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3DMM Fitting for 3D Face Reconstruction

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Abstract: Most facial recognition techniques are self-contained on a three-dimensional model to ensure the challenge posed by facial expressions that are variable depending on the situation. In this research we aim to provide the latest SDK package which is used to identify faces with attention to flipping because the face changes its expressions and using the technique of 3D-expandable Model 3DMM we can introduce facial changes, 3DMM also enables us to isolate identity variations from those resulting from changes in facial expressions. We face two problems that need to be addressed: accurate measurement of the parameters of the situation and computational efficiency. When the verification is performed with the adjustment, a new face view is created where the situation is corrected and the expression is disabled to define the expression we provide two methods for it. The first depends on the prior knowledge to illustrate the neutral expression image of the input image. While the second method is based on the idea of verification on the transfer of expression of the exposed face to the probe. Experiments using neutral and equivalent view with the FR SDK commercial standard are demonstrated on two-face databases, PIE and AR, thus, demonstrating a significant improvement in the experimental SDK's performance in terms of expression.

Key words: SDK package, flipping, 3DMM, identity, facial expressions, significant

INTRODUCTION

In order to analyze the facial image, we must have all the features of the face which is important information in the analysis. Therefore, most existing face recognition techniques rely on the three-dimensional model to guarantee nature by normalizing or simulating changes in facial expressions. The latest assessment of facial recognition algorithms, formed by NIST from 2010 (Grother *et al*., 2010) also showed (MBE) that we can obtain a very high resolution of the image of the front face of any person at a rate achieved above 95% and false alarm rate 0.1%, However, when one image of a person is inadvertently compared, the verification rate drops to 20%. The (NIST MBGC) report in 2009 (NIST., 2009) also states that "cross-matching is still very difficult". These assessments do not record results when there is a change in the expression of placements. Thus, the independent evaluation of facial recognition programs under the differences of systematic expression does not exist, despite all this, the strong recognition of the faces, took a lot of interest in academic science (Drira *et al*., 2013; Gass *et al*., 2011; Li *et al*., 2011; Tan *et al*., 2005, 2009; Wei and Li, 2013; Yang *et al*., 2011). This is due to the database of faces available with the difference in regular expressions as in the (AR) dataset (Martinez and Benavente, 1998), PIE (Sim *et al*., 2002) and Multi-PIE (Gross *et al*., 2010). All this leads us to extend research interest to an unrestricted environment. Compared to traditional 2D techniques (Zhou *et al*., 2003; Wu and Trivedi, 2008; Liu *et al*., 2009). We note that three-dimensional methods are responsible for variations in formation that show complete hegemony through the use of comprehensive facial information (Bowyer *et al*., 2006; Bronstein *et al*., 2005). The high cost of acquiring 3D environments and the recording and calculation process should be made difficult to use widely in face recognition systems. Looking at two-dimensional and three-dimensional techniques we find that they have an attractive value in facial recognition. Our main motivation is to combine both 2D and 3D methods while avoiding their flaws, for example, monograms of 3D data in the exhibition with 2D images of the probe. This technique is based on the idea of applying three-dimensional models to two-dimensional image analysis. There is no requirement (obtaining 3D data at the verification stage) which greatly reduces the cost of computing.

To deal with this idea, an effort has been made by some researchers Blanz and Vetter (2003) have built a statistical model based on the training data and are highly compatible with the images taken to match but generally require a long convergence process Riccio and Dugelay (2007). It has established the compatibility of the face of the three-dimensional exhibition and the two-dimensional probe, using geometric variables on the

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face, (Toderici *et al*., 2010). The two worlds confirmed that the facial images were settled in different and multifaceted situations, although, some of the predefined key features (eye angles and nose edges) on facial images in different situations will be aligned to a three-dimensional frontal model for matching. Zhang *et al*. (2012) proposed is the owner of the asymmetric idea (3D-2D) FR approach. (2D-2D) by combining two-dimensional images from three-dimensional models in the same direction (probe samples). We note here that there is a pre-treated pipeline that performs the normalization function of lighting and corrects a correction. OGMs (Oriented Gradient Maps) (Huang *et al*., 2012) based simulated face.

In this study we are particularly interested in adopting an effective and independent face recognition approach at the same time. Here, we deal with the highly accurate reconstitution of the dose by providing a stepwise processing with clearly improved computational efficiency. The experiments conducted on the UHDB data set show us the accuracy of this technique and its superiority over prevailing techniques.

