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Pain Detection Using Face Expression

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Abstract - *The basic idea of this project is to build an interactive system among software that takes some mandatory inputs to recognize the symptoms and stress level of a person and hardware that tells about brain signals and pain intensity of that person. Affective computing research field is growing on large scale with the frequent development of human computer application. These application use information of mental or affective condition of the desired subject to train their brain responses. Usually classification algorithm is used for text physiology, vocal, expression of face and other accumulation. Pain may be a personal, particular experience that's normally evaluated through graphical analog scales. Generally it's appropriate and functional, machine-driven system of pain detection that can reduce pain score attainment exertions in big scale studies by guessing it directly from the contributors' facial expressions. Face plays significant role in social communication. This is a 'window' to human personality, emotion and thoughts. Many times, body languages and particularly facial expressions, tell us quite about one's state of mind.*

Keywords— *Facial Expression, Feature Extraction, Intensity, Pain, Haar Cascade, Image Recognition, Emotions.*

I. INTRODUCTION

Facial expressions are considered as a useful checkpoint for the identification of various emotions, including pain. Improving the talents of reading expressions is a crucial step towards successful relations. For certain emotions, it's very hard, and perhaps even impossible, to avoid it's fitting countenance. While the incidence of pain are often defined clearly, the sensation and severity that every individual undergoes may be a subjective experience, differing from person to person. Facial expressions encountered during the course of lifestyle and during a clinical setting weren't limited to a one, still image, but were composed of multiple images that were in motion. Computer-based detection and software limited the influence of subjectivity on diagnosis, and the information gained from such studies has the potential to add to our knowledge and experience about pain. Many times, body languages and particularly facial expressions, tell us quite words about one's state of mind. The basic idea of this project is to build an interactive system among software that takes inputs to recognize the expression of a person through the picture and hardware or device that tell about the expression and stress of that person. Specifically, we implement multitask learning approach based on facial expression that accounts for individual differences in pain and emotional responses while still leveraging data from across the population.

There are various methods to extract features of both appearance and shape of person's face. The shape and appearance can be extracted separately and then used to train a classifier. The extracted features of the patients face include various properties of painful images such as head movements, appearance and shape of person's facial expression information.

Haar Cascade, it's an Object Detection Algorithm used to identify faces in a picture or a true time video. The algorithm uses edge on line detection features proposed by Viola and Jones. The algorithm is given a lot of positive images and a lot of negative images. The storehouse has the models stockpiled in XML files, and may be read with the OpenCV methods. These comprise models for face detection, eye detection, upper body and lower body detection, etc.

We proposed a concept for recognizing facial expressions of pain and rating its intensity. It is based on facial distance and gradient features. The model parameters are trained using Comparative Learning, a novel technique based on a form of labelling that goes without the need of experts. We plan to perform a more extensive evaluation of the proposed approach and investigate further the relationship between different pain score, and their automatic estimation from facial expression.

II. Literature Review

Facial recognition has become one of the most important factors in monitoring medical, criminal identification and IoT applications etc. It is making smooth path for security where password authentication uses face recognition system [15] which is safer and secure and strengthens the security, using the face as the password. In medical field it is used for the understanding of human expression and pain expression using the features extraction.

Facial Expression Recognition, because the main procedure approach for non-verbal purposes, is a vital and hopeful field of laptop idea and computer science, and one among the topic areas of balance. As for deep learning-based ways, four variations of neural network-based advanced FER approaches are bestowed and analysed. Besides, we incline to present seventeen normally used FER datasets and summarise four FER-related fragments of datasets that will affect the choosing and method of FER approaches. [1]

