International Journal of Computer Sciences and Engineering Open Access
Research/ Review/Survey Paper Volume-5, Issue-8 E-ISSN: 2347-2693

REVIEW ON EMOTION RECOGNITION FROM PHYSIOLOGICAL SIGNALS

[1]Adheena M.A.*, [2]Sindhu N

[1*]Dept. of ECE, Govt. Engineering College Thrissur, Abdul Kalam Technological University, Kerala, India
[2] Prof. Dept. of ECE, Govt. Engineering College Thrissur, Abdul Kalam Technological University, Kerala, India

e-mail: adheenaabraham@gmail.com, sindhun@gectcr.ac.in

*Corresponding Author: adheenaabraham@gmail.com, Tel.: 9995900331

***Abstract*—** Emotion is a state of feeling which results in physical and psychological changes and it in turn influence thought and behavior of an individual. Emotions are also characterized by the biological reactions. Emotion is associated with mood, temperature, personality, character and motivation. Emotion Recognition is a progressive research area and it has great contribution in several fields. Extracting features relevant to emotions, recognition and validations of emotions is important for achieving good interaction between human and machines. Emotion recognition also have applications in numerous fields like cognitive science, interaction psychology, health monitoring, philosophy, intelligent transport systems, security and access control, and work load assessment. Various physiological signals are used for emotion recognition. Various methods for feature extraction and classification are discussed in this paper.

Keywords—Physiological signal, feature extraction,classifier

I. INTRODUCTION

Emotion is a state of mind that occurs impulsively without of any endeavour and accompanies physiological changes. Emotions are formed by subjective feelings, behavioural reactions, cognitive process, motivational tendencies and physiological arousal. Emotions result in psychological and physical changes. These changes influence our behaviour and interact with the mathematical, verbal and perceptual intelligence associated with the human brain. At a physiological level, both autonomic and central nervous system play a central role, responsible for specific internal reactions related to the manifestation of different emotions.

Automatic detection of emotion has received attention in several field including human computer interaction, intelligent transport systems, security and access control, workload assessment, health monitoring and clinical anxiety treatment programs. Measurement of arousal linked with emotions supplement treatment programs for many populations. These populations have the problem in communication, introspection and emotion recognition. Individual with ASD (Autism Spectrum Disorder) is an example of such population.

Autism Spectrum Disorder (ASD) is a pervasive neurodevelopment disorder [1]. The individuals with ASD have difficulties in social and communication skills, and they show restricted and repetitive behaviour. Children who are suffering from ASD and intellectual disability have scarcity in communal and emotional skills, which may be one of several contributing risk factors to the very high prevalence of mental health issues in this population. Thus, promoting interventions to communal and emotional skills provide an opportunity to support the mental health and welfare of children with ASD and intellectual disability.

This paper consists of 3 sections. Section II describes about the previous works done in the field. Conclusion of the paper is included in the Section III.

II. RELATED WORK

Emotions can be defined as a mental state that occurs spontaneously without any conscious effort and is accompanied by physiological changes. There are two models for emotion: Discrete model and Dimensional model. The six basic emotions, that is, happy, fear, sad, disgust, surprise, and anger that are universally accepted are included in the discrete model. All other emotions are considered to be a part of these basic emotions. The dimensional model plots

emotions on a two scale: valence and arousal. Valence denotes the polarity of emotion and arousal denotes the intensity of emotions. All emotions can be plotted on the valence-arousal plot.

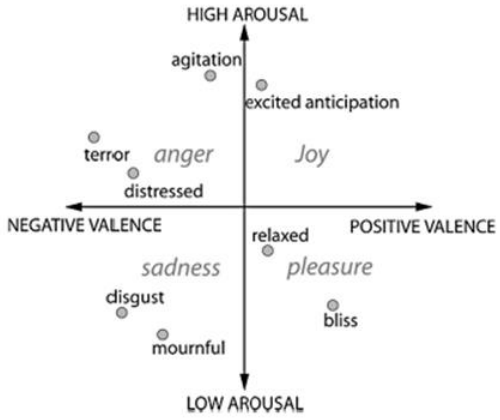

Fig: Valence - Arousal model

Gestures, speech and facial expression are the main audio-visual channels used for automatic recognition of emotions [2]. These modalities have higher results and researched widely and all this approaches are prone to social masking. An emotion that is not conveyed, emotion communicated differently or slight emotional variation that is concealed to the eye cannot be traced. ANS activities are reflected in physiological signals and it helps to identify the inherent emotions. So physiological signals are the most powerful method for the recognizing inner emotions even if there is a social mask.