Literature review: This study includes many methods used to identify the three-dimensional faces that I have studied and rely on in building the idea of this research Bronstein *et al*. (2005). This researcher attempted to link the use of changes in the Euclidean spaces with the surface distances between the corresponding points on the surface of the canonical faces as properties used. Which are used to treat the open mouth where they discover and remove the lip area first and then calculate the distance of the surface through the presence of a hole compatible with the removed part. This action stimulates the assumption that surface distances are maintained for the many expressions that occur in the face of the researchers, through which it determines the features based on distance to identify the face.

Blanz and Vetter (2003) have built a statistical model based on the training data and are highly compatible with the images taken to match but generally require a long convergence process.

Samir *et al*. (2009) in his technique (the curves of the level of the function of surface distance), he used it as a facial recognition feature. Since, the mouth is open, it will affect the shape of certain curve levels. This is why the technique is unable to address the problem of data lost due to changes situation or differences. Faltemier *et al*. (2008) the researcher employed 38 facial areas to cover face density and scores of decisions and results, after applying the (ICP) program to each area.

Riccio and Dugelay (2007), it has established the compatibility of the face of the three-dimensional exhibition and the two-dimensional probe, using geometric variables on the face.

Toderici *et al*. (2010), the two worlds confirmed that the facial images were settled in different and multifaceted situations, although, some of the predefined key features (eye angles and nose edges) on facial images in different situations will be aligned to a three-dimensional frontal model for matching. Zhang *et al*. (2012) proposed is the owner of the asymmetric idea (3D-2D) FR ap-proach. (2D-2D) by combining two-dimensional images from three-dimensional models in the same direction (probe samples).

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Gordon (1992) said more than once that the bending descriptors have the ability to give higher accuracy in the description of surface features and that they are more appropriate by using them in describing properties of faces in the areas of the chin, forehead and cheeks as well as are considered fixed on viewing angles.

MATERIALS AND METHODS

Contains a frame 3D face reconstruction based on expression and pose variations in three basic stages because there is no constant standard of expression and pose variants where we first conduct the detection

Pose adaptive (3DMM) fitting, second we do on provide two methods for selecting expressions, the first depends on the average expression taken from the neutral images while the second works to provide images closer to the gallery, third we evaluate the experience which demonstrates the robustness of the experiment in introducing changes and expression changes through the use of two data generators, AR (Martinez and Benavente, 1998) and Multie-PIE (Gross *et al*., 2010).

Pose adaptive (3DMM) fitting: In this study of our experience we will introduce 3D Morphable model 3DMM and then describe the technique of 3DMM fitting.

3D face Morphable Model: Morphable 3D technology is the most successful way to represent human face space, thanks to its learning from 3D scanning as suggested by Blanz and Vetter (2003). Here, the 3DMM Model can determine the shape of the digestive face to a large extent, the recent back-model Chu *et al*. (2014).

He created his technique which is based on the (3DMM) Model which contains expressions as neutral face offsets. The (3DMM) Model is proposed to approximate any single face by using linear integration for limited situations. It should be noted that thanks to the third dimension, (3DMM) is more accurate in relation to the 2D level, so, it can handle the changes of cochlea even outside the plane, for example, Deviation or rotation deviation while looking at the face image input in 2D, so, the 3DMM installation technique estimates the coefficients of deformation of the shape and in the same context case and configuration calculations at that moment, a new view of the 2D face image can be created and the situation is corrected, so that, we can call the standard (FR SDK) procedure and have the ability to handle the situation changes. First, the procedure which is calculated on neutral Si tests, gives a vandalized identity model to be the main focus of the substitutions through the aid matrix, thus, requiring the generation of a new neutral object. This occurs by changing the coefficient of the aid:$(n_{id}$-1)x1. The second (PCA) Models show us the resulting out-of-the-box PCA and the (PCA) is applied to the discrepancies between neutral scanning and expressive scans $\Delta S_{i,e} = S_{i,e}-S_{i,0}$, for e = 1, ... , 6. The axis of distortions is expressed as a result of expression in (A_{exp}). Thus, we can generate distortions of the face through expressions. This is done by changing the vector of expression coefficients $(\propto_{exp})$:-$(6n_{id}$-1)x1:

$$S = \bar{S}+A_{id}\alpha_{id} \quad (1)$$

where, the $(\Delta_{exp} = A_{exp}\propto_{exp})$ three-dimensional face is S which represents the average shape and aid is based on it as the main axes trained to perform three-dimensional scanning of the faces with neutral transparency. A_{exp} represents the axons (principle) that are trained on the offset between the neutral scan and the expressive scans while the weight represents the shape representing the weight of expression in this technique we combine two famous face models with non-rigid ICP (Amberg *et al*., 2007). It is used to build (3DMM) and comes in the form of aid identity of BFM (Paysan *et al*., 2009) technology face. While the (A_{exp}) expression is from the warehouse face (Cao *et al*., 2014) in order to get a suitable (3DMM) to the face image, we do the following to get the appropriate aspect by displaying the face model at the image level taking into consideration the weakness of the projection perspective.

