Stress Detection Using Facial Image Recognition Model And Thermal Camera

SREERAM S – CB.EN.U4ECE18157
PULLA NITHIN – CB.EN.U4ECE18146
VAMSI KRISHNA – CB.EN.U4ECE18167
ELECTRONICS AND COMMUNICATION ENGINEERING
AMRITA VISHWA VIDYAPEETAM
COIMBATORE,INDIA

Abstract—

This Project ,"Stress Detection" as the name suggests is to detect if a person has stress using the eyebrow movement , the eye blinking movement and with the help of a thermal camera using the image processing techniques with the help of Python. Stress Detection from facial Recognition is a subject that has not received much attention although it is an Important problem . This project presents a method to detect stress using the Facial Recognition Model and body heat maps with the help of concept of Deep Learning , Machine Learning , Image Processing and Convolutional Neural Network .

I. INTRODUCTION

As will be discussed below this project is based on stress detection using two methods that is using a eyebrow detection tool and the other is through the usage of a thermal camera . The project is divided into two basis . At first the real time face stress detection model is carried out . The image of person is captured using a webcam and then his/her eyebrow movement observed carefully , the eye blink movement as well is also checked thoroughly . The model classifies face as stressed or Not Stressed . And in the second part , the stress level is calculated with the help of eyebrows contraction and the second method is detection of stress by means of generating a body heat map of the patient with the help of a thermal camera .

II. THERE ARE 5 PHASES FOR THIS MODEL

A . Real Time Web Cam Feed

The Web Camera is turned "ON" . The camera detects the face of the person .The real time image of the person is captured and stored as data safely . As it is based on Emotion Recognition and Eyebrow detection method please be clear with your emotions , Fakeness cannot be detected .

B. Detection of Faces

After the image of the person has been captured the next step is to detect the face rightly . The model will detect eyebrows and its movement both left eyebrow as well as the right eyebrow is detected and noted well and its dimensions and shapes is captured and detected to perfectly to endorse with the rest of the upcoming operations . The contraction of the eyebrows and the displacement of the eyebrows from the mean position is carefully detected .

C. Prediction of Stress

Here , Our Emotion Recognition model is run and it will return the emotion predicted real time . The model will recognize your emotion using machine learning the emotion is detected and based on appropriate data's and calculations obtained from the detected face . The end result classifies the face as stressed and not stressed . The model is trained on a legit dataset .

D. Stress Level

The Stress level is actually calculated using the help of eyebrows contraction and eyebrows displacement from the mean position . The distance between the left eyebrow and the right eyebrow is being calculated using the exponential function and is normalized between 1 to 100 range .

E. Using Thermal Camera

This is the last phase and also the second method to detect stress .

- The Thermal Facial Image of the subject is captured by an IR Thermal Camera .ss
- The Captured Image is sent into a Convolutional Neural Network for the mapping of the given heat map into its corresponding mental conditions .
- The heat map is then sent into an Image Processing Function where the pixels matching the given colour scale determine the intensity of the condition .
- And , Finally You receive the accurate results of the diagnosis .

III Problem Statement

Stress is most common in students and working professionals as well . Nearly 9 in 10 Indians suffer from stress . According to the surveys conducted almost 95 percent of Indian millennials between the age group of 18-34 are stressed compared to the global average of 86 percent . Making it even worse , one in eight Indians have serious trouble in dealing with stress and almost 75 percent of the Indian Victims said that they don't feel comfortable talking to others or even with medical professionals about their stress . The Consultation cost was cited as one of the biggest barriers to seek professional help . Currently there is Inaccuracy and Uncertainty in diagnosing mental health diseases like stress , depression and anxiety .

