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An Efficient Human Emotion Recognition System Using Improved-MSIFT & Neural Classifiers

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Abstract: Human Face detection and recognition is an important part of Human biometric and security related field. There are several challenges that are being faced for the facial recognition since the external conditions are always varying and the facial gestures are not similar at times. In this work, we have presented the algorithm which is invariant to the external scales and physical factors like illumination, scaling and orientation and thus used in the key features extraction. Thus, we have utilized the CoC and neural classifiers for the classification. Also, we have added music player utility such that music will play as per the recognized emotions. The algorithm has been developed using MATLAB and thus the overall performance has been evaluated ad verified.
Keywords: Human Face, MSIFT, Facial Gestures

I. INTRODUCTION

Human face recognition has always been very important part of researches all over the world. The human facial expression is an important social aspect and thus possessed a crucial social importance. This human face detection and recognition finds important part in various applications like- Intelligent surveillance robotic systems, Bio-medical image processing, Human Driver Alertness Systems in automobiles and other various applications.

In past few years various algorithms have been introduced and thus various issues and methods have been explored. The various developed algorithms have been developed and successfully tested. The methodologies of the face detection and recognition are (i) Image Filtering (ii) Geometrical detection , normalization of the faces (iii) Feature Extraction and (iv) Classification of the emotions. The various templates are generated using several feature extraction methods like PCA, geometrical extraction, Voila-Johns etc. and thus normalization is done using various image processing methods and applications.

In our proposed work, we have used the DWT (Discrete Wavelet transform) for improving the feature extraction procedure combined with the MSIFT (Modified Scale Invariant Feature Transform). The DWT is used for localization of the energy bands of the image. The LL band has been utilized for the feature extraction as it extracts the low frequency components of the image. The advantage of the MSIFT is that it is invariant to the various factors like the illumination, scaling, orientation and other several external factors. MSIFT extracts the key features in the images which are the gradient in the image pixels around. Here, thus the features are extracted from the image passed through the DWT. Finally, we need to store the key points of all images in the databases and thus template has been created. These key point features are used for training the neural networks and finally, the neural classifiers are used for the classification of the images. We have included the recognition of the five emotions viz- sad, happy, anger, neutral, surprise. And thus, music player utility has also been introduced to play the songs as per recognized emotion. Our proposed algorithm is 98.05% accurate and more efficient. We have tested the 103 images using JAFFE database images and thoroughly verified. The system has been developed using MATLAB-GUI. MSIFT and DWT toolboxes have been used for implementing the algorithm.

II. METHODOLOGY

When you open these guidelines, select "Print Layout" from the "View" menu, which will allow you to see the two-column. Here, in this paper, represented the flowchart. The project concluded step by step. Here mainly generate two basic step, first, Generate all the image template and second test image compare by the template.

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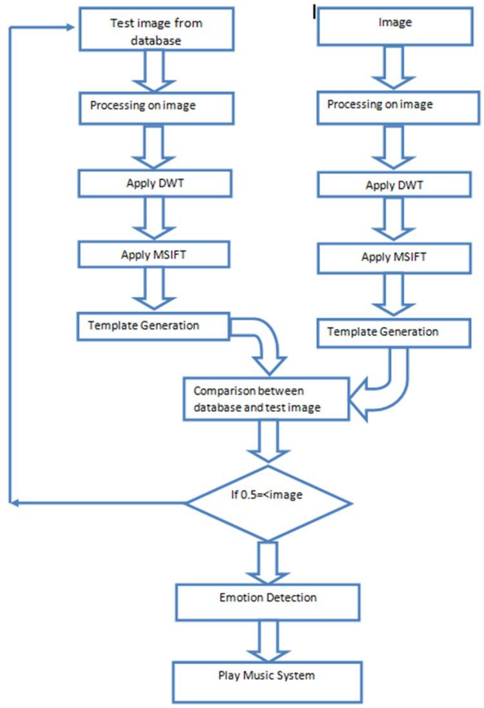


Mostly, template properly generation it take step by step.All the image read on the system and convert into gray scale. And apply on discrete wavelet transform(DWT) and MSIFT.