The main steps in emotion recognition from physiological signals are feature extraction and classification which is represented in below figure.

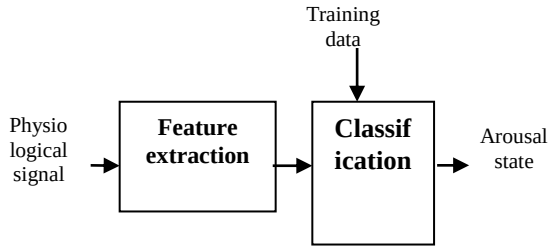

Fig: Emotion recognition system

Power mean values and statistical features from ECG, EMG, Skin Conductivity were used to classify emotions (Joy, anger, sadness, pleasure) using pseudo inverse linear discriminant analysis [3] with accuracy of 70 and 95 percentage for subject-independent and subject-dependent respectively. Murugappan et al. [4] uses discrete wavelet transform for extracting statistical feature from ECG signal. Happiness, disgust, fear, sadness, and neutral emotions are classified using LDA and KNN (k-nearest neighbor) with maximum accuracy of 50.28 percentages for sadness using LDA.

A fuzzy logic system was proposed by Jerritta S et al. [6] to classify happiness, sadness, fear, surprise, disgust and neutral using ECG signal. Rescaled range statistics (RRS) and finite variance scaling (FVS) methods are used to find Hurst exponent. Hurst exponent is a nonlinear feature derived from QRS complex. The authors reported detection accuracies above 70 percent.

Support vector machine (SVM) classifier is widely used by researchers for classifying the extracted features from physiological signals [5, 7, 9, and 10]. In [5], the time domain and frequency domain statistical features extracted from ECG, skin conductance, and PPG are fed to SVM, CART and LDA classifiers to obtain an accuracy of more than 90 percentages.

Hany Ferdinando et al. [8] proposed KNN to solve 3-class problem (low-medium-high) for emotions in valence and arousal. 168 features are calculated by representing statistical distributions of dominant frequencies (DFs) from intrinsic mode Functions (IMF) after applying the bivariate empirical mode decomposition (BEMD) to short-time ECG. Along with KNN classifier, Discriminant function analysis (DFA) is used to classify sadness, anger, surprise, fear, frustration by deriving minimum, maximum, mean values of Galvanic skin response, heart rate, and temperature [11].

Integrated system was proposed by Katsis et al [12]. It provides a monitoring system for the patients who have anxiety in therapeutic sessions. The system can recognize patient's emotional state such as neutral, relaxed, apprehensive, startled and very apprehensive. Physiological signals like Heart rare (HR), Blood volume pressures (BVP), respiration and Galvanic skin response were collected via noninvasive sensors. Artificial Neural Networks (ANNs), Support Vector Machines (SVM), Random Forests (RF) and a Neuro-Fuzzy System was used for classification. The overall classification accuracy is about 84.3%.

An optimal algorithm was proposed by Park et al. [13].the algorithm classifies the emotions happy, anger, sad, stress, surprise, fear and disgust based the on features extracted from physiological signals. Four channels of physiological signal, that is, Electrocardiogram, Skin temperature, Photoplethysmograph, and Electrodermalactivity were recorded and analyzed.

In the work [14], analyzed various physiological signals (ECG, EEG and respiratory signals) were analyzed to detect the stress of a automobile driver under different conditions. Two features are extracted to get different levels of stress. SVM classifier is used for classification.

Valenzi et al [15] proposed offline and computer aided experiment for emotion classification. Video clips are used to elicit emotional states (sad, amused, sad and disgusted) and corresponding EEG signal is measured. Different supervised and clustering algorithm is used to classify emotions. The highest accuracy is for SVM.

Wanhui Wen et al [16] proposed evaluation system for social anxiety. Eleven Heart rate features from ECG signal is used for detection of low and high level anxiety. SVM, KNN (K-nearest neighbor), LDA (Linear Discriminant analysis), QDA (Quadratic Discriminant analysis) and NB(Naive Bayes) classifiers are used. Range of local hurst exponent is the most excellent feature for each classifier.

A multimodal database [17] which includes eye gaze data, audio signals, face videos, and physiological signals is used for emotion recognition. ECG, respiration amplitude, GSR and skin temperature are used as physiological signals. A total of 102 features are extracted from physiological signals. Fusions of EEG and eye gaze modality have high classification accuracy of 76.1%.

