

A PRAGMATIC SMILE DETECTION APPROACH USING INTERVAL TYPE-2 FUZZY LOGIC AND CONVOLUTIONAL NEURAL NETWORKS

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Abstract

Human Face Recognition is having assorted aspects including Eye Identification, Smile Detection, Lips Dimensions Recognition, Cheeks Variations and many others which contribute to the final recognition and prediction of a face. In face smile detection, a number of approaches are available including meta-heuristics and soft computing with fuzzy integration so that the overall accuracy can be elevated in the predictive mining and knowledge discovery from the face. In this research manuscript, the effectual strategy and methodology using Convolutional Neural Network (CNN) is used that is the key component of deep learning and is quite effective and accuracy aware on assorted parameters. The approach of CNN based smile detection and type-2 fuzzy integration is providing the higher degree of accuracy in association with the deep Convolutional networks based approach on diversified parameters.

Keywords: Convolutional Neural Network; Deep Learning based Smile Detection; Face Smile Detection; Interval Type-2 Fuzzy Logic.

I. INTRODUCTION

The face grin or smile identification is a widely used approach to distinguish an individual with the profound investigation examples

utilizing the inborn properties of the human face [1]. In traditional aspects, there are assorted ways to identify the human smile including eigenfaces, fisherfaces and many others as presented below.

Utilizing this methodology, the normal qualities of the human face having grin is distinguished and it is hard to imagine it as other individual [2, 3].

There are different types of face recognition algorithms including the following [4, 5, 6, 7, 8, 9, 10, 11].

- a. Eigenfaces
- b. Local Binary Patterns Histograms (LBPH)
- c. Fisherfaces
- d. Scale Invariant Feature Transform (SIFT)
- e. Speed Up Robust Features (SURF)
- f. Elastic Bunch Graph Matching (EBGM)
- g. Kernel Methods
- h. Trace Transform
- i. Active Appearance Model (AAM)
- j. 3-D Morphable Model
- k. 3-D Face Recognition
- l. Bayesian Framework
- m. Support Vector Machine (SVM)
- n. Hidden Markov Models (HMM)
- o. Boosting & Ensemble Solutions
- p. Video-Based Face Recognition Algorithms
- q. Principal Component Analysis (PCA)
- r. Independent Component Analysis (ICA)
- s. Linear Discriminant Analysis (LDA)

Figure 1 is depicting the assorted dimensions and savor human smile which can be trained in

the model of CNN. These different face expressions form the base of training and further knowledge discovery.



Figure 1: Human Face with Savor of Smile

II. BROAD TAXONOMY OF THE FACE AND SMILE RECOGNITION

- Traditional
- 3-Dimensional recognition
- Skin texture analysis
- Facial recognition combining different techniques
- Thermal cameras
- Facial Motion Capture

III. FACE SMILE DETECTION

In traditional aspects, the HAAR cascade approach is used in OpenCV based library in which the XML dataset is processed and face segments are analyzed as follows [12, 13, 14]

```
face_Dataset = FuzzyComputerVision.DatasetClassifier('haarDataset_frontalface_default.xml')
eye_Dataset = FuzzyComputerVision.DatasetClassifier('haarDataset_eye.xml')
```

```

smile_Dataset =
FuzzyComputerVision.DatasetClassifier('haarDat
aset_smile.xml')
video_Analyze =
FuzzyComputerVision.VideoAnalyze(0)
while True:
    # Analyzes video_AnalyzeSmileFrame by
    SmileFrame
    _, SmileFrame = video_Analyze.read()
    # To Analyze image in monochrome
    gray =
FuzzyComputerVision.cvtColor(SmileFrame,
FuzzyComputerVision.COLOR_BGR2GRAY)
    # calls the detect() Approach
    canvas = detect(gray, SmileFrame)
    # Displays the result on camera feed
    FuzzyComputerVision.imshow('Video',
canvas)
    # The control breaks once q key is
    pressed
    if FuzzyComputerVision.waitKey(1) &
0xff == ord('q'):
        break
    # Release the Analyze once all the processing
    is done.
    video_Analyze.release()
    FuzzyComputerVision.destroyAllWindows()
ws()

```

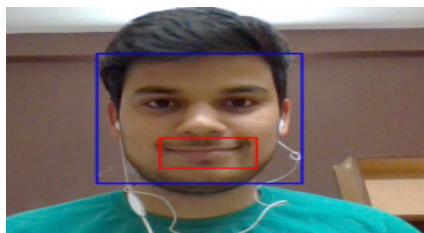


Figure 2: Smile Identification Patterns

Figure 2 is showing the human face with the specific key points or region in the human face where the smile can be detected and recognized using the model of Convolutional network.

