A Review on Various Mood Detection and Regulation Methods


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Abstract----Advancements in research and technology have made the human capacity to interact with computers or machines. The most natural way of communication is through emotions. In this era of Artificial Intelligence, Affective computing and virtual reality, to sense and regulate the person’s emotional states without another person’s intervention is possible. Enormous research has taken place in the field of mood detection and regulation. This paper focuses on the major highlights in the recent research of mood detection and regulation with different approaches for providing a technological perspective on society.

Keywords--- Human-Human interaction, Human-Computer Interaction, Mood Detection, Mood Regulation, Self-Regulation

I. INTRODUCTION

Moods and emotions play a vital role in our life. Emotion is nothing but the energy-in-motion, a way of expressing oneself whereas mood is the state of being emotional. Irrespective of culture a human grows with basic seven emotions (Anger, Contempt, Fear, Disgust, Happiness, Sadness, and Surprise). Emotions and moods can mutually influence each other. If emotion is strong and deep enough, it can turn into a mood [1]. Moods and emotions have significant effects on all aspects of individuals such as body, perception, cognition, actions and personality development [2]. They can be recognized through various modes like neuroimaging, speech, text, facial expressions, physiological signals, body postures, and gestures, etc. Extracting and understanding moods and emotions can help us how we act, behave, or think [3].

Mood regulation is the process in which individuals modify their emotions, respond to the emotions of the situations that evoke emotions to respond properly [4]. Mood detection used in various applications which include Personal Robots [5], Security, Medical Diagnosis [6], Web-based E-Learning, Computer Gaming [7], Call Centers, Intelligent Toys, Autonomous Cars [8]. Mood regulation used in Education [9], Car Safety [10], Mental Healthcare [11]. The notion of emotional intelligence is an active research topic in computer vision, pattern recognition, artificial intelligence and affective computing fields for more than two decades due to its diverse applications. This paper focuses on the analysis of various mood detection and regulation methodologies. This paper is organized as follows: Section II discusses different mood detection methods. Their comparative analysis is given in Section III. Section IV describes mood regulation methods and therapies and Section V concludes this survey.

II. MOOD DETECTION METHODS

All methods of mood detection have three main steps: preprocessing, feature extraction, and classification. Some of the most researched mood detection methods are given below.

A. Neuroimaging:

Brain is the main organ of the central nervous system which controls and monitors all the activities of the body. Producing imaging scans of the brain or other nervous systems (i.e. Neuroimaging) for different emotions has always been a challenging task. Since the early 1990s, development in imaging technology has allowed research in neural structures related to moods or emotions [12]. Over the years, several studies and meta-analysis described the functional neuroanatomy of emotions using Functional magnetic resonance imaging (fMRI) and Positron Emission Tomography (PET). Our brain is divided into several non-overlapping parts and each brain region is involved in different aspects of emotions [13]. However, individual imaging studies cannot fully characterize which brain regions are responsible for emotion. Some techniques like multi-voxel pattern analysis allow for the possibility that neural responses to emotional stimulation occur in many brain areas simultaneously [14]. Some of the studies to detect emotions in the brain using neuroimaging are given in Table 1.
Table 1: Different Studies on Neuroimaging

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Method</th>
<th>n</th>
<th>Experimental Paradigm</th>
<th>Emotions</th>
</tr>
</thead>
<tbody>
<tr>
<td>[15]</td>
<td>fMRI</td>
<td>26m</td>
<td>Viewing emotional facial expressions</td>
<td>S, H</td>
</tr>
<tr>
<td>[17]</td>
<td>fMRI</td>
<td>18f, 11m</td>
<td>Mood Induction by Tactile Task based on Discrimination of Braille-like Raised Dots Patterns &amp; Negative F/B</td>
<td>FR, AN</td>
</tr>
<tr>
<td>[18]</td>
<td>fMRI &amp; GNB</td>
<td>8f, 2m</td>
<td>Mood Induction by Self-Experiencing Emotions &amp; by Viewing Pictures</td>
<td>A, D, E, F, H, L, P, S, SH</td>
</tr>
<tr>
<td>[19]</td>
<td>MRI &amp; VBM</td>
<td>69 f, 41m</td>
<td>Viewing emotional Facial Images</td>
<td>F, A, D, S, N, SU, H</td>
</tr>
<tr>
<td>[20]</td>
<td>PET</td>
<td>18f, 16m</td>
<td>Social anxiety questionnaires &amp; brief telephone interview</td>
<td>SA</td>
</tr>
<tr>
<td>[21]</td>
<td>fMRI &amp; SVM</td>
<td>65 mix</td>
<td>Resting Experiment</td>
<td>DE</td>
</tr>
<tr>
<td>[22]</td>
<td>PET</td>
<td>53 mix</td>
<td>Mood Induction by self-bio recall &amp; re-experience</td>
<td>S, H, A, F</td>
</tr>
</tbody>
</table>


