**AI PROJECT Documentation**

**(20) FACIAL EXPRESSION RECOGNITION USING ARTIFICIAL NEURAL NETWORKS:**

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**CONTENT:**

**The report include the following:**

**Introduction to AUTOMATED FACIAL EXPRESSION RECOGNITION USING ANN.**

**(1) Project idea in details.**

**(2) Main functionalities(diagrams that we use).**

**(3) Similar applications in the market.**

**(4) An initial literature review of Academic publications (papers) relevant to the idea .**

**(5) the Dataset employed .**

**(6) Details of the algorithm(s)/approach(es) that will be used.**

FACIAL EXPRESSION RECOGNITION USING ARTIFICIAL NEURAL NETWORKS

**INTRODUCTION**:

**Humans can detect a facial expressions of any person easier, because its naturally directly recognized, but its very difficult to do by machine or computer. There are 3 main stages when designing a facial expression recognition system, that is, face detection (recognizes faces), extraction of the facial expression information (feature extraction which is separate parts of the face that has information about facial expressions) and the last is the classification of the expression[1]. This research facial expression, specially for smile and not smile expression, recognition using Artificial Neural Network algorithm with Back Propagation models and optimization using Principal Component Analysis.**

* Facial detection. A camera detects and recognizes a face either alone or in a crowd. No matter what technology you use, it’s better to have consistent lighting, high camera resolution, and limited motion. Lighting has to be bright enough to provide enough contrast for the recognition algorithm. Many systems require a certain number of pixels to identify facial features, and if you want to detect a larger area, you need to increase the camera resolution. Cameras with high frame rates will help you avoid problems with subject motion.
* Facial analysis. There are two main methods for capturing and matching faces. The first measures various features of a person’s face. These geometric measurements are then stored in a database for later comparison. The second method is more complex: It captures the full facial image and uses as much information as it can. Then it uses various computer algorithms, including machine learning, to build a set of definition data.
* Conversion of image into data. The detected facial features are then converted into a mathematical formula in a code called a faceprint. Every person has their own faceprint consisting of a unique set of physical features.
* Identification of a match. Finally, the system compares the code to a dataset of other faceprints and identifies a match with attached information. The underlying principle here is called object classification. During this phase, the system detects multiple objects in an image that comprises both object localization and object classification.

**(1) Project idea in details:**

**Face Detection This is the first step in face processing:**

The main purpose of this step is to detect face from the images from dataset. In this step individual images are taken from the dataset, scanned and then verified wether the image contains a face or just background image. The face determination system determins if the input data(image) is a face.

After this step the result is sent for pre-processing so that facial features can be extracted from the face image.

**Pre-Processing:**

Since any unprocessed or raw image data is easily corrupted by noise and hardware issues. This step is done to find smooth face images by removing unwanted noise, blur images and shadowing effects. There are many techniques available for image pre processing. Many of them are based on pixel transformation like pixel brightness transformation, geometric transformation, image restoration etc. Without pre-processing good quality images cannot be obtained to achieve a high accuracy detection system. The resultant images are used to extract facial expressions.

**Feature Extraction and Face Recognition:**

This step is critical step as it extracts the features using the applied feature extraction algorithm. The steps performs compression of information, reduction irrelevant features as well as removing the noise of the data.After this the facial region is converted into a vector with a given dimension in which the facial features correspond to their locations.After the prior step is done, analysis of the features is done and then the recognition part is used to learn each person’s face and then store it in the database. After the model is trained, then the model is tested against a given input image. All the previous steps like preprocessing and others are performed again. If it works perfectly the model is able to correctly able to determine the person’s identity without the consent of the individual himself. While the evaluation of the model is must be able to determine if the assumption is correct or not.

**Classification:**

This is the last step in any image processing system. There are numerous methods and techniques to classify images. Neural network is a very powerful technique for classification. It works for both linear and non linear dataset. It works even for images not in the dataset as it is a self learning model which consists of many hidden layers. In the recent years, many models of artificial neural networks has been used. There are many approaches within ANN like deep convolutional neural network, radial basis function neural network, back propagation feed forward neural network, bilinear neural network etc. There are many other classification techniques like clustering, decision tree, support vector machines etc.

