



Facial Expression Recognition of Children Based on Machine Learning Approach

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Article History

Received on: 25 Dec 2020

Revised on: 28 Jan 2021

Accepted on: 02 Feb 2021

Keywords: about four/five key words separated by commas

e-ISSN: 2455-6491

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ABSTRACT

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Note: Abstract not more than 160 words.

1. INTRODUCTION

Facial expressions are considered as the most indicative, strong and natural way of knowing the psychological state of a person during the communication. As per Mehrabian [1] effective communication constitutes: seven percent meaning of the words that are spoken at that time, thirty eight percent by the means of paralinguistic, that is the way those words are said (normally or sarcastically) and fifty five percent of the communication is done by the means of facial expressions. This indicates that facial expressions play a major role in human communication. That's

why The Human Facial Expression Recognition approaches are now being considered as the most active research area in the domain of image processing and Human Computer Interaction (HCI). In the recent years, many improvements and advancements have been accomplished in the areas like face recognition, face tracking and it anticipated the interest in the domain of facial expressions recognition. Several studies in the field of psychology. Several studies in the field of psychology [2] have concluded that the recognition of facial motion is fundamental portion for the recognition of facial expressions. This makes the communication more influential and interactional.

In Facial Expressions Recognition System, the image is processed to extract such information from it, which can help in recognizing six universal expressions that are neutral, happy, sad, angry, disgust and surprise. This processing is done in several phases including image acquisition, features extraction and finally expressions classification using different techniques.

2. PROSPECTIVE APPLICATION

Facial expressions analysis/recognition is very active and open research area in the domain of machine learning. They have several applications in various exciting areas. Real time and fully automatic facial expression systems are helpful in interpreting non-verbal facial gestures used in a variety of applications like behavioral research, human computer interaction, video-calling and vision systems. But the major challenge nowadays is to develop a system to perform natural interactions between man and a machine. For instance, in HCI, if the computer is able to sense the expressions of the users and can understand their intentions with the help of those expressions, then it would become easy for the system to assist the users by giving them responses and suggestions in accordance to certain circumstances in a natural way, which indeed could be used in interactive computers, entertaining systems for users, sensors, robots etc.

As computers have started becoming a part of our living spaces and workspaces, and began to interact more and more with humans, the systems are supposed to be more accurate in understanding the emotional states and moods of humans. Having an intelligent facial expression recognition system makes the creation of good visual interfaces easier and helpful for human and computer interactions. The communication among humans is effective as they can give responses

according to the other persons expression, so for interacting effectively with the humans, the computers are also supposed to gain this ability. Human Computer Interfaces and robotics are not the only applications of facial expressions recognition systems, it rather finds its applications in several distinct areas like Video Games, Animations, Psychiatry, Educational Software, Sensitive Music, Medical science, Forensics, Criminal Interview etc. As the facial expressions recognition systems are becoming robust and real time, many other innovative applications and uses are yet to be seen.

3. AUTOMATIC FACIAL EXPRESSION RECOGNITION SYSTEM

A. Architecture

The method of Facial Expression Recognition is categorized into following stages:

1. Detection of Face
2. Extraction of Features
3. Classification of Expressions

Firstly, the image is taken from test database and face detection from the image is done. When the face is detected, important features are extracted from the facial image like eyes, eyebrows, lips etc. After extracting these important features, the expression is classified by comparing the image with the images in the training dataset using some algorithm. But it's not difficult to guess that if the memory is well-organized, the search operation will be faster. However unorganized memory will be slower in search operation.

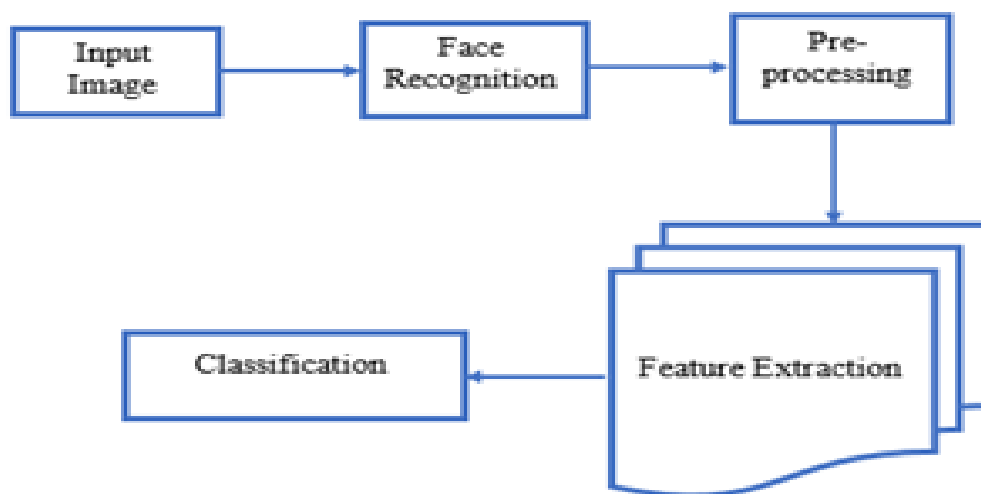


Figure 1: Flow of the Facial Expression Recognition System

B. Level Of Description

Using whole frontal face: Using the frontal image of the face as it is (whole), and processing it for classifying the six prototypic emotions comes under this approach. In this approach, it is considered that every prototypic emotion has its own characteristic expressions on the face of the person and the recognition of those characteristics is important. Ekman et al. [4] and Izard [5] put forward this type of facts in their researches while Bartlett et al. [6], [7] used these facts in designing the automatic facial expressions system.

