Square Error (MSE)	21.1395
3	Structural Content (SC)	1.00768
4	Average Difference (AD)	0.278144
5	Normalized Absolute Error (NAE)	0.0012610
6	Signal to noise ratio (SNR)	61.0228
7	Maximum Difference (MD)	51
8	Training Based Measure (BIQI)	0.0276939

The result obtained for the above image is: It's a Real Biometric

For Second sample:

a) b)



c)

Fig. 7. Result analysis of the figure of iris (a) Input Image (b) Gaussian image (c) Graphical representation of Quality Parameters.

Table 4. Calculations of values for different parameters

Sr. No.	Parameter	Value
1	Peak Signal to Noise Ratio (PSNR)	89.6621
2	Mean Square Error (MSE)	3.60282
3	Structural Content (SC)	1.00303
4	Average Difference (AD)	0.175285
5	Normalized Absolute Error (NAE)	0.0012111
6	Signal to noise ratio (SNR)	25.6343
7	Maximum Difference (MD)	32
8	Training Based Measure (BIQI)	3.10663e-005

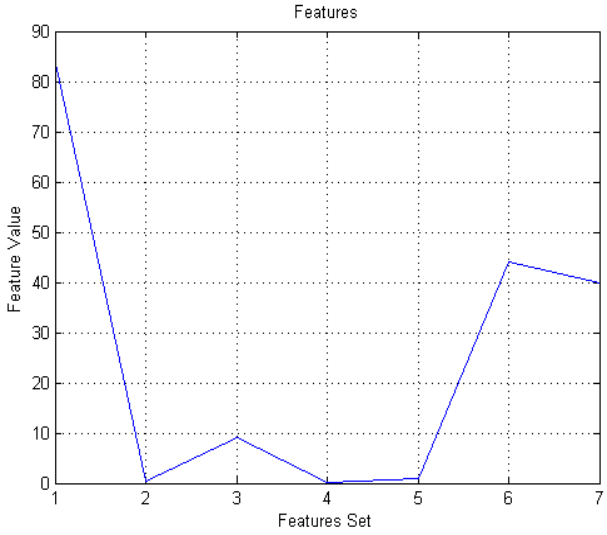
4) Result for Face recognition

We can compare the face parameters of the input image with database information

For first sample:

a)

b)



c)

Fig. 8. Result analysis of the figure of iris (a) Input Image (b) Gaussian image (c) Graphical representation of Quality Parameters.

Table 5. Calculations of values for different parameters

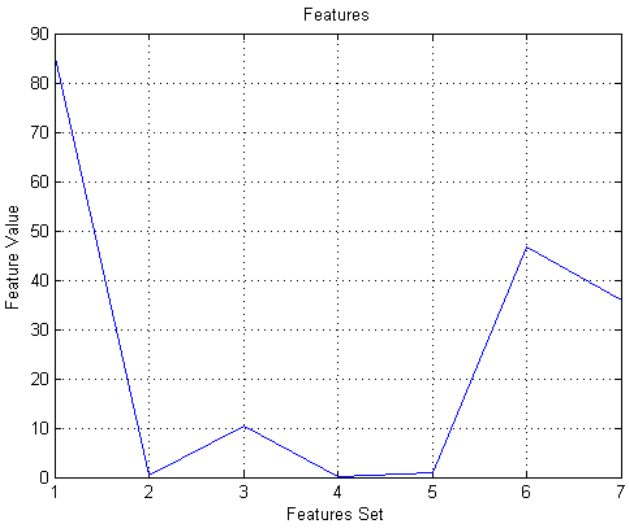
Sr. No.	Parameter	Value
1	Peak Signal to Noise Ratio (PSNR)	83.1288
2	Mean Square Error (MSE)	9.025
3	Structural Content (SC)	1.0002
4	Average Difference (AD)	0.4005
5	Normalized Absolute Error (NAE)	0.00267
6	Signal to noise ratio (SNR)	43.1506
7	Maximum Difference (MD)	40.02
8	Training Based Measure (BIQI)	4.01243e-005

The result obtained for the above image is: It's a Fake Biometric

For Second sample:

a)

b)



c)

Fig. 9. Result analysis of the figure of iris (a) Input Image (b) Gaussian image (c) Graphical representation of Quality Parameters

Table 6. Calculations of values for different parameters

Sr. No.	Parameter	Value
1	Peak Signal to Noise Ratio (PSNR)	84.6073
2	Mean Square Error (MSE)	10.30052
3	Structural Content (SC)	1.00072
4	Average Difference (AD)	0.32058
5	Normalized Absolute Error (NAE)	0.00550385
6	Signal to noise ratio (SNR)	45.5269
7	Maximum Difference (MD)	36.02
8	Training Based Measure (BIQI)	0.0031456

The result obtained for the above image is: It's a Real Biometric

3. Conclusion

The current development of the Biometric framework expanded so there is a requirement for insurance of that framework. Picture quality evaluation is the method utilized for recognizing genuine and counterfeit picture. It likewise gives multi-biometric and multi assault assurance highlight to the framework because of this the security level is expanded. By looking at all highlights or parameters of the example it gives the proficient outcome. With the assistance of novel programming and picture quality appraisal, it gives a quick reaction. For this reason, we will consider 8 general picture quality parameters. The novel technique executed for various biometric modalities like iris, fingerprint, and face utilizing publicly accessible database data. The biometric recognizable proof framework gives a precise outcome with simple and safe utilize. Likewise, programming and equipment are easy to use without the need for an additional piece of establishment and treatment of framework. it finishes its activity inside a few seconds, so it is efficient. This framework is utilized for office or different applications like login reason. Since the utilization of biometric property of the human body, it can't be stolen or speculated by someone else, consequently, it is having long execution for the utilization in the organization. Rather than utilizing the digit secret word, we can utilize the physical highlights of the human body. The biometric framework considers as advantageous security arrangement since client can't require any ID confirmation, watchword which is hard to deal with consistently for login framework.