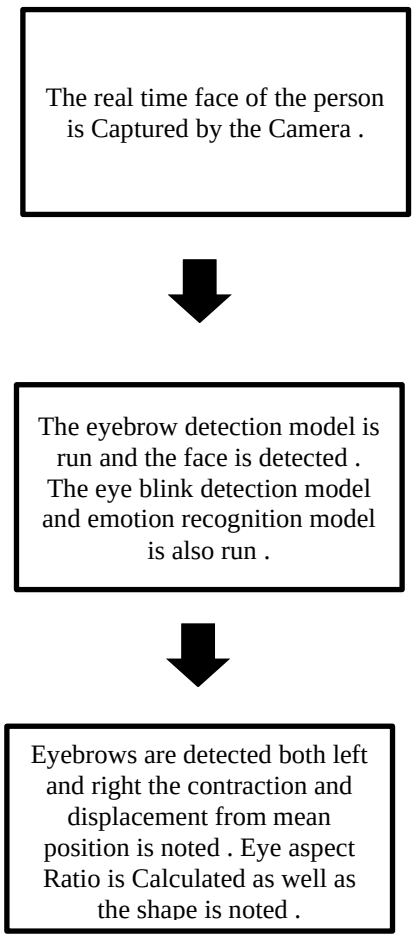
.

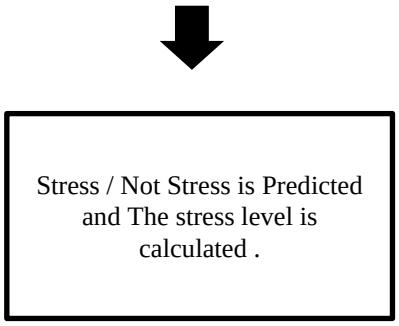
IV Our Solution to the Problem

- Detection of stress using Eyebrow Movement and Thermal Camera . With the help of Machine Learning in Recognizing your emotions and analyzing the dimensions and measurements of your eyebrows with the Datasets and calculating the stress level in a Person . Detecting the disease with accuracy by means of generating a body heat map of the patient with the help of a thermal camera and applying the techniques of Image Processing and Deep Learning Image Classifications models to measure the magnitude of the detected disease .