Using Action Units: In this approach the image is divided into sub-sections and then used for analysis. This approach is called as FACS, which was put forwarded by Ekman et al. [6], this describes the 44 AUs (Action Units) on the face. There is total 44 Action Units at all and out of them 30 are acquired by the contractions of certain muscles. 12 of these 30 action units are of the upper portion of the face while the remaining 18 are for the lower portion of the face. It is an effective method for facial expressions recognition as it divides the face into action units by applying objectivity and flexibility on the image. This approach is applicable in those applications in which fine level of changes in the expressions are needed to be identified. There are some methods in which the whole frontal face or all the 44-

action units are not used; rather some regions are selected manually from the face and used for the recognition of expressions.

4. PARAMETERIZATION

A. Geometric based parameterization

It is one of the oldest techniques in which the tracking and processing is done on some of the spots on the facial images; this was first proposed by Suwa [9] for the recognition of the facial expressions. Yacoob et al. [10] and Mase [11] used the parameters of facial motion, while Lanitis et al. [12] and Kaapor et al. [13] used spatial location and shapes of the facial points as feature vectors in their respective work and used these feature vectors for the classification of the expressions. Expressions of a person change morphologically and dynamically with time that makes it more difficult for us to estimate general parameters for the same as in [14].

B. Appearance based parameterization

Instead of using the spatial points for tracking position, movement parameters are used in this approach. These parameters vary with the time and colors of the related regions of the face. Different types of features like haar wavelet coefficients, gabor wavelets along with the feature extraction and selection techniques like PCA and LDA are used within this concept.

Table 1: Summary of previous research work of facial expression detection based on machine learning

Authors	Dataset Used	Sample Size	Feature Extraction Technique	Classification Technique	Accuracy
Murugappan M. et. al. (2021)	International Affective Picture System	85	Lucas-Kanade optical flow algorithm	KNN, ELM, PNN, RF, DT, and SVM	95.37%
Pierluigi Carcagni et. al. (2015)	Chon-Kanade	68	HOG, FER	SVM	98.8%
Barrett et. al. (2019)	Facial action coding system (FACS)	22	Statistical Analysis	--	92%
Weiqing Wang et. al. (2020)	Real time faces	27	FER	CNN	90%
Yusra Khalid Bhatti et. al. (2021)	Cohn-Kanade, Japanese Female Facial Expression, Facial Expression Recognition	425	CNN	RELM	82%

Ben Niu et. al. (2021)	Cohn-Kanade database (CK+), Japanese Female Facial Expressions database (JAFFE), and MMI	593	LBP, ORB	SVM	73%
Ai Sun et. al. (2018)	JAFFE, CK+	327	Decision-level fusion	CNN	98%
Shervin Minaee et. al. (2019)	FER-2013, CK+, FERG, JAFFE	60	ReLU	ACN	92.8%

5. CHALLENGES AND FUTURE SCOPE

Facial expressions recognition has gained a lot of interest these days, but the main focus has shifted to the expressions that are not posed or that are spontaneous. So, the very first problem that is being faced recently is unavailability of the databases having the spontaneous facial expressions and creating such database is one of the major challenges. As per the conclusion of Sebe et al., if the subjects have prior knowledge that they are being captured then the expressions will not remain natural. For such situations, using the hidden cameras for capturing the images and videos creates the databases with spontaneous expressions. The next problem is having these spontaneous expressions with different medical and lighting conditions. For this type of cases the approach of using the hidden camera will not work out well. Finding out the labeled data for testing as well as training is also a challenge for working in this field. Unlabeled data is easily available and one can find such data in huge amount. Labeling of data is a lengthy and a complicated process, it consumes a lot of time and the chances of error are also very high. An expertise is required on the coder part as well as on the observer part. To avoid the problems with labeling of data semi-supervised learning techniques could be used because they allow the use of labeled data along with the unlabeled data. There are some systems that are not fully automatic, they require some manual actions during processing, like some systems need fiducial points to be marked on the face manually during the initialization. So, the challenge here is to make a system that is fully automatic and does not require any manual interference. Other factors that affect the expressions like: Subjects belonging to different cultures like Asians, Europeans, age groups will have different expressions. A facial expression recognition system should be able to handle these problems. Angles of head and their rotations are also a big concern. A future extension of facial expressions analysis could be the analysis of micro expression. Nowadays only few training techniques are available that works for micro expressions. One more issue that may rise in automatic facial expression systems is recognizing the expressions of the subjects, who have lost their natural facial expressions because of the medical

problems. There are 12 diseases that results in this loss of the facial expressions namely: Facial Paralysis, Autistic Disorder, Asperger Syndrome, Hepatolenticular Degeneration, Depressive Disorders, Bell's Palsy, Depression, Facial Weakness, Major Depressive disorder.

CONCLUSION

It can be concluded from this paper that creating a database that is totally authentic is very difficult but making a semi authentic database is comparatively easy. Asking the subjects to watch certain video and then capturing their expressions creates the semi authentic databases. Semi supervised learning techniques are useful for labeling of data. And for a system to be more effective it should be able to detect micro expressions and deal with the different angles of head.

ACKNOWLEDGEMENT (OPTIONAL)

The author acknowledges the immense help received from the scholars whose articles re cited and included in references to this manuscript. The author is also grateful to authors/editors/publishers of all those articles, journals and books from where the literature for this article has been reviewed and discussed.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

FUNDING SUPPORT

The author declare that they have no funding support for this study.

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