

Accuracy Analysis of Facial Expression Recognition using Distance Classifiers

Rupali N Shinde^{1,2}

¹Dept. of Electronics and Telecomm. Engineering
Terna Engineering College, New Mumbai, India.

Imdad Rizvi²

²Sharjah Campus, Higher Colleges of Technology, Sharjah, UAE.
and Terna Engineering College, New Mumbai, India.

Abstract: Face recognition could be a characteristic, simple to use and non-contact path for human distinctive proof/confirmation. Face Recognition plays dominant role in person identification and verification. To get perfect Face recognition system with less tolerance, there is need of proper accuracy analysis of different methods. The difficulties for face recognition focus on facial highlights, look, and feelings. This paper focuses on a methodology used for face recognition, that relies on Singular Value Decomposition (SVD) using various distance classifiers. New Distance Classifiers are tested for face recognition includes Bhattacharya distance, Mahalonobis distance, Housdroff distance, Hamming and City block distance. A description of all classifier strategies is additionally discussed in this paper. The dataset used for this analysis is taken from ORL face database. Best classifier method is figured out in this analysis.

Keywords: Face Recognition, Feature extraction, Singular Value Decomposition (SVD).

I. INTRODUCTION

The external body part features a vital job in our social cooperation, passing on individual's temperament. Utilizing the external body part as a key to security, biometric face recognition innovation has gotten noteworthy consideration within the previous quite whereas attributable to its potential for a good assortment of uses in each law implementation and non-law authorization. As contrasted and completely different statistics frameworks utilizing distinctive finger impression/palmprint and iris, face recognition has specific points of interest in light-weight of its non-contact method. Face footage is caught from separation while not contacting the individual being recognized, and also the identifying proof does not need associating with the individual. what is more, face recognition fills the wrongdoing obstacle want since face footage that is recorded and filed will later facilitate acknowledge a private. A face recognition framework is AN innovation suited to identifying or confirming a private from a sophisticated image or a video define from a video supply.

There square measure completely different methods during which biometric authentication frameworks work, but once all is alleged in done, they work by different chosen facial highlights from a given image with faces within the info. it's likewise represented as a Biometric computer science-primarily based application which will very acknowledge a private by examining examples obsessed on the individual's facial surfaces and form.

As shown within the Fig.1 the face recognition module has four units particularly, face location, face institutionalization, face highlight extraction and coordinative. The face affirmation procedure is worked in arise to affirmation, go up against clear verification and face watch. In arise to examine an invitation face image is investigated against a company face image whose character is being genuine. In arising to recognizing verification an invitation go up against image is contemplated against all configurations within the info to decide on the thoroughbred character. In arise to following and police work, arise to footage square measure pursued and differentiated and also the set away databases.

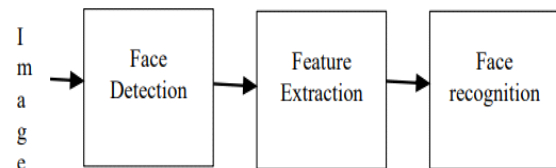


Fig. 1. Face Recognition module

Face recognition incorporates getting face picture from a video or from a perception camera. They are differentiated and the set away database. Face biometrics incorporates getting ready known pictures, request them with known classes and subsequently they are put away in the database. Right when a test picture is given to the system it is orchestrated and considered with set away database. Face biometrics is a trying field of examine with various restrictions constrained for a machine go up against affirmation like assortments in head act, change in lighting up, facial explanation, developing, obstruction in view of additional items etc.,.