Facial pain expression is a crucial modality for assessing pain, particularly when the patient's verbal ability to speak is impaired. The facial muscle-based action units (AUs) that are outlined by the Facial Action Coding System (FACS) are wide studied and are extremely reliable as a technique for police work facial expressions (FE) as well as valid detection of pain. Patients who are dying, intellectually disabled [9], critically sick and insensible [10] [5], or have insanity [8], head and neck cancer, or brain metastasis [7] [6] [11] are notably vulnerable and in would like of technology that would offer reliable and valid alerts concerning their pain to busy clinicians. The American Society for Pain Management Nursing (ASPMN), in its position statement on pain assessment within the nonverbal patient [7], describes a hierarchy of pain assessment during which the observation of behavior as well as facial expressions is noted to be a legitimate approach to pain assessment. [2]
Haar-Cascade is used for facial recognition. It is a facial recognition system that recognizes the face with videos, images etc. [16] The Algorithm uses feature extraction to distinguish the different faces. Features are the eyes, nose, eyebrows, ears etc. This paper shows the type of expression expressed using the feature extraction from the images. This may further used for the medical purpose.

Pain is troublesome to assess and manage. Pain is basically subjective and is often measured by patient self-report, either through clinical interview or visual analog scale (VAS). Using the VAS, patients indicate the intensity of their pain by marking a line on a horizontal scale, anchored at every finish with words like ''no pain" and ''the worst pain imaginable". This and similar techniques are in style as a result of their convenient, simple, satisfy a desire to connect variety to the expertise of pain, and infrequently yield information that make sure expectations. Self-report measures, however, have many limitations [12] [13]. In real-world applications and particularly in patients experiencing acute pain, out-of-plane head motion and fast changes in head motion and expression are notably challenging. Extending the approach of [14], we tend to applied machine learning to the task of automatic pain detection in a very real-world clinical setting involving patients undergoing assessment for pain. [3]

The facial parameterization victimisation Facial Action committal to writing System(FACS) action units and therefore the ways that acknowledges the action units parameters using face expression information that are extracted. Varied kinds of facial expressions are present in face which might be known supported their geometric features, appearance features and hybrid features. The 2 basic ideas of extracting features are supported facial deformation and facial motion. [4]

It is a facial recognition system that recognizes the face with videos, images etc. it uses feature extraction to distinguish the different faces. Features are the eyes, nose, eyebrows, ears etc. This paper shows the type of expression expressed using the feature extraction from the images.

The temporal order and also the configuration of a personality's face expression square measure vital in feeling expression and recognition. Their square measure several approaches that analyse the facial expressions mechanically and take a look at to acknowledge a little set of prototypic emotional facial expressions like concern, anger, happiness, sadness, etc. rather than classifying the expressions of an individual into few common feeling classes, we can attempt to live an oversized quantity of facial behaviors by victimization action units that are created by the person's expressions.[24] Muscle movement and actions modify the form and site of elements of the face of an individual a number of these changes within the expressions square measure evident whereas some don't seem to be.[23] Spontaneous facial expressions square measure totally different from posed expressions in each that muscles square measure rapt and within the dynamics of the movement.[22] The detected feature points square measure analyzed and categorized into action units (AUs) to acknowledge the face expression in every frame. Face expression element were mechanically detected and metameric. Then, we've detected facial feature points that go along with face expression deformations.[21]

III. DATA COLLECTION

Representative dataset is the fundamental basis for training and examine an AFER system. The performance evaluation of and comparison among different SFER approaches would not be fair or meaningful without context of the datasets used in the evaluation. Establishing a pain-oriented facial expression to dataset is much more inspiring than establishing a general AFER dataset. The UNBC-McMaster(2011), shoulder pain expression archive dataset is the only publicly available spontaneous facial expression dataset targeting pain at the time till 2011. It contains 48,398 FACS coded frames in 200 video sequences. The video segment is captured from patients suffering from shoulder pain and spontaneous facial expression are triggered by moving their affected and unaffected limbs. Another dataset, the SEMAINE dataset provides high-quality, multi-model recording to study social signals occurring during interaction between human beings and virtual human avatars. The video frames were recorded from 150 participants of varying age and partitioned into subset for training (48,00), development (45,000), and testing (37,695).