III. CONCLUSION and Future Scope

Collecting of important data relevant to emotions is an important task. Physiological signal provide more accuracy than conventional methods. Fusion of physiological signals gives better accuracy.

REFERENCES

[1]. Azadeh Kushki, Ajmal Khan, Jessica Brian, and Evdokia Anagnostou, A Kalman Filtering Framework for Physiological Detection of Anxiety-Related Arousal in Children With Autism Spectrum Disorder, IEEE Transactions On Biomedical Engineering, Vol. 62, No. 3, March 2015.

[2]. Jonghwa Kim and Elisabeth Andre, Emotion Recognition Based on Physiological Changes in Music Listening, IEEE Transactions On Pattern Analysis And Machine Intelligence,Vol. 30, No. 12, December 2008.

[3]. Kessous L, Castellano G and Caridakis G, Multimodal emotion recognition in speechbased interaction using facial expression, body gesture and acoustic analysis, J Multimodal User Interfaces 2009, 3:3348..

[4]. Murugappan Murugappan PhD, Subbulakshmi Murugappan, Frequency Band Analysis of Electrocardiogram (ECG) Signals for Human Emotional State Classification Using Discrete Wavelet Transform (DWT) , J. Phys. Ther. Sci. 25: 753759, 2013.

[5]. Eun Hye Jang, Byoung Jun Park, Sang Hyeob Kim and Jin Hun Sohn, Emotion Classification by Machine Learning Algorithm using Physiological Signals, Proceedings of 2012 4th International Conference on Machine Learning and Computing IPCSIT vol. 25, 2012.

[6]. Jerritta S, M Murugappan, KhairunizamWan, S Yaacob, Emotion Recognition from QRS complex of ECG signals using Hurst Exponent for different age groups, IEEE Humaine Association Conference on Affective Computing and Intelligent Interaction, 2013.

[7]. Tabitha A. Chiu, Evdokia Anagnostou, Jessica Brian, Tom Chau, and Azadeh Kushki, Specificity of Autonomic Arousal to Anxiety in Children with Autism Spectrum Disorder, International Society for Autism Research, Wiley Periodicals, Inc., 2015.

[8]. Hany Ferdinando, Tapio Seppnen and Esko Alasaarela, Comparing Features from ECG Pattern and HRV Analysis for Emotion Recognition System, Conference Paper October 2016.

[9]. K Kiruba and D Sharmila , AIEFS and HEC based emotion estimation using physiological measurements for the children with autism spectrum disorder, Biomed Res- India 2016.

[10]. Zied Guendil ,Zied Lachiri ,Choubeila Maaoui and Alain Pruski, Emotion Recognition from Physiological Signals using Fusion of Wavelet based Features, IEEE conference, 2014.

[11]. Christine Ltitia Lisetti and Fatma Nasoz, Using Noninvasive Wearable Computers to Recognize Human Emotions from Physiological Signals, EURASIP Journal on Applied Signal Processing: 11, 2004.

[12]. Katsis CD, Katertsidis NS, Fotiadis DI. An integrated system based on physiological signals for the assessment of affective states in patients with anxiety disorders. Biomed Signal Process Control 2011; 6: 261-268.

[13]. Park BJ, Jang EH, Kim SH, Huh C, Sohn JH. Seven emotion recognition by means of particle swarm optimization on physiological signals: Seven emotion recognition. 2012 9th IEEE International Conference on Networking, Sensing and Control (ICNSC), 2012, 277-282.

[14]. Subi D, Anuja HS. Detection of Automobile Drivers Stress from Physiological Signals. Int J Comput Sci Mobile Comput 2014; 3: 454 – 458

[15]. Valenzi S, Islam T, Jurica P, Cichocki A. Individual classification of emotions using EEG. J Biomed Sci Eng 2014; 7: 604.
[16]. Wanhui Wen, Guangyuan Liu, Zhi-Hong Mao, Wenjin Huang, Xu Zhang, Hui Hu, Jiemin Yang and Wenyan Jia, " Toward Constructing a Real-time Social Anxiety Evaluation System: Exploring Effective Heart Rate Features ", IEEE Transactions On Affective Computing, 2017.
[17]. Mohammad Soleymani, Jeroen Lichtenauer, Thierry Pun, and Maja Pantic, ''A Multimodal Database for Affect Recognition and Implicit Tagging'', IEEE Transactions on Affective Computing, Vol. 3, No. 1, January-March 2012.