REFERENCES

[1] Javier. Galbally, Sebastien Marcel, Member, IEEE, and Julia Fierrez, "Image Quality Assessment for Fake Biometric Detection: Application to Iris, Fingerprint, and Face Recognition.", IEEE Transactions On Image Processing, Vol.23, No.2, February 2014.

[2] Javier. Galbally, Chris McCool, Julian Fierrez, Sebastien Marcel, and Javier Ortega-Garcia, "On the vulnerability of face verification systems to hill-climbing attacks," Pattern Recognit., vol. 43, no. 3, pp. 1027–1038, 2010.

[3] Sarvesh Manav Meena, Prof. Arun B. Nandurbarkar "A Literature review on liveness assessment of Multimodal Biometrics through Image Quality Assessment" IJSTE.Vol.2,Issue-08,February 2016.

[4] Yujia Jiang & Xin Liu "Spoof fingerprint detection based on co-occurrence matrix" International journal of signal processing, image processing and pattern recognition" Vol 8, No. 8, pp. 373-384, 2015.

[5] S Chinthu, C. Dhanabal "Fake identification in fingerprint, Iris and face recognition using Image Quality Assessment", IJARSE Vol. no. 4, Issue no. 02, February 2015.

[6] Tija Thomas, Helice K Babu, Ambikadevi Amma T. "A novel fake detection system for biometric modalities", IJARCSSE, Volume 5, Issue no. 4, 2015.

[7] M. S. Aleena T. A., Ms. Chithra. K., Mr. Rahul Ramachdran" Spoofing protection for biometric system", IJSTE, volume 1, Issue 10, April 2015.

[8] Anju. M. I., G. Sheeba, G. Sivakami, Monika. J., Savitri. M.," Multimodal biometric recognition security system", IJAREETE, volume.4, Issue 3, March 2015.

[9] Maria G. Martini, Chaminda T.E.R. Hewage, Barbara Villarini, "Image quality assessment based on edge preservation," Signal Process., Image Commun., vol. 27, no. 8, pp. 875–882, 2012.

[9] Mojtaba Sepasian, Cristnel Mares, Wamadeva Balchandran, "Liveness and spoofing in fingerprint identification: Issues and Challenges" Recent advances in Computer Engineering & Applications, pp. 150-158.

[10] Arjun Nichal et. al "Face Recognition using PCA and Eigen Face," International Journal of Innovative Research in Electrical, Electronics, Instrumentation & Control Engineering, Vol. 2, Issue 5, pp. 1435-1438, May 2014.

[11] Arjun Nichal et. al "DCT Based Iris Feature Extraction and Recognition for Security System International Journal of Advanced Research in Computer and Communication Engineering, Vol. 3, Issue 5, pp. 6490-6494, May 2014.

[12] Galbally, J., Fierrez, J., & Ortega-Garcia, J. (2010). Fingerprint liveness detection based on quality measures. Pattern Recognition, 43(1), 271-283. https://doi.org/10.1016/j.patcog.2009.06.014

[13] Galbally, J., Marcel, S., & Fierrez, J. (2014). Biometric antispoofing methods: A survey in face recognition. IEEE Access, 2, 1530-1552. https://doi.org/10.1109/ACCESS.2014.2381273

[14] Galbally, J., McCool, C., & Marcel, S. (2014). Image quality assessment for fake biometric detection: Application to iris, fingerprint, and face recognition. IEEE Transactions on Image Processing, 23(2), 710-724. https://doi.org/10.1109/TIP.2013.2293423

[15] Meena, S. M., & Nandurbarkar, A. B. (2016). Liveness evaluation at multimodal biometrics through the picture quality appraisal. International Journal of Computer Applications, 135(6), 21-26. https://doi.org/10.5120/ijca2016908765

[16] Thomas, T., Babu, H. K., & Amma, A. T. (2015). A novel fake detection system for biometric modalities using image quality assessment. Journal of Computer Science, 11(5), 674-683. https://doi.org/10.3844/jcssp.2015.674.683

[17] Sepasian, M., Soryani, M., & Fathy, M. (2010). A novel fingerprint liveness detection technique using quality-related features. Forensic Science International, 207(1-3), 1-9. https://doi.org/10.1016/j.forsciint.2010.01.018

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Article

The Effect of Special Training in Developing Some Mechanical Variables and Shooting Skill from Jumping for Players Under 19 Years Old in Handball

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Abstract: Biomechanics has an important and fundamental role in the current scientific progress of motor performance in general and the player in particular. Because the basis of biomechanics is the study of the causes of instantaneous movement and interest in studying all the forces that lead to effective movement. This science is one of the very precise sciences that gives an honest and accurate indication of the subject of study and reaching a solution to the current problem in a scientific and accurate manner by describing the movement in a mechanical and accurate description by applying mechanical laws and principles to the course of movements in the human body to reach a movement path adopted by the body. Hence the importance of research in adopting special training in developing mechanical variables and shooting skill from a fixed position for handball players to determine their strengths and weaknesses in each shooting attempt in order for coaches to focus on them to achieve the best results in sports competitions. The research problem was that many coaches do not use skill-specific exercises in the handball training process, so the researcher decided to prepare special exercises to develop some mechanical variables and the skill of shooting from a standstill to know the effect of using these special exercises and their importance and the possibility of real benefit from them in order to develop the training process and save effort and time. The study aimed to prepare special exercises. Identify the effect of special exercises in developing some mechanical variables and the skill of shooting from a standstill. The research hypotheses were there is a positive effect of special exercises in developing some mechanical variables and the skill of shooting from a standstill. The research sample was represented by the players of Al-Qasim Youth Club, numbering (16) players. The researcher used the statistical truth (SPSS) to extract the results and through the statistical results. The researcher concluded that the special exercises had a great effect in learning the skill of shooting from a standstill for the members of the experimental group. The use of new methods, techniques and advanced aids during training sessions played an effective, important and major role in the development process, and this is what we saw from the players' enthusiasm for training and practice due to the presence of incentives, including photography and competition in play.