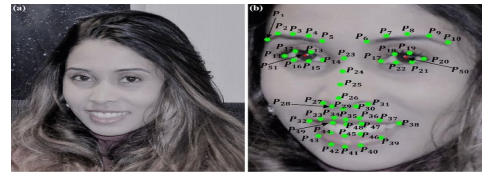


Figure 3: Smile Identification Key Points

Figure 3 and Figure 4 are presenting the key points and the angles with the penetration of smiles associated with the human face. These are the quite important and mandatory key extracts which are required to be trained with the deep learning model.

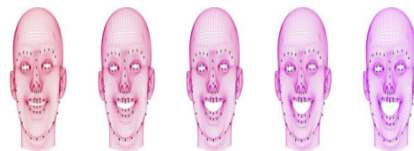


Figure 4: Smile Identification Angles with Penetration.

The inherent features and parameters of human face can be presented using the deep neural network based algorithm as shown in Figure 5 and thereby the effectual results can be depicted.



Figure 5: Smile Identification with Inherent Details.

IV. INTERVAL TYPE-2 FUZZY LOGIC

Type-2 Fuzzy Systems and Algorithmic approaches makes use of the uncertainty with the handling on the key points of membership functions [15, 16]. The uncertainty is effectively handled and solved in the approach of type-2 fuzzy systems and that is the key point in this research work with the integration of convolutional neural network as the prime associates of deep learning [17, 18, 19].

It generalizes the traditional type-1 fuzzy systems [20, 21] with the more processing and handling towards the uncertainty as shown in Figure 6.

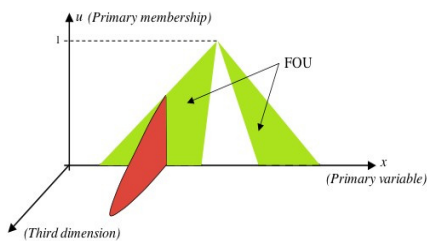


Figure 6: Interval Type 2 Fuzzy Logic

Figure 7 is showing the Interval 2 Fuzzy Logic based plot with the max-min analysis of the objects and the nearby points.

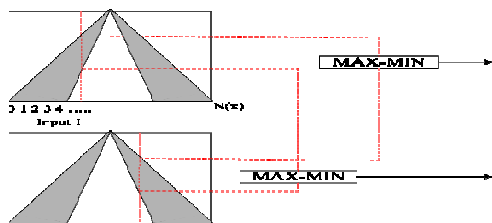


Figure 7: Interval Type 2 Fuzzy Logic

V. FACE SMILE USING CONVOLUTIONAL NEURAL NETWORKS (CNN)

Python is the key programming language that is used in almost every area of high performance computations [22, 23]. Python provides the tools and libraries which can be used for the secured CNN development including decentralized applications. As in secured CNN technology, there are secured protocols and algorithms, the Python Programming is having enormous toolkits available on its official repository <https://pypi.org/> [24, 25].

Using these, the scenarios of secured CNN can be in generating mode with the fuzzy based hash values so that overall operations and records will be highly secured with dynamic features extraction. In the scenario the Fuzzy CNN based adoption gives the dynamic hash value is generated that is the base of any secured CNN with different operations in a chain and that makes the overall secured CNN [26, 27].

In Secured CNN Programming, the integration of feature dynamic is one of the very important algorithms. It is used to confirm and validate the operations so that the new blocks are added in the secured CNN. It is referred as the key consensus algorithm for the verifications and authenticity of the operations. In secured CNN network, different miners participate for the validation and completing the operations [28, 29].

1. Activation Function or Transfer Function is used to determine the output of node
2. Determine the output of neural network like yes or no.
3. It maps the resulting values in between 0 to 1 or -1 to 1 etc. (depending upon the function).

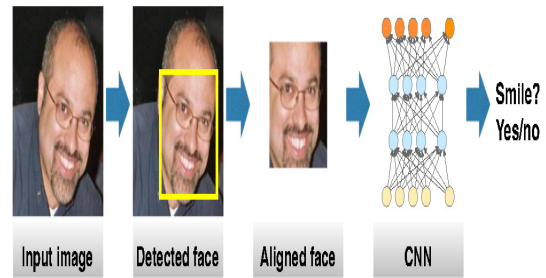


Figure 9: Detection of Face.