In fMRI and PET, if greater the activation, greater the flow of blood in that region of the brain which gives activation pattern of emotions in the brain, however, their low time resolution makes it difficult to investigate temporal aspects of emotional states [16].

B. Speech Emotion Recognition (SER):

Speech is one of the important ways of communication. Emotion recognition from the speech signal has been a research topic for more than two decades. Speech processing came into existence in 1920 when a celluloid toy named “Radio Rex” was made [23]. In SER, Feature selection is based on the type of features such as Prosodic, Spectral, etc. Patterns of derived speech features such as Energy, Pitch, Formant Frequency, Mel-frequency Cepstrum Coefficients (MFCC), Linear Prediction Cepstrum Coefficients (LPCC) and Modulation Spectral Features (MSFs) are mapped using Classical ML classifiers like k-nearest neighbors (KNN), Artificial Neural Network (ANN), SVM, Hidden Markov Model (HMM), Gaussian Mixture Model (GMM) [24], Modified Brain Emotional Learning Model [25] or Deep Learning-Based Classifiers. Other models are Decision Tree, Fuzzy Classifier and many more. Overview of Speech emotion recognition is given in Fig. 2.

Speech Emotion Recognition

- Preprocessing
  - Prosodic
  - Spectral
  - Qualitative
- Feature Selection
  - Based on Teager Energy Operator
- Classification
  - Classical ML
  - Deep Learning (DL) Based
  - DL Based Enhancement Techniques

Fig. 2: Overview of SER [26]

The important issues in speech emotion recognition system are choice of database, signal processing unit in which appropriate features are extracted from available speech signal and another is a classifier which recognizes emotions from the speech signal [8]. Some of the studies on SER are given in Table 2.
Table 2: Different Studies on Speech Emotion Recognition

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Emotions</th>
<th>Database</th>
<th>Technique</th>
<th>Recognition Rate in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>[27]</td>
<td>H, S, A, N</td>
<td>IEMOCAP</td>
<td>RNN</td>
<td>Overall Feature WA UA 57.7 53.78</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Raw Spectra 1</td>
</tr>
<tr>
<td>[28]</td>
<td>H, S, A, SU, F, N</td>
<td>Vocal Data from Social Media</td>
<td>LS-SVR</td>
<td>82.43</td>
</tr>
<tr>
<td>[29]</td>
<td>H, S, A, N</td>
<td>SEMAINE</td>
<td>FPCA &amp; QDC</td>
<td>75.8</td>
</tr>
<tr>
<td>[31]</td>
<td>H, S, A, F, N, D, B</td>
<td>EMO-DB</td>
<td>FT AlexNet &amp; AlexNet-SVM</td>
<td>FT AlexNet - 76, AlexNet-SVM - 68</td>
</tr>
<tr>
<td>[33]</td>
<td>H, S, A, N</td>
<td>IEMOCAP</td>
<td>DCNN</td>
<td>WA - 71.8, UA - 68</td>
</tr>
</tbody>
</table>

C. Text-Based Emotion Recognition:

Emotion recognition from text has been promising research over the years. Texts reflect a writer’s emotional state and feelings which can be detected using different methods. Emotion recognition from text is nothing but the classification problem which comes under Text data mining [34]. Social media has facilitated an increase in online communication, blogs, public review sites, microblogging sites like Twitter have opened the newer approaches to detect the emotions from that text data. Recognizing emotions conveyed by a text can give an insight into the author’s intent and may lead to better understanding of the text’s content. Mainly, there are four approaches for emotion recognition from text data: keyword spotting based, Lexical affinity-based, Machine learning (ML) based and hybrid-based methods [35].