III. MSIFT & CLASSIFICATION

A. Discrete Wavelet Transform (DWT)

The wavelet transform focuses into a small number of wavelet coefficients. The wavelet is to decompose in four basic subbands (LL, LH, HL, HH). LL is the low frequency subband. The low frequency component in both direction horizontal and vertical. The subband LL will be most stable subband. So that, it can be used for feature representation of an image.

B. Scale Invariant Feature Transform (SIFT)

The SIFT algorithm locates the key points in an image which are invariant to scale and shift. SIFT mostly used in object recognition. It feature are basically used in the image detection. So that, here used SIFT feature are invariant to scale, rotation, illumination change and it can use the all direction. The SIFT algorithm mostly categories into basic step: extrema detection, removal of key point with low control, orientation assignment and descriptor calculation.

C. Scale Space Extrema Detection

In space scale extrema detection, the primary stage of key point detection involves the detection of stable features of the image. That is, the key point location which are invariant to scale change of the image. Difference of Gaussian (DoG) implemented in the points of interest. The scale space of an image is defined as a function,$L(x, y, \sigma)$, that is produced from the convolution of a variable-scale Gaussian, $G(x, y, \sigma)$, with an input image, $I(x, y)$

$$L(x, y, \sigma) = G(x, y, \sigma) * I(x, y) \qquad (1)$$

where $*$ is shows the convolution operator

$$L(x, y, \sigma) = \frac{1}{2\pi\sigma^2} e^{-(x^2+y^2)/2\sigma^2} \qquad (2)$$

Two different images are calculated by using the difference of Gaussian (DoG):

$$D(x, y, \sigma) = \big(G(x, y, k) - G(x, y, \sigma)\big) * I(x, y)$$
$$= L(x, y, k\sigma) - L(x, y, \sigma) \qquad (3)$$

The DoG is a impact very high and very smoothly. And DoG is smoothly compute images by simple image subtraction and also provides the most stable images features as compared to the gradient, Hessian, or Harris corner function.

D. Extrema Detection,

Here, in this section using DoG pyramid, neighboring pixel compare with its around the each point, that is, on the level as well as on the lower and higher levels, that is, 128 pixels. When neighboring pixel are minimum or maximum for all pixel image, always considered a potential key point. So that, the localization of the key point of image is improved, by using a second order Taylor series expansion. This gives the true extrema location.

$$D(x) = D + \frac{\partial D^T}{\partial x^2}x + \frac{1}{2}x^T\frac{\partial^2 D}{\partial x^2}x \quad (4)$$

where D and its derivatives are evaluated at the sample point and $x = (x, y, \sigma)^T$ is the offset from this point

1) *Low Contrast Key Point Removal.* Here at this step, chosen our best key point of the image by removing of low contrast point and poor edge localize.

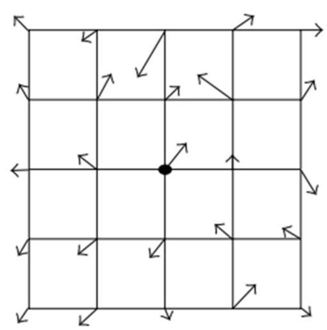
$$D(\hat{x}) = D + \frac{\partial D^T}{\partial x^2}\hat{x} \quad (5)$$

If the value of $\hat{x}$ is below a threshold value. Good localized extrema are chosen by using the fact. There is a large principle curvature across the edge using this case, but a small curvature in the perpendicular direction in the DoG function. The Hessian matrixes (2 x 2) can be calculated by using the principle of curvature. H at the location, and scale of key points.

$$H = \begin{bmatrix} D_{xx} & D_{xy} \\ D_{yy} & D_{yy} \end{bmatrix} \quad (6)$$

Then, by using of H compute the sum of the eigen values and their product from the determinant.

$$\text{Tr}(H) = Dxx + Dyy = \alpha + \beta,$$
$$\text{Det}(H) = DxxDyy - (Dxy)^2 = \alpha\beta. \quad (7)$$



(a)

Figure 1: (a) The middle point is known as candidate key point and orientations to this point are computed using pixel differences.

