

A SURVEY ON FACE RECOGNITION TECHNOLOGIES AND TECHNIQUES

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Abstract: This paper is proposed the face recognition technologies and techniques. Face recognition has been a fast growing, challenging and interesting area in real time applications. A large number of face recognition algorithms have been developed in last several years, the methods are PCA, LDA, ICA, SVM, ANN for recognition and various hybrid combination of this techniques. This review investigates all these methods with parameters that challenges face recognition like pose variation, facial expressions.

Keyword: Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), Face Recognition, Independent, Component Analysis (ICA), Artificial Neural Networks (ANN), Dot Net Framework 4.0(.NET), C# language , EmguCV, SQL Server 2008 R2.

I. INTRODUCTION

Human eye sees so many people's face repeatedly in his life. But it's very hard to remember all faces, Whenever he or she meet someone, he/she needs to remembers particular facial features of that persons so it's very difficult to remember so with the help of feature extraction process rather than whole face. Face recognition is a very important part of the capability of human perception system and could be a routine task for humans, now day's recognition of face is very much needed while in building a similar computational model.[27][28]. The computational model not only share the theoretical insights but also to many practical applications like automated crowd surveillance, design of human computer interface (HCI),image database management, criminal identification and so onset. During the past few decades, face recognition has received tremendous boosting attention and also has been boost advance technically. Now days many commercial systems uses face recognition for many purpose. Recently, significant research efforts have been focused on video-based face modelling/tracking, recognition and system integration. New databases have been created and evaluations of recognition techniques using these databases have been carried out. Now, the face recognition has become one of the most active applications of pattern recognition, image analysis and understanding. [27][28][29]

II. FACE RECOGNITION TECHNOLOGIES

.Net Framework 4.0:-

NET Framework is a software framework developed by Microsoft that runs primarily on Microsoft Windows. It includes a large class library known as Framework Class Library (FCL) and provides language interoperability across several programming languages. Programs written for .NET Framework execute in a software environment (as contrasted to hardware environment), known as Common Language Runtime (CLR), and an application virtual machine that provides services such as security, memory management, and exception handling. FCL and CLR together constitute .NET Framework.[62]

FCL provides user interface, data access, database connectivity, cryptography, web application development, numeric algorithms, and network communications. Programmers produce software by combining their own source code with .NET Framework and other libraries. .NET Framework is intended to be used by most new applications created for the Windows platform. Microsoft also produces an integrated development environment largely for .NET software called Visual Studio.[62]

C# language:-

C# is a multi-paradigm programming language encompassing strong typing, imperative, declarative, functional, generic, object-oriented and component-oriented programming disciplines. It was developed by Microsoft within its .NET initiative[62]. C# is an evolution of the C and C++ family of languages. However, it borrows features from other programming languages, such as Delphi and Java. If you look at the most basic syntax of both C# and Java, the code looks very similar, but then again, the code looks a lot like C++ too, which is intentional. Developers often ask questions about why C# supports certain features or works in a certain way. The answer is often rooted in its C++ heritage. Recent language features, such as Language Integrated Query (LINQ) and Asynchronous Programming (Async) are not necessarily unique to C#, but do add to its uniqueness.[62]

EmguCV:-

It is essentially a huge library of “wrapper” functions that allows calling OpenCV functions from a Visual Studio Windows Forms application. It is necessary because Visual Studio/.NET is an “interpreted” environment that cannot directly call functions written in native C/C++.[6]. Emgu CV is a cross platform .Net wrapper to the OpenCV image processing library. Allowing OpenCV functions to be called from .NET compatible languages such as C#, VB, VC++, IronPython etc.[6]

