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A Drift Indication of Unearthing in Face Detection and Feature Extraction

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Abstract: ***Nowadays analysis of research on face recognition has explored to extracting auxiliary data from varied biometric techniques like fingerprints, face, iris, palm, voice etc. Research on face recognition, face detection and feature extraction has a long history, and even may be derived back to the nineteenth century. However, the first face detection in the main reckons on a priori information of bound folks and might not free itself from human intervention. Until the looks of high-speed, superior computers, the face detection methodology makes a big burst through. Face detection has been a quick growing, difficult and fascinating space in real time applications. Facial detection and feature extraction becomes an interesting research topic. A large range of face detection and feature extraction algorithms are developed in last decades. In this paper a shot is created to review a good vary of strategies used for face recognition comprehensively. This paper contributes a huge survey of varied face detection and feature extraction techniques. At the moment, there are loads of face detection and feature extraction techniques and algorithms found and developed round the world.***

Keywords: ***Face detection, feature extraction, neural Network, Precision rate,***

I. INTRODUCTION:

Biometric Traits are the automatic recognition of any person, which depends upon behavioral and biological characteristics of that particular person. In practical applications the biometric traits which successfully used are face, palm print, fingerprint, iris, vein, voice, footprints, DNA etc. Jain et al. discussed the biometric face recognition system has distinguished between 2 stages, first is enrollment and second is recognition stage. In enrollment stage, the framework or system at first gets the biometric characteristics i.e., face of a person, then features are extracted and store these extracted features in the database. Throughout the recognition stage, the framework or system once more procure those same biometric traits, then extract the features and this time these features will be compared by the stored templates for figure out a match alternately will confirm those guaranteed character. The history of Face recognition was started after 1960.At Panaromic Research centre Bledsoe developed a "man-machine" system in which facial landmarks are located on a photograph. It is developed by facial landmarks which derive normalized distances. In 1973, the Ph.D Thesis is published by **Takeo Kanade's** in which the system will automatically extract the features of facial landmarks.

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In 1991, Turk and Pentland, gives the Eigen face approach which is popularized and based on holistic appearance . This approach generates the compact representation of mapping of high dimensional image and into low dimensional image of an entire face image and it is defined with vectors which are used for training sets.
Penev and Atick proposed a analysis method for local feature and Behumeur et.al. Proposed a fisher face method. Wiskott et.al. Proposed a elastic bunch graph matching approach for face recognition system based on model. It builds a 2D and 3D face models for finding the various points of the face i.e., tip of nose, corners of eyes, mouth corners, chin etc. In 2001, Viola and Jones proposed a face detector. They used a haar like features and Adaboost algorithm for detecting the face. Ahonen et al. in 2006 proposed a Local Binary patterns. Sparse representation of faces is discussed by Wright et al. in 2009 and Jia et al. in 2014 develop the Deep learning approach is proposed for the advancements of face recognition in the current research.

2.1 Face Detection: As we know that an image is a high dimension vector and represented as high dimensional pixel arrays in terms of features and patterns. The dimension of these coordinates of features and patterns are too high to evaluate and specify the data points. So, for the same the aim is to apply the right and appropriate approach for analysis and extraction of data points. Moving ahead in the terms of face, the user has to recognize the face [Zhao et al.].Finding and analyzing the faces is the foundational problem of computer vision. Though great researches have been made in the area of face detection still it is a challenging task to obtain the reliable estimates of head, pose and facial landmarks particularly in the wild images. Face detection is the specific part of object detection and it is used to find locations of an face into the image and video sequence. It belongs to a different object which belongs to a given class is known as object detection. Face detection majorly focus on detection of frontal faces, side faces, faces having structural components etc.

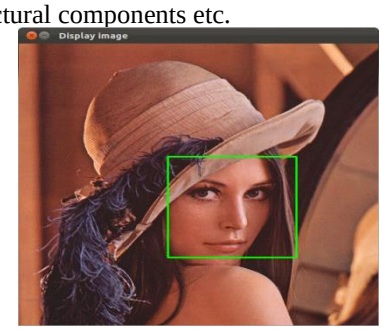


Fig 1.1: Face detection in green rectangle

Face detection is shown in Fig 1.1 given above in which the rectangle green color box detects the face in the image.