For this project we have also used dataset available on Kaggle and Github which also contains image and videos of participants of varying age and suffering from some type of pain. The dataset contains facial expressions from different slides. The videos from this dataset are continuous shots at 480p from different angles. This is meant to advance as a dataset for facial expression recognition below different angles and poses. Talking about the image recognition for pain assessment the facial expressions can be classified in different emotions like: Anger, Sad, Surprised, Happy, Neutral, etc. The expression while the human face is in anger is at extreme and it shows more pain, but while in a happy mood human expression is more positive. Neutral facial expression is considered as normal, the surprised emotion is quite non-describable so for that moderate pain is considered. Sad emotion contains some amount of pain because the facial expression for Anger and Sadness is 60%-70% same.

In real-world bids of image acknowledgement, training data is usually constrained, which is commonly the core motive for the over-fitting difficulty and sub-optimal accuracy. However, it is impractical to get adequate training sample in real-world application. Therefore, we can expand the training data artificially, which is a widespread pre-processing technique in image recognition. We can add to the training data by rotating, transforming, cropping, casual scaling the image etc. Observe that the augment method requires to conform to the probable variations in real world.

IV. METHODOLOGY

A. Face Detection

Detecting a person's face is an easy task for people. On the subsidiary hand, this is not easy for a computer, due to huge differences in the real-moving picture data. As the image can be each and every one with human, animal, intention etc the data varies. Face detection is identifying the human incline from the video or describe. It may be one or many faces. It detects the human faces and ignores supplementary things. It is used to detect faces in images and video by matching alike properties by using Haar based features [18]. As the figure shown the camera detects the point and the faces are with wrapped taking place in a crate to comport yourself faces.

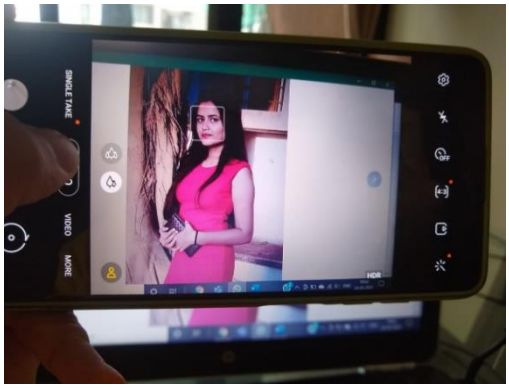


Figure. *An example of face detection.*

B. Facial feature extraction

After detecting the face, extracting the facial features is important for grasping what type of expression the face is conveying. It is a procedure where it identifies the important elements of the face. Facial detection differentiates the images formulated on the feature extraction [19]. Haar uses feature extraction to classify the faces. It recognizes whether the face is image is a male or a female or who the person is. Facial feature extraction are eyes, nose, ears, lips etc. Facial recognition is possible due to these extracted features.

C. Haar Cascade Classifier

Haar Cascade, it is an Object Detection Algorithm used to identify faces in an image or a real time video. The algorithm uses edge or line detection features proposed by Viola and Jones [18]. It is trained from lot of images. It is a machine learning built methodology where it is set with plentiful positive images and plentiful negative images to train the classifier.

Positive images- These are the images which we want the classifier to identify.

Negative images- These are the images of everything which does not contain the object we want.

Haar feature is classified in:

Calculating Haar features,

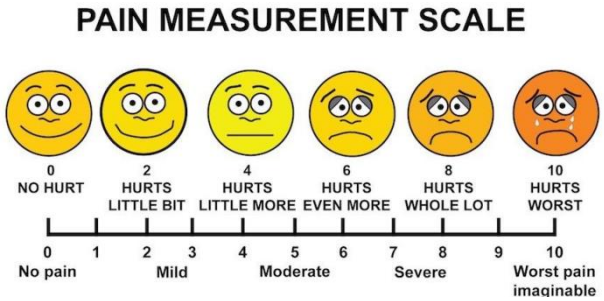
Creating Integral Images [15],

Implementing Cascade Classifiers.