II. LITERATURE REVIEW

Incredible progress has been created at intervals the territory of machine acknowledgment and numerous ways that square measure dead [1-4]. Anand et al., prompt an automatic face recognition technique victimization SURF choices and SVM classifier [5]. on prime of techniques has been tested on Yalefaces and UMIST face databases. Akbar et al. projected a durable and reliable method model for face recognition. throughout this model, a pair of Transformation methods like distinct ripple work (DWT) and distinct sin work (DST) along with native based feature illustration namely: native binary pattern (LBP) and native half division unit of measurement accustomed extract numerical choices from face footage. Irrelevant, noisy, and redundant choices unit of measurement eradicated victimization Minimum redundancy most association (mRMR). varied classification learners like K-nearest neighbor (KNN), Support vector machine (SVM) and Probabilistic Neural Network (PNN) unit of measurement used. SUMS facial dataset and 10-folds cross-validation take a glance at the unit of measurement accustomed to assess the performance of classification algorithms [6]. Sanjay, G. studied Face recognition has become a field of interest in pattern recognition and engineering science [7]. Wang et al., used associate degree s-level decomposition on the premise of dual-tree advanced ripple work (DTCWT), thus on getting 12s “variance and entropy (VE)” choices from each subband. Afterward, we have an inclination to use a support vector machine (SVM) and its a pair of variants [8]. native descriptors unit of measurement wide used the technique of feature extraction to induce knowledge relating to every native ANd world properties of associate degree object. Here, we have an inclination to debate associate degree application of the Chain Code-Based native Descriptor to face recognition by that focus on varied datasets and considering altogether totally different variants of this description methodology. Kaczmarek et al., inflated the generic sort of the descriptor by adding a gap of grouping pixels into blocks, i.e., effectively describing larger neighborhoods [9]. Current approaches haven't obtained smart results. Zhang et al. aimed to propose a replacement feeling recognition system supported facial expression footage. It listed twenty subjects and let each subject produce seven altogether totally different emotions: happy, sadness, surprise, anger, disgust, fear, and neutral [11], offers associate degree up-to-date basic outline of still-and video-based face recognition think about. Paper [12], centers around the exponent highlights unit of measurement steady and substantial highlights in object acknowledgment, for example, face acknowledgment. It proposes solitary esteem deterioration (SVD) based strategy that uses the solitary esteems as a result of the half extractor ANd had acquired associate degree worthy acknowledgment rate. Paper [13], presents associate degree calculation for face acknowledgment

by activity solitary estimable deterioration on the removed element of pictures and later on preparing were finished utilizing back proliferation neural system where the ORL information of countenances was used. Paper [14], proposes a totally distinctive strategy for face acknowledgment. This strategy consolidates the upsides of the continued LDA enhancements to be specific significance weighted LDA and solitary esteem decay and furthermore diminishes measurements of data grid utilizing 2DLDA arrange. Paper [15], centers on the chief [*fr1] investigation (PCA) is actual with Singular value deterioration for highlight extraction to form your mind up to head feelings. Paper [16], acknowledgment is performed on a consistent eigenspace of Singular value Disintegration of the upgraded image set. Paper [17], we have got an inclination to first examine the task of SVD and FFT in every recorded. At that point, the decay data from SVD and FFT unit of measurement tried. Reference [18], considers solitary value decay based JPEG image pressure procedure.

III. SINGULAR VALUE DECOMPOSITION

The Singular price decomposition is an outcome of algebra. It plays a, basic role in varied applications like, face recognition, compression, watermarking, object detection, scientific computing, signal process, texture classification etc. The special feature of SVD is that it will be performed on any matrix. The singular price decomposition of an oblong matrix A may be a decomposition of the shape

$$A = USVT \quad (1)$$

Where A is AN m x n matrix, U = m x m and V = n x n. U and V square measure orthogonal Matrices. A matrix A with real entries ANd satisfying the condition $A^{-1} = A^t$ is termed an orthogonal matrix. S is AN m x n square matrix with singular values on the diagonal.

$$AAT = USVT (USVT) T$$

$$= US^2 UT$$

$$ATA = (USVT)T USVT$$

$$= VS^2 VT$$

Thus U and V square measure calculated because the chemist vectors of AAT and ATA severally. The root of the chemist values square measure the singular values on the diagonal of

the matrix S. If the matrix A is real, then the singular values square measure continuously real numbers, and U and V also are real.

Properties of SVD:

The singular values $\sigma_1, \sigma_2, \dots, \sigma_n$ square measure distinctive, but the matrix U and V aren't distinctive. $AAT = USVT(USVT)^T = USVTVSUT = US^2UT$ therefore V diagonalises ATA. It follows that the matrix V will be computed through the chemist vector of ATA. The matrix U will be computed through the chemist vector of AAT. The rank of the matrix A is up to the amount of its non-zero singular values.

IV. PROPOSED SYSTEM

The designed system is incredibly straightforward. It consists of a set of pictures i.e. the dataset already hold on within the system. Dataset is consist of Fourty peoples pictures with variation of expressions having ten pictures of each person.

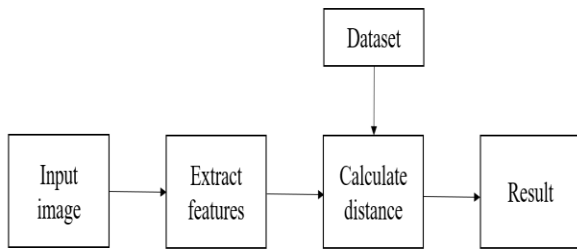


Fig. 2. Proposed System.

As shown in Fig 2, once we tend to choose a picture to be tested, the image can endure feature extraction. counting on the extracted options and dataset pictures by applying SVD algorithmic program and calculate the space of that exact image within the dataset. counting on this the image is going to be known and displayed.