V BLOCK DIAGRAM - 1

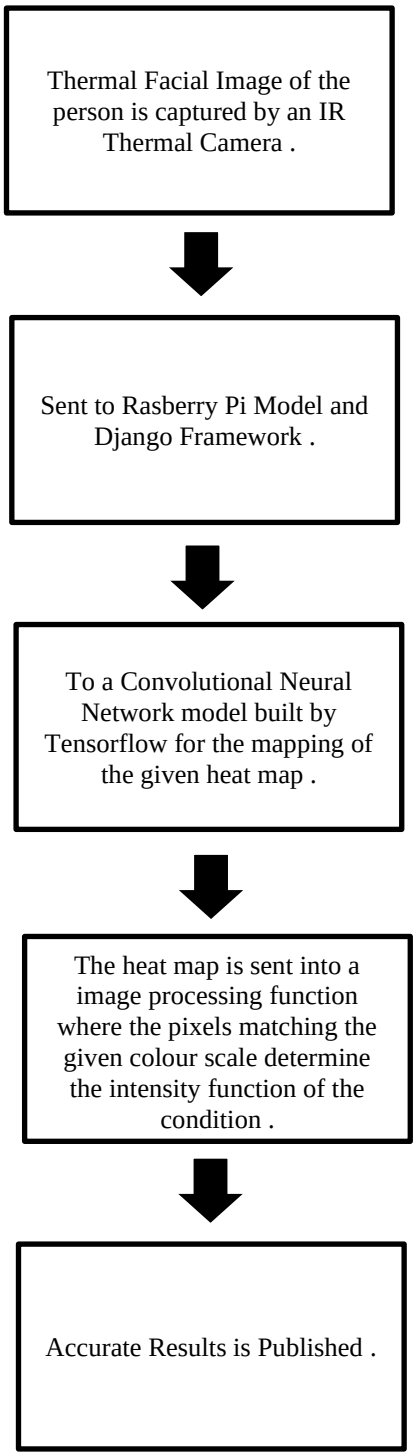
A. Detection Using Eyebrow Movement





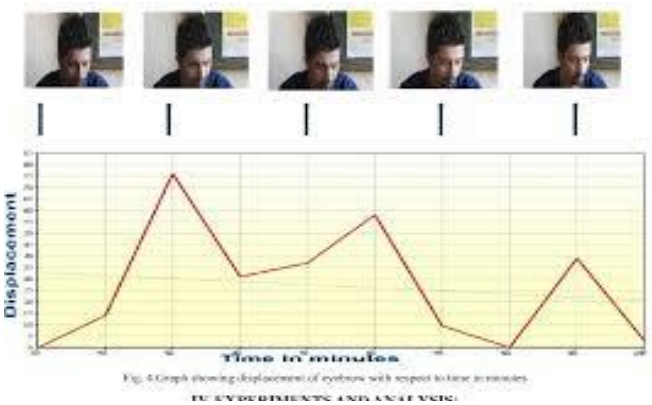
BLOCK DIAGRAM – 2

B. Detection Using Thermal Camera



VI Working Principle

The emotion recognition model will return the emotion predicted real time . The stress level is calculated with the help of eyebrows contraction and displacement from the mean position . The distance between the left and the right eyebrow is being calculated and then the stress level is calculated using exponential function and normalized between 1 to 100 .



The above graph shows displacement of eyebrow with respect to time , this is used to calculate the eye aspect ratio .

We have Used **TensorFlow** for this Approach .

TensorFlow

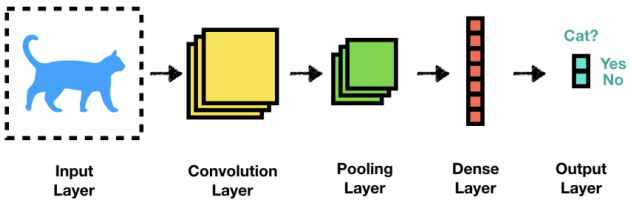
TensorFlow is an Open Source and flexible Machine Learning Software library developed by google brain .TensorFlow offers multiple levels of abstraction we can train models by using the high level Keras API . It has more flexibility , Immediate Iteration and Intuitive Debugging . The Major use of this library include classification , perception , understanding , discovering, prediction and creation .

To Maintain More accuracy we have developed another model because Fakeness cannot be detected in the Emotion Recognition model so accurately hence we use the Thermal Camera Model Approach also for the perfection of output and results .

In the second method we generate body heat map of the patient and apply techniques of image processing and Deep Leaning Image Classification . Datasets of too many labelled body heat maps were collected and fed into the image classification model empowered by Convolutional Neural Network for training .

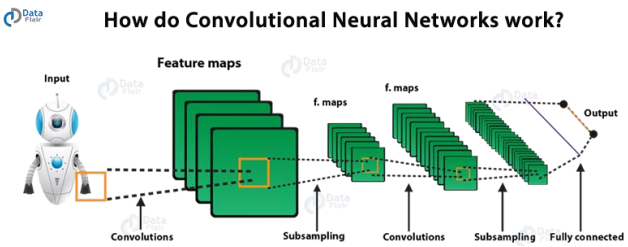
Convolutional Neural Network :-

Deep learning is a subfield of machine learning that is inspired by artificial neural networks .
A specific kind of such a deep neural network is the convolutional network, which is commonly referred to as CNN. It's a deep, feed-forward artificial neural network. Remember that feed-forward neural networks are also called multi-layer perceptron's(MLPs), which are the quintessential deep learning models. The models are called "feed-forward" because information flows right through the model. There are no feedback connections in which outputs of the model are fed back into itself.



Convolutional neural networks have been one of the most influential innovations in the field of computer vision. They have performed a lot better than traditional computer vision and have produced state-of-the-art results. These neural networks have proven to be successful in many different real-life case studies and applications,
like:

- Image classification, object detection, segmentation, face recognition;
- Self-driving cars that leverage CNN based vision systems;
- Classification of crystal structure using a convolutional neural network;