SQL Server 2008 R2:-

Microsoft SQL Server is a relational database management system developed by Microsoft. As a database server, it is a software product with the primary function of storing and retrieving data as requested by other

software applications which may run either on the same computer or on another computer across a network (including the Internet).[62]. Microsoft markets at least a dozen different editions of Microsoft SQL Server, aimed at different audiences and for workloads ranging from small single-machine applications to large Internet-facing applications with many concurrent users. SQL Server 2008 R2 certain features to SQL Server 2008 including a master data management system branded as Master Data Services, a central management of master data entities and hierarchies. Also Multi Server Management, a centralized console to manage multiple SQL Server 2008 instances and services including relational databases, Reporting Services, Analysis Services & Integration Services.[62]. SQL Server 2008 R2 includes a number of new services, including Power Pivot for Excel and SharePoint, Master Data Services, Stream Insight, Report Builder 3.0, Reporting Services Add-in for SharePoint, a Data-tier function in Visual Studio that enables packaging of tiered databases as part of an application, and a SQL Server Utility named UC (Utility Control Point), part of AMSM (Application and Multi-Server Management) that is used to manage multiple SQL Servers. [62]

III. FACE RECOGNITION TECHNIQUES

A. Principal Component Analysis (PCA)

Recognition of human faces with the help of PCA was 1st done by Turk and Pent land [7] and reconstruction of human faces was done by Kirby and Sirovich [8]. The recognition technique, known as Eigen face technique defines a feature area which reduces the depth of the authentic data space. This reduced knowledge area is used for recognition. However poor discriminating power inside the class and enormous computation are the documented common issues in PCA technique. This limitation is overcome by Linear Discriminant Analysis (LDA).[27][28][29]

LDA is the most dominant algorithms for feature choice in look primarily based strategies [8]. But several LDA primarily based face recognition system 1st used PCA to scale down the dimensions and then use LDA to maximize the discriminating power of feature choice. The reasoning is that LDA has the small sample size drawback within which dataset selected ought to have larger samples per category for good discriminating options extraction. Thus direct implementing LDA results into a poor extraction of discriminating options. In the proposed methodology [9] Gabor filter is used to filter frontal face pictures and PCA is used to break down the dimension of filtered feature vectors then LDA is used for feature extraction.[27][28][29]. The performances of appearance primarily based statistical ways like PCA, LDA and ICA are compared and tested for the recognition of coloured faces pictures in [10]. PCA is better than LDA and ICA beneath distinct illumination variations however LDA is improved than ICA.LDA is extra sensitive than PCA and ICA on partial occlusions, however PCA is lesser sensitive to partial occlusions compared to LDA and ICA. PCA is used as a dimension reduction methods in [11][28] and for modelling expression deformations in [12][28]. A new face recognition methodology supported PCA, LDA and neural network were proposed in [13][28].This methodology consists of 4 steps: i) Pre-processing ii) Dimension

reduction practicing with PCA iii) feature extraction practicing with LDA and iv) classification practicing with neural network. Combination of PCA and LDA were used for rising the potential of LDA when a number of samples of pictures were offered and neural classifier was wont to scale back range misclassification caused by not-linearly dissociable classes. The proposed methodology was tested on Yale face database or table. Experimental results on this database or table demonstrated the effectiveness of the projected method for face recognition with less misclassification as compared with previous methods. [27][28][29].

A different approach for face detection was proposed in [14] that minimizes computation time at the same time achieving higher detection accuracy. PCA was wont to scale back the dimension extracting a feature vector. GRNN used as a operation approximation network to find whether or not the input image contains a face and if existed then reports regarding its orientation. The projected system had shown that GRNN will perform higher than back propagation algorithmic rule and provides some resolution for higher regularization. [27][28][29]. M.A. Turk and Alex P.Pentland[7] developed a close to real time Eigen faces system for face recognition using Euclidean distance. A face recognition system is thought of as a decent system if we tend to extract with the assistance of Principal Component Analysis and for recognition process back propagation Neural Network are used. Face recognition system uses face verification, and face recognition tasks. In verification task, the system is aware of a priori the identity of the user, and must verify this identity, that is, the system must decide whether or not the a priori user is a cheater or not. In face recognition, the a priori identity isn't known: the system must decide which of the pictures keep in an exceedingly information resembles the most to the image to acknowledge. [27][28][29].The proposed face recognition system consists of two phases which are the enrolment and Recognition/verification phases as depicted in Fig. 1. [30].

