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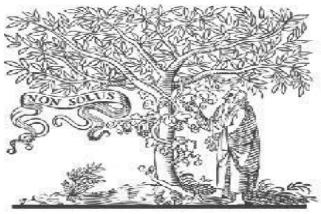

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A Novel Perspectives on Emotional Classification Using Facial Expression for E-Learning

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Abstract
Due to the recent pandemic circumstances, Education in whole the world has intensively oriented to Electronic learning (E-learning) and online virtual classes for teaching, which has an extensive impact on education quality and efficiency. A lot of research has been conducted to progress the online teaching method and improve its outcomes investigating the application of Artificial Intelligence (AI)solutions, such as personalized content, virtual reality, 3-D technology, etc. And all of these techniques have proven their great impact in distance learning. On the other hand, there is some aspects of online teaching that require special attention, the difficulty of verifying the students' identity for attending the classes and exams due to their large number and their privacy concerns. It is also difficult to manage and assess the students' engagement due to the lack of interaction between the instructor and the learners which affect the learning process. To solve these issues, this article focus on investigation of the application of Face Recognition to verify students' identity with the respect to their privacy, in addition to Facial Expression Recognition (FER) for academic emotions to improve the efficiency of learning process.

KEYWORDS: - Emotions, Expressions, Facial, FER, Image processing

Introduction

Humans communicate mostly through words, but also over body movements to stress specific parts of speech and to express emotions. Psychologists and engineers have attempted to examine facial expressions, vocal emotions, gestures, & physiological signs in order to better comprehend and categories emotions. This information can be used to teach computers to understand human emotions using video pictures captured by built-in cameras and voice waveforms captured by

on-board microphones. Figure.1 depicts a typical 2-way interaction between a human and a computer using different modalities.

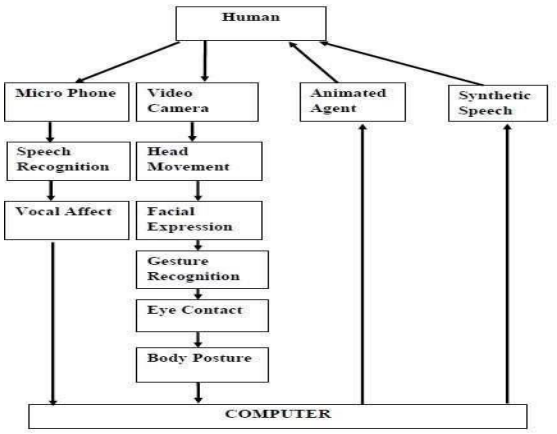

Fig.1 Multimodel Human-Computer Interaction

In this illustration, a video input to the computer can be utilized to extract gaze, position, gestures, and facial and lip motions. Computers may be able to discern gestures, postures, facial expressions, and eye contact. Similar to this, speech and voice (audio) across a microphone can transmit verbal and paralinguistic information. On the output side, the computer can seem as a "agent," which is an animated face created by a computer. This "agent" may interact with people by speaking in pre-recorded messages and making facial and lip movements that can be seen on a screen.

Overview

Due to the extensive orientation towards Online Education in the whole world because of the Covid-19 pandemic and its consequences that prevent the attendance to universities and schools, the need to improve E-learning efficiency has appeared. Online learning and virtual classes have shown a few shortcomings in some aspects that we can address using AI techniques. First, the difficulty of verifying the students' identity for attending the classes and exams due to their privacy concerns and their large number which can consume a part of the class time. Second, indirect contact between the instructors and their students has a great impact on learning process effectiveness and the students' engagement for learning.

The proposed system has two main parts:

- Face recognition and
- Emotion recognition.

Extracted faces from all the images using Viola Jones Algorithm and then trained the faces of each user using Local Binary Pattern Histogram. For emotion recognition we have detected pose and face landmarks of the user using the mediapipe package which uses Blazeposeand Blazeface algorithms. Then, trained the landmarks using Random Forest Classifier.