VII Results and Discussions

At first we explored with the eye blink , eyebrow and emotion recognition method for the calculation of stress level and to predict if a person is stressed . Eyebrow Detection Code :

```
from scipy.spatial import distance as dist
from imutils.video import VideoStream
from imutils import face_utils
import numpy as np
import imutils
import time
import dlib
import cv2
import matplotlib.pyplot as plt
from keras.preprocessing.image import img_to_array
from keras.models import load_model

def eye_brow_distance(leye,reye):
    global points
    distq = dist.euclidean(leye,reye)
    points.append(int(distq))
    return distq

def emotion_finder(faces,frame):
    global emotion_classifier
    EMOTIONS = ["angry" ,"disgust","scared", "happy", "sad", "surprised","neu
    x,y,w,h = face_utils.rect_to_bb(faces)
    frame = frame[y:y+h,x:x+w]
    roi = cv2.resize(frame,(64,64))
    roi = roi.astype("float") / 255.0
    roi = img_to_array(roi)
    roi = np.expand_dims(roi,axis=0)
    preds = emotion_classifier.predict(roi)[0]
    emotion_probability = np.max(preds)
    label = EMOTIONS[preds.argmax()]
    if label in ['scared','sad']:
        label = 'stressed'
    else:
        label = 'not stressed'
    return label
```

```
def normalize_values(points,disp):
    normalized_value = abs(disp - np.min(points))/abs(np.max(points) - np.min(points))
    stress_value = np.exp(-(normalized_value))
    print(stress_value)
    if stress_value>=75:
        return stress_value,"High Stress"
    else:
        return stress_value,"low_stress"

detector = dlib.get_frontal_face_detector()
modelPath = r"C:\Users\Pranay\shape_predictor_68_face_landmarks.dat"
predictor = dlib.shape_predictor(modelPath)
emotion_classifier = load_model("_mini_XCEPTION.102-0.66.hdf5", compile=False)
cap = cv2.VideoCapture(0)
points = []
while(True):
    _,frame = cap.read()
    frame = cv2.flip(frame,1)
    frame = imutils.resize(frame, width=500,height=500)


    (lBegin, lEnd) = face_utils.FACIAL_LANDMARKS_IDXS["right_eyebrow"]
    (rBegin, rEnd) = face_utils.FACIAL_LANDMARKS_IDXS["left_eyebrow"]

    #preprocessing the image
    gray = cv2.cvtColor(frame,cv2.COLOR_BGR2GRAY)

    detections = detector(gray,0)
    for detection in detections:
        emotion = emotion_finder(detection,gray)
        cv2.putText(frame, emotion, (10,10),cv2.FONT_HERSHEY_SIMPLEX, 0.5, (0, 255, 0), 2)
        shape = predictor(frame,detection)
        shape = face_utils.shape_to_np(shape)

        leyebrow = shape[lBegin:lEnd]
        reyebrow = shape[rBegin:rEnd]

        reyebrowhull = cv2.convexHull(reyebrow)
        leyebrowhull = cv2.convexHull(leyebrow)
```

The code for Emotion Recognition is as follows :-

```
from keras.callbacks import CSVLogger, ModelCheckpoint, EarlyStopping
from keras.callbacks import ReduceLROnPlateau
from keras.preprocessing.image import ImageDataGenerator
from load_and_process import load_fer2013
from load_and_process import preprocess_input
from models.cnn import mini_XCEPTION
from sklearn.model_selection import train_test_split

# parameters
batch_size = 32
num_epochs = 10000
input_shape = (48, 48, 1)
validation_split = .2
verbose = 1
num_classes = 7
patience = 50
base_path = 'models/'

# data generator
data_generator = ImageDataGenerator(
                        featurewise_center=False,
                        featurewise_std_normalization=False,
                        rotation_range=10,
                        width_shift_range=0.1,
                        height_shift_range=0.1,
                        zoom_range=.1,
                        horizontal_flip=True)

# model parameters/compilation
model = mini_XCEPTION(input_shape, num_classes)
model.compile(optimizer='adam', loss='categorical_crossentropy',
              metrics=['accuracy'])
model.summary()
```

And the Eyeblink code is as follows which is to detect the eyeblink so as to get the eye aspect ratio , the shape of the eye which is required for further operations .

```
from scipy.spatial import distance as dist
from imutils.video import VideoStream
from imutils import face_utils
import numpy as np
import imutils
import time
import dlib
import cv2

#get the location of the eyes
def eye_aspect_ratio(eye):
    # compute the euclidean distances between the vertical landamrks
    A = dist.euclidean(eye[1], eye[5])
    B = dist.euclidean(eye[2], eye[4])

    # compute the euclidean distance between the horizontal
    C = dist.euclidean(eye[0], eye[3])

    # compute the eye aspect ratio
    eye_opening_ratio = (A + B) / (2.0 * C)

    # return the eye aspect ratio
    return eye_opening_ratio


# the consecuting frame factor tells us to consider this amount of farme.
ar_thresh = 0.3
eye_ar_consec_frame = 5
counter = 0
total = 0

# get the frontal face detector and shape predictor
detector = dlib.get_frontal_face_detector()
predictor = dlib.shape_predictor("shape_predictor_68_face_landmarks.dat")
cap = cv2.VideoCapture(0)
while(True):
    _,frame = cap.read()
    frame = cv2.flip(frame,1)
    frame = imutils.resize(frame, width=500,height=500)
```