In Back-propagation, while calculating gradients of loss (Error) with respect to the weights, the gradients tends to get smaller and smaller as it keeps on moving backward in the Network. This means that the neurons in the Earlier layers learn very slowly as compared to the neurons in the later layers in the Hierarchy. The Earlier layers in the network are slowest to train.

Figure 9 shows the process of face detection with the alignment and passing to the CNN based approach to identify the smile.

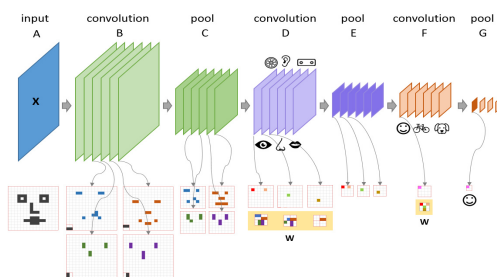


Figure 8: Face Data Extraction using CNN

Figure 8 depicts the process of face data extraction that is implemented using the deep neural network. The process is showing that the human face is extracted on the key base of features from different segments of human face and then trained for the knowledge discovery and predictions.

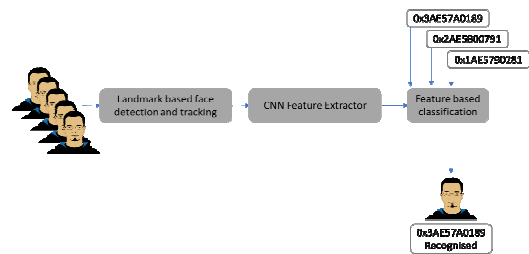


Figure 10: Recognition Patterns using CNN

Figure 10 is showing the recognition patterns with the feature extractor and then feature classification. The CNN feature extractor identifies the hidden patterns of the human face and then evaluates the deep patterns.

```
argparse.ArgumentParserInitiates
ap.add_argument("-m", "--model",
requiredTrue,
help"path to trained model model"
ap.add_argument("-i", "--image", requiredTrue,
help"path to input image"
parametersvarsap.parse_parametersActivation
Model Fuzzy CNN
```

```

Integration.imreadparameters"image"origimag
e.copy
Activation Model Fuzzy CNN
Integration.resizeimage,28, 28
Activation Model image.astype"float"/ 255.0
Activation Model img_to_arrayimage
Activation Model np.expand_dimsimage,
axis0
print"INFO loading network..."
modelload_modelparameters"model"
notFaceSmile,
FaceSmilemodel.predictimage0
FaceLabel"FaceSmile" if
FaceSmile>notFaceSmile else "Not
FaceSmile"
probaFaceSmile if FaceSmile>notFaceSmile
else notFaceSmile
FaceLabel"{}: {:.2f}%".formatFaceLabel,
proba * 100
outpututils.resizeorig, width400
Fuzzy CNN Integration.putTextoutput,
FaceLabel,10, 25,Fuzzy CNN
Integration.FONT_HERSHEY_SIMPLEX,
Fuzzy CNN Integration.imshow"Output",
output
Fuzzy CNN Integration.waitKey0
argparse.ArgumentParser
ap.add_argument"-d", "--dataset",
requiredTrue,
ap.add_argument"-m", "--model",
requiredTrue,
help"path to output model"
ap.add_argument"-p", "--plot", typestr,
default"plot.png",
help"path to output loss/accuracy plot"
parametersvarsap.parse_parameters
forFaceDataPaths in FaceDataPathss:
load the image, pre-process it, and store
it in the data list
Activation Model Fuzzy CNN
Integration.imreadFaceDataPaths
Activation Model Fuzzy CNN
Integration.resizeimage,28, 28
Activation Model img_to_arrayimage
data.appendimage
extract the class FaceLabel from the
image path and update the
FaceLabels list
FaceLabelFaceDataPaths.splitos.path.sep
-2
FaceLabel1 if FaceLabel "FaceSmile"
else 0
FaceLabels.appendFaceLabel
Scaling the raw pixel intensities to the range 0,
1
datanp.arraydata, dtype"float"/ 255.0
FaceLabelsnp.arrayFaceLabels
partition the data into training and testing
splits using 75% of
the data for training and the remaining 25%
for testing
trainX, testX, trainY, testYtrain_test_splitdata,
FaceLabels, test_size0.25,
random_state42