If determinant is calculated sign negative, the curvature has different signs, so the point is discarded. Let r can be take the ratio between the largest magnitude eigenvalue and the smaller one, so that $\alpha = r\beta$. Then,

$$\frac{Tr(H)^2}{\text{Det}(H)} = \frac{(\alpha+\beta)^2}{\alpha\beta} = \frac{(r\beta+\beta)^2}{r\beta^2} = \frac{(r+1)^2}{r} \quad (8)$$

The quantity $(r + 1)2/r$ is at a minimum when the two eigenvalues are equal and it increases with r hence if

$$\frac{Tr(H)^2}{\text{Det}(H)} = \frac{(r+1)^2}{r} \quad (9)$$

Then, the key point is removed. Here, r is taken as 10.

2) *Orientation Assignment*, Here, properties is analysis on the basis of local image, on the basis of key points of the orientation is assigned. The gradient formed orientation histogram, sample points within a region around the key point as described in Figure 1. Here chosen a 16 × 16 square matrix for this implementation. For orientation range is covering to 360 degree and orientation histogram has 36 bins cover. The gradient magnitude, $m(x, y)$, and orientation, $\theta(x, y)$, are precomputed using pixel differences:

M(x,y)

$$= \sqrt{(L(x+1,y) - L(x-1,y))^2} + \sqrt{(L(x,y+1) - L(x,y-1))^2}$$

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$$\theta(x,y) = tan^{-1}\left(\frac{(L(x,y+1)-L(x,y-1))}{(L(x+1,y)-L(x-1,y))}\right) \qquad (10)$$

3) *Descriptor Calculation,* here last session completed, descriptor algorithm involves the computation of 16 by 16 neighborhoods of the pixel. At each point are calculated neighborhood, the gradient magnitudes and orientations. The orientation histograms are created for each subregion of size 4 by 4 (16 regions).
4) *Descriptor Calculation in Modified SIFT,* here modified the orientation assignment, the gradient magnitude and orientation, at each point in the image are computed to create a key point descriptor. The Gaussian to assign each samplepoint for weight functions through the Gaussian window. Gaussian window always ignore the small changes in descriptors by repositioning the window. It also provides small weightage to the gradients that are far from the center of the descriptor. The computation involves orientation histogram and each (4 × 4) subregion is created. The trilinear interpolation is used to provide histogram bins of each gradient sample value. The histogram array arranged (4 x 4) with 8 orientation bins in each. Hence, the totals element achieved (4 × 4 × 8 = 128) feature vectors are used. The affect the performance of recognition algorithm are change, by changing the illumination and contrast. MSIFT is reduced complexity of SIFT and reduce the effect of same original SIFT. Unit length are normalized using descriptors and by using MSIFT.

E. Coefficient of Correlation (CoC)

Correlation is a method for establishing the degree of probability. Linear variable directly comparison between two measured quantities. Karl Pearson defined the Pearson product-moment correlation coefficient. Pearson's correlation coefficient is widely used in statistical analysis, pattern recognition, and image processing.

$$CoC=\frac{\sum_i(xi-xm)(yi-ym)}{\sqrt{\sum_i(xi-xm)^2}\sqrt{\sum_i(yi-ym)^2}}$$

where and yi are intensity values of ith pixel in 1st and 2nd image, respectively. Also, xm and ym are mean intensity values of 1st and 2nd image, respectively.

IV. RESULTS & DISCUSSIONS

A. Angry emotion

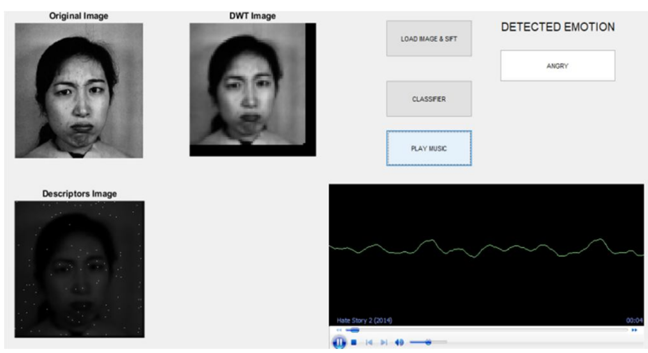

Fig.4 Test Image of JAFEE for detection of emotion "ANGRY"