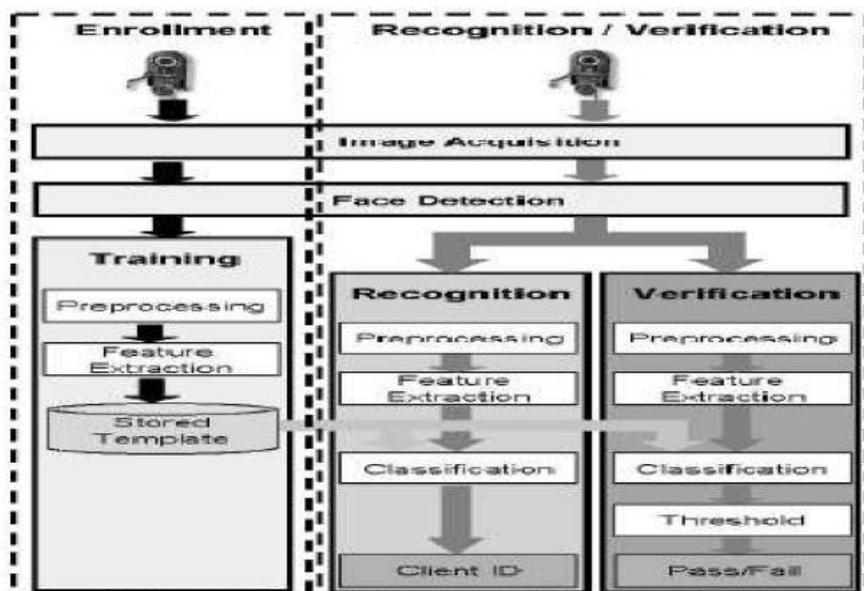


Fig. 1 : Block Diagram of Face Recognition System

B. Support Vector Machine (SVM)

Support Vector Machines (SVM) are one among the most useful techniques in classification issues. One clear example is face recognition. However, SVM cannot be applied once the feature vectors defining samples have missing entries. A classification algorithm that has been implemented efficiently used in this framework is the all-known support Vector Machines(SVM) [15][28], which may be applied to the initial look space or a subspace of it obtained when applying a feature extraction technique[16][17][18]. The advantage of SVM classifier over ancient neural network is that SVMs are able to do higher generalization performance.

C. Independent Component Analysis (ICA)

Independent component analysis (ICA) is a technique for finding underlying factors or parts from multivariate (multidimensional) statistical information. There is have to be compelled to implement face recognition system using ICA for facial pictures having face orientations and totally different illumination conditions, which will offer higher results as compared with existing systems [19] [20] [21][28] . What distinguishes ICA from different strategies is that, it's for component that is both statistically autonomous and non-Gaussian [19]. The ICA is related to blind source separation drawback in [22]. The comparison of face recognition mistreatment PCA and ICA on FERET information are different classifiers [23] [24][28] were mentioned and located that the ICA had better recognition rate as compared with PCA with statistically autonomous basis pictures and likewise with statistically autonomous coefficients.

Face recognition using with ICA with massive rotation angles with poses and variations in illumination conditions was proposed in [25]. A novel subspace technique called consecutive row column independent component analysis for face recognition is proposed in [26]. In ICA every face image is transformed into a vector before manipulating the independent elements. RC_ICA reduces face recognition error and spatiality of recognition subspace becomes smaller.[28]. An innovative technique for face recognition combined the innovative component analysis (ICA) model with the optical correlation technique was proposed in [31]. This approach relied on the performances of a powerfully discriminating optical correlation technique forth with the robustness of the ICA model. Autonomous component analysis (ICA) model had sparked interest in checking out a linear transformation to express a collection of random variables as linear combinations of statistically independent supply variables [32].

