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Performance Analysis of Novel Face Tracking and Recognition Framework

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Abstract: *The novel face tracking and recognition framework which consists of pre-processing, face descriptor extraction, features extraction and selection, and classification proposed in this paper. The input face image used to track the face and crop the detected face using the Viola–Jones (VJ) method, then applied the Gaussian filtering to smooth the cropped face image. To address the various challenges related to illumination conditions, noise conditions and expression variations, then designed the novel face descriptor method called Tracked Directional Ternary Pattern (TDTP). In TDTP, the tracked local face image is divided into different 8 directions compass masks using the Kirsch template and ternary examples to remarkably speaking to the input confront picture. The TDTP approach defeats the challenges of all previous face descriptors in face recognition. In third phase, after the TDTP code generation, using the TDTP code the feature vector formed. The proposed TDTP based features extraction from the ternary face code technique delivers the finer grain description of facial motions to improve the facial expression performance under various illumination conditions and unconstrained environment. The proposed face tracking and recognition framework is evaluated under different real time facial datasets available publically.*

Keywords: *face recognition, face descriptor, low resolution, features extraction, classification, face detection.*

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I. Introduction

Researcher from the computer observation patterns recognition, image analysis processing, machine learning and different locales are working consolidate, propelled broadly the quantity of conceivable practical applications. On the other hand, the face researcher or analysis is the key for issue descriptor of the face appearance. Case of extracting it from face is the efficiency of descriptor based on their representations. A good descriptor classes (the same person or different situations in the expression) within little or no variation but a higher variance (different individuals or expression), should be between classes [1]. Extract facial feature have the two common approaches as appearance based techniques and geometric feature based. The size and places various facial parts that speaks to an element vector of a face are combined in the East encode [2]. These are instances of graph based method which create a face presentation and use it to process many faces component. In summation, in local global graph algorithms, Voronoi tessellation uses an interesting technique and local feature section graphs and recognition of faces and expressions creates a Delaunay graph. These features are mixed and local graph algorithm generates the skeleton (global graph) to present local face topology graph by interrelating. In summation, facial feature are largely recognized in expression, pioneer of Ekman's work and specify six general emotions expression face fighting Friesen coding system, is known as produced a system for classifying and coding system to this emotional face action was later simplified as is used [3].

Basically, geometric features based methods are precise and reliable to facial features reorganization and tracking the many cases is complex to adjust. The appearance based method face image strainer, or overall features, or change the appearance in some specific face-to-face to remove local image features, making use, to make the field. Appearance-based methods performance is excellent in controlled environments, but environmental variation their performance degrades. Recently proposed some other methods, but again there are such methods to improve accuracy of the scope. Therefore, between past two decade, face and facial expression recognition has analysed the interest of significant in scientific group it play the vital position in human cantered interface. Number of application such as video conferencing, virtual reality user profiling and customer satisfaction analysis, broadcast, web service to obtain desired result for efficient face along with facial expression recognition is required. Therefore, the given application techniques on the facial expression recognition's influence is growing steadily. Several research efforts in relation to facial expression have been recognized [4]. Facial expressions test fewer than six general facial expression is hatred, anger, happiness, fear, sadness and surprise as the set of defined by psychologists. In order to make identification of the task more

standardized facial action each facial expression as the production unit (FAUs) a group of known muscle movement, this is the forming so called facial action coding system that was generated. These ordering protocols FAUs facial expression to make a responsible is added [5]. All these factors become a motivating toward this proposed new frameworks face its emotion for all previous techniques. In this research work, we aim to design novel face descriptor technique for continuous face detection and recognition over the different types of research datasets so as to deliver the difficulties identified with the posture varieties, expression variations, illumination conditions variations etc.

II. Related Works

In this section, we discuss the recent face and expression recognition methods reported.

In [6], author proposed the sparse representation (or coding) - based game plan (SRC) has extended amazing achievement in face acknowledgment generally. In any case, SRC underscores the insufficiency excessively and expels the relationship information which has been seemed, by all accounts, to be fundamental in genuine face acknowledgment issues. They presented the versatile sparse representation-based game plan (ASRC) in which lack and connections are as one considered.

In [7] author proposed the transferable representation learning model overhaul the face recognition execution. The strategy yields an assembled increase in the highlights and shows a sensible way to highlight and sharing discriminate presentations and scales.