**RELATED WORK:**

* Emotion detection and recognition has shown a notable advancement in the field of computer vision and artificial intelligence.
* The paper proposes Viola Jones algorithm to extract Haar like features for detecting a face and to verify and categorize human emotion using neural network.
* The paper proposes a system that detects human emotion by extracting facial features.
* A wide variety of methodologies have been used in this field to detect human emotions.
* One of the breakthrough publication on Face detection was given by Ihor Paily.
* This work shows detection of face by extracting Haar like features and then categorizing them using neural network [2].
* In another work the scholars have taken an interesting approach to the problem of mapping facial expressions because of the challenges posed by the 2-dimensionlaity of an image and therefore trying to do a digital image analysis using the region of interest.
* Here the scholars have used the features of the lips and analyze them according to the expression that they make [4].
* Another work done on facial expression recognition explores statistical unsupervised technique called ICA (independent component analysis) along with the feature optimizing techniques called genetic algorithm uses a concept of evolutionary systems in biology to implement a system to recognize and predict facial emotions [3].
* It is also proved by Kharat and Dudul that about 55% effect of overall emotion expression is facial expression which is contributed during social interactions [5].

**PROPOSED SYSTEM:**

The problem statements we have are having robust and automated face detection, analysis of the captured image and its meaningful analysis by facial expressions, creating data sets for test and training and then the designing and the implementation of perfectly fitted classifiers to learn underlying classifiers to learn the vectors of the facial descriptors. We propose a model desing which is capable of recognising upto six models which are considered universal among all walks of cultures.

Mainly being fear, happiness, sadness, surprise,disgust and lastly surprise.

Our system would be to understand a face and its charactieristics and then make a weighted assumption of the identity of the person.

**Neural Network to classify emotion:**

The concept of neural networks is biologically inspired paradigm which allows a computer to learn from the given data. It is an adaptive learning method.

An Artifical Neural network model is built on a group of symbiotic units or nodes called artificial neurons.

Each connection between the neurons have the capability to transmit a signal to each other. The node that receives the signal processes it and then signals its own signal to interconnnected nodes and the cycle continues.

The units which are also known as single perceptrons are joined to the other units of the layer and the strength of the network is valuated or signified by the values ranging from −1 to 1 from each joined or connected unit to another.

The negative links are called as inhibitionary excitations and the positive links are called as activity excitations. More the value to the extreme ranges stronger the network between each unit to its connections.

A transher function is also an inherent part of the neural unit.

In terms of neural units there are several types of units that can classified and they are input units, hidden units and the output units. The first of the three is responsible for taking in the given data for further processing.

The intermediate layers between the input and the output that is the hidden layer/unit is resposible for the complex processing and the last output unit is responsible for the outputs targets.

While the information is passed in the neural model the weights of the units are changed and modified in accordance to the input and the the activation value generated from the activation function is then passed onto the next layer or units.

The desired outcome of this approach was to solve complex problems similar to a human brain.

With some experiments over time, scholars shifted towards matching explicit mental abilities, paving the way for deviations from the biological networks.

Neural Networks are starting to be used on a group of learning based tasks and types of tasks which require inference to be made.

**(2) Main functionalities :**

The network comprises of two parts: the multimodal feature extraction part and the RNN part. The multimodal part extracts features from raw speech and visual signals. The extracted features are concatenated and used to feed 2 LSTM layers. These are used to capture the contextual information in the data.

A. Ablation study

B. Speech Modality

C. Visual Modality

D. Multimodal Analysis

**Flow chart of facial expression recognition system:**



**Block diagram of facial expression recognition system:**



**Diagram of the proposed facial expressions:**



**(3) Similar applications in the market :**

* **Time & attendance:** FaceSDK provides quick, efficient and reliable facial recognition, allowing to build highly efficient time and attendance control systems.
* **Access control:** High-performance, precise facial recognition allows building efficient access control systems based solely on personnel biometric properties and requiring no PIN entry or secure keys.
* **Secure authentication:** The SDK provides highly reliable biometric identification based on live video recognition with extremely low false positive rates, allowing to build secure authentication systems for multiple applications.
* **Photo/video search:** Highly optimized still and video-based face recognition and identification enables near real-time search through huge photo and video libraries.
* **Facial effects:** FaceSDK has long been used by the entertainment industry to create products and services applying a wide range of facial effects. This includes augmented reality and digital mirror apps, virtual makeup, aging, and a lot more.
* **Facial animation:** FaceSDK can be used to build animated 3D models of human faces based on a single still image. Animated avatars, talking face apps and many other applications can be built for all supported mobile, desktop and Web platforms.
* **Fever screening:** Thermal face detection is the best solution to measure human temperature and enable fever screening in crowded places such as airports, offices, schools, shopping malls and more.