There square measure varied classifier ways obtainable nowadays specifically, area distance, playing distance, Hausdorff distance, Mahalanobis distance, and Bhattacharya distance. of these classifier ways square measure utilized in the designed system.

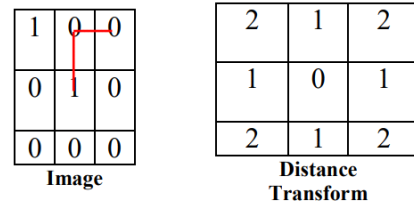
V. CLASSIFIER METHODS

Classification is the way toward anticipating the class of given information focuses. Classes are now and again called as targets/names or classifications. For instance, spam location in email specialist organizations can be distinguished as an arrangement issue. A classifier uses some preparation

information to see how given information factors identify with the class. For this situation, known spam and non-spam messages must be utilized as the preparation information. At the point when the classifier is prepared precisely, it tends to be utilized to recognize an obscure email. Order has a place with the class of managed realizing where the objectives additionally gave the info information. There are numerous applications in characterization in numerous spaces, for example, in credit endorsement, medicinal analysis, target showcasing and so on.

• City Block Distance:

In picture investigation, the separation change gauges the separation of each item point from the closest limit and is a significant apparatus in PC vision, picture preparing, and design acknowledgment. Out yonder change, a parallel picture indicates the good ways from every pixel to the closest non-zero pixel. The Euclidean separation is the straight-line separation between two pixels and is assessed utilizing the euclidean standard. The city square separation metric estimates the way between the pixels dependent on a four associated neighborhood and pixels whose edges contact are one unit separated and pixels corner to corner touching are two units apart.



The cab separation, d_1 between two vectors p and q in a n-dimensional genuine vector space with fixed Cartesian facilitate framework, is the whole of the lengths of the projections of the line fragment between the focuses onto the organize tomahawks. All the more officially,

where p,q are vectors
 $p = (p_1, p_2, \dots, p_n)$ and $q = (q_1, q_2, \dots, q_n)$

For example, in the plane, the taxicab distance between (p_1, p_2) and (q_1, q_2) is $|p_1 - q_1| + |p_2 - q_2|$.

• Hamming Distance

Hamming distance is a metric for comparing two binary data strings. While comparing two binary strings of equal length, Hamming distance is the number of bit positions in which the two bits are different. The Hamming distance between two strings, a and b is denoted as $d(a,b)$. It is used for error detection or error correction when data is transmitted over

computer networks. It is also using in coding theory for comparing equal length data words.

A function on words of fixed length over an alphabet describing the number of changes to the symbols of one word required to reduce it to another. Let A be an alphabet of symbols and C a subset of A^n , the set of words of length n over A . Let $u=(u_1, \dots, u_n)$ and $v=(v_1, \dots, v_n)$ be words in C . The Hamming distance $d(u,v)$ is defined as the number of places in which u and v differ: that is, $\#\{i: u_i \neq v_i, i=1, \dots, n\}$.

The Hamming distance satisfies

$$\begin{aligned} d(u,v) &\geq 0 \text{ and } d(u,v) = 0 \text{ if and only if } u=v; \\ d(u,v) &= d(v,u); \\ d(u,v) &\leq d(u,w) + d(w,v). \end{aligned}$$

Hamming distance is thus a [metric](#) on C .

- *Housdroff Distance:*

Hausdorff separation is a measurement between two point sets. It quantifies the degree to which each purpose of a set lies close to some purpose of another set. Since a picture can be considered as a lot of focuses, Hausdorff separation can be utilized to decide the level of likeness of two pictures. The conventional definition is as per the following:

Given two limited point sets

$$A = \{a_1, a_2, \dots, a_p\} \text{ and } B = \{b_1, b_2, \dots, b_q\}$$

the Hausdorff separation is characterize as:

$$H(A,B) = \max\{h(A,B), h(B,A)\}$$

Where

$$h(A,B) = \max_{a \in A} \min_{b \in B} \|a-b\|$$

what's more, $\|a-b\|$ is some basic standard on the purposes of A and B .

The capacity $h(A,B)$ is known as the coordinated Hausdorff good ways from A to B .

The Hausdorff separation is touchy to even a solitary remote purpose of A or B . For instance, consider $A = BU \oplus x$, where the point x is some huge separation D from any purpose of A . For this situation $H(A,B) = D$ is resolved exclusively by the point x . In this manner as opposed to utilizing $H(A,B)$ two elective strategies are accessible:

A speculation of the Hausdorff separation (which doesn't comply with the metric properties on A and B , yet obeys them on explicit subsets of A and B). This summed up Hausdorff measure is given by taking the k -th positioned

separation instead of the most extreme, or biggest positioned one,

$$h_k(A,B) = \max_{a \in A} \min_{b \in B} \|a-b\|^k$$

where k indicates the k -th positioned esteem.