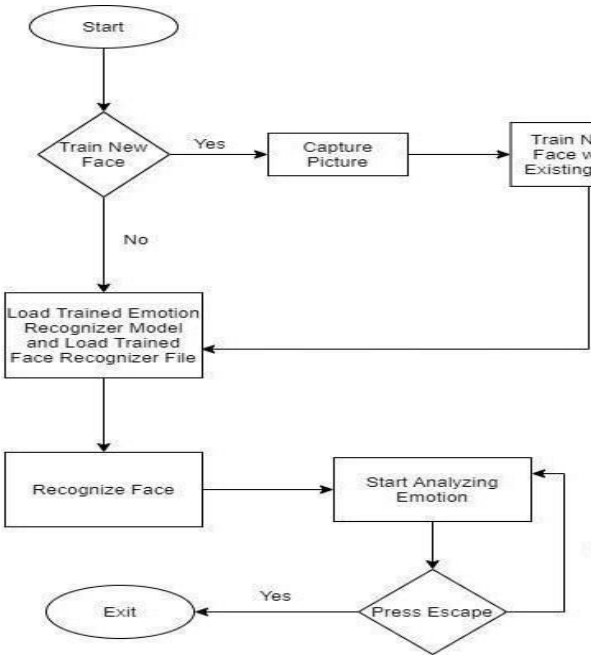

Fig.2 Random Forest Classifier

Face Detection - Viola Jones Haar Classifier

Real-time feature detection for images is made possible by the object-recognition framework known as the Viola-Jones algorithm. Regardless of being an old framework, Viola-Jones is fairly strong, and used in real-time facial identification process has proven to be noteworthy. The two steps of the Viola-Jones(VJ) algorithm are as follows: Detection and Training.

Viola-Jones is better able to sense front faces than faces gazing sideways, above, or downwards because it was created for frontal faces. The image is changed to grayscale before a face is detected since it is simpler to deal with and requires less treating power. The Viola-Jones algorithm locates the position on the colored image after identifying the face on the grayscale image. Despite being an outdated framework, Viola-Jones is very effective, and real-time face identification has proven to be one of its most notable applications. Although it takes a while to learn, this algorithm has a high rate of real-time facial recognition. An image is provided, and the algorithm breaks it into smaller sub regions before trying to identify a face by looking for specific characteristics in each one (this technique only works with grayscale images). An image must validate several distinct positions and scales because it may have numerous faces of several sizes. In this technique, Viola and Jones exploited Haar-like properties to find faces.

The Viola Jones algorithm has four main steps, which we shall discuss in the sections to follow:

- Selecting Haar-like features.
- Creating an integral image.
- Running AdaBoost training and
- Creating classifier cascades.