**(4) An initial literature review of Academic publications (papers) relevant to the idea :**

ABSTRACT A Review of the Literature on Emotional Facial Emotional Expression and Its Nature Understanding emotional facial expressions accurately is one of the determinants in the quality of interpersonal relationships. The more one reads another’s emotions correctly, the more one is included to such interactions. The problems in social interactions are shown in some psychopathological disorders may be partly related to difficulties in the recognition of facial expressions. Such deficits have been demonstrated in various clinical populations. Nonetheless, with respect to facial expressions, there have been discrepant findings of the studies so far. The purpose of this article is to review the topic of emotion, emotional facial expressions since ancient ages, to emphasize the strengths and weaknesses of the related studies, to compare their results and to pay attention to this novel issue for Turkey. Keywords: emotion, emotional facial expressions, emotional facial recognition, facial recognition related disorders ÖZET Duygusal Yüz ‹fâdeleri ve Do¤as› Üzerine Literatür Taramas› Yüzdeki duygu ifâdelerini do¤ru bir biçimde anlamak kifliler aras› iliflkilerin kalitesinin belirleyicilerinden biridir. Bir kifli di¤erinin duygular›n› do¤ru olarak ne kadar iyi okursa, o kadar sosyal iliflkilere dâhil edilir. Bâz› psikopatolojik bozukluklarda bulunan sosyal iliflkilerdeki aksakl›klar›n bir k›sm›, yüzdeki duygu ifâdelerinin yanl›fl okunmas›yla ilgili olabilir. Bu aksakl›klar farkl› birçok klinik bozukluklarda gözlenmifltir. Ne var ki bu zamana kadar yüzdeki ifâdelerle ilgili tutars›z/farkl› birçok bulguya da rastlanm›flt›r. Bu makalenin amac›, antik ça¤lardan itibâren popüler olan duygu ve yüzdeki ifâdeleri konular›n› gözden geçirmek, ilgili çal›flmalar›n güçlü ve zay›f yönlerini vurgulamak, sonuçlar›n› karfl›laflt›rmak ve Türkiye için yeni olan bu konulara dikkat çekmektir. Anahtar Kelimeler: duygu, yüzdeki duygusal ifadeler, yüzsel alg›lama, duygular› okuma ile ilgili

Emotional Facial Expressions (EFE) Human emotions occur without our need to say to ourselves, “this situation is dangerous”, instead we simply feel frightened and take action (Oatley and Jenkins, 1996, p. 258). In daily life, we monitor the emotional reactions of others and prefer reacting and regulating our behaviors based on these expressions. Thus, they constitute very powerful tools in social coordination and interpersonal relationships (Batty and Taylor 2003, Ekman 1992 p177). According to the authors emotions can be characterized as basic or fundamental in terms of action readiness mode or expressing universal biological rules handed down genetically through evolution (Frijda 1977 p72, Lazarus p70, Ekman 1992 p173-175). Recently, there are seven universally accepted basic emotions; fear, surprise, sadness, happiness, anger, disgust and nowadays contempt. Each emotion has its own characteristics and appearance figures. Furthermore, there are other emotions such as love, jealousy, hatred, envy, regret, interest, guilt or despair that are spoken in some societies but not in others. These emotions are called as social emotions (Stein and Oatley 1992 p162). Basic emotions are distinguished as negative and positive. Happiness is a positive; Fear, anger, disgust, and sadness are negative emotions and most people do not enjoy them. Contempt is still not known because many people like feeling contemptuous. Surprise is neither positive nor negative (Ekman 2003 p1-19, Ekman and Friesen 1975 p99).

Happiness Happiness is the emotion that most people want to experience. Oatley and Jenkins (1996 p259) defined happiness as the emotion or mood of achieving subgoals and of being engaged in that one is doing. It is used almost synonymous with the pleasure and excitement. However, Pleasure is defined as a product of positive physical sensations that is opposite of the physical sensation of pain. Excitement is defined as the opposite of boredom. Excitement and pleasure are different experiences, which often involve happiness (Ekman 2003 p193, Ekman and Friesen 1975 p110)

Sadness There are many words to describe sad feelings: distraught, disappointed, dejected, blue, depressed, despairing, grieved, helpless, miserable, and sorrowful. According to Oatley and Jenkins (1996 p259), sadness can be described simply as the emotion of losing a goal or social role. As compared with fear that looks toward future, sadness seems to look toward the past (Oatley and Jenkins 1996 p260, Ekman 2003 p83, Ekman and Friesen 1975 p114). Sadness is rarely a brief and passive feeling that includes mostly disappointment and hopelessness. It is one of the long-lasting emotions. (Ekman 2003 p84).

Fear Fear is the emotion of anticipated danger, physical or psychological harm (Oatley and Jenkins 1996 p260, Ekman 2003 p156, Ekman 1992 p184, Ekman and Friesen 1975 p47). Fear renders a mode of readiness to cope with danger. Thus, it promotes vigilance for the feared event that can be an imagined or real.

Anger Ekman and Friesen (1975 p76) claimed that anger is very likely the most dangerous emotion. When people are angry, they hurt others purposefully. However, according to Lazarus, although anger is commonly classified as negative emotion, people often report feeling good about their anger. Nevertheless, he added that when anger is acted out, it can have harm ful social or physiological consequences, especially when it is not managed (1991 p5).