In [8], the researcher shows a novel fragment extraction system named as local patterns of gradients (LPOG) for strong face acknowledgment. LPOG utilizes square wised indirect local parallel patterns (BELBP), a refined assortment of ELBP, and local stage quantization (LPQ) supervisors coordinate on slope pictures for getting neighbourhood surface patterns to develop a section vector of a face picture.

In [9], researcher outlined a compact binary face descriptor (CBFD) feature the learning method for face portrayal and acknowledgment. Given each face picture, they first think pixel contrast vectors (PDVs) in adjacent fixes by enrolling the qualification between every pixel and its neighbouring pixels. All things considered, creator assembled and pooled these binary codes into a histogram consolidate as the last portrayal for each face picture. Also, they composed a coupled CBFD (C-CBFD) framework by reducing the methodology hole of heterogeneous faces at the segment level to make our strategy associated to heterogeneous face acknowledgment.

In [10], creator depicts the strategy which named Discriminate Analysis on the Riemannian complex of Gaussian appropriations (DARG) to evade the issues of face following an acknowledgment with image datasets.

In [11], the creator builds up the lively descriptor-based subspace learning with complex information is a working subject in plan examination and machine knowledge. Several investigates concentrate the perfect arrangement on feature portrayal and metric learning. Nonetheless, generally used features of single-type, e.g., image gradient orientations (IGOs), are missing to portray the entire varieties in fiery and discriminate subspace learning.

In [12], Unlike existing MSE (Mean Square Error)-based Representation based Classifiers, their structure depends on the base blunder entropy premise, which isn't subject to the error conveyance and appeared to be more vigorous to the commotion.

In [13], the ongoing work detailed for the face acknowledgment in which creator planned the weight spatial areas dependent on their discriminative points of confinement in scanty coding. Specifically, they take in the weights at face areas as exhibited by the data entropy in each face locale, with the end goal to feature areas in face images that are essential for grouping. Moreover, with the end goal to make solid weights to thoroughly manhandle structure data of each face locale, they utilized outer information to take in the weights, which can cover all conceivable face image varieties of various people, so the vitality of acquired weights can be guaranteed. Finally, they consider the get-together structure of preparing images (i.e. those from a relative subject) and consolidated an ℓ 2, 1-standard (add up to Lasso) fundamental upon the definition, which supporting the insufficiency at the get-together level.

In [14], another approach for face representation was proposed to address the face recognition problems under the uncontrolled environment based on transferable representation learning technique. They modelled bio inspired face representation as approximately stable and structured characterization correspondence among various domains in order to greatly exploit source domain discriminate information.

Thus in [15], researcher revealed the face portrayal technique called superposed direct portrayal classifier all together ease the face acknowledgment issue through the face image portrayal in type of class Centroid superposition and concentrate the distinction among various classes.

In [16], the author designed method uses the Kirsch template for the local directions and LDN code generation from the face image. After that they have designed single and multi level LDN histogram features extraction method.

In [17], the endeavour made towards taking care of the issue of uncontrolled face acknowledgment. Creator proposed the 3D face acknowledgment strategy dependent on three local descriptors, local phase quantization (LPQ), Three-Patch Local Binary Patterns (TPLBP) and Four-Patch Local Binary Patterns (TPLBP). The input face image is passed through either of the descriptors. The histogram features extracted for the classification purpose. However, the challenge is still remains same for low-resolution face images recognition and face tracking.

In [18], author used the local ternary pattern for the face recognition. The concept of ternary pattern we adopted in our work while generating the TDTP 8 bit code. The TDTP is composite of LDN and LTP methods.

III. Methodology

We studied the different methods designed for the robust facial expression and face recognition; however most of the techniques perform poor under the non-monotonic light variety, irregular clamor, and changes in posture, age, and articulation conditions. Therefore designing efficient facial expression recognition method is main research problem in this work.. The face representation performed by many face descriptors in literature such as LBP, LPQ, LDP, LDN, HOG, and LTP. Further the techniques based on edge based local features and histogram representations proven successful in many recent facial expression recognition systems. However, using such edge based methods with histogram representation suffered from the problems of poor classification results. The face expression recognition under the unconstrained environment also leads to poor classification results.