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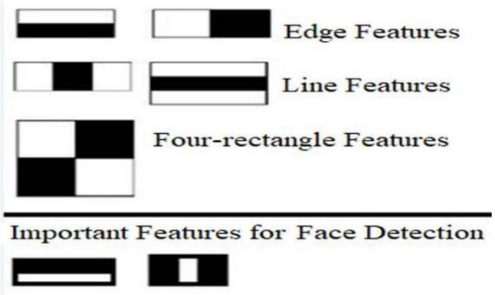
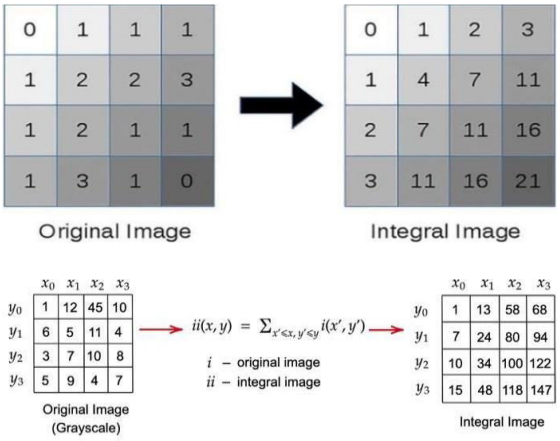
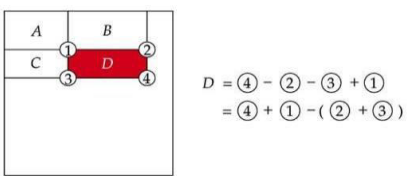
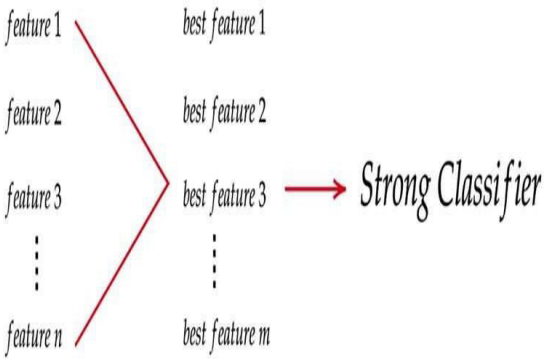


Integral Image: - An integral image is both the name of a data structure and the name of the algorithm that produces it (summed-area table). It is used to quickly and accurately determine the summation of the pixel standards in an image or a rectangular fragment of an image. In this, assessment of each and every point is the totality of entire pixels above and to the left, in which the target pixel also added:



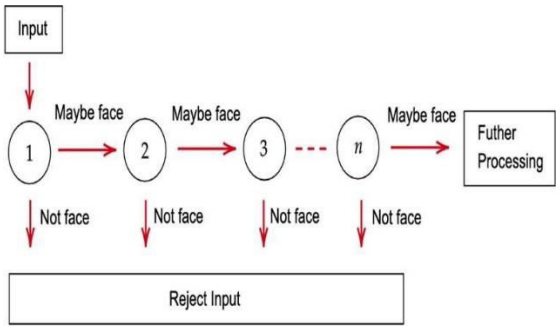


AdaBoost Classifier: -



where $n > m$

The Cascade Classifier: -



A multi-stage classifier with quick and accurate detection is called a cascade classifier. For each stage, the AdaBoost Algorithm creates a potent classifier. As a strong classifier advances through the stages, the number of weak classifiers increases. On an input, a sequential (stage-by-stage) evaluation is carried out.

Face Recognition

LBPH: -" Face recognition is a technique for recognizing a individual based on the profile or facial traits of that individual. A technique for locating and identifying a

person's face is called the LBPH (Local Binary Patterns Histogram). In LBP, a piece of the picture that is grayscale is first taken as a 33 window size, the neighboring pixel value is compared to the center pixel value, and then a binary value is assigned. This binary value is then transformed to a decimal value. An LBPH method is then created by combining LBP with histograms. An electrical component known as a GPU (Graphics Processing Unit) is more potent than a Central Processing Unit .

The computing process is just getting started at this point. A sliding window concept has been used to create an intermediate image that better represents the original image by taking into consideration the neighbor and the radius. New binary values are created by comparing the 8 neighbor values to the threshold value. The value is set to 1 for any neighbor value above the threshold value and to 0 for any neighbor value below the threshold value. With the exception of the threshold, this results in a binary number matrix. By changing the binary number to a decimal value that represents the pixels of the original image, the center value of the matrix can be found.