- *Mahalonobis Distance*

Mahalanobis separation is a successful multivariate separation metric that estimates the separation between a point (vector) and an appropriation. It has superb applications in multivariate abnormality recognition, arrangement on exceptionally imbalanced datasets and one-class grouping and progressively undiscovered use cases. Thinking about its very helpful applications, this measurement is only sometimes talked about or utilized in detail or ML work processes. Mahalanobis separation is the separation between a point and dissemination. What's more, not between two particular focuses. It is adequately a multivariate likeness of the Euclidean separation. It was presented by Prof. P. C. Mahalanobis in 1936 and has been utilized in different measurable applications from that point onward. Be that as it may, it's not all that notable or utilized in the AI practice. All things considered, we should get into it. So computationally, how is Mahalanobis separation not quite the same as Euclidean separation?

1. It changes the segments into uncorrelated factors
 2. Scale the segments to make their fluctuation equivalent to 1
 3. Finally, it ascertains the Euclidean separation.
- The equation to figure Mahalanobis separation is as per the following:

Where,

D^2 is the square of the mahalanobis separation.

x is the vector of the perception (push in a dataset)

m is the vector of mean estimations of free factors (mean of every section)

C^{-1} is the opposite covariance grid of free factors.

- *Bhattacharyya Distance*

In statistics, the Bhattacharyya separation quantifies the comparability of two likelihood conveyances. It is firmly identified with the Bhattacharyya coefficient which is a proportion of the measure of cover between two factual examples or populaces. The two measures are named after Anil Kumar Bhattacharyya, an analyst who worked during the 1930s at the Indian Statistical Institute. The coefficient can be utilized to decide the general closeness of the two examples

being considered. It is utilized to gauge the detachability of classes in characterization and it is viewed as more solid than the Mahalanobis separation, as the Mahalanobis separation is a specific instance of the Bhattacharyya separation when the standard deviations of the two classes are the equivalent. Subsequently, when two classes have comparative methods however extraordinary standard deviations, the Mahalanobis separation would will in general zero, while the Bhattacharyya separation develops relying upon the contrast between the standard deviations.

Bhattacharyya Distance is the estimation between two likelihood appropriations. The meaning of Bhattacharyya Distance is:

where:

$$BC(p,q) =$$

is the Bhattacharyya coefficient (BC). $p(x)$ and $q(x)$ are the two standardized conveyances. For Bhattacharyya separation, a higher worth demonstrates a superior match between two appropriations. The worth or separation of an all out jumble is 1, and an ideal match is 0. The histograms of pictures must be standardized before looking at so the size of the picture won't affect the separation.

VI. RESULT

The Outcome of the input image is shown in Fig 3 which gives correctly found image from dataset.

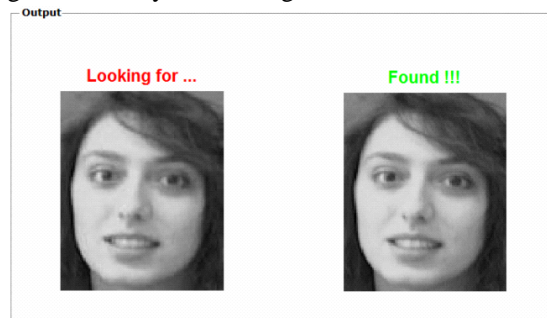


Fig. 3. Input and Output image for the system

Following table displays the precision level of the considerable number of strategies. From the table it is seen that the precision of Mahalanobis Distance is most extreme and henceforth more dependable than different classifiers. Likewise a structured presentation portrayal for the equivalent is plotted for better understanding.

TABLE I: ACCURACY RESULTS

Algo Name	City Block Distance	Hamming Distance	Housdroff Distance	Mahalanobis Distance	Bhattacharya Distance
Accuracy	95	85	83	99.5	87

Fig. 4. Bar graph representation of accuracy results.

VII. CONCLUSION

Another philosophy utilized for face acknowledgment is expected, which is predicated on Singular worth Decomposition (SVD). 5 classifiers explicitly, zone separation, acting separation, Hausdorff separation, Mahalanobis separation, and Bhattacharyya separation region unit went to ascertain the space. A survey of these classifiers is referenced in the paper. The information check picture os assigned and sent extra for the procedure. taking a gander at the alternatives and dataset, the subsequent picture is known and showed. From results, it's resolved that Mahalanobis separation recipe serves best for the targetted perform on the grounds that the precision of this equation is most noteworthy that is 99.5%.