ICA provided a a lot of powerful information representation than PCA as its goal was that of providing AN A novel subspace technique called consecutive row column independent component analysis for face recognition is proposed in [33]. In ICA every face image is transformed into a vector before

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ICA provided a lot of powerful information representation than PCA as its goal was that of providing AN autonomous uncorrelated image decomposition and illustration. A fast incremental principal non Gaussian directions analysis rule known as IPCA_ICA was planned in [36]. This rule computes the principal components of a sequence of image vectors incrementally without estimating the variance matrix and at identical time remodel these principal elements to the autonomous directions that maximize the non-Gaussianity of the source. Uncorrelated image decomposition and illustration.

A fast incremental principal non Gaussian directions analysis rule known as IPCA_ICA was planned in [36]. This rule computes the principal components of a sequence of image vectors incrementally without estimating the variance matrix and at identical time remodel these principal elements to the autonomous directions that maximize the non-Gaussianity of the source. IPCA_ICA is very much efficient for calculating the first basis vectors. PCA_ICA has achieved greater moderate success rate than Eigen face, the Fisher face and FastICA methodology's.

D. Linear Discriminant Analysis (LDA)

The linear discriminant analysis (LDA) The powerful technique for face recognition. It yields AN effective illustration that linearly transforms the original info area into a low-dimensional feature space wherever the info is well separated. However, the within-class scatter matrix (SW) becomes singular in face recognition and so the classical LDA cannot be resolved the under sampled problem of LDA (also referred to as small sample size problem).

A subspace analysis technique for face recognition known as kernel discriminant locality preserving projections (MMDLPP) was projected in [37] supported by the analysis of LDA, LPP and kernel perform. A nonlinear subspace which can not only be used to preserves the local facial manifold structure but also it can be used to emphasizes discriminant information. Combined with maximum margin criterion (MMC) a new technique known as maximizing margin and discriminant locality preserving projections (MMDLPP) was projected in [38] to seek out the subspace that best discriminates completely different face change and storing the intrinsic relations of the local neighbourhood within the same face category according to preceding category label info. The proposed technique was compared with PCA likewise as locality

preserving projections (LPP) ORL, YALE, YALEB face info and authors had shown that it provides a stronger illustration of class info and achieved higher recognition accuracy. Illumination adaptive linear discriminant analysis (IALDA) was projected in [39] to resolve illumination variation issues in face recognition.

The recognition accuracy of the advised technique (IALDA), far higher than that of PCA technique and LDA method. The recognition accuracy of the suggested technique was lower than that the Logarithmic Total Variation (LTV) rule [40]. However, The LTV rule has huge time complexity. Therefore, the LTV technique isn't practically applicable. At constant time, this also indicates that the projected IALDA technique is robust for illumination variations. David Monzo. [41]

Compared many approaches so to extract facial landmarks as much as possible and studied their influence on face recognition issues so as to get truthful comparisons, they used constant variety of facial landmarks and also the same group of descriptors (HOG descriptors) for every approach.

The comparative results were obtained by applying FERET and FRGC [42] datasets and shown that higher recognition rates were obtained once landmarks are settled at real facial fiducially points. During this work, comparison was done applying Principal component Analysis (PCA) [43], Linear Discriminant Analysis (LDA) [44] and Orthogonal Linear Discriminant Analysis (OLDA) [45]. OLDA is one of the various variations of LDA which aims to tackle the matter of under sampling. The key plan of OLDA, the discriminant vectors are orthogonal to every different. In [45] this provides AN economical manner of computing OLDA.