B. Disgusted Emotion

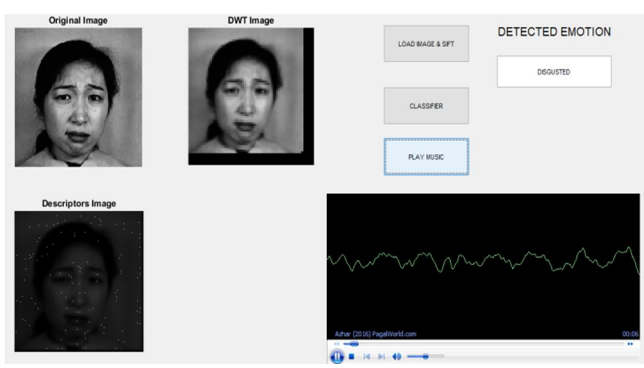

Fig.5 Test Image of JAFEE for detection of emotion "DISGUSTED"

C. Fear Emotion

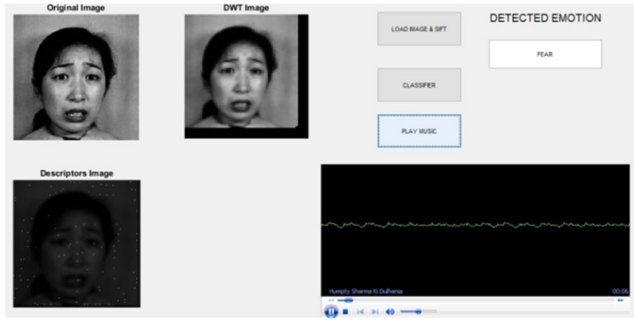

Fig.6 Test Image of JAFEE for detection of emotion "FEAR"

D. Happy Emotion

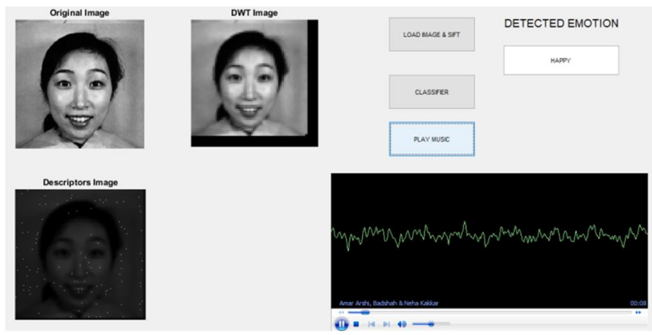

Fig.7 Test Image of JAFEE for detection of emotion "HAPPY"

E. Neutral Emotion

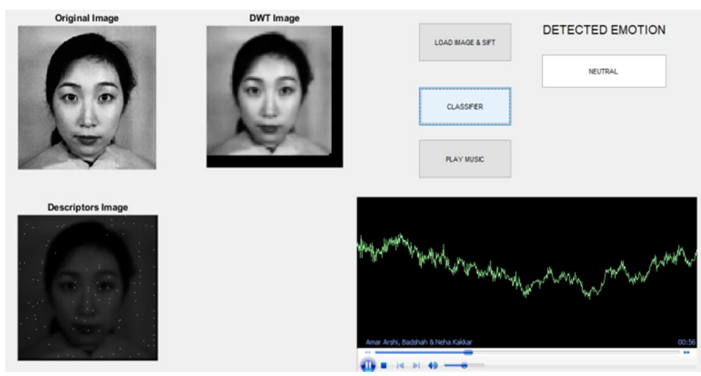

Fig.8 Test Image of JAFEE for detection of emotion "NEUTRAL"

F. Sad Emotion

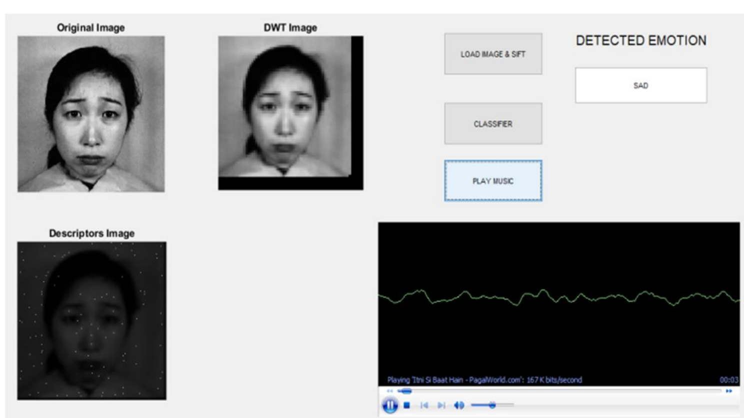

Fig.9 Test Image of JAFEE for detection of emotion "SAD"