Here, we add a variable $(\Delta_{exp} = A_{exp}\propto_{exp})$ to Eq. 1 and this enables us to generate any face within this application with the differences of expression and identity, thus, the equation becomes as follows:

$$S = \bar{S}+A_{id}\alpha_{id}+A_{exp}\ \alpha_{id} \quad (2)$$

Fitting the model morphable for 2D face image: This procedure can be applied to the decision of Matthews in Gross *et al*. (2010) to apply a three-dimensional model to a two-dimensional model, working at the expense of strict model coefficients to reduce the distance between the three-dimensional face projection and the two-dimensional image. Here, the process is done by preparing the process by using the texture information for the image of the input face which is in 2D format, for example, ... , feature points, contour (as de- fined in the mpeg4 norm (Ostermann, 1998) and the silhouette, then Levenberg-Marquardt method is used to solve the problem of the minimization, given a two-dimensional image, the fitting calculates the different form parameters, identity parameters can be represented by $(\propto_{id}\in R_{n\bar{id}}1)$ (While parameters expression is represented by $(\propto_{exp}\in R_{nexp}$-1) and also parameters pose is represented by $(\propto_{pose}\in R^6)$.

Synthesizing a novel view: The technique in this study is based on the formation of a new presentation with the neutral expression during the predefined identification period (so that, the depth information for the whole image is estimated). This helps to correct the expression and the situation easily. This is done by creating a new neutral display which is considered as input to the input using the changeable model. For a two-dimensional face image, the collection is assembled to display the novel using the frame shown in the Fig. 1. In order to do foresight, we follow Blanz and Vetter (2003) in which the knowledge of the possible model of the two-dimensional formation (the map of the fabric the parameters of the antennae-expressed in length) was extracted and this is implemented with parameters in a new position. In this research, it should be noted here that we are taking advantage of the previously extensible three-dimensional model by its ability to isolate identity variations from those resulting from expression changes, After that, the (3DMM) procedure leads us to a set of change parameters in addition to the parameters in the (3DMM) standard which is then formed. The presentation can then be performed by changing the expression coefficients and the modulation parameters used to create a frontal and neutral face display.

Here, we will present two ways to select coefficients expression for neutral facial image synthesizing. The first technique is based on an average expression extracted from the neutral images and then a second procedure is proposed which presents a picture with an expression closer to the exhibition here. This method depends on the mechanism of expression transfer (the expression calculated on the image of the exhibition is transferred to the image of the probe).

Neutral expression technique: Here, in this part of the first technique (3DMM) can generate any individual face in any expression. So that, a neutral neutral expression can be used by presenting all faces with the same neutral

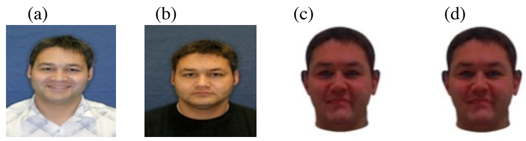

Fig. 1: Use CMU MultiPIE database for expression neutralizations where: a) Gallery image; b) Resulted neutralization expression; c) Resulted the transfer and d) Expression from gallery to probe

expression mechanism. This neutral expression should be determined on a neutral image training group (N). Here, it should be noted that (3DMM) has been fitted on the neutral design of the training kit. We can also calculate expression coefficients $\propto^{i}_{exp}$, through this procedure these images can be extracted in this technique, mean expression neutral coefficients are calculated as the mean of all expression coefficients in the neutral training group:

$$\alpha_{exp} - \text{neutral} = \frac{1}{N}\sum_{i=1}^{N}\alpha^{i}_{exp}$$

These transactions give us the possibility of generating a new vision of the image of the probe which includes a neutral expression. In this technique 3DMM has been fitted, so that, you can insert a 2D face to calculate the (coefficients identity, pose parameters and the expression coefficients), Next, a new neutral a novel view is created by using the same identity coefficients but this is done with neutral mean coefficients and images of insertion as a tissue map as shown in Fig. 2. Using this procedure, the image of each face is determined in the same manner as neutral expression. Here, in this procedure each image is handled separately. This procedure is used during the implementation period.