The proposed method is different and specially designed to improve the overall efficiency for face recognition by considering all the conditions of face image through optimized 8 directional compass mask representations. To handle the conditions like illuminations, sunglasses, low-resolution, occlusions, we initially applied the Gaussian filtering and then represented the face image through the directional patterns. This analysis proposed work extended approach for the face and outward appearances acknowledgment dependent on the TDTP approach. The TDTP approach mainly designed to track the face image and then generate the ternary pattern for the robust recognition of input face and its expressions. The TDTP effectively address the challenges related to pose, expressions, illumination variations in input face image. From the outcome of TDTP code, we further applied the different types of feature extractions to extract the all sorts of unique characteristics that help to optimize the recognition rate performance. Finally we designed PCA based ANN classifier to perform the classification. Below summarized contributions of this research work:

1. **Preprocessing**: The raw face image is captured first, and then we connected the VJ technique for face discovery. After the face discovery, cropping is performed on detected part. This helps to get the more relevant and unique features for the face recognition. The cropped face is further smoothed by Gaussian filtering.
2. **TDTP Code Generation**: The face descriptor method called TDTP. The TDTP approach mainly designed to track the face image and then generate the ternary pattern for the robust recognition of input face and its expressions. The TDTP effectively address the challenges related to pose, expressions, illumination variations in input face image.
3. Features Extraction: Using the outcome of TDTP code, we compute the different types of features and combine them for the recognition process.
4. **PANN**: We applied the PCA with ANN for the classification purpose as well as methods evaluation.
In algorithm 1, the input image is captured for the face recognition or expression recognition tasks. We exploited the simple Gaussian filtering and median filtering methods to smooth the face image in algorithm 1. The input face image I passed to Pre-processing function and output return is improved image IP. After that we applied the VJ algorithm for face tracking and then tracked face area is cropped and resized to 128x128 sizes.

Algorithm 1: Pre-processing (I)

Inputs:
I = Face image,
$\alpha = 0.25$, default alpha value
$\mu = [3\ 3]$, Kernel size
Output:
Cropped Image F

1. Browse I
2. Greyscale Conversion
3. Apply Gaussian filter
   P_1 = filter ('Gaussian, α),
4. Apply Average filter
   P_2= filter ('average', μ)
5. Estimate the difference of two filters

	IP = P_1-P_2
6.	detect = VJ (IP)
7.	face = crop (IP, detect)
8.	F = resize (face, [128 128])
9.	Return (F)

The TDTP is 8 bit code doled out to every pixel of an information face image. In appearance acknowledgment, the state of the facial highlights that change as indicated by looks is more persuasive than entire face surfaces utilized in face acknowledgment, and the limits of the facial highlights have high edge sizes. Along these lines, we receive Kirsch compass veils as an edge administrator to ascertain edge reactions effectively, and take two principle bearings at every pixel to speak to local edge shapes. After the TDTP code extraction, we extracted the different features extraction methods and construct the fused features vector. Discrete Wavelet Transform (DWT) features, Histogram Features etc. Addition to these features, we proposed the Discrete Cosine Transform (DCT) based features extraction technique to solve the challenges caused by the low quality and low resolution facial images. Algorithm 2 shows the Modified DCT (MDCT) features extraction technique.

Algorithm 2: MDCT Feature Extraction

Input:
I: TDTP code
Output:
Q: Extracted Features

1.	Apply sliding blocking approach on me with different block size such as 4, 5, and 6.
2.	Compute the total number of blocks for each block size 4
3.	Extract each block and apply DCT in order to extract 3*3 features (9-features) from each block
4.	Perform this in for loop and store the each block 9 features in Q4 vector
5.	Compute the total number of blocks for each block size 5
6.	Extract each block and apply DCT in order to extract 3*3 features (9-features) from each block
7.	Perform this in for loop and store the each block 9 features in Q5 vector
8.	Compute the total number of blocks for each block size 6
9.	Extract each block and apply DCT in order to extract 3*3 features (9-features) from each block
10.	Perform this in for loop and store the each block 9 features in Q6 vector
11.	Finally save the Q4, Q5 and Q6 for next module processing
12.	Return Q = [Q4, Q5, Q6]

All extracted features are fused and form the final feature vector of size 42 features is constructed by combining the TH (TDTP Histogram), MTH (Multi TDTP Histogram), DWT, MDCT, GLCM features for face recognition and facial expression recognition. Face recognition is done by using dissimilarity based distance measurement metrics. And classification evaluations are done by PANN method. The outcomes are discussed in next section.

IV. Results And Discussions

The performance evaluation is done using the MATLAB tool and publically available four research datasets such as LWF [19], CK [20], CAS [21], and JAFEE [22]. The proposed face descriptor TDTP is evaluated with two recent face descriptors LDN [16] and TPLBP [17]. The performance parameters used for the comparative study are recognition rate (accuracy), precision rate, recall rate.