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G. Surprise Emotion

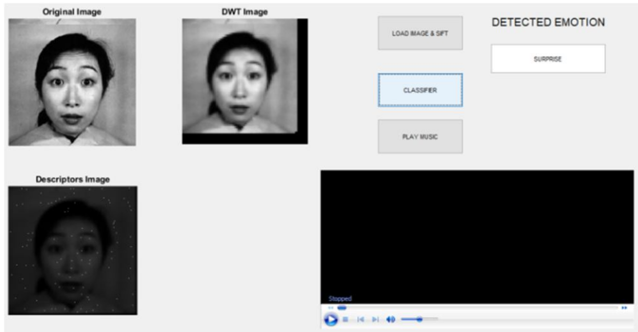

Fig.10 Test Image of JAFEE for detection of emotion “SURPRISE”

H. Angry Emotion

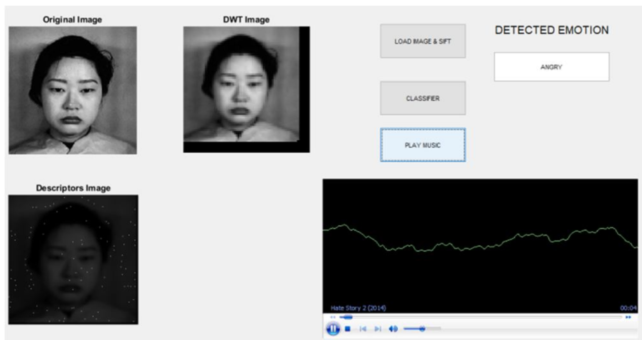

Fig.11 Test Image of JAFEE for detection of emotion “ANGRY”

I. Disgusted Emotion

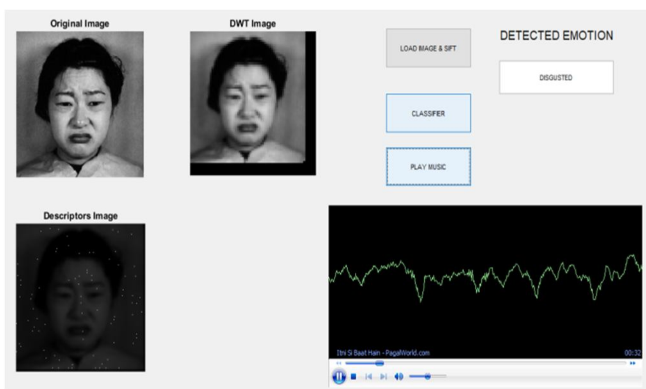

Fig.12 Test Image of JAFEE for detection of emotion “DISGUSTED”

J. Fear Emotion

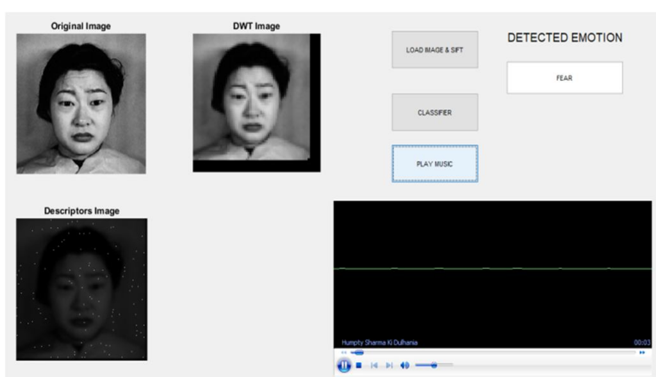

Fig.13 Test Image of JAFEE for detection of emotion “FEAR”