Input :-

We give the input by making a person sit in front of the camera to capture the real time facial image and run the eyebrow detection and eye blink code and then we run the Emotion recognitino file .

The input Image is given as folows (Fig a) the eye blink detection file is run to get the value of Eye Aspect Ratio value as you see it is displayed in the right side in Fig (a) .

Fig (a)

Output :-

The eyebrows are detected and the subject is predicted as stressed or Not stressed with his/her stress level indicated as you see in Fig (b) .

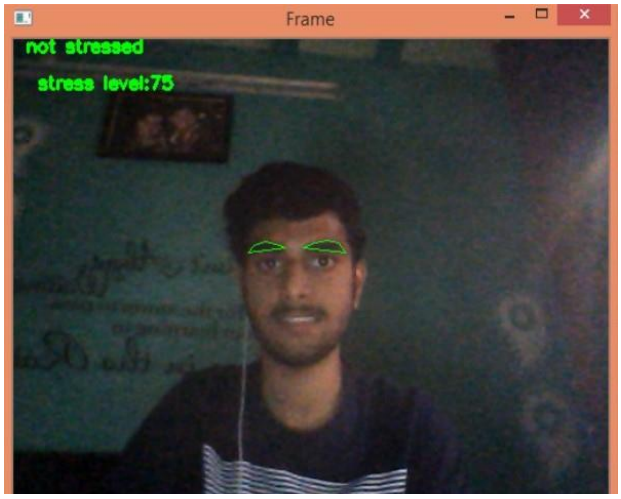


Fig (b)

In the first method we used the help of the packages like TensorFlow , keras , imutils . The eyebrow detection file was run to detect the Eyebrows. The eye blink model was run and the Eye Aspect Ratio was found out , Secondly the Emotion Recognition model was run to detect the Emotions and then finally the stress / not stress was predicted and the stress level was shown to the user .

In Our Second method for more accuracy that is using the thermal camera we give the input image as a thermal image as you see below in Fig (c) and Fig (d) .

Detection Using Thermal Camera

The Code to find a stressed and not stressed using the thermal camera method is as follows .

Code :-

```
import numpy as np
from keras.preprocessing import image
test_image = image.load_img('testimages/0170.jpg', target_size = (64, 64))
test_image = image.img_to_array(test_image)
test_image = np.expand_dims(test_image, axis = 0)
result = model.predict(test_image)

#training_set.class_indices
if result[0][0] == 1:
   prediction = 'stressed'
   print('-----THE GIVEN IMAGE DENOTES A STRESSED PERSON-----')
else:
   prediction = 'notstressed'
   print('-----THE GIVEN IMAGE DENOTES A NOT STRESSED PERSON-----')
```

The code to train our data is given below

```
from keras.models import Sequential
from keras.layers import Conv2D
from keras.layers import MaxPooling2D
from keras.layers import Flatten
from keras.layers import Dense
from keras.preprocessing.image import ImageDataGenerator

classifier = Sequential()

classifier.add(Conv2D(32, (3, 3), input_shape = (64, 64, 3), activation = 'relu'))

classifier.add(MaxPooling2D(pool_size = (2, 2)))

classifier.add(Flatten())

classifier.add(Dense(units = 128, activation = 'relu'))

classifier.add(Dense(units = 1, activation = 'sigmoid'))

classifier.compile(optimizer = 'adam', loss = 'binary_crossentropy', metrics = ['accuracy'])

train_datagen = ImageDataGenerator(rescale = 1./255, shear_range = 0.2, zoom_range = 0.2, horiz
test_datagen = ImageDataGenerator(rescale = 1./255)
training_set = train_datagen.flow_from_directory('training_set', target_size = (64, 64), batch_
test_set = test_datagen.flow_from_directory('test_set', target_size = (64, 64), batch_size = 32

classifier.fit_generator(training_set, steps_per_epoch = 100, epochs = 1, validation_data = tes
with open('model\\model_architecture.json', 'w') as f:
    f.write(classifier.to_json())
classifier.save_weights("model\\model.h5")
```