VIII. REFERENCES

- [1]. Turk, M. And Pentland, A. , "Eigenfaces for Recognition", Journal of Cognitive Neuroscience, Vol. 3, 1991
- [2]. Roberto Bruunelli and Tomaso Poggio, "Face Recognition:Features versus Templates" ,IEEE Transactions on Patten analysis and Machine intelligence Vol.15.No.10, October 1993
- [3]. P.N. Belhumeur, J.P. Hespanha, and D.J. Kriegman, "Eigenfaces vs.Fisherfaces: Recognition using class specific linear projection", IEEE Transactions on Pattern Analysis and Machine Intelligence, 19(7):711-720, 1997.
- [4]. Onsen Toygar, Adnan Acan, "Face Recognition Using PCA, LDA and ICA Approaches on Colored Images", Journal of Electrical and Electronics Engineering, Vol.3, no. 1, pp.735-743, 2003.
- [5]. Anand, B., & Shah, M. P. K. (2016). Face Recognition using SURF Features and SVM Classifier. International Journal of Electronics Engineering Research, 8, 1-8.
- [6]. Akbar, S., Ahmad, A., Hayat, M., & Ali, F. (2015). Face Recognition Using Hybrid Feature Space in Conjunction with Support Vector Machine. J. Appl. Environ. Biol. Sci, 5(7), 28- 36.
- [7]. Sanjay, G. (2016). A Comparative Study on Face Recognition using Subspace Analysis. In International Conference on Computer Science and Technology Allies in Research-March (p. 82).

- [8]. Wang, S., Lu, S., Dong, Z., Yang, J., Yang, M., & Zhang, Y. (2016). Dual-tree complex wavelet transform and twin support vector machine for pathological brain detection. *Applied Sciences*, 6(6), 169.
- [9]. Karczmarek, P., Kiersztyn, A., Pedrycz, W., & Dolecki, M. (2017). An application of chain code-based local descriptor and its extension to face recognition. *Pattern Recognition*, 65, 26-34.
- [10]. Zhang, Y. D., Yang, Z. J., Lu, H. M., Zhou, X. X., Phillips, P., Liu, Q. M., & Wang, S. H. (2016). Facial emotion recognition based on biorthogonal wavelet entropy, fuzzy support vector machine, and stratified cross validation. *IEEE Access*, 4, 8375-8385.
- [11]. W. Zhao, R. Chellappa, P.J. Phillips and A. Rosenfeld, "Face Recognition: A literature Survey.", *ACM Comput. Surv.*, 35(4): 399-458, 2003.
- [12]. Z. Hong, "Algebraic feature extraction of image for recognition", *Pattern Recognition*, Vol.24, pp211-219, 1991.
- [13]. Thaahirah S.M. Raised, Othman O. Khalifa and Yuslina Binti Kamarudin, "Face Recognition Based on Singular value Decomposition and Back Propagation Neural Network", *IEEE*, 2005.
- [14]. Neeta Nain, Prashant Gour, Nitish Agarwal, Rakesh P Talwar, Subhash Chandra, "Face Recognition using PCA and LDA with Singular Value Decomposition (SVD) using 2DLDA", *Proceedings of World Congress on Engineering 2008, Vol 1 WCE 2008, July 2-4, 2008, London, U.K.*
- [15]. Mandeep Kaur, Rajeev Vashisht, Nirvair Neeru, "Recognition of Facial Expressions and Principal Component Analysis and Singular Value Decomposition", *International Journal of Computer Applications*, 0975-8887, Volume 9-No.12, November 2010.
- [16]. Jaizhong HE, Di Zhang, "Face Recognition Using Uniform Eigen-Space SVD on Enhanced Image for Single Training Sample", *Journal of Computational Information Systems* 7:5, 1655-1662, 2011.
- [17]. Lina Zhao, Wanbao Hu, Lihong Cui, "Face Recognition Feature Comparison Based SVD and FFT", *Journal of Signal and Information Processing*, 3, 259-262, 2012.
- [18]. Rehna, V.J., Jeyakumar. M.K., "Singular Value Decomposition Based Image for Achieving Additional Compression to JPEG Images", *International Journal of Image Processing and Vision Sciences (IJIPVS)*, Volume-1, Issue-1, 2012.
- [19]. Lijie Cao, "Singular Value Decomposition Applied To Digital Image Processing", *Division of Computing Studies, Arizona State University Polytechnic Campus Mesa, Arizona*