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Mathematical Modeling and Real-Time Testing Of Expression Understanding Using Neural Network

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Abstract: *Expression and facial pattern understanding are one of the major key leading research happening theses day, from the neural net to a simple comparison of images this action can be performed in various formats depending on the need and the accuracy of the neural network possible. The neural network present also possesses, the flexibility and functionality of recognizing highly complex facial expressions. The collective database of images is used as a reference base for training and to make the entire system give highly accurate results. The trained model and the final output helps in generating output in terms of programmed results and terms of accurate data pointers. This high-performance data can be used to perform functional programming and applications like expression-based lights and appliances control.*

Background*: This Described Is a novel algorithm that not only helps us understand human expression but also allows us to link those expressions with real-time equipment. This not only allows this algorithm to be used in homes but also helps understand the possibility of multi linkage of multiple cameras. The proposed algorithm uses a neural network to work and process the information. The flexibility and modularity lie where we are trying to impose the algorithm in mobile devices and cell phones. Demonstrated here is a networked place home that uses the doorbell camera to understand the condition of the person and further change the ambiance of the home.*

Materials and Methods *Laplacian Transform – essentially to find the edges and recognize the feature of the image, we use the Laplacian filter, this allows us to find the edge and help us figure out the properties of the image as well.*

Finally, it is implemented to figure out the corrected log function and exponential function, this also helps us understand the distribution of the parameters in the image

Edge and color detection for classification model not only improved the data accuracy but also the overall results of the image

Results*: The contents of the journal are peer-reviewed and archival. The journal publishes scholarly articles of archival value as well as tutorial expositions and critical reviews of classical subjects and topics of current interest.*

Authors should consider the following points:

Key Word*: **Pattern Recognition, Facial expression, Trained Model.***

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I. Problem Statement

The problem we are trying to solve is that the neural network system is not applicable in understanding the facial expression and classify the results in terms of levels. What we are trying to achieve is the flexible system that allows us to achieve the same. Another problem in this system. This is the fact that these don't allow for a stable and reliable source of information at points. Lack of reference data set and the problem with the user interface causes the result to change over time.

II. Solution

Presented here is a novel approach to solve this problem, the system uses the flexibility and functionality of both neural network and reference data set, We are using a standard human face data set which is classified and helps classify while taking inputs from the camera as well.

III. Previously Done Work

Yongmian Zhang[1] uses a sequential image processing method to process the repetition of images and classify them into different models, the processed models allow for linking the images together and also to process the expression, this lacks in the dynamic and differential expression output, which means it is not clear

if the expression ins a mixture of more than one expression.
Y. Ou[2] uses a human understanding based expression recognition system that used actions and facial expressions to predict the final expression again this lacks in terms of multiclassification and processing images in real-time
G. H. Weber[3] demonstrated a 3dimenstional expression recognition and classification system that not only allows us to read the facial expression but also allows to justify the places where expression is generated and classified.
M. Ceresa[4] classified a database which is essentially helpful in understanding the human gene and finally helping the user understand the need of the 3d gene database and classification.
Y. Chen[5] showed the structural classification of expression and understanding of expression in a cluster format and database.
N. Arunwattanmongkol[6] demonstrated a robotic platform based expression understanding that is essentially helpful in human-robot interaction and human interface.
Y. Guo[7] uses structural programming to solve the problem of data processing and data management, this also includes the type of data that is required to be processed and classified into a different type of datasets. Ideally, this can be used to classify every data set and data expression set for a cluster of data.