2.1.1 Face Detection Process

It is a two class problem, in which the system has to decide that whether there is a face exist in the system or not. For this, in the input image or video, initially system has to detect and locate the face. Then after some tracking algorithm are needed to track the face. This is shown in Fig 1.2 given below

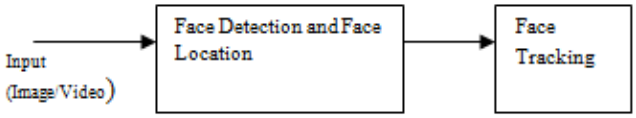


Fig 1.2.Face Detection Process

2.1.2Face Recognition Process: The face recognition system is always works on input of an image or a video sequence which consists of faces. The output of the system is the identification and verification of the face which appears in the image or video. Majorly, it is a three phase process which includes face detection, feature extraction and face recognition itself. As it is defined that face detection is a process of locating and detecting the faces from the image or the video sequences. The next phase is feature extraction which obtains the important features of the face from the input source. Feature extraction has three steps i.e., dimensionality reduction, feature extraction and feature selection as shown in Fig1.3 given below.

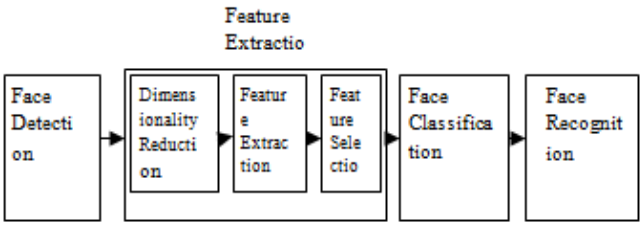


Fig 1.3: Face Recognition Process

2.1.3 Face Detection Methods: Yan, Kriegman and Ahuja [Yang et al.] presented classifications method which is divided following categories and they are shown in the Fig 1.4 given below

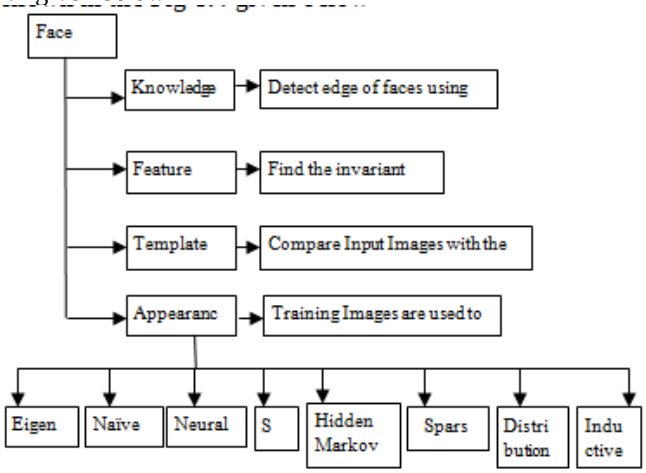


Fig 1.4. Face Detection Approaches

2.1.3.1 Knowledge-Based Methods: It is based on rule method, in which the set of appropriate rules has to build according to the facial features.

2.1.3.2 Feature Invariant Methods: This method is used to find some constant or unaffected features for face detection. It performs the calculation to measure the face area, its fixed size, orientation etc. It is a successful method but only for simple inputs. If the person wears glasses or he is having beard then this method is not successful.

2.1.3.3 Template Matching Methods: In this method the standard template is find out for the detection of face which can be divided into many parts like face contour, mouth, eye, nose and this face can be represented as a silhouette. But the limitation of this method is that it is only for frontal faces and unconcluded.

2.1.3.4 Appearance Based Methods: This method consists of multiple techniques of machine and statistical learning methods for finding the characteristics and features of faces.

Eigen Face Approach: It is an efficient method for representing face. Kirby and Sirovich uses the PCA (Principal Component Analysis) for face detection .The vectors used for this co ordinate system is known as Eigen pictures and the output faces based on this algorithm are known as Eigen faces as mentioned by Sirovich and Kirby.

Naive Bayes Classifiers: This classifier will give the good results for frontal face detection. Schneiderman and Kenade calculate the occurrence rate of a sequence of similar patterns for the images which are used for training. It works as a complementary part of other algorithms.