Keywords: special training, shooting skill, handball

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1. Introduction

Handball is one of the ancient games that has made progress in reaching the highest levels based on correct scientific foundations. Handball is one of the oldest known games. Handball is one of the games that has special requirements and determinants in addition to its competitive, sporting, social and psychological goals, as it is played within special laws and special organizational rules that govern competition between players. Biomechanics has an effective and fundamental role in the current scientific progress of

motor performance in general and sports in particular. Because the basis of biomechanics is the study of the causes of basic movement and interest in studying all the forces that lead to movement. Each offensive movement has a special mechanical position from which it is performed because this game, like other sports, requires analysis of its basic movements or skills.

In addition to containing a number of important and difficult movements through which the largest possible number of goals can be scored and the best results can be obtained in matches. We cannot obtain good results and good levels without knowing the influencing factors and mechanical variables that are specific to this sports competition. Hence the importance of research in preparing special training in developing mechanical variables and shooting skill from a fixed position to determine the strengths and weaknesses in each of the offensive movements of this skill in order to focus on them by the working coaches to achieve the best results in sports competitions. Handball sport or game requires speed in motor performance on the field and continuous movement and movements for rapid attack and defense, so the player must have the ability to continue mechanical work between body movements and skill movements and with strong muscular ability in one ascent with maximum effort and the least time, reaching the goal, and with high accuracy to score a goal. Therefore, it is necessary to work on introducing special training for this skill and benefit from it in developing the skill used in attack to improve the player's offensive level. This game is closely related to biomechanics like other sports and the extent of benefiting from the finest motor details and basic skills and their paths and importance in developing these basic skills must be studied carefully.

The researcher noted that many coaches do not use modern training in the training process for handball. Therefore, the researcher decided to prepare special training in developing some mechanical variables and the skill of shooting from a fixed position for players to know the effect of using these training and knowing their importance and the possibility of real benefit from them in order to develop training work and save effort and time to come out with the best results.

Research objectives:

- Preparing special training to develop some mechanical variables and the skill of shooting from a fixed position with a handball.
- Identifying the effect of special training to develop some mechanical variables and the skill of shooting from a fixed position with a handball.

Research hypotheses:

There is a positive effect of special training to develop some mechanical variables and the skill of shooting from a fixed position with a handball.

Research areas:

- Human field: Al-Qassim Sports Club handball players.
- Time field: From 6/9/2023 to 11/11/2023.
- Spatial field: Al-Qassim Youth Sports Forum Hall.

2. Materials and Methods

Research Methodology

The researcher used the experimental method to suit the nature of the study problem, which is the design of two equivalent groups "with pre- and post-measurement. This is consistent and compatible with the requirements of his research and achieving the study objectives. As shown in Table 1.

Table 1. The experimental design of the two research groups

Group	Pre-test	Experimental treatment	Post-test
Experimental group	Mechanical variables Shooting skill from a standstill	Special training	Mechanical variables Shooting skill from a standstill
Control group	Mechanical variables Shooting skill from a standstill	Curriculum prepared by the trainer	Mechanical variables Shooting skill from a standstill

Research Community and Sample

The research community was defined as the players of Al-Qasim Sports Club, numbering (16) players. The research sample was chosen randomly, numbering (16) players. The researcher divided the sample randomly into two groups: the experimental group using special training, numbering (6) players, and the control group, numbering (6) players. Table 2 shows this.

Table 2. The distribution of the research community

Research community	Experimental group	Control group	Survey sample	Total
16	6	6	4	16

Methods, Devices and Tools Used

Methods used in the research:

- Arab and foreign references.
- Interview.
- Questionnaire.
- Results collection form.
- Special forms for data collection.
- Observation.

Devices and tools used in the research:

- Laptop (Dell).
- Electronic timers (Casioy) number (3).
- Video camera type (banSony) with a frequency of 300 images/second.
- Measuring tape length (6m).
- Handballs number (15).
- Display device (Data show).
- Drawings with various measurements to display the shooting skill.
- Medical scale to measure weight.
- Legal handball field.

Field research procedures:

The researcher determined the shooting skill from a fixed position due to a clear weakness in it.

Description of the shooting test from a standstill:

- Shooting from a high jump on shooting accuracy squares
- Purpose of the test: Measuring shooting skill

Tools:

- Handball court

- Shooting accuracy squares 50 x 50 cm hung in the upper corners of the goal
- 6 handballs

Performance specifications:

The player performs two or three steps, then jumps from the 9m line and shoots at the shooting accuracy squares from a high jump, and three balls are sent to each shooting accuracy square in succession. Evaluation: The number of successful shooting attempts in which the ball enters completely into the shooting accuracy squares is recorded for the examiner (2 points for each successful attempt).