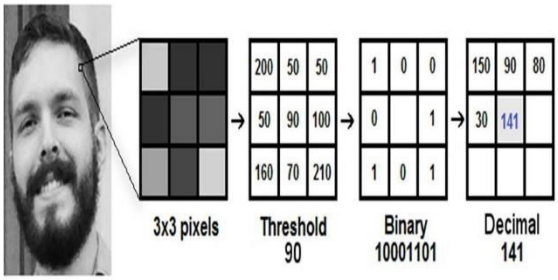
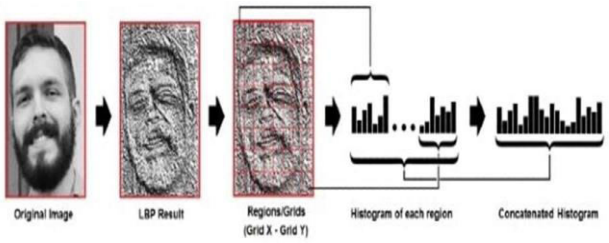


Fig.3 Facial Landmark Detection - BlazeFace

The Grid Parameters X and Y are used to divide the image obtained in Step into several grids. Each histogram on each grid in this grayscale image represents the intensity of the occurrences of each pixel. The qualities of the source image are then represented by a new histogram that is produced by combining each histogram.



BlazeFace makes use of a Mobile Net-based upgraded network. Given that a 3x3 depth wise convolution of a 56x56x128 tensor on the iPhone X takes 0.07ms whereas a subsequent 1x1 convolution from 128 to 128 channels is 4.3 times slower at 0.3ms. To speed up the procedure, the authors suggest replacing 3x3 depth wise convolution with 5x5

depth wise convolution, making the model shallower.

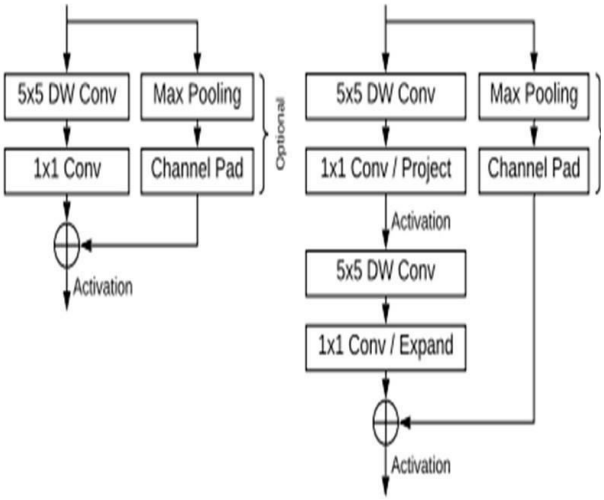


Fig.4 BlazeFace- An improved network

Implementation

The proposed AI based Teaching assistant system consists of two main parts: For face recognition, we used Viola-Jones Algorithm to detect the face, and then LBPH for face recognition.

Face Recognition:

Data Preprocessing: Four subjects have been randomly selected from the DAiSEE Dataset. We extracted around 26- 28 images for each subject from the video frames, using the following code that was included with the dataset. These images are used as a pre-existing dataset while training the model to recognize a new face.

```
import os
import subprocess

dataset = os.listdir('Data/')

def split_video(video_file, image_name_prefix, destination_path):
    return subprocess.check_output('ffmpeg -i "' + destination_path+video_file + '" ' + image_name_prefix
    + '%d.jpg -hide_banner', shell=True, cwd=destination_path)

for ttv in dataset:
    users = os.listdir('Data/'+ttv+'/')
    for user in users:
        currUser = os.listdir('Data/'+ttv+'/'+user+'/')
        for extract in currUser:
            clip = os.listdir('Data/'+ttv+'/'+user+'/'+extract+'/')[0]
            print (clip[:-4])
            path = os.path.abspath('.')+'/Data/'+ttv+'/'+user+'/'+extract+'/'
            split_video(clip, clip[:-4], path)

print ("========================================================================\n")
print ("Frame Extraction Successful")
```