Surprise Ekman and Friesen indicated that surprise is the briefest emotion (1975 p34, Ekman 2003 p148, Frijda 1986 p18). It is sudden and if you have a time to think about that event, you will not feel surprised. Surprise is triggered by both unexpected and/or misexpected events. Almost anything can be surprising; a sight, smell, taste, touch and surely, the greater the unexpected thing, the more surprised you will be (Teigen and Keren 2002).

Disgust Disgust is a feeling of aversion and is the emotion of revulsion and avoidance of anything that makes one sick (Ekman 2003 p172-173, Ekman and Friesen 1975 p66). People can feel disgust from any taste, a smell, a sight, a touch or a sound or even an idea. Disgust usually involves getting-rid-of and getting-awayfrom responses. Removing the object or oneself from that object is a goal. Generally, nausea and vomiting accompany with disgust but not compulsory (Ekman 2003 p174, Ekman and Friesen 1975 p66).

Contempt Contempt is only expressed about people or the actions of people instead of foods, smells unlike in disgust. In contempt there is an element of condescension toward the object of contempt. Acting in a proud manner toward others, scornful in disliking the persons or their actions, you feel superior to them (Ekman 2003 p181).

MOOD DISORDERS, ANXIETY DISORDERS, RECOGNITION OF EMOTIONAL FACIAL EXPRESSIONS AND REACTION TIMES: THE LITERATURE REVIEW Most of the studies have demonstrated that mood or emotional states influence the way people make judgments, inferences, and predictions as well as memory. Beck’s (1976) schemata theory and Bower’s (1981) network theory proposed that in both anxiety and depression, cognitive biases operate through information processing (mood congruency hypothesis). The main difference between anxiety and depression in terms of information processing system is about the content of bias (cited in Persad and Polivy 1993). Namely, anxious individuals selectively perceive threatening information (attentional vigilance/hypervigilance), whereas depressed individuals have a bias for information related to sadness, loss and failure (evaluative bias) (Mogg et al 2000, Mogg and Bradley 2006, Rohner 2002). Several studies about the existence of attentional biases in anxiety disorders, in order to obtain ecological validity, nowadays facial expressions have begun to use instead of stroop task and probe detection task (Mogg and Bradley 2006, D’Argembeau et al 2003, Leppanen et al 2004, Surcinelli et al 2006, Philippot and Douilliez 2005, Mendlewicz et al 2005, Weniger et al 2004). (See, Tables 1 and 2). With respect to facial expressions, there have been discrepant findings of the studies so far. Philippot and Douilliez (2005) compared a group of anxiety disorders: generalized anxiety disorder, social phobia, panic disorder with agoraphobia, obsessive-compulsive disorder with control group. They concluded that no

significant differences could be found between anxiety disorders and control group in terms of EFE decoding accuracy. The authors believed that these unexpected results were due to several methodological limitations such as small sample size. Even though it can be expected a statistical significance between healthy controls and any group of anxiety disorders, it should be considered that social phobia is generally associated with evaluation and criticism of people around them. Perhaps, if the authors used contempt faces additional to others, then it might represent a socially threatening stimulus which might have caused a different result. Because contempt expression includes a scornful or arrogant look, social phobics may react more sensitive to these expressions because of their high sensitivity of criticism and rejection. In order to examine the attributional style of depressed patients, Leppanen et al (2004) conducted a study in which recognition of different facial expressions were compared in patients with moderate to severe depression. The findings of Leppanen et al (2004) have focused processing of neutral expressions differently from previous studies. The depressed individuals tend to attribute neutral faces to sad faces. This result can be interpreted as depressed individuals need more time to think neutral faces. The authors could not confirm the mood congruency theory. They did not find any increased recognition of sad faces related to their negative mood or impaired reading of happy expression. On the contrary, depressed people have a happy face advantage like other disorders and healthy controls. However, this result confirms that depressed individuals have some impairment on recognition of neutral expressions due to their attentional bias towards negativeness. Mendlewicz and his colleagues (2005) designed a study to investigate the recognition of facial expressions among female adolescent inpatients with major depression and female adolescents with eating disorders. They also compared these two inpatients groups with the healthy control group. As a result of this design, they did not find any significant differences between eating disorder group and controls in their facial expression recognition. Only depressed patients demonstrated less accuracy rates in decoding angry expression than inpatients with eating disorders and control group. Equal ratings of eating disorders inpatients and healthy controls were divergent from previous studies. This discrepancy can be explained by participation of only female participants rather than mixed-gender sample and participation of only anorexia nervosa rather than all eating disorders. Nevertheless, this study supports the existence of decoding impairments of negative emotions in depression. This reminds us the relationship between anger inhibition and etiology of depression.

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