IV. Programming and Data set for training

Process of detection and classification
Steps Followed

1. Setting Up Python environment
2. Adding a reference dataset
3. Training the model depending on image processing algorithm
4. Collecting the information and linking it to the user API
5. Controlling the devices depending on the output results

Dependencies

- Python 3
- Pytorch
- sklearn

Dataset Used

FER2013 Dataset
The Dataset consists of 3,589 images, each of different expressions, including Angry, Disgust, Fear, Happy, Sad, 5=Surprise, 6=Neutral

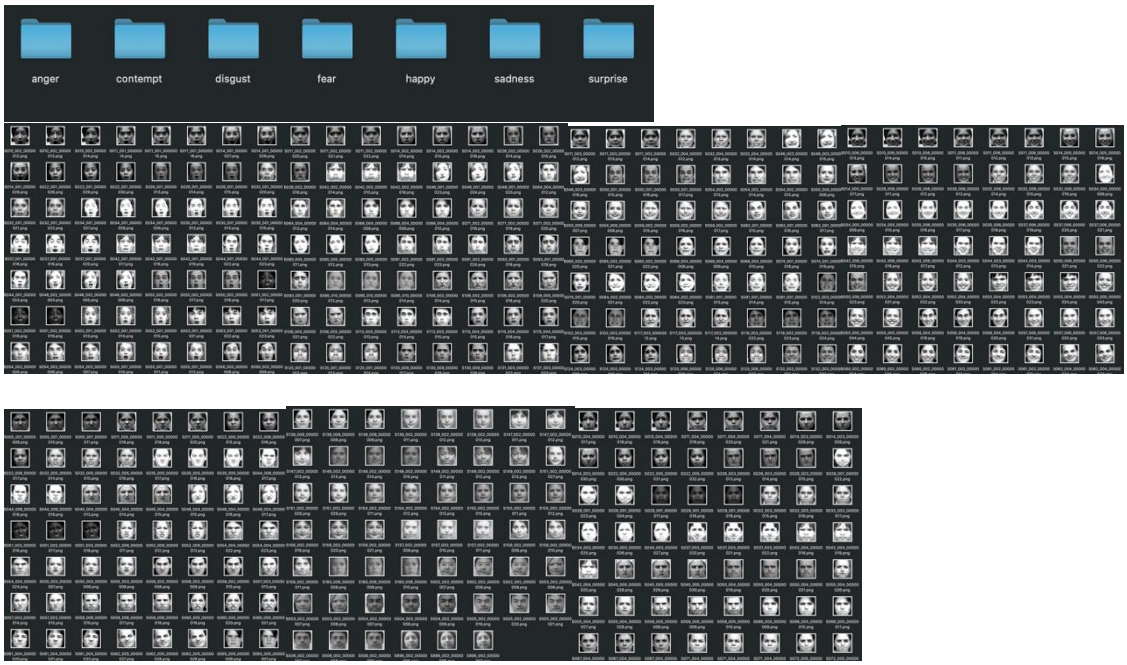

Fig 1: Multi Expression Data Set with classification in different folders for better arrangement and sorting

```python
''' Fer2013 Dataset class'''

from __future__ import print_function
from PIL import Image
import numpy as np
import h5py
import torch.utils.data as data

class FER2013(data.Dataset):
    """FER2013 Dataset.

    Args:
        train (bool, optional): If True, creates dataset from training set, oth
            creates from test set.
        transform (callable, optional): A function/transform that  takes in an
            and returns a transformed version. E.g, ``transforms.RandomCrop``
    """

    def __init__(self, split='Training', transform=None):
        self.transform = transform
        self.split = split  # training set or test set
        self.data = h5py.File('./data/data.h5', 'r', driver='core')
        # now load the picked numpy arrays
        if self.split == 'Training':
            self.train_data = self.data['Training_pixel']
            self.train_labels = self.data['Training_label']
            self.train_data = np.asarray(self.train_data)
            self.train_data = self.train_data.reshape((28709, 48, 48))

        elif self.split == 'PublicTest':
            self.PublicTest_data = self.data['PublicTest_pixel']
            self.PublicTest_labels = self.data['PublicTest_label']
            self.PublicTest_data = np.asarray(self.PublicTest_data)
            self.PublicTest_data = self.PublicTest_data.reshape((3589, 48, 48))
```

Fig 2: Python script for training

Output -

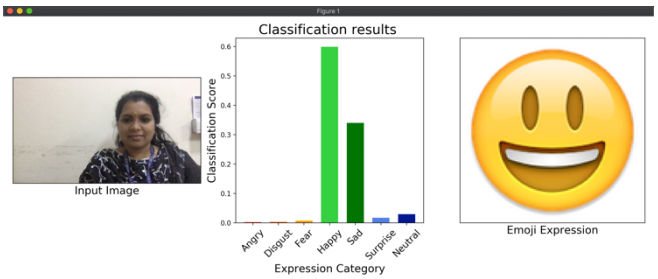

Fig 3: Co-author at a neutral facial expression. With classification emoji expression.