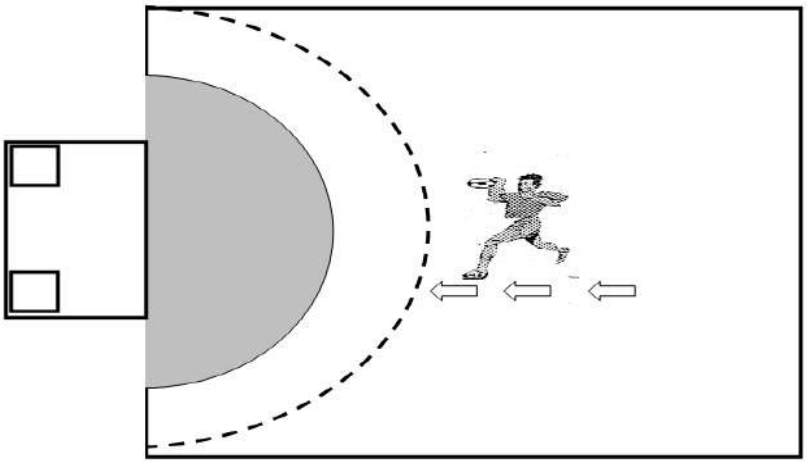

Figure 1. The skill of shooting from a jump

Procedures for determining mechanical variables

By reviewing a set of references and sources, in addition to the interviews he conducted with experts and specialists in the field of biomechanics and handball, a set of mechanical variables related to the research problem were determined. The researcher isolated the biomechanical variables of the skill and measured them individually. They were measured by placing a camera with a frequency of (25) images/second, where the camera was placed in a side view of the playing field and was fixed on a large tripod with a height of (1.70 m) and a distance of (6 m) from the lens. Also, photography was done to the drawing scale and in the place where the shooting skill was performed from a standstill. Also, a camera with the same specifications was placed behind the player performing the skill and a third camera above. All of these cameras are connected to a computer to collect information and cut the necessary images to extract the results and send them to the arbitrators to extract the results and measurements of the mechanical variables of the skill, as shown in the Table 3 below.

Table 3. The skill of shooting from a fixed position and its mechanical variables

Shooting from stability
Mechanical variables
Shoulder speed while shooting
Elbow speed while shooting
Wrist speed while aiming
Torso angle while shooting
The angle of the shoulder joint while shooting
Jumping distance while aiming

Measuring mechanical variables

To measure mechanical variables, the researcher used a Japanese video camera (banySony) with a frequency of (300 fps) for the purpose of photographing the sample in the main experiment. The camera was placed at a distance of (6 m) and a height of (70.1 m).

Analysis by computer

The analysis was conducted by computer:

1. The video material was converted from the video film to the file format (FILES) using a conversion card ((FPS 18 8T VIDEO IN - OUT (MJPEG CARD) and then to (CD) in order to know and facilitate the analysis steps.
2. The video movement of the skill was cut using the program (MAKE MORIE. ITMPSQUENCE) into images to extract the variables under study and store those images in the file folder.
3. After identifying the clips that needed analysis, the images were transferred to the program (AUTO CADE) that was previously installed on a (Dell) computer, where the distances and angles to be analyzed for the shooting pass from jumping were measured.

Exploratory experiment

The exploratory experiment is considered "practical training for the researcher to stand on the negatives and positives that he encounters during the tests To avoid them in the future. The researcher conducted a survey experiment on a sample of (4) players from outside the research sample. The aim of the experiment was as follows:

1. Ensure the efficiency of the devices and tools used
2. Adjust the dimensions of the cameras, their height and the clarity of the image
3. Efficiency of the assistant work team
4. Know the difficulties facing the researcher in order to avoid them in the future
5. Find scientific coefficients for the tests.

Scientific foundations for skill performance evaluation forms

1. Validity of the forms:

The degree of validity is the most important factor for the quality of tests and measures.

The skill performance evaluation forms have gained one of the types of validity, which is content validity, which is one of the most common and used types of validity in the field of physical education and sports sciences.

2. Stability of the questionnaires:

The researcher extracted the stability coefficient of the correctors, which is one of the main sources of variation in the error in the test score in the scales that depend on the corrector's evaluation and not on the correction key when the evaluation of the performance of the players of the exploratory sample of (4) players was adopted through the evaluation of three judges for the performance of the skills by the players. After that, the researcher sought to extract the correlation coefficient (Pearson) between the judges' estimates, as shown in Table 4.

Table 4. The values of Pearson's correlation coefficient (correction stability coefficient) for the skill performance questionnaire.

Skill	1st and 2nd referee correlation values	1st and 3rd referee correlation values	2nd and 3rd referee correlation values
Shooting from jump	0.894	0.903	0.878

Developing the educational program

The researcher prepared special trainings, Appendix (5), which included special trainings for the skill of shooting from a jump, and also included emphasis and reminders of the stages of performing the skill through models of the trainings provided in learning the skill and the effect of mechanical variables on motor performance. The researcher took into account in his selection of trainings that they were consistent with the objectives of the research and that their content was consistent with the capabilities of the sample and that gradualness, excitement, suspense and competition were taken into account, and that they were consistent with the capabilities of the players and that security and safety factors were taken into account. The training criteria (distance, time, repetition) were also determined, which is related to the field work of the skill.

The implementation of the training program continued for (8) weeks, at a rate of three training units per week, thus the number of training units is (24) training units. The units were divided into (3) sections, which are:

1. The preparatory section: It is the preparation and readiness of the body and contains a group of movements: walking, walking, jogging, running, twisting the trunk, foot movement and general warm-up.

2. Main section: The shooting skill is applied through explanation and field application in a way that divides the skill and then integrates it with emphasis on the importance of mechanical variables in achieving the ideal performance of the skill.

3. Final section: It is done through calming down and some recreational games that suit the research sample.

Pre-measurement

The researcher conducted the pre-measurement on the research sample in the Al-Qassim Youth Forum Hall in order to establish the measurements of the studied variables and determine the level of the research sample sample before implementing the main experiment, as all mechanical variables and shooting skill from jumping were measured.

Equivalence of groups

The researcher made an equivalence table for the two research groups as shown in Table 5.