Neural Networks: According to the study of neural network , Raphel et al. discuss the face detection problem is a two class problem one will contain the faces and another will contain the non faces .For classification of patterns Rowley et al. use the discriminant function and distance measures and also find the optimal threshold between non face and face.

Support Vector Machines : SVM is used for linear classification of characteristics that increase the difference between the training set and decision hyper plane. Osuna et al. will minimize the classification error of unseen patterns.

Hidden Markov Model: The reason of using HMM is that the output will be trusted in probability manner and it will define the facial features in terms of strips of pixels.

Sparse Network of Winnows: The SNoW is a less time consuming approach. It incrementally learned the feature space as it is discussed by Yang et al.

Distribution-Based Approach: The idea of this method is to collect the large number of samples and appropriate feature space is chosen from these samples. The trained classifier is used to test the target pattern this is based on measurements between the input pattern and the pattern based on distribution.

Inductive Learning: Mitchell's FIND-S algorithms and Quinlan's C4.5 algorithms for face detection are used in inductive learning by both Duta and Jain and Golstein et al.

2.2 Face Tracking: Face tracking is actually a motion estimation problem and it may require in the video sequences as input.

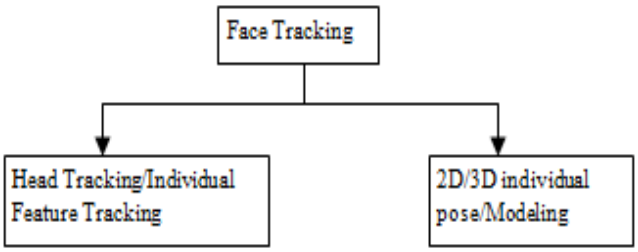


Fig1.5: Face Tracking Approaches

It can be performed by feature tracking, head tracking, model tracking, image tracking etc. This method locates the image in a picture or video.

Partial Occlusions, illumination changes, facial dimensions are the basic problems faced by face tracking process [Zhao et al.]. Face Tracking is majorly classified in two approaches which is shown in Fig 1.5.

Individual feature/Head tracking: Head is tracked as a entity and features are tracked individually.

2D/3D Systems: 2D systems are used to locate the face where as 3D systems are used to model the face. This approach allows orientation variations, pose estimation etc.

2.3 Feature Extraction: The process of feature extraction consists of extracting the relevant features from the given image. This extracted information is important at the later steps of face recognition because it subjects with an acceptable error rate as explained by Bentin et al. It is shown in Fig 1.6 given below-

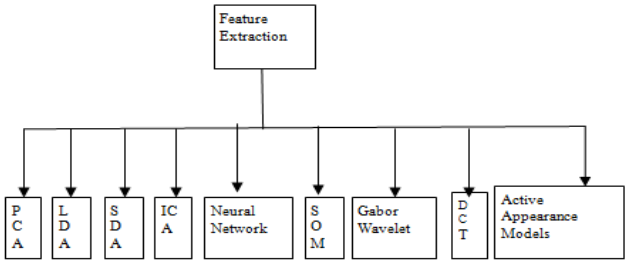


Fig 1.6: Feature Extraction Approaches

2.4.1 Principal Component Analysis: PCA procedure as discussed by Turk and Pentland is defined here. If there are M number of images as a training set of each face and they are represented by s-dimensional vector. Then the PCA is used to find a t-dimensional subspace whose basis vectors correspond to the maximum variance direction in the original space..PCA basis vectors are also known as Eigen vectors and the image is known as Eigen faces.

$$S_T = \sum_{i=1}^{M}(x_i - \mu).(x_i - \mu)^T \quad (1)$$

Where μ –mean of all images of training set, x_i –i^{th} image and its columns are concatenated in the vector [Prabhjot and Anjana].

2.4.2 Linear Discriminant Analysis: LDA is used to find the vector which best discriminate the class in the underlying space. For all samples there are two scatter matrix one is S_B i.e., between class scatter Matrix S_B and another is within class scatter matrix S_W are defined as follows-

$$S_B = \sum_{i=1}^{c} M_i(x_i - \mu).(x_i - \mu)^T \quad (2)$$

$$S_W = \sum_{i=1}^{c}\sum_{x_k \in X_i}(x_k - \mu_i).(x_k - \mu_i)^T \quad (3)$$

Here, M_i –number of training samples in class i, c-number of distinct classes, μ_i-mean vector of samples, x_i-set of samples of class i.S_B-scatter matrix of features around the overall mean for all face classes, S_W-scatter matrix of features around the mean of each face class. The aim is to maximize S_B while minimizing the S_W accordingly [Kaur et al.].