In this procedure we face an important problem which represents the main flaw in this technique which is (the method of separation of identity and expression may be inaccurate), in this procedure, facial deformities related to expression can be assigned to the identity part or vice versa as Fig. 3.

Verification context from expression: The procedure in this technique is based on the idea of verifying (is I the invited person) in the same context and here must be available both the display stands and the probe during the period of conformity, If the two faces are assumed to have the same identity, the difference in appearance here is in the same situation and lighting conditions, due mainly to the change in facial expression. Based on this hypothesis, 3DMM can be simultaneously installed on

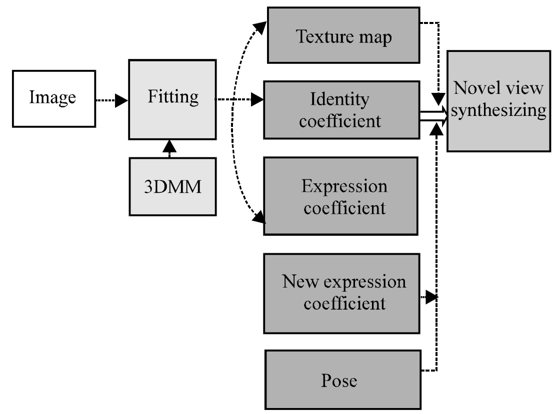

Fig. 2: Synthesis for a new vision

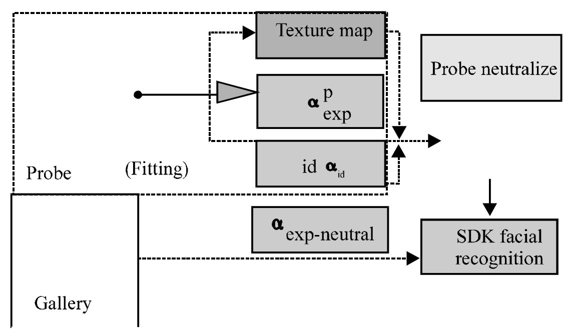

Fig. 3: Expressions neutralization map

the image of the exhibition and the image of the probe using the same set of identity parameters as well as two different sets of coefficients expression. Specifically, the SIP image is used as a texture map by placing a unique set of coefficients identity on two images of two sets of expression parameters (one for each-image), Fig. 2 shows this, the view the novel procedure can then be performed by using the coefficients identity, the coefficients expression extracted from the exhibition image as well as the resulting map of the probe.

The main key points of this method are prominent and are represented in this simultaneous coefficients identity and the transfer of the expression of the exhibition to the probe. It should be noted that thanks to this synchronization, facial distortions are well separated between expression and identity. In addition, when compared with the previous neutral expression method, the expression will generate a new (novel view), For the probe through the expression closest to the image gallery, the simultaneous 3DMM fitting goes into the probe and faces galley, here is an expression transfer that can be calculated offline. This leads us but verification is the most appropriate application procedure for this method.

RESULTS AND DISCUSSION

Robustness of the experiment: In order to demonstrate the effectiveness and robustness of our experience, the changes in expression and the introduction of changes through the use of commonly used face databases AR (Martinez and Benavente, 1998) and namely multie-PIE (Gross *et al*., 2010). In such experiments, the method of using mug images as reference will be followed while images with differences in expression, pose and illumination as probe and the results are shown in the most precise to identify the first rank and this is the Table 1 and 2.

As we mentioned previously, the fitting of the three-dimensional extended and scalable model through the use of fabric information and to test the effectiveness and robustness of the approach in our study is done by taking the images manually described in the initialization step. This is necessary to exclude potential disruptions, accurate.

Scenario evaluations: The evaluation scenario is intended to predict performance through test results which we evaluate our work is the use of (FR FRK). Where different pre-processing configurations are selected. This is done first: using the SDK before pre-processing; Second: processing each image through the use of a neutral medium expression and the last procedure: Evaluating the expression transfer procedure. It should be noted that for each query, the face of the exhibition is turned to the probe for the (matching) and (non-matching) pairs, the evaluation here is done by following the following:

Database (CMU-Multi PIE): The CMU Multi-PIE (Gross *et al*., 2010) database contains more than (750,000) images with variations in status, pressure and brightness for (338) people. So that, each subject depicts different facial expressions (such as his smile, disgust, shouting, surprise, about) 16 images under 19 illuminations.