Table 5. The equivalence of the two research groups in terms of study variables

statistics / Variables	measuring unit	Control group		group Experimental				Statistical significane
		middle	deviation	middle	deviation	Calculated T value	Sig	
Tallness	poison	160.3	6.22	161.6	6.19	0.186	2.44	random
Bloc	kg	48.4	5.89	48.95	5.99	0.249	2.44	random
Training age	Sh	19	3.96	19.5	3.85	0.387	2.44	random
Shooting from jump	Dr	4.13	0.5	4.27	0.09	0.53	0.62	random

Shoulder speed while shooting	m / s	0.09	0.01	0.09	0.01	0.59	0.58	random
Elbow speed while shooting	m / s	1.15	0	1.14	0.02	0.47	0.65	random
Wrist speed while aiming	m / s	1.18	0	1.18	0.01	0.11	0.92	random
Torso angle while shooting	Dr	139.25	0.13	139.65	0.35	2.14	0.08	random
The angle of the shoulder joint while shooting	Dr	145.55	0.08	145.85	0.15	3.44	0.01	random
Jumping distance while aiming	poison	38.75	0.96	39	1.83	0.24	0.82	random

Note: Table (T) value at significance level (0.05).

Application of special exercises

The researcher used special exercises on the experimental group sample, while the control group sample kept the exercises prepared by the trainer, where the special exercises were implemented, at a rate of three training units per week, thus the total training units became (48) training units divided into two groups, the experimental group share was (24) training units and the control group share was (24) training units. The training units included exercises for mechanical variables and shooting skill from jumping in line with the capabilities of the study sample, and the researcher was keen that there would be no difference between the individuals of the two groups in all parts of the training unit.

Post-measurement

The researcher conducted the post-measurement on the individuals of the experimental and control groups under the same conditions and specifications of the pre-measurement and obtained the data and recorded it in special forms to be processed statistically.

Statistical methods used

The researcher used the statistical bag (SPSS) to extract the results statistically.

3. Results

Results of the control group

Table 6. The arithmetic means, standard deviations and the calculated (t) value for the pre- and post-tests for the individuals of the control group

Type of significance		t value is calculated	Posttest		Pretest		Statistical features
	sig		A	¯ s	A	¯ s	Variables
moral	0	6.9	0.18	5.92	0.5	4.13	Shooting from jump
moral	0	226	0.02	1.15	0	0.09	Shoulder speed while shooting
moral	0	16.31	0.75	1.71	0.01	1.15	Elbow speed while shooting
moral	0	440.7	0.02	1.79	0	1.18	Wrist speed while aiming
moral	0	105.4	0.18	135.11	0.14	139.25	Torso angle while shooting
moral	0	50.01	0.18	139.9	0.08	145.55	The angle of the shoulder joint while shooting
moral	0	2.71	1.82	40.5	0.95	38.75	Jumping distance while aiming

Table 6 shows that the calculated (t) value was greater than the statistical value and below the significance level (0.05), which indicates the existence of a significant difference between the two tests in favor of the post-test in all the variables studied.

Table 7. The arithmetic means, standard deviations, and the calculated (t) value for the pre- and post-tests of the experimental group members

Type of significance		t value is calculated	Posttest		Pretest		Statistical features
	sig		A	¯ s	A	¯ s	Variables

moral	0	44.38	0.18	7.9	0.1	4.27	from Shooting jump
moral	0	53.12	g070	1.86	0	0.09	speed Shoulder while shooting
moral	0	33.6	0.08	2.5	0	1.14	speed Elbow while shooting
moral	0	228	0.02	2.34	0	1.18	speed Wrist while aiming
moral	0	74.32	0.19	121	0.4	139.7	angle Torso while shooting
moral	0	18.11	1.87	128.8	0.2	145.9	of the The angle shoulder joint while shooting
moral	0	6.11	1.82	48	1.8	39	Jumping distance while aiming

Table 7 shows that the calculated (t) value was greater than the statistical value and below the significance level (0.05), which indicates the existence of a significant difference between the two tests in favor of the post-test in all the variables studied.

Table 8. The arithmetic means, standard deviations, and the calculated (t) value for the post-test for the experimental and control research groups

Type of significance	sig	t value is calculated	Experimental group		Control group		Statistical features
			A	- s	A	- s	Variables
moral	0	23	0.18	7.9	0.19	5.88	from Shooting jump
moral	0	24.6	0.09	1.86	0.03	1.13	Shoulder speed while shooting

moral	0	14	0.07	2.5	0.78	1.75	speed Elbow while shooting
moral	0	60	0.018	2.34	0.04	1.8	speed Wrist while aiming
moral	0	104.6	0.18	120.61	0.19	134.1	angle Torso while shooting
moral	0	12.5	1.89	128.79	0.15	140.3	of The angle the shoulder joint while shooting
moral	0	8.19	1.76	48	1.9	40.5	Jumping distance while aiming

Table 8 shows that the calculated value of (t) was greater than the statistical value and below the significance level (0.05), which indicates the existence of a significant difference between the two groups in favor of the experimental group in all the variables studied.

4. Discussion

The researcher attributes this to the way the training is presented, which creates a positive and effective atmosphere and excitement during work, and draws a clear and understandable picture of how to perform the skill. "Since any work is not successful without competition, therefore, when the process is devoid of elements of competition and excitement, its results will not be good. In contrast, the player will be more positive when competition is provided and presented to the player, helping him to create a desire to deal with the duties required of him to implement, and forming in him great psychological satisfaction and acceptance, resulting in the creation of a learning process and rapid adaptation to sports movements and activities.