E. Artificial Neural Networks (ANN)

Multi-Layer Perceptron (MLP) with a feed forward learning algorithms was chosen for the planned system as a result of its simplicity and its capability in supervised pattern matching. It's been successfully applied to several pattern classification problems [46]. A unique approach to face detection with Gabor wavelets & feed forward neural network was proposed in [47]. The methodology used Gabor wavelet transform and feed forward neural network for both finding feature points and extracting feature vectors. The experimental results, have shown that planned methodology achieves better results compared to the graph matching and Eigen faces methods, which are best-known to be the most flourishing algorithms [28]. A new category of convolutional neural network was projected in [48] where the process cells are shunting restrictive neurons. Antecedent shunting restrictive neurons have been employed in a traditional feed forward architecture for classification and non-linear regression and were shown to be a lot of powerful than MLPs [49] [50] i.e. they'll approximate complex choice surfaces far more easy than MLPs.

A hybrid neural network result was presented in [51] which mixes local image sampling, a self-organizing map neural network, and a convolutional neural network. The self-organizing map provides a division of the

image samples into a topological space wherever inputs that are close within the original area also are nearby within the output area, thereby providing dimensionality reduction and invariance to minor changes within the image sample, and therefore the convolutional neural network (CNN) provides for partial invariance to translation, rotation, scale, and deformation. PCA+CNN & SOM+CNN methodology are both superior to Eigen faces technique even when there's only 1 practice image per person[28]. SOM +CNN methodology systematically performs better than the PCA+CNN methodology. A new face detection methodology is projected in [52] exploitation polynomial neural network (PNN) [53] [54]. The PNN functions as a classifier to judge the face likelihood of the image patterns of the multi scale shifted local regions. The PCA technique won't to reduce the spatiality of image patterns and extract options for the PNN. Exploiting a single network the author had achieved nearly very high rate of detection and low false positive rate on pictures with advanced backgrounds. Compared with a multilayer perceptron, the performance of PNN is superior. To best replicate the geometry of the 3D face manifold and improve recognition, Spectral Regression Kernel Discriminate Analysis(SRKDA) [55] supported regression and spectral graph analysis introduced in projected [56] methodology.

When the sample vectors are linearly self-dependent, which is usually the case for tiny sample size problems; SRKDA can efficiently give a lot of actual solutions than normal subspace learning approaches. It not only solves high dimensional and little sample size problems, but also boost up and enhances feature of extraction from non-linear local face structure[28]. SRKDA is the one needs to solve a group of regularized regression issues and no eigenvector computation concerned, that may be a large saving in computational rice. A novel Haarlet Pyramid based face recognition technique was projected in [57]. Here face recognition is done using the picture image feature set extracted from Haarlets on grey plane. PCA is usually used but it is very time consuming. In paper [58] authors have shown the comparative study of different face recognition rule for plastic surgery Based on the experimentation carried out by authors it has been concluded that face recognition algorithm such as PCA ,FDA ,LLA, LBP & GNN have shown recognition rate more than 40% for local plastic surgery. A new approach to plastic surgery based face recognition A set theory was proposed in [59] [60]. An approach based on closely related theory for analysing pre and post-surgical facial images is proposed in [61][28].

IV. CONCLUSION

This paper has attempted to make a survey of a significant number of papers to cover the recent development in the field of face recognition technologies and techniques. With the help of this survey we can come to know many other ways for building up face recognition. With the help of list of reference paper listed can provide more detailed understanding of the approaches. We apologize to researchers whose important contributions may have been overlooked.