2.4.3 Gabor Wavelets: Gabor Wavelets are used to represent the face images. Different frequencies and orientations are required with the set of Gabor filters, to extract the face image.

Gabor filters are explained and defined in Chao as follows.

$$\varphi_{n(f,\theta,\gamma,\eta)}(x,y) = \frac{f^2}{\pi\gamma\eta} e^{(-(\alpha^2 x'^2 + \beta^2 y'^2))} e^{j2\pi f x'} \quad (4)$$

$$x' = x\cos\theta + y\sin\theta \quad (5)$$

$$y' = -x\sin\theta + y\cos\theta \quad (6)$$

Here, f-central frequency of the sinusoidal plane wave

θ-anticlockwise rotation of Gaussian and the plane wave

α-sharpness of the Gaussian along with the major axis parallel to the wave

β- Sharpness of the Gaussian along with the minor axis perpendicular to the wave

$\gamma = \frac{f}{\alpha}$ -Ratio between frequencies

$\eta = \frac{f}{\beta}$ -Ratio between sharpness

2.5.4 Discrete Cosine Transform: DCT is used for feature extraction in images. It will transform the image as a whole and extract the relevant features from the image. Mathematically, [Manikantan et al.] explained that it is a linear function and Fourier related transform. The 2D-DCT of an image size MxN:

$$F(u,v) = \alpha(u)\alpha(v)\sum_{x=0}^{N-1}\sum_{y=0}^{M-1}\cos\left[\frac{\pi u}{2N}(2x+1)\right]\cos\left[\frac{\pi u}{2M}(2y+1)\right]f(x,y) \quad (7)$$

$$\alpha(u)\alpha(v) = \begin{cases}\sqrt{\frac{1}{N}}\, for u,\ v \neq 0 \\ \sqrt{\frac{2}{N}}\, for u,\ v = 0\end{cases} \quad (8)$$

here f(x, y)- intensity of the pixel at coordinates (x, y), u varies from 0 to M-1, and v varies from 0 to N-1.

2.5.5 Active Appearance Models: AAM are used for face modeling. For modeling of the face, initially the fit the AAM to an input image i.e., model parameters are found to maximize the 'match' between the model instance and the input image. The model parameters are then used according to the application.

AAM is defined within the base mesh s_0.Now, S_o is a set of pixels x=(x, y) ^{T} that lie inside the base mesh s_o. An image A (x) is defined over the pixels $x \epsilon s_0$.Now, here, A(x) can be expressed as a base appearance $A_o(x)$ plus a linear combination of m appearance images $A_i(x)$-

$$A(x) = A_0(x) + \sum_{i=1}^{m}\lambda_i A_i(x)\ \forall x \in S_0 \quad (9)$$

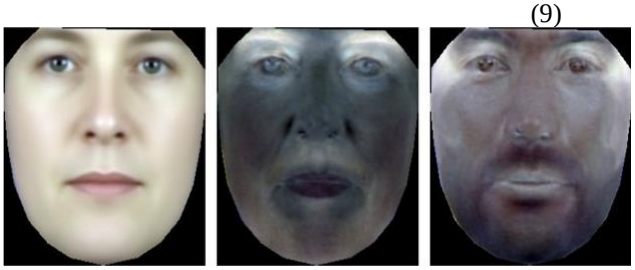


Fig 2.8: AAM Model Images

In the Fig 2.8 the linear appearance variation of an independent AAM is shown and is explained in [Matthews and Baker]. The model consists of a base appearance image A0 defined on the pixels inside the base mesh s0 plus a linear combination of m appearance images Ai also defined on the same set of pixels.

2.5.6 Self Organizing Maps: SOM is based on competitive learning. The difference is the units which are all interconnected in a grid. In this, the unit which is closest to the input vector is called as Best Matching Unit (BMU).

The SOM is represented by the following equation which is explained in [Kohonen et al.]-

$$Wv(t+1) = Wv(t) + \Theta(v,t)\alpha(t)(D(t) - Wv(t)) \quad (10)$$

Here-

Wv(t)-weight vector, α(t)-monotonically increasing learning coefficient, D(t)-the input vector, Θ(v,t)-neighborhood function.