The researcher believes that the reason for the development that has occurred is due to the influence of special training that helped develop the players' performance. It was characterized by diversity and excitement, approaching in its requirements the nature of the skill performance. The difference in speeds among players led to an increase in the accuracy factor and concentration of players during viewing and performance. Also, the suitability of the skill performance of the model to the players' abilities and capabilities and their physical levels played a major role in the development of their skill performance for shooting. The reasons for paying attention to the training process and increasing the speed of learning and building a good training base require us to use the best training means and methods and modern methods, as training or teaching methods and techniques are of great importance in the educational process and these methods and techniques affect increasing the speed of the learner and the degree of satisfaction of the learner.

It is also necessary to keep pace with the events of the current scientific development in various fields of the training process and use what suits the players and their abilities and technical and skill capabilities and other special training and educational curricula and training methods and new tools based on real and purposeful scientific foundations that will raise the training level and achieve the best results in the learning and training process, "as the goal that training curricula seek through practice and repetition of the learning process is to develop and improve the level of technical and skill performance of the games, as the basis of skill learning is the player's acquisition of capabilities The skill that helps him achieve a good level in applying basic skills. There must be a programmed preparation that ensures learning basic skills.

The factor that showed the extent of development of the research variables for the experimental group is the extent of the suitability of the special training and the way it is presented to the level, capabilities and abilities of the players. Choosing the training and training on it continuously and continuously and repeating it gives positive, effective and good results. This is what the researchers confirmed that "using special and purposeful training has a positive effect on the development and improvement of the skill" and that "repeating the training enables the player to master the movements completely, which together represent the skill to be applied and ensures coordination between these skills, which makes their performance in the correct order and appropriate time. Also, taking into account the extent of the suitability of the performance with the level of physical effort exerted, which is one of the important matters that must be taken into account in the stages of applying the basic skill. In this topic, it was confirmed that programmed sports exercises have a great effect in increasing the amount of learning.

5. Conclusion

1. Special training has a good effect on learning the skill of shooting from a standstill for the experimental group sample.
2. Special training units and presentation of the skill to the model had a great effect on the learning process.
3. The use of modern methods and tools and auxiliary tools during the training units had an important role in motivating the players to train.

6. Recommendation

1. Applying special training in learning new offensive skills other than the skill of shooting from a jump.
2. Conducting studies on other samples because we have seen the benefit for the current sample.
3. Training can be developed to include higher age groups and in other games.

REFERENCES

1. Ahmed Khater and others. *Studies in Motor Learning*, Cairo, Dar Al-Maaref, 1978.
2. Khalil Ibrahim Suleiman, "The Effect of Using the Cooperative Learning Method Using the Circular Training Method in Learning Some Basic Skills in Volleyball," PhD thesis, College of Physical Education, University of Baghdad, 2003.
3. Muhammad Hassan Alawi, *Introduction to Sports Psychology*, 2nd ed., Cairo, Dar Al-Maaref, 2003.
4. Muhammad Hassan Alawi and Omar Nour El-Din, *Measurement in Physical Education and Sports Psychology*, 32, Cairo, Dar Al-Qalam, 2000.
5. Muhammad Hassan Alawi and Osama Kamel, *Scientific Research in Physical Education and Sports Psychology*, Cairo, Dar Al Fikr Al Arabi, 1999.
6. Qasim Lazam Sabr, *Topics in Motor Learning*, Baghdad, College of Physical Education Press, 2005.

7. Kamal Abdel Hamid and Muhammad Subhi, *Handball Measurement*, Cairo, Dar Al Fikr Al Arabi, 1980.
8. Z.F. Abod, "Achievement Motivation and Its Relationship to Jump Pass and Jump Shot in Handball," *Sport TK*, vol. 11, 2022, doi: 10.6018/sportk.537131.
9. J.B. Apidogo, "Resonance Effects in Variable Practice for Handball, Basketball, and Volleyball Skills: A Study on Contextual Interference and Differential Learning," *Sports*, vol. 12, no. 1, 2024, doi: 10.3390/sports12010005.
10. M.A. Mahmoud Sha'lan, "The Impact of Using Small-Sided Games on Teaching Basic Handball Skills to Students of the College of Sports Sciences at Mu'tah University," *Sport TK*, vol. 11, 2022, doi: 10.6018/sportk.539091.
11. R. Kawamura, "Classification of Handball Shot Through Image Analysis," in *International Conference on ICT and Knowledge Engineering*, 2022, vol. 2022, doi: 10.1109/ICTKE55848.2022.9983130.
12. W. Nopianto, "Shooting Skills Training Needs Analysis in Handball Game for Young Athlete," *International Journal of Human Movement and Sports Sciences*, vol. 9, no. 3, pp. 554-559, 2021, doi: 10.13189/saj.2021.090322.
13. M.A.M. Sha'lan, "The Effect of Using Virtual Reality Technology, VR Box Glasses, on Learning the Skill of Shooting in Handball," *Revista Iberoamericana de Psicologia del Ejercicio y el Deporte*, vol. 18, no. 2, pp. 163-169, 2023.
14. I.M. Alkhawaldeh, "Impact of VO2max on Mechanical Variables, Lactic Acid Concentration and Shooting Accuracy of the 7-Meter Throw Among Handball Players," *Sport TK*, vol. 11, 2022, doi: 10.6018/sportk.531631.
15. M.A.M. Sha'lan, "The Level of Psychological Energy and Its Relationship to the Performance of Some Basic Skills in Handball Among Young Players in Jordan," *Dirasat: Human and Social Sciences*, vol. 51, no. 3, pp. 83-94, 2024, doi: 10.35516/hum.v51i3.4632.
16. S.A. Wolf, "Everything Is Cool When You're Part of a Team? The Effects of Outcome Interdependence on Appraisal, Emotions, and Performance Under Pressure," *Psychology of Sport and Exercise*, vol. 74, 2024, doi: 10.1016/j.psychsport.2024.102683.
17. M. Gómez-Ferolla, "Comparative Analysis of Two Strength Training Protocols on Throwing Speed in Women's Handball," *Retos*, vol. 56, pp. 439-448, 2024, doi: 10.47197/retos.v56.104191.