REFERENCES

- [1] Sujata G. Bhele and V. H. Mankar, "International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 1", Issue 8, October 2012
- [2] Nirmalya Kar, Mrinal Kanti Debbarma, Ashim Saha, and Dwijen Rudra Pal , "International Journal of Computer and Communication Engineering", Vol. 1, No. 2, July 2012
- [3] Daniel Georgescu , "Journal of Mobile, Embedded and Distributed Systems", vol. III, no. 4, 2011
- [4] Arun A.V., Bhatath S., Chethan N., Manmohan C.M., Hamsevani M., "Efficient Attendance Management System Using Face Detection and Recognition".
- [5] A. Khan and L. Alizai,"Introduction to Face Detection Using Eigenfaces," in Proceedings of the 2nd IEEE International Conference on Emerging Technologies (ICET 2006), pp. 128-132, Nov 2006.
- [6] http://www.emgu.com/wiki/index.php/Main_Page [date: - 13/03/2016]
- [7] M. Turk and A. Pentland, "Eigenfaces for recognition," J. Cognitive Neuroscience, vol. 3, 71-86., 1991.
- [8] D. L. Swets and J. J. Weng, "Using discriminant eigenfeatures for image retrieval", IEEE Trans. PAMI., vol. 18, No. 8, 831-836, 1996.
- [9] C.Magesh Kumar, R.Thiyagarajan , S.P.Natarajan, S.Arulselvi,G.Sainarayanan,|| Gabor features and LDA based Face Recognition with ANN classifier||,Proceedings Of ICETECT 2011
- [10]Önsen TOYGAR Adnan ACAN, ||Face recognition using PCA, LDA and ICA approaches on colored images||, Journal of Electrical and Electronics Engineering, vol- 13, 2003
- [11]Y. Cheng, C.L. Wang, Z.Y. Li, Y.K. Hou and C.X. Zhao,|| Multiscale principal contour direction for varying lighting face recognition||,Proceedings of IEEE 2010
- [12]F. Al-Osaimi·M. Bennamoun · A. Mian,|| An Expression Deformation Approach to Non-rigid 3D Face Recognition||, Springer Science+Business Media, LLC 2008
- [13] A. Hossein Sahoolizadeh, B. Zargham Heidari, and C. Hamid Dehghani,|| A New Face Recognition Method using PCA, LDA and Neural Network||, International Journal of Electrical and Electronics Engineering 2:8 2008
- [14]Feroz Ahmed Siddiky, Mohammed Shamsul Alam,Tanveer Ahsan and Mohammed Saifur Rahim,||An Efficient Approach to Rotation Invariant Face detection using PCA,Generalized Regression Neural network and Mahalanobis Distance by reducing Search space||,Proceedings Of IEEE 2007
- [15] Vapnik. Statistical Learning Theory. JohnWiley and Sons, New York, 1998.
- [16] E. Osuna, R. Freund, and F. Girosit. Training support vector machines: an application to face Detection. Proc. of CVPR, pages 130–136, 1997.
- [17] B. Heisele, T. Serre, and T. Poggio. A componentbased framework for face detection and Identification. IJCV, 74(2):167–181, 2007.
- [18] Q. Tao, D. Chu, and J. Wang. Recursive support vector machines for dimensionality reduction. IEEE Trans. NN, 19(1):189–193, 2008.