Figure 1 is showing the graph for accuracy evaluation using four datasets. As showing in figure, the accuracy of state-of-art techniques like TPLBP, LDN is less compared to the all variants evaluated using the TDTP method. The TDTP using the PCA for the features selection/reduction delivers the best recognition rate compared to non-PCA method as unwanted features reduction using PCA. PCA helps to generate the maximum difference among the different classes of training, therefore the performance improvement in proposed method. As the JAFEE research dataset having the significant variations in pose and expressions, it suffered from the poor face recognition rate.

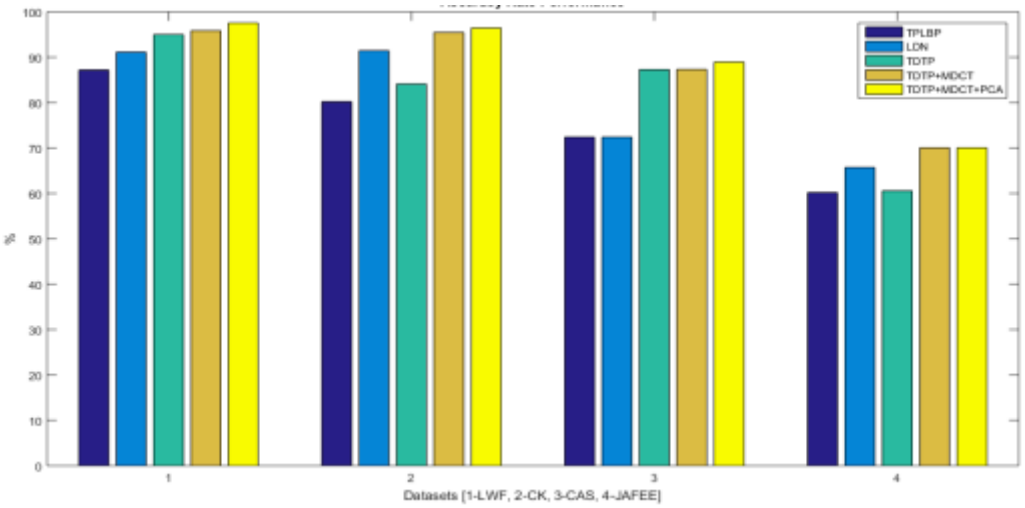

Figure 1: Face Recognition Accuracy evaluations

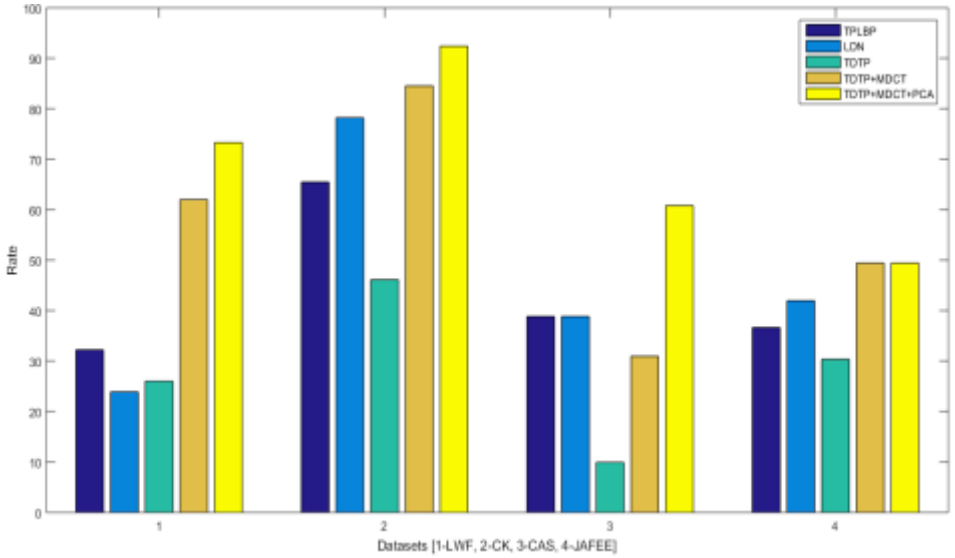

Figure 2: Face recognition based precision rate evaluation

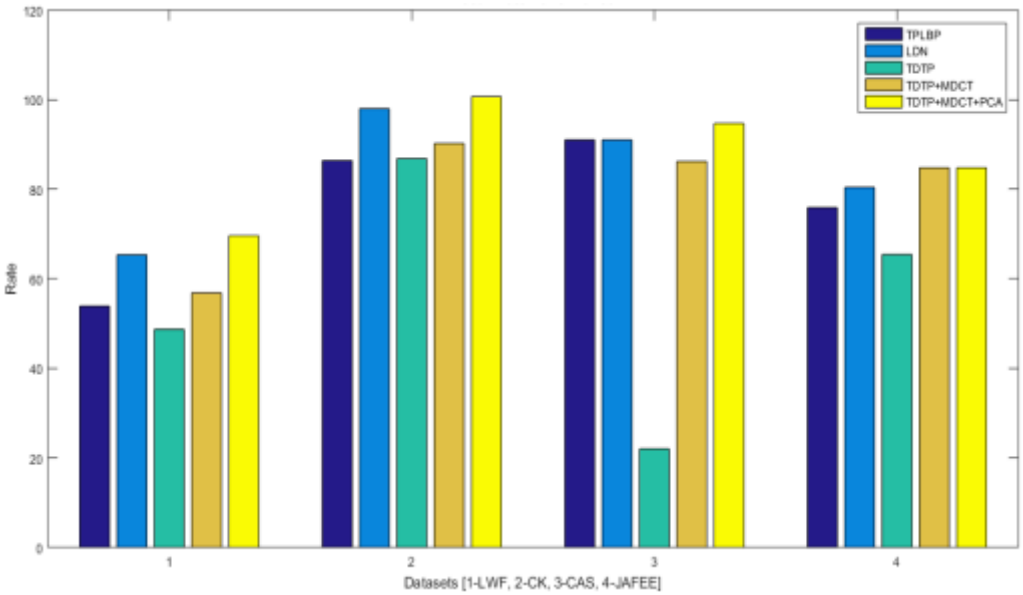

Figure 3: Face recognition based recall rate evaluation

As observed in figure 2 and 3, the precision and recall rate performances are showing results for datasets LFW and JAFEE opposite to accuracy performance. The both precision and recall rates are less for using LWF dataset as compared to other datasets. The proposed method TDTP+MDCT+PCA shows the highest precision and recall rate performance. In table 1, we presented the face recognition accuracy evaluations. As observed the TDTP individually outperforms the TPLBP and LDN. The TBLBP, LDN, and TDTP works using the histogram features. Further we shown that how using the MDCT features extraction with TDTP can helps to enhance the recognition rate, MDCT extracts the very unique and deep features from the input face image. Finally inclusion of PCA for features reduction proves the advantageous.

Table 1: Face recognition Rate comparative study

	LFW	CK	CAS	JAFEE	Average
TPLBP [17]	88.16	80.39	70.39	59.9	74.71
LDN [16]	91.5	91.67	72.5	66.13	80.45
TDTP	94.9	84.42	87.92	60.4	81.91
TDTP+MDCT	95.83	95.87	88.25	70.14	87.52