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Article

Principal Component Analysis for Feature Extraction

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Abstract: Feature extraction in image processing involves transforming raw pixel data into a more meaningful representation that can be used for various tasks such as image classification, object detection, or image retrieval. The goal is to extract important attributes or characteristics (features) from the image that capture essential information and reduce the dimensionality of the data while preserving its most significant aspects. One of most Common Feature Extraction Techniques One popular The Principal Component Analysis (PCA) method is used to reduce dimensionality and extract features. In various domains, including image processing, finance, and bioinformatics. This paper explores the fundamentals of PCA, its mathematical foundation, and practical applications for feature extraction. We demonstrate how High-dimensional data can be converted into a lower-dimensional space using PCA, while retaining significant information, enhancing computational efficiency, and improving model performance. Using PCA for feature extraction involves transferring, as much as possible, the variance (information) of the initial data with high dimensions placed in an area with lower dimensions. Images are inherently high-dimensional data, with each pixel representing a feature. For example, a 256x256 grayscale image has 65,536 features. Analyzing and processing such high-dimensional data can be computationally intensive and may lead to overfitting in machine learning models. Autism Facial image dataset used in this paper. PCA reduces this dimensionality by identifying the most significant components (principal components) that demonstrate the variation in the image data.

Keywords: PCA, Dimensionality, Robust Technique, Image Processing

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1. Introduction

To identify large-scale data, such image data, feature extraction is required [1]. It is crucial that the features acquired contain all of the input data's information. In the era of big data, handling and analyzing large datasets is a common challenge. High-dimensional data may result to problem such as overfitting, more complex computations, and challenges with data visualization [2].

Dimensionality reduction techniques like PCA help mitigate these challenges by reducing the number of features while preserving essential information. PCA is particularly effective in feature extraction, allowing us to identify the most significant components of the data and discard noise and redundant information [1, 3]. Prior to World War II, Principal Components Analysis (PCA), a multivariate statistics technique, was developed. But it wasn't until the 1960s, during the Natural and Social Sciences' "Quantitative Revolution," that this approach was used more widely [4].

The primary cause of this delay was the extreme complexity of the calculations required by this technique. Principal components and other multivariate statistical

techniques have nearly infinite applications, but this was only made possible with the invention and advancement of computers [2, 5].

At the same time, since the use of principal components in technical problems necessitated perfect accuracy, exact numerical techniques for calculating eigenvalues and eigenvectors, among other things, became necessary [5].

2. Materials and Methods

PCA for Feature Extraction

Data Preparation

To effectively apply PCA, the data needs to be preprocessed and standardized. Standardization guarantees that every feature makes an equal contribution to the analysis, preventing features with larger scales from influencing the outcomes [6].

Applying PCA

Once the data is standardized, PCA can be applied. The number of components to retain can be specified based on the desired amount of variance to preserve [5].

Interpretation and Visualization

The principal components can be analyzed to understand the variance they explain. Visualization techniques, such as scatter plots, can help interpret the transformed data [7].

3. Results and Discussion

Mathematical Foundation of PCA

According to any data projection, the biggest variance is located in the principal component, also known as the first coordinate., followed by the second coordinate, the second greatest variance, and so on. This is how PCA transforms the data into a new coordinate system. The procedures in PCA are [7]:

1. **Standardization**: transforming the data to a variance of 1 and a mean of 0. Before applying PCA, it's essential to standardize the data so that each feature has a mean of 0 and a variance of 1.

   Given a dataset (X) that includes p features and n samples:

$$\mathbf{Xstandardized} = \mathbf{X} - \frac{\boldsymbol{\mu}}{\mathbf{Q}} \ldots\ldots\ldots\ldots \quad \text{Eq (1)}$$

   where μ is each feature's mean, and σ is each feature's standard deviation [6].

2. **Covariance Matrix Computation**: Calculating the covariance matrix to understand how the variables of the data relate to each other.

   The covariance matrix captures the variance and the linear relationships between features.

   For the standardized data matrix Xstandardized (denoted as X for simplicity), the covariance matrix C is given by:

$$\mathbf{C} = \frac{\mathbf{1}}{\mathbf{n-1}} * \boldsymbol{X^T} * \mathbf{X} \ldots\ldots\ldots\ldots \quad \text{Eq (2)}$$

   where X^T is the transpose of X [8].

$$\mathbf{Cv} = \boldsymbol{\lambda}\mathbf{v} \ldots\ldots\ldots \quad \text{Eq (3)}$$

   where λ is an eigenvalue and v is the corresponding eigenvector.

The eigenvalues ($\lambda 1, \lambda 2, \ldots, \lambda p$) represent the amount of variance captured by each principal component [9].

The eigenvectors (v1,v2,…,vp) represent the directions of the principal components.

3. **Eigenvalue and Eigenvector Calculation**: To determine the principal components, the eigenvalues and eigenvectors are derived from the covariance matrix.

Eigenvalues and eigenvectors of the covariance matrix C are computed to identify the principal components.

The eigenvalue equation is

4. **Formation of Principal Components**: Ordering the eigenvectors by eigenvalues in descending order and forming the principal components.

Principal components are formed by projecting the original data onto the eigenvectors.

The main components Z are given by:

$$Z = XV$$

Where V/math {V}V is the matrix of eigenvectors [6, 9].

5. **Projection of Data**: Transforming the original data into the new space defined by the principal components.