- [19] Marian Stewart Bartlett, Javier R. Movellan, Terrence J. Sejnowski, —Face Recognition by Independent Component Analysis, IEEE Transactions on Neural Networks, vol-13, No- 6, November 2002, PP 1450- 1464.
- [20] Pong C.Yuen, J.H.Lai, —Face representation using independent component analysis, Pattern Recognition 35 (2002) 1247-1257.
- [21] Tae-Kyun Kim, Hyunwoo Kim, Wonjum Hwang, Josef Kittler, —Independent component analysis in a local facial residue space for face recognition, Pattern Recognition 37 (2004) 1873-1885
- [22] Aapo Hyvärinen and Erkki Oja —Independent Component Analysis: Algorithms and Applications, Neural Networks Research Centre Helsinki University of Technology P.O. Box 5400, FIN-02015 HUT, Finland, Neural Networks, 13(4-5):411-430, 2000
- [23] Bruce A. Draper, Kyungim Baek, Marian Stewart Bartlett, —Recognizing faces with PCA and ICA, Computer Vision and Image Understanding 91 (2003) 115-137.
- [24] Jian Yang, David Zhang, Jing-yu Yang, —Is ICA Significantly Better than PCA for Face Recognition? Proceedings of the Tenth IEEE International Conference on Computer Vision (ICCV'05) 1550- 5499/05.
- [25] Kailash J. Karande, Sanjay N. Talbar, Face Recognition under Variation of Pose and Illumination Using Independent Component Analysis, ICGST-GVIP, ISSN 1687-398X, Volume (8), Issue (IV), December 2008
- [26] Kyungim Baek, Bruce A. Draper, J. Ross Beveridge, Kai She, "PCA vs. ICA: A Comparison on the FERET Data Set", Proceedings of the 6th Joint Conference on Information Science (JCIS), 2002, pp. 824-827
- [27] Taranpreet Singh Ruprah--Face Recognition Based on PCA Algorithm, (IJCSI), ISSN (PRINT) : 2231-5292, Vol.- II, Issue-1, 2
- [28] Sujata G. Bhele and V. H. Mankar--A Review Paper on Face Recognition Techniques, (IJARCET) Volume 1, Issue 8, October 2012
- [29] Bruner, I. S. and Tagiuri, R. *The perception of people.* In *Handbook of Social Psychology*, Vol. 2, G. Lindzey, Ed., Addison-Wesley, Reading, MA, 634-654.1954
- [30] Kyungim Baek, Bruce A. Draper, J. Ross Beveridge, Kai She, "PCA vs. ICA: A Comparison on the FERET Data Set", Proceedings of the 6th Joint Conference on Information Science (JCIS), 2002, pp. 824-827
- [31] A. Alfalou and C. Brosseau, A New Robust and Discriminating Method for Face Recognition Based on Correlation Technique and Independent Component Analysis Model, *Optics Letters* 36 (2011) 645-647
- [32] P. Comon, —Independent component analysis: a new concept?, *Signal Process.* 3, 287-314 (1994).

- [33] Quanxue Gao , LeiZhang, DavidZhang,|| Sequential row–column independent component analysis for face recognition||, *Elsevier* 2008
- [34] A. Alfalou and C. Brosseau,|| A New Robust and Discriminating Method for Face Recognition Based on Correlation Technique and Independent Component Analysis Modell, *Optics Letters* 36 (2011) 645-647
- [35] P. Comon, —Independent component analysis: a new concept?||, *Signal Process.* 3, 287-314 (1994).
- [37] Issam Dagher and Rabih Nachar,||Face Recognition Using IPCA-ICA algorithm||, *IEEE Transactions On Pattern Analysis and Machine Intelligence*, VOL. 28, NO. 6, JUNE 2006
- [36] Issam Dagher and Rabih Nachar,||Face Recognition Using IPCA-ICA algorithm||, *IEEE Transactions On Pattern Analysis and Machine Intelligence*, VOL. 28, NO. 6, JUNE 2006.
- [37] Rongbing Huang , Changming Su a, Fangnian Lang a, Minghui Du,|| Kernel Discriminant Locality Preserving ProjectionsforHuman Face Recognition||, *Journal of Information & Computational Science* 7: 4 (2010)
- [38] Xiaohu Ma, Yanqi Tan, Yaying Zhao, Hongbo Tian,|| Face Recognition Based on Maximizing Margin and Discriminant Locality Preserving Projection||, *Journal of Information & Computational Science* 7: 7 (2010)
- [39] Zhonghua Liu , Jingbo Zhou,Zhong Jin,|| Face recognition based on illumination adaptive LDA||, *International Conference on Pattern Recognition*,2010.
- [40] T. Chen, W. Yin, X.S. Zhou, D. Comaniciu, T.S. Huang, Total variation models for variable lighting face recognition, *IEEE Trans.Pattern Anal. Mach. Intell.* 28 (9) (2006) 1519—1524
- [41] David Monzo, Alberto Albiol, Antonio Albiol, Jose M. Mossi,|| A Comparative Study of facial landmark localization methods for Face Recognition using HOG descriptors||, *Proceedings of IEEE 2010*
- [42] P. J. Phillips, P. J. Flynn, T. Scruggs, K. W. Bowyer, J. Chang, K. Hoffman, J. Marques, J. Min, and W. Worek, —Overview of the face recognition grand challenges,|| in *Proc. IEEE Int. Conf. Comput. Vis Pattern Recognit.*, pp. 947–954,2005
- [43] K. Fukunaga. *Introduction to Statistical Pattern Recognition*, Second Edition (Computer Science and Scientific Computing Series). Academic Press, 1990
- [44] P. Belhumeur, J. Hespanha, and D. Kriegman. Eigenfaces vs. fisherfaces: Recognition using class specific linear projection. In *ECCV*, pages 45–58, 1996
- [45] J. Ye. Characterization of a family of algorithms for generalized discriminant analysis on undersampled problems. *Journal of Machine Learning Research*, 6:483– 502, 2005.
- [46] Li X. and Areibi S., —A Hardware/Software co-design approach for Face Recognition||, *The 16th International Conference on Microelectronics*, Tunisia 2004
- [47] Avinash Kaushal, J P S Raina,|| Face Detection using Neural Network & Gabor Wavelet Transform|| *IJCST* Vol. 1, Issue 1, September 2010