This process is repeated for each input vector for a large number of cycle's λ.

Now, SDA (Semi supervised Discriminant Analysis) is the semi supervised adaptation of LDA. Independent Component Analysis (ICA) having the linear Map and it separates the non-Gaussian distributed features. Neural Network based methods are using PCA.

2.6 Feature Selection: Feature selection is the promising factor of finding the feature sets for the need of massive feature selection. The motivation towards the feature selection process is that, it is reasonable and important to ignore those input features which are less effective on the output, to keep the size approximately small, because the underlying function exists between the input and output and the number of inputs varies the output. Basically, the feature selection are the trade-offs between the high accuracy and small model size. Another motivation towards feature selection discussed in [Srivastava et al.] is to extract features and then select the features in the form of subset with less classification errors and this feature selection is based on the classification algorithm which is used to solve the problem. In practice, there are major problems evoked by the selection of irrelevant features in the learning process are-

- The irrelevant feature increases the computational cost. With more number of features the computational cost for predictions increase polynomial, especially in the case of large number of features.
- The irrelevant input features may also increase the over fitting problem.

The various feature selection algorithms are shown below in the given Fig 2.9-

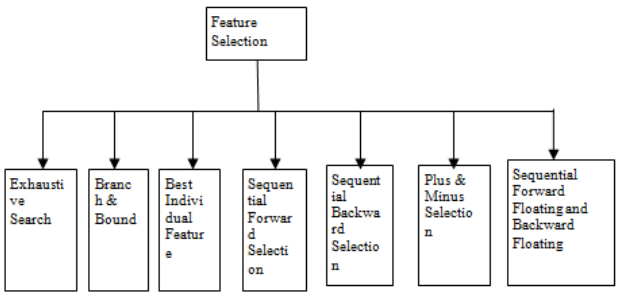


Fig 2.9: Methods of Feature Selection

2.6.1 Exhaustive Search: This method evaluate all possible subsets of Optimal solution of the problem , but it is too complex, because if the exhaustive search is going to be work then it will be highly constrained and that constraining must be done in an intelligent way. As it will explained and evaluate all possible subsets in [Liu et al]; so for a total of d variables and subset of size p, and T is the total possible subsets are-

$$T = \frac{d!}{(d-p)!p!} \quad (11)$$

2.6.2.Branch and Bound: In this method, if the calculated or evaluated value of the node is less then bound value and it is set as the criteria, then all the existing successor nodes are also have the criteria value is less than the bound value . It can be an optimal algorithm.

2.6.3Best Individual Features: This method will evaluate and select features individually from the existing features. It is very simple method but It is not effective method for feature selection. So, usually it is not used.

2.6.3.Sequential Forward Selection (SFS): This method evaluates the growing feature sets described by Yan and Chang. It will Start with the empty set, X=0;then repeatedly add the most significant feature with respect to X or one can say that it will select the best feature. The major disadvantage of this approach is that once a feature is retained, it cannot be discarded; It is a greedy algorithm so it cannot be retracted, that's why the nesting problem of the existing features also exists in sequential forward selection method.

2.6.4Sequential Backward Selection (SBS): This method works with the complete set of features i.e., X=Y .It will evaluate the shrinking features from the set of features. It will repeatedly delete the least significant feature in X, but once the feature is deleted then it can't be reevaluated. The disadvantage that exists in Sequential Backward Selection scheme is that it requires more computation than the Sequential Forward Selection approach. It is a greedy algorithm so it cannot be retracted, that's why the nesting problem of the existing features also occurs in this method as discussed by Zhao and Chellappa.

2.6.5.Plus and Minus Selection: In this method for choosing the values of plus and minus, sequential forward approach is first performed and then after backward approach is performed, so that plus features are added from forward selection and discard or minus the features with the backward selection. This method is used for decide optimal plus and Minus features. Subset nesting problem will also not exist in this method.

2.6.6. Sequential Forward Floating and Backward Floating: Sequential Forward Floating will work like a Plus and minus method. It will automatically pick the values and moves closer to the optimal solution and it will dynamic update the features. Actually ,it use the SFS method for selection of most significant feature and then find the least significant feature and continues to the finding of least significant feature .Then the best feature subset is found having a greater criterion value covered by Chan in 2010.