Evaluating the expression, we using it as a reference, neutral faces are used in the experiment with a front image and ambient light. To evaluate our research in this study, we use the database and use four individual groups, this is due to the idea followed in (Yang *et al*., 2011). So that, each individual group is associated with a particular expression (smile in session 1, sadness and fear in session 2, then smile at session 3). This interacts with the foreground situation and the conditions illumination different {2, 7, 13} in the experiment to obtain a more recognition challenging, Table 1 shows the recognition rates for each subset and we can see that, it is an improved neutral expression method that improves the accuracy of the general recognition of the (FR SDK). This occurs, especially with subgroups with strong distortions of expression (Smile S3, Surprise S2). In the other two subcategories, this technique reduces this procedure slightly with (FR FRK) performance. In (Squint S2), closed eyes are associated with the main deformities of the wave. It is difficult to see the effect of the appropriate algorithm on these distortions in the expression part (closed eyes) or on the part of identity (epic fold). When we look at the table we see that, it is the last row, the results are presented by the use of expression transfer and this technique increases the efficiency of the (FR FRK) identification rate in all four trials. It should be noted that during the experiment we have the problem of installation of more restrictions, due to the simultaneous installation of (3DMM) of the image of the probe and exhibition images and thus, can be followed a better separation between (expression and identity), this is an indication of the superior superiority of the technique of expression transfer to other techniques in terms of expression changes and the last column of the table when viewed, we notice a significant decrease in the differences in recognition rate in this way. Pose variations and expression this procedure is summarized in this study, where we describe some of the results of the expression simultaneous neutralization and normalization pose for different subgroups, the lack of experience in this context in our latest findings led us to design this experimental procedure for each expression ((smile in session 1, smile in session 3, surprise in session 2 and squint in session 2)), so that, this procedure uses three subgroups with different modes ((camera 05 1, 13 0 and 12 0 approximately at 0, 15 and 30)), this is illustrated by Fig. 3.

We continue to evaluate our experience. In Table 3 we present the corresponding recognition rates and as we are told, the performance of the standard FR SDK is improved, the improvement is made considerably when the probe is facing are normalized pose and identify the expression of the face, either what happens when using the technique of neutral expression or technique of transfer expression.

The idea used in this procedure is impressive when using expression transfer technology which can increase the recognition rate to 36 points for the surprise of the subgroup in the (session 2 (Sur-S2)) under the yaw angle-30°.

Get the database: Any person who wishes to obtain the database for use in his/her experience shall sign and fax

Table 1: Test the recognition rates using the CMU Multi PIE database on different subsets of expression with variations in illuminations

Variables	S_{ur} S_2 (%)	S_{qi} S_2 (%)	S_{mi} S_1 (%)	S_{mi} S_3	Average	SD
SRC (Wright *et al*., 2009)	51.3	58.0	93.6	60.2	65.7	18.8
LLC (Wang *et al*., 2010)	52.2	64.0	95.5	62.4	68.5	18.6
RRC.L_2 (Yang *et al*., 2011)	59.1	58.0	96.0	70.1	70.8	17.6
RRC.L_1 (Yang *et al*., 2011)	68.7	65.7	97.7	76.0	77.0	14.3
No pre-processing with (SDK)	83.6	89.3	94.5	91.4	89.7	4.5
Neutral expression with (SDK)	89.3	87.0	94.1	92.4	90.7	3.1
SDK for expression transfer	99.0	95.8	97.7	98.5	97.7	1.3

Table 2: Test the recognition rates using the CMU Multi PIE with variations of expression and pose composition and according to our information there are no results in the case of art on these subgroups

	Without pre-processing (%)				Neutral expression mean (%)				Transfer expression (%)			
Camera	S_{ur} S_2	S_{qi} S_2	S_{mi} S_1	S_{mi} S_3	S_{ur} S_2	S_{qi} S_2	S_{mi} S_1	S_{mi} S_3	S_{ur} S_2	S_{qi} S_2	S_{mi} S_1	S_{mi} S_3
12-0 (30°)	46.5	58.6	73.2	58.6	62.0	52.1	73.4	66.0	82.2	71.8	90.7	86.0
13-0 (15°)	66.4	79.4	89.4	79.4	86.6	75.0	90.6	85.7	95.5	89.1	97.1	98.6
05-1 (0°)	85.0	89.6	94.2	89.6	93.4	87.6	94.7	89.3	99.4	96.5	99.1	97.7