```

convert the FaceLabels from integers to vectors

trainYto_categoricaltrainY, num_classes2

testYto_categoricaltestY, num_classes2

construct the image generator for data augmentation

augImageDataGeneratorrotation_range30,
width_shift_range0.1,

height_shift_range0.1, shear_range0.2,
zoom_range0.2,

horizontal_flipTrue, fill_mode"nearest"

initialize the model

print"INFO compiling model..."

modelLeNet.buildwidth28, height28, depth3,
classes2

optAdamlrINIT_LR, decayINIT_LR /
EPOCHS

model.compileloss"binary_crossentropy",
optimizeropt,

metrics"accuracy"

train the network

print"INFO training network..."

Hmodel.fit_generatoraug.flowtrainX, trainY,
batch_sizeBS,

validation_datatestX, testY,
steps_per_epochlentrainX// BS,

epochsEPOCHS, verbose1

save the model to disk

model.saveparameters"model"

plot the training loss and accuracy

plotting of values with fuzzy np.arange0, N,
H.history"loss", FaceLabel"train_loss"

plotting of values with fuzzy np.arange0, N,
H.history"val_loss", FaceLabel"val_loss"

plotting of values with fuzzy np.arange0, N,
H.history"acc", FaceLabel"train_acc"

plotting of values with fuzzy np.arange0, N,
H.history"ValAcc", FaceLabel"ValAcc"

plt.title"Training Loss and Accuracy on
FaceSmile/Not FaceSmile"

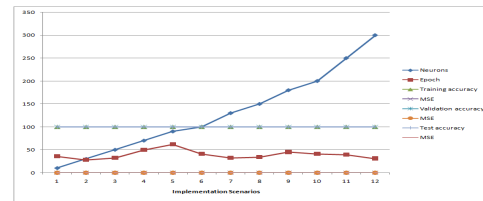


Figure 11: Cumulative Analysis of parameters in implementation

Figure 11 is showing the cumulative performance on the assorted parameters. Loss depicts the scalar value that is minimized in the training of the model. The lower the loss, the closer our predictions are to the true labels. Both loss and val_loss should be decreasing and Accuracy (Accr: and ValAcc) should be increasing. Accr: is the accuracy of training set. ValAccr: is the measure of how good the predictions of the model are [30, 31]. Training loss is the average of the losses over each batch of training data.

$$output = \begin{cases} 0 & \text{if } \sum_i w_i x_i < threshold \\ 1 & \text{if } \sum_i w_i x_i \geq threshold \end{cases}$$



$$output = \begin{cases} 0 & \text{if } \sum_i w_i x_i + threshold < 0 \\ 1 & \text{if } \sum_i w_i x_i + threshold \geq 0 \end{cases}$$

Effectively, bias = - threshold

The Sequential model is a linear stack of layers. You can create a Sequential model by passing a list of layer instances to the constructor:

```
from keras.models import Sequential
from keras.layers import Dense, Activation
model = Sequential([
    Dense(32, input_shape=(784,)),
    Activation('relu'),
    Dense(10),
    Activation('softmax'),
])
```

You can also simply add layers via the .add() method:

```
model = Sequential()
model.add(Dense(32, input_dim=784))
model.add(Activation('relu'))
```

Human Face Recognition is having arranged angles including Eye Identification, Smile Detection, Lips Dimensions Recognition, Cheeks Variations and numerous others which add to the last acknowledgment and forecast of a face. In face grin identification, various methodologies are accessible including meta-heuristics and delicate processing with fuzzy combination so the general accuracy can be raised in the

prescient mining and learning revelation from the face. In this exploration composition, the solid system and technique utilizing

Convolutional Neural Network (CNN) is utilized that is the key part of profound learning and is very compelling and accuracy mindful on grouped parameters. The methodology of CNN based grin identification and type-2 fuzzy combination is giving the higher level of accuracy in relationship with the profound Convolutional networks put together methodology with respect to differentiated parameters.

VI. CONCLUSION

The face smile detection is a prominent strategy to identify a person with the deep analytics patterns using the inherent properties of the human face. Using this approach, the common characteristics of the human face having smile is identified and it is difficult to pretend it as other person. Using the approach of interval type-2, the effective accuracy and predictive mining can be elevated and presented in the manuscript.

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