Fig shows how software allows to understand the facial expressions and make conclusion output from the feed, this not only helps in understanding system feed but also allows to understand the expression type and multi expression output

V. Mathematical modeling

Laplacian Transform – essentially to find the edges and recognize the feature of the image, we use the Laplacian filter, this allows us to find the edge and help us figure out the properties of the image as well.
Denoted by

$$L(x,y) = \frac{\partial^2 I}{\partial x^2} + \frac{\partial^2 I}{\partial y^2}$$

Fig 4: Laplacian transform

For a standard image, this can be converted into matrices which are followed upon like this

0	−1	0
−1	4	−1
0	−1	0

−1	−1	−1
−1	8	−1
−1	−1	−1

Fig 5: Matrices conversion

Finally, it is implemented to figure out the corrected log function and exponential function, this also helps us understand the distribution of the parameters in the image

$$LoG(x,y) = -\frac{1}{\pi\sigma^4}\left[1 - \frac{x^2+y^2}{2\sigma^2}\right] e^{-\frac{x^2+y^2}{2\sigma^2}}$$

Fig 6: Log function conversion

Edge and color detection for classification model not only improved the data accuracy but also the overall results of the image

0	1	1	2	2	2	1	1	0
1	2	4	5	5	5	4	2	1
1	4	5	3	0	3	5	4	1
2	5	3	-12	-24	-12	3	5	2
2	5	0	-24	-40	-24	0	5	2
2	5	3	-12	-24	-12	3	5	2
1	4	5	3	0	3	5	4	1
1	2	4	5	5	5	4	2	1
0	1	1	2	2	2	1	1	0

Fig 7: Image classification

Peak detection to find out change and variation in the edge of the image corners

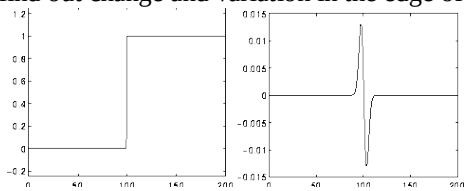

Fig 8: Edge Detection

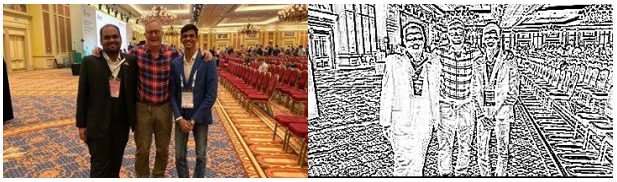

Fig 9: Output of Laplacian

MATHEMATICAL MODELING

Philips Smart bulb with the required software is connected and the data streams are established to send the data depending on the mood

Fig 10: Colour Change depending on the facial expression

Fig 10 demonstrates, software enabling the change in colours and change in the RGB colour patterns. This works over the Wi-Fi and operates to control the brightness depending on the face expression

VI. Discussion

The contents of the journal are peer-reviewed and archival. The journal publishes scholarly articles of archival value as well as tutorial expositions and critical reviews of classical subjects and topics of current interest. Authors should consider the following points:

1) Advanced image processing and parallel processing allowed us to perform image classification using neural nets.
2) Image distribution and classification using the trained neural nets and existing libraries
3) The rasterized image is then classified into different sections to perform the required function.
4) The final designed algorithm is capable of connecting hardware and more complex structure to the code
5) Further improvements also allow for better and stable compatibility over the same.

VII. Conclusion

The proposed method helps in understanding the facial expressions of human and classify them with all the possible expression, in this case 6 in total , with neutral as one of the static expression . This method is applicable in adaptively controlling home automation lights and colors and is also helpful in connecting advance home automation application, the application of mathematical modeling for the process of face recognition and understanding helps in determining and improving the final output.

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