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K. Happy Emotion

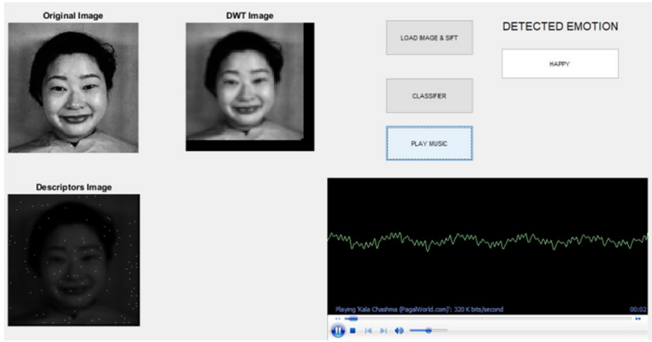

Fig.14 Test Image of JAFEE for detection of emotion "HAPPY"

L. Neutral Emotion

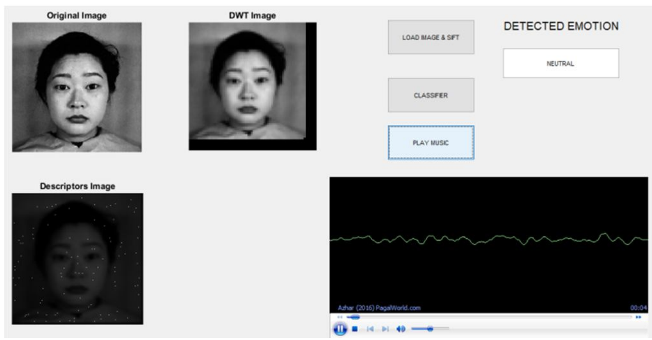

Fig.15 Test Image of JAFEE for detection of emotion "NEUTRAL"

M. Sad Emotion

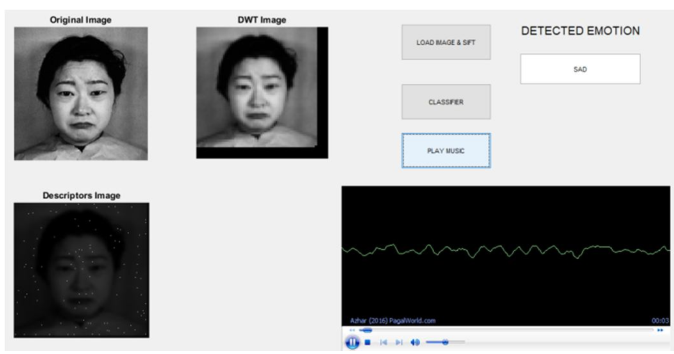

Fig.16 Test Image of JAFEE for detection of emotion "SAD"

N. Surprise Emotion

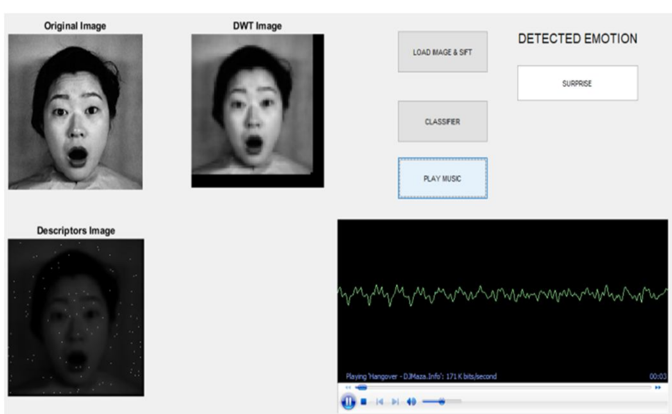

Fig.17 Test Image of JAFEE for detection of emotion "SURPRISE"

Methods	Recognition Rate
SIFT	89.67%
SIFT + CoC	89.67%
DWT + SIFT + CoC	92.49%
DWT + MSIFT + CoC	97.65%
DWT + MSIFT + CoC + Neural Networks (Proposed Work)	98.05%

V. CONCLUSION

Thus, the proposed work has been presented in this work. This involves the improved recognition rate up to 98.05% for JAFFE database. This algorithm has been used for face recognition and emotion classification. We have been using DWT and MSIFT for the feature extraction. DWT filters the image and presents the low frequency contents for the feature extraction by the MSIFT. CoC and neural classifiers has been combined to form a classifier for the classification of the 7 emotions. Thus, our proposed work is found to have 98.07% accuracy for 103 images of JAFFE Database.