Input :-

We give the input image has a thermal image

Fig (c)

Output :-

```
In [6]: runfile('C:/Users/Vamsi/Downloads/UnorthodoxInc-master/app.py', wdir='C:/Users/
Vamsi/Downloads/UnorthodoxInc-master')
-----THE GIVEN IMAGE DENOTES A NOT STRESSED PERSON-----

In [7]:
```

IPython console | History log

The output is "Not Stressed" Hence the given input thermal image was that of a not stressed persons Image .

Input :-

Fig(d)

Output :-

Console 1/A

```
In [4]: runfile('C:/Users/Vamsi/Downloads/UnorthodoxInc-master/app.py', wdir='C:/Users/
Vamsi/Downloads/UnorthodoxInc-master')
-----THE GIVEN IMAGE DENOTES A STRESSED PERSON-----
```

And this shows that the given thermal image in Fig(d) is that of a person with "Stress" .

Hence we get to know the difference in both the images using the thermal camera method . Fig (C) is that of a Not stressed person and Fig(d) is of a stressed person .

The Image Classification Algorithm used is Convolutional Neural Network and datasets were labelled as Stressed and Not stressed And we used Binary Classification Approach .

VIII Inference

To check the fine working of the model , certain sample data were collected and given as input to the eyebrow detection model and the file was made to run using both the methods the data contained the eyebrow length and width and displacement length from the mean position and eyebrow contraction , dimension data as well for the method-1 . Based on the input values given by the user the model checked carefully and compared the new data with existing huge dataset . It was Predicted as a Stressed Person based on the results and the stress level of the person with the given input data was also identified . After the Positive Outcome of this Operation we made a person sit straight In front of the webcam , the image of person was captured using a webcam and then his/her eyebrow movement was observed carefully , the eye blink movement as well was also checked thoroughly and the results were obtained accordingly . For the second method we experimented it first with an Already Captured Image before working with real time face . After the capturing of the Thermal Facial Image of the person using an IR Camera , the captured was passed through raspberry Pi model and the Django framework and then to the convolutional neural network that was built by TensorFlow which is very important package for Machine Learning and Deep Learning Principles . In the Convolutional Neural Network the mapping of the given heat map to its corresponding mental conditions was done Accurately . The accurate Result of the Diagnosis was obtained both with real time face as well as with Pre-Obtained input Data .

Prior to this Datasets of hundreds of such Labelled Body Heat Maps was collected and fed into the Image Classifying model empowered by Convolutional Neural Networks for training. The trained model was thus able to map the given unlabeled body heat map to its corresponding mental health condition with the help of the concept of Deep Learning . The magnitude of the thus identified condition is computed by means of Image Processing with the help of the colour scale . The model can be further improved by other facial features inputs as well that include Lip movement , Head Positioning , Eye Blinking and Gaze moment . We found that the following features can be detected and a cumulative function can be defined to give out the total stress value .

IX Conclusion

As we have seen earlier this project is mainly based in the objective of helping people aging between 18-35 to know their stress level and help them sought it out as the consultation cost was cited as one of the biggest barriers for people with this disease to seek the medical professionals help . The Eyebrow movement model can be developed into a Web-Application and made available for everyone and make the process of stress detection easier . And the Thermal Camera Method can be used an accurate analytical tool for the Psychiatrists , an essential tool that could be of support for the counsellors , caretakers , medical staff in schools , colleges and offices . This will also ease out Researches on Mental health . Our Main goal with this model is to reach out and help every youngster with the stress , anxiety and depression issues and see each and every healthcare , clinics ranging from small scale to Multi-Facility . Hospitals to take into consideration of their patients mental health as well.

X References

1. Heat Maps Article
2. Global Mental Health Stats
3. Research on Stress among Indians Articles
4. TensorFlow
5. GitHub
6. Keras
7. Pypi.org
8. Researchgate.net