TDTP+MDCT+PCA	97.6	95.9	90	73.34	89.21

In table 4.2 we present the accuracy performance analysis compared to recent face acknowledgment strategies. As appearing in the table, the consequence of proposed method is compared against the all recent techniques. The datasets included in our practical work are composed of different illumination conditions, expressions, clean pose, and occlusions conditions. By considering this, the results of the proposed technique are exceptionally noteworthy and enhanced when contrasted with all recent face recognition methods.

Table 2: Evaluations of Face Recognition Methods

Reference	Year & Dataset	Max Accuracy (%)
[23]	2015 (AR-illumination)	89.53
[24]	2016 (AR)	90.4 %
[25]	2016 (YaleB)	82.61
[26]	2017 (LFW)	94.3
[27]	2017 (FRGC 2.0)	95.2 %
Proposed	**LFW**	**97.6 %**

V. Conclusion and Future Work

First assessed some prominent techniques on face acknowledgment of its techniques, feature extraction techniques, and datasets are used in research. Then introduced the novel tracking and recognition framework which is generalized supports both constrained and unconstrained facial datasets. We presented this framework for face and facial expression recognition. The complete design and algorithms presented effectively in this research. The experimental analysis is performed using the four different facial datasets to justify the scalability of proposed method. We mainly contributed with tracked face descriptor method called TDTP method to address the challenges of variations in pose, illuminations and expressions by preserving the edge properties efficiently. Further, to strengthen the features extraction, we proposed the modified block based DCT technique as well. The classification is performed by PCA based ANN framework. The simulation results outperform the existing face descriptors in both face and facial expressions recognition.

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