The number of principal components to retain can be determined by the explained variance.

The explained variance ratio for each principal component is:

$$\boldsymbol{R} = \frac{\boldsymbol{\lambda i}}{\sum_{j=1}^{p} \boldsymbol{\lambda j}} \ldots\ldots\ldots\ldots \quad \text{Eq (4)}$$

Where R represent Explained Variance Ratio to retain a certain percentage (e.g., 95%) of the variance, select the smallest K such that: $\sum_{j=1}^{k}$ Explained Variance Ratio ≥ 0.95 [10].

Practical Applications

Image Processing

PCA can lower an image's dimensionality during image processing., making storage and computation more efficient while preserving essential features for tasks like face recognition and object detection [11].

Finance

PCA is used in finance to identify underlying factors that influence asset prices, aiding in portfolio management and risk assessment [12].

Bioinformatics

In bioinformatics, PCA helps in analyzing gene expression data by reducing noise and highlighting significant patterns in high-dimensional genomic data [13].

4. Conclusion

PCA is a robust technique It is essential in many domains working with big datasets for feature extraction and dimensionality reduction. Using PCA, high-dimensional data is transformed into a lower-dimensional space. Enhances computational efficiency and

model performance, while retaining critical information. As data continues to grow in complexity and volume, PCA will remain a fundamental tool in the data scientist's arsenal.

By projecting high-dimensional data onto the directions of maximum variance, PCA converts it into a lower-dimensional space. The directions (eigenvectors) of the covariance matrix that correspond to the largest eigenvalues are known as the principal components. PCA reduces the dimensionality of the data while maintaining major information by keeping the principal components that capture the most variance.

This mathematical foundation and example illustrate how PCA works and how it can be applied to feature extraction in various applications, including image processing.

REFERENCES

[1] A. Maćkiewicz and W. Ratajczak, "Principal Components Analysis (PCA)," *Computers & Geosciences*, vol. 19, no. 3, pp. 303-342, 1993.

[2] H. Abdi and L. J. Williams, "Principal Component Analysis," *Wiley Interdisciplinary Reviews: Computational Statistics*, vol. 2, no. 4, pp. 433-459, 2010.

[3] S. P. Mishra, U. Sarkar, S. Taraphder, S. Datta, D. Swain, R. Saikhom, and M. Laishram, "Multivariate Statistical Data Analysis-Principal Component Analysis (PCA)," *International Journal of Livestock Research*, vol. 7, no. 5, pp. 60-78, 2017.

[4] M. Greenacre, P. J. Groenen, T. Hastie, A. I. d'Enza, A. Markos, and E. Tuzhilina, "Principal Component Analysis," *Nature Reviews Methods Primers*, vol. 2, no. 1, p. 100, 2022.

[5] B. M. S. Hasan and A. M. Abdulazeez, "A Review of Principal Component Analysis Algorithm for Dimensionality Reduction," *Journal of Soft Computing and Data Mining*, vol. 2, no. 1, pp. 20-30, 2021.

[6] A. Tharwat, "Principal Component Analysis—A Tutorial," *International Journal of Applied Pattern Recognition*, vol. 3, no. 3, pp. 197-240, 2016.

[7] H. Cardot and D. Degras, "Online Principal Component Analysis in High Dimension: Which Algorithm to Choose?," *International Statistical Review*, vol. 86, no. 1, pp. 29-50, 2018.

[8] S. Naveen, A. Omkar, J. Goyal, and R. Gaikwad, "Analysis of Principal Component Analysis Algorithm for Various Datasets," in *2022 International Conference on Futuristic Technologies (INCOFT)*, 2022, pp. 1-7.

[9] F. Yao, J. Coquery, and K. A. Lê Cao, "Independent Principal Component Analysis for Biologically Meaningful Dimension Reduction of Large Biological Data Sets," *BMC Bioinformatics*, vol. 13, p. 1-15, 2012.

[10] A. Tharwat, "Principal Component Analysis—A Tutorial," *International Journal of Applied Pattern Recognition*, vol. 3, no. 3, pp. 197-240, 2016.

[11] G. R. Naik, Ed., *Advances in Principal Component Analysis: Research and Development*. Springer, 2017.

[12] F. Kherif and A. Latypova, "Principal Component Analysis," in *Machine Learning*, Academic Press, 2020, pp. 209-225.

[13] M. Zhao, Z. Jia, Y. Cai, X. Chen, and D. Gong, "Advanced Variations of Two-Dimensional Principal Component Analysis for Face Recognition," *Neurocomputing*, vol. 452, pp. 653-664, 2021.

[14] J. Deng, K. Wang, D. Wu, X. Lv, C. Li, J. Hao, and W. Chen, "Advanced Principal Component Analysis Method for Phase Reconstruction," *Optics Express*, vol. 23, no. 9, pp. 12222-12231, 2015.

[15] Y. Hao, "Integrated Analysis of Multimodal Single-Cell Data," *Cell*, vol. 184, no. 13, pp. 3573-3587, 2021, doi: 10.1016/j.cell.2021.04.048.

[16] J. Chong, "Using MetaboAnalyst 4.0 for Comprehensive and Integrative Metabolomics Data Analysis," *Current Protocols in Bioinformatics*, vol. 68, no. 1, 2019, doi: 10.1002/cpbi.86.

[17] J. Grove, "Identification of Common Genetic Risk Variants for Autism Spectrum Disorder," *Nature Genetics*, vol. 51, no. 3, pp. 431-444, 2019, doi: 10.1038/s41588-019-0344-8.

[18] R. D. Riley, "Calculating the Sample Size Required for Developing a Clinical Prediction Model," *The BMJ*, vol. 368, 2020, doi: 10.1136/bmj.m441.