Face Detection: At the beginning, while the student is registering, a web cam turns on and captures 20 frames of images for the new student. Then, Viola Jones algorithm detects the face from the captured images after converting them to gray scale images.

```
main.py  X
Users > alanoud > Desktop > final_project > main.py

    def detect_face(self,test_img):
        gray_img=cv2.cvtColor(test_img,cv2.COLOR_BGR2GRAY)
        face_haar_cascade=cv2.CascadeClassifier('HaarCascade/haarcascade_frontalface_default.xml')
        faces = face_haar_cascade.detectMultiScale(
                gray_img,
                scaleFactor=1.1,
                minNeighbors=5,
                minSize=(30, 30),
                flags=cv2.CASCADE_SCALE_IMAGE)

        return faces,gray_img
```

Model Training: To train the model, Local Binary Pattern Histogram (LBPH) recognizer is used. When the student is registering, the web camstarts to take 20 frames of images for the new student, in addition to pre-existing dataset, the

model will be trained to recognize the student's face.

```
main.py  X
Users > alanoud > Desktop > final_project > main.py
222
223         face_recognizer=cv2.face.LBPHFaceRecognizer_create() # initiate LBPH Face recognizer
224         face_recognizer.train(faces,np.array(faceID)) # Train face recognizer
225
226         face_recognizer.write('trained.yml') # Save file
227
228         print('Training Completed')
229
```

The output is listed in following figures –

```
final_project — python main.py — 80×24
id: Anoud
[[787 333 504 504]]
[[787 333 504 504]]
[[173 177 179 ... 208 197 185]
 [178 178 180 ... 210 201 189]
 [180 179 180 ... 213 209 203]
 ...
 [172 172 170 ... 156 151 150]
 [167 169 171 ... 152 144 143]
 [161 166 169 ... 153 148 155]]
img_path: train_data/Anoud/2frame.npy
id: Anoud
[[818 336 506 506]]
[[818 336 506 506]]
[[140 144 149 ... 181 168 159]
 [145 146 150 ... 183 172 162]
 [149 147 150 ... 188 183 176]
 ...
 [149 149 149 ... 131 128 128]
 [145 146 149 ... 129 123 123]
 [139 144 146 ... 129 127 131]]
img_path: train_data/Anoud/10frame.npy
id: Anoud
```

```
final_project — python main.py — 80×24
      [136, 123, 111, ...,  29,  18,  46]], dtype=uint8), array([[180, 180, 177
, ..., 151, 151, 152],
      [180, 180, 178, ..., 151, 151, 152],
      [179, 179, 179, ..., 151, 151, 152],
      ...,
      [116, 109, 103, ...,  42,  73,  92],
      [109, 104, 101, ...,  43,  71,  91],
      [104, 101, 102, ...,  44,  70,  89]], dtype=uint8), array([[186, 186, 186
, ..., 157, 157, 157],
      [186, 186, 186, ..., 157, 157, 157],
      [186, 186, 186, ..., 157, 157, 157],
      ...,
      [174, 172, 170, ...,  25,  56,  75],
      [170, 165, 160, ...,  32,  44,  75],
      [166, 160, 151, ...,  35,  44,  74]], dtype=uint8), array([[170, 174, 166
, ..., 156, 158, 160],
      [180, 176, 171, ..., 150, 153, 157],
      [180, 177, 174, ..., 151, 156, 158],
      ...,
      [ 99,  91,  89, ...,  88,  76,  53],
      [ 96,  87,  90, ...,  88,  77,  56],
      [ 93,  89,  95, ...,  87,  77,  58]], dtype=uint8)]
Training Completed
```

Fig.5 Output of proposed Algorithm

Conclusions and Future Work

In conclusion, studies that are conducted for FER were adopted on six basic expressions (happiness (or joy), sadness, surprise, anger, fear, and disgust) which do not reflect any academic emotions (attentive, boredom, confusion, distraction, etc.) that the learner could feel during the class.

Our emotion recognizer has given an accuracy of 99% with a dataset of 12 people which shows that our model is sufficient for a class. For future work we can integrate the whole authentication and analysis system with the online streaming platform using rest API and cloud services as per availability.

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