3.1. Proposed Methodology: The primary idea of this research is to utilize the best face detection methodology and improve the efficiency of the system. For this aim the local and global features are combined to make the feature vector. This section includes the main steps of face detection and feature extraction.

3.1.1 Block diagram: The necessary block diagram is given in the fig 3.1 shown below which shows the preprocessing step, feature extraction and all the steps which are used to perform during the processing. In this block diagram all the algorithms which are used for the processing are given and these algorithms are used according to the need of the application and also they are quite good for face detection and face recognition of our approach.

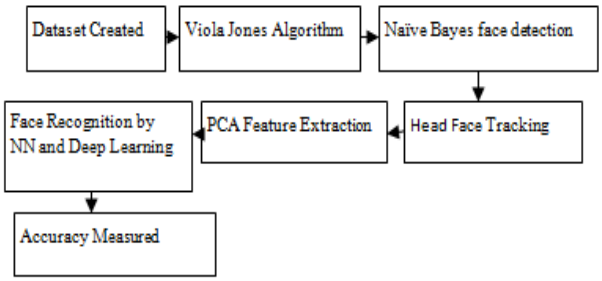


Fig.3.1Block diagram of Proposed Method

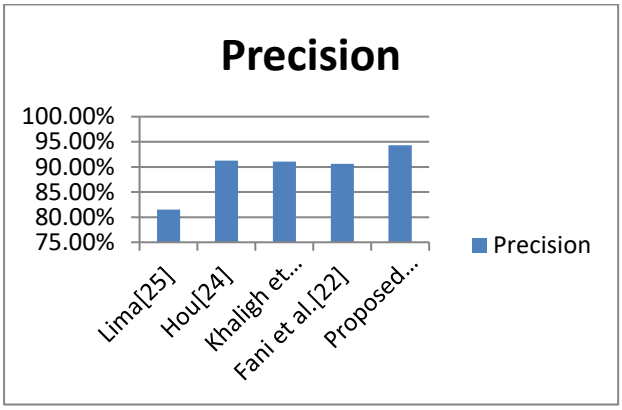
3.1.2 Algorithm: Initially all the algorithms of video surveillance and face detection and feature detection are studied thoroughly. After this instead of taking already available dataset the author has used the self-created database so that maximum complexities are taken and experimented properly. This section includes the step by step procedure of the research work.

1. For this purpose 1000 images are taken and 3 classes are made. Some images are taken for testing purpose from each class and some are taken for training purpose.
2. After creating the dataset the video surveillance algorithm is applied through which the face is detected.
3. Viola Jones algorithm is used to detect the face algorithm using naïve Bayes classifiers.
4. Face tracking is used with head face tracking method.
5. Then after PCA is used to Feature extraction.
6. For face recognition neural networks and deep learning is used.
7. When the system is trained then testing images are used to perform the output and check the efficiency of the system.
8. Now, the tested results are matched and number of parameters is tuned to improve the productivity of the system.
9. Now, the output is tested and its accuracy is calculated, it is also checked using confusion matrix and some other parameters.

3.1.4 Result Analysis: In this experiment the proposed approach is tested on the test sets. The results are based on accuracy and precision. The accuracy of the proposed model is 99.78%.The precision rate is 94.30%.The comparison table of precision is given in the table1.1.given below. And its related graph is also given here in graph 1.1.

Table 1.1Comparision Table of Precision Rate

Approach	Precision
Lima[25]	81.48%
Hou[24]	91.28%
Khaligh et al.[23]	91.07%
Fani et al.[22]	90.60%
Proposed Approach	94.30%



Graph1.1. Comparison graph of Precision Rate

Conclusion:

In this paper, many ordinarily ways employed in face recognition has been suggested, and compared. How to explore new and innovative ways that supported the prevailing ways is value operating within the future for additional analysis. This proposed model did not need to find the features manually and its development is quite fast and fine tune features are to be more appropriate to use. This literature analysis showed ceaselessly increasing interest within the field of face recognition. All these analyses can provides a right direction to the man of science in future to resolve the unsolved challenges.

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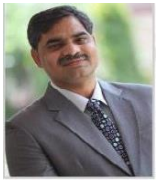

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