It has some features like Edge feature, Line feature and Four-rectangle features. These features in the images make it easy to discover the edges or lines on the images. [19]

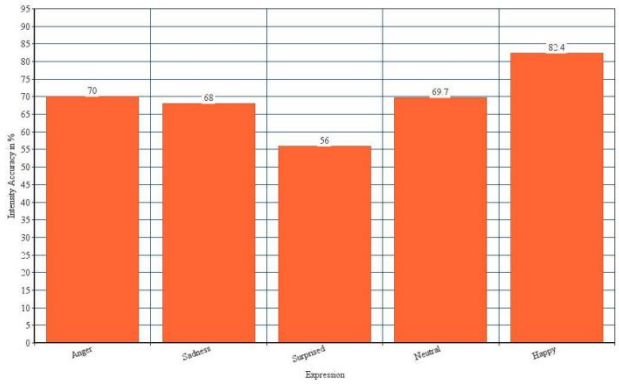
V. RESULTS

The pain level intensity detection gets tougher for the people who are unwilling to share and who cannot share the experienced pain. In real world applications and especially in patients experiencing acute pain, out-of-plane head motion and rapid changes in head motion and expression is particularly challenging. Thus extending the approach, we applied Haar Cascade machine learning to the task of automatic pain detection for assessment of pain.



So based on the experiment, the levels are divided into three classes, low level, medium level and high level intensity pain. Low level intensity was chosen between 10 and 40 percent. Again, medium level was taken between 50 and 70 percent and

between 80 and 100 was defined as high intensity. These percentages of intensities are defined on the basis of expressions and precisely enough the high intensity was observed for anger and sad expressions, medium level was observed for surprised and low level was observed for happy and neutral. The accuracy of this identification is about 89%.



Sensitivity Analysis:
The mean absolute error for pain level assessment need to be optimal in clinical settings. So it is important that the input and output pain distribution are similar. It is quite possible that the system is always giving the similar pain level as output, but the absolute error is low. Further findings could be more accurate if the sample is large and different types of population. As it is more relevant that multiple culture express their facial expression as well as pain differently, this is why, different expressions and behavioural bias for a single pain intensity reduces the performance of a system.

VI. DISCUSSIONS AND CONCLUSIONS

This paper introduces an automated way to track and recognize the facial expression features from the sequence of images. In this paper a new feature based approach for recognition of facial expression is introduced. This approach ensures automatic solutions to identify the expressions of humans as well as rising above facial expression variations and intensity. In this project the facial components namely eyes, mouth, eyebrows were automatically detected and were also segmented.[24] Also we have detected the points of interest surrounding the segmented features and some distances between the points of interest were also calculated. Also in this paper, we presented the facial expression recognition using the action units that is the subtle changes of a person's facial expressions and emotional expressions. Even though the system can work very well but the result of the system still had medium accuracy in the surrounding areas of mouth.[23] By comparing the accuracy of the experiment with various amounts of training data the system using more training data has a higher accuracy. Therefore in order to work with more accuracy the process of face recognition and facial feature extraction needs more training face data that are various. Due to the changes in light and shifting the face during the capturing process the facial feature points that are generated from the system are less satisfactory because of the unstable motion of a person.[23]

VII Future Work

The future is search in this project would be focused on improving the scale of the captured object. In this study the captured object is just a face from the front view.[It has the limitation that the position of the face must not be moving and should not be blur.[24]In the advanced and developed technology the captured object could be developed into a human body that can move freely. The future work is to extend to create a faced template to rectify the locations of the features of the face in case of any failure. The future work in pain level detection using facial expression is on applying the proposed facial feature extraction scheme for quick 3D face modelling using a stereo system.[23] In future it can also be used for quick video sequences.

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