Table 3: AR database rates recognize in different subsets of the expression

Variables	S_{mi} S_1 (%)	A_{ng} S_1 (%)	S_{mi} S_1 (%)	S_{cr} S_1 (%)	A_{ng} S_2 (%)	S_{cr} S_2 (%)
SRC (Young *et al*., 2009)	98.0	89.0	54.0	80.0	77.0	32.0
FS (Wang *et al*., 2010)	100.0	100.0	90.4	95.5	97.0	59.6
CTSDP (Gass *et al*., 2011)	100.0	100.0	94.5	99.5	99.2	85.4
DICW (Tan *et al*., 2009)	100.0	98.0	85.0	90.0	93.0	44.0
SOM (Zhang *et al*., 2012)	100.0	97.0	89.0	87.0	91.0	63.0
PD (Tan *et al*., 2009)	100.0	98.0	92.0	89.0	85.0	62.0
RRC-L1 (Yang *et al*., 2011)	68.7	65.7	97.7	76.0	77.0	14.3
No pre-processing with (SDK)	100.0	100.0	95.0	98.0	99.0	4575.0
Neutral expression with (SDK)	100.0	100.0	97.0	98.0	98.0	86.0
SDK for expression transfer	100.0	100.0	96.0	99.0	98.0	81.0

(mail) the form of the license agreement provided, if the license agreement form is received. The database can then be downloaded or shipped. For more details on how to access the database, visit the following Web site: http://isl.ira.uka.de/face_recognition/doordb.html.

This enables us to obtain AR database on more than (4000) front images and more than (126) subjects and this includes a discrepancy in expressions, occlusions and illuminations. As in Wei and Li (2013), For experimentation and exercise, we will select 50 males and 50 female images as sub-groups for investigations, here, it should be noted that these identities are not defined in previous works, so, we chose a random subgroup. The exhibition images are faces neutral recorded during the session-1. To evaluate the work in this technique, 6 subtotals with different expressions are selected.

To see how robustness is our experience, we have to compare the recognition rates resulting from our proposed method with the latest techniques in this context. It is noticeable that the mechanism of recognizing the face with the expression of screaming is the most difficult task, while sub-expression sets are created for excellence between 100 and 99%. In the case of screaming, large facial deformities are associated with the open mouth and closed eyes on a large scale, one more, we refer to the robustness of our experience where the proposed two pre-processing methods work in normalizing pose and neutralize expressions facial, this improves the (FR SDK's) accuracy, so, our experience outperforms other technologies, especially, the most expressions challenging ones, the method used in this study achieves a comparative performance with CTSP technology which also depends on the distortion of facial images. This comparison is in the case of expression scream at Session 2, so that, facial deformity does not return to expression only but the variation temporal affects as well.

From the expectations that emerged during the training which were avoided, the difficulty of separating the expression and identity, where we proposed in this study a second way to transfer the expression of the image of the exhibition to the image of the probe in the conclusion that they are of the same identity and whenever the need for both the object and the exhibition, this method is more suitable for verification, our results on both AR and Multi-PIE showed that, the methods we proposed in this study have significantly improved the accuracy of the FRUST SDK (FR SDK) towards variations pose and expression. This proved the effectiveness of the method. In this study, we conducted the experimental results of the methods proposed through a difficult experimental protocol using PIE technique where the faces were observed and expressed in facial imaging images. We suggest that the future should be improved (3DMM) extended to deal well with deformities.

CONCLUSION

In this study, the method we proposed consists of two novel techniques that increase the performance and robustness of the standard (FR SDKs), we know that standard (FR FRK) processors are the primary purpose of improving them for 2D (FR) performance, so that, it is permeated with reliable reliability through a frontal and neutral image, although, performance is achieved in restricted environments and unrestricted environments. In this study, we proposed a new idea that includes a synthesize a novel-vision of the probe through which the expression is determined and pose corrected. For the performance of this purpose we use a three-dimensional model morphable, through which we can isolate the variations of identity from those resulting in facial expressions, a summary of the basic idea of this proposed technique includes synthesizing tow a novel vision. The first is a technique used to generate an image with mean expression neutral, to this end, novel a new vision of the probe is combined with expression coefficients extracted on neutral training images. The main feature of this technique is the need for the probe only during of the neutralization expression, so that, we can pre-processing this procedure during the registration period, second: in order to obtain a recognition rate with expressions in which it is difficult to separate the expression from the identity well, we propose that the expression of the image of the exhibition be transferred to the image of the probe in the conclusion that they are of the same identity, urging us that whenever there is a need for verification and exhibition is better.

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