- [48] F. Tivive and A. Bouzerdoum,||A new class of convolutional neural network(siconnets)and their application to face detection,||*Proc. Of the International Joint Conference on neural Networks*,vol. 3,pp. 2157- 2162,2003
- [49] A.Bouzerdoum,||A new class of high order neural networks with non-linear decision boundaries||,*Proc. Of the sixth International Conference on neural Information Processing*,vol.3,pp. 1004-1009,1999
- [50] A.Bouzerdoum,||Classification and function approximation using feed-forward shunting inhibitory artificial neural networks,vol. 6,pp.613-618,2000
- [51] Steve Lawrence,C.Lee Giles,A.h Chung Tsoi, Andrew D. Back,|| Face Recognition: A Convolutional Neural Network Approach
- [52] Lin-Lin Huang, Akinobu Shimizu, Yoshihiro Hagihara, Hidefumi Kobatake,|| Face detection from cluttered images using a polynomial neural network||, *Elsevier Science* 2002
- [53] U. KreQel, J. SchRurmann, Pattern classification techniques based on function approximation, in: H.Bunke, P.S.P. Wang (Eds.), *Handbook of Character Recognition and Document Image Analysis*, *World Scienti5c*, Singapore, 1997, pp. 49–78.
- [54] J. SchRurmann, Pattern Classi5cation: A Unified View of Statistical Pattern Recognition and Neural Networks, *Wiley Interscience*, New York, 1996
- [55] D.Cai, X.He and J.Han, —Efficient Kernel Discriminant Analysis via Spectral Regression||, *Technical report*, Computer Science Department, UIUC, UIUCDCS-R-2007- 2888, August 2007.
- [56] Yue Ming, Qiuqi Ruan, Xiaoli Li, Meiru Mu,|| Efficient Kernel Discriminate Spectral Regression for 3D Face Recognition||, *Proceedings Of ICSP* 2010
- [57] Dr.H.B.Kekre,Sudeep D. Thepade,AkshayMaloo,|| Face Recognition using Texture Features Extracted form Haarlet Pyramid||, *International Journal of Computer Applications* (0975 – 8887) Volume 12– No.5, December 2010
- [58] R.Singh, M.Vatsa; —Effect of Plastic Surgery on Face Recognition: A Preliminary Studyl||, *West Virginia University*,Morgantown, USA.
- [59] A.Skowron, J. Stepaniuk; —Tolerance approximation spaces||, *Fundamenta Informaticae*, 27(2-3) pp: 245-253, 1996.
- [60] J.F.Peters; —Near Sets. Special Theory about Nearness of Objects||, *Fundamenta Informaticae*, vol: 76, pp:1-27, 2006.
- [61] K. R. Singh, Roshni S Khedgaonkar, Swati P Gawande,|| A New Approach to Local Plastic Surgery Face Recognition Using Near Sets||, *International Journal of Engineering Science and Technology (IJEST)* Feb 2011