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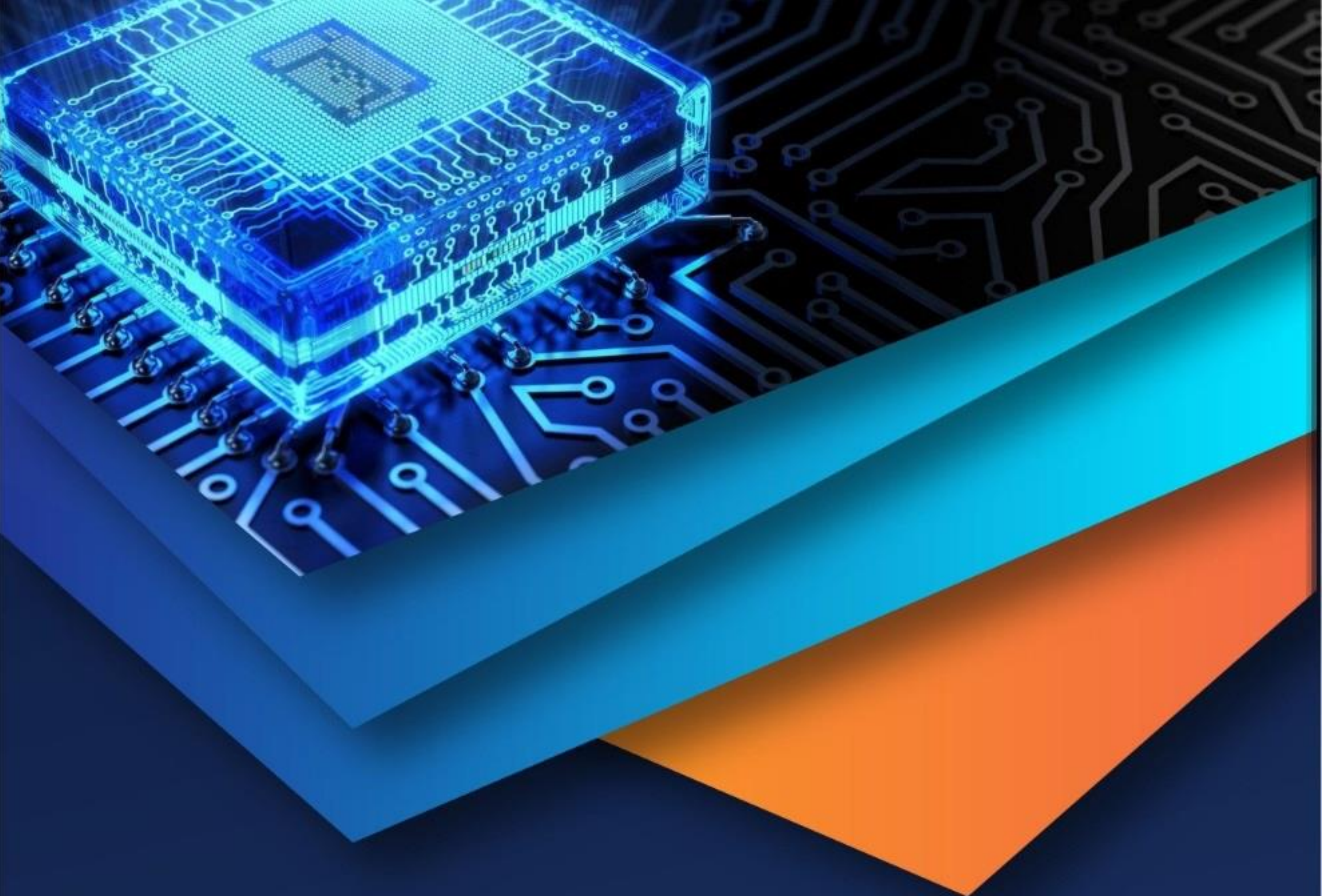

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