There are considerable issues in the first three methods such as a collection of data, feature choice, labeling of emotions, ambiguity in keyword, incapability of recognizing sentences without emotional keywords, incapability of recognizing sentences without emotional keywords, and difficulties in determining emotion Indicators. Thus, the hybrid-based method combines in keyword-based and ML-based methods to increase the performance [35] [36]. Systematic classification of Text-Based Emotion Recognition methods is given in Fig. 3.

Text – Based Emotion Recognition (TER)

- Keyboard Spotting Based
- Word Based
- Line Based
- Document Based
- Lexical Affinity Based
- Probability Based
- Machine Learning Based
- Hidden Markov Model
- Support Vector Machine
- Naive Bayes
- Decision Tree
- Hybrid Based
- Combination of Keyword Spotting & Machine Learning Based

Fig. 3: Classification of TER Methods [35]

Text based emotion recognition system still requires attraction of researchers. Some of the recent studies on Text Based Emotion Recognition are given in Table 3.
Table 3: Different Studies on Text Based Emotion Recognition

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Emotions</th>
<th>Database</th>
<th>Technique</th>
<th>Recognition Rate in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>[38]</td>
<td>H, S, A</td>
<td>On-line website text</td>
<td>Fuzzy Logic &amp; NN</td>
<td>90</td>
</tr>
<tr>
<td>[40]</td>
<td>H, S, A, F, D, SU</td>
<td>HC Corpora Punjabi Text Data</td>
<td>Naive Bayes &amp; SVM</td>
<td>81</td>
</tr>
<tr>
<td>[41]</td>
<td>J, S, A, F, D, G, SH</td>
<td>ISEAR</td>
<td>Lexicon &amp; Word Embedding</td>
<td>_</td>
</tr>
<tr>
<td>[42]</td>
<td>H, S, A, F, D, SU</td>
<td>ISEAR</td>
<td>Line based Keyword Spotting</td>
<td>65</td>
</tr>
<tr>
<td>[43]</td>
<td>H, S, A, F, D, SU</td>
<td>Aman 2007, Twitter Data</td>
<td>K-NN &amp; PMI</td>
<td>84 (F-Score)</td>
</tr>
<tr>
<td>[44]</td>
<td>PO, NE</td>
<td>News Summary</td>
<td>CNN</td>
<td>Headlines – 67.95 Blogs – 60.73</td>
</tr>
</tbody>
</table>

(G - Guilt; Po - Positive; NE - Negative; ISEAR - International Survey on Emotion Detection Antecedents and Reactions; PMI - Point Mutual Information; CNN – Convolution Neural Network)

D. Facial Emotion Recognition (FER):

In 1977, Ekman and Friesen developed Facial Action Coding System (FACS) to code facial expressions in which the movements on the face are described by action units. This system inspired many researchers to analyze facial expressions by means of image and video processing. In this work, tracking of facial features and measuring the amount of facial movements is done to classify different facial expressions [37]. The most effective non-verbal communication is through facial expressions. In communication, most of the message contribution is in the form of non-verbal communication especially facial expressions. There are multiple approaches to recognize mood using facial expressions including Machine Learning, Deep Learning, and Fuzzy Logic. Facial Emotion Recognition basic architecture is given in Fig.4. In this, facial features such as geometric and appearance features which include shapes and locations of eyes, nose mouth, facial regions or patches are extracted from the face.

Facial expression recognition becomes difficult in case if a human face has multiple variations such as color, orientation, expression, posture, and texture, etc. [51]. Some of the methods that detect emotions from facial expressions are given in Table 4.

Table 4: Different studies on FER

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Emotions</th>
<th>Database</th>
<th>Technique</th>
<th>Recognition Rate in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>[45]</td>
<td>H, S, A, F, D, SU</td>
<td>Real time Images</td>
<td>K-NN Classifier</td>
<td>90</td>
</tr>
<tr>
<td>[48]</td>
<td>H, S, A, D, N, SU, AF</td>
<td>KDEF</td>
<td>CNN, AOD</td>
<td>Average 84.9</td>
</tr>
</tbody>
</table>
Emotion Recognition by Physiological Signals

Physiological signals which are controlled by the autonomic nervous system are increasing attention in the field of emotion recognition. However, a single signal may not describe emotions completely and accurately [58]. So, one or more signals such as EEG, ECG, GSR, EMG, PPG, RSP, HRV, etc. are sensed using sensors and wearable devices to recognize mood and emotion. Some research findings of physiological signals are given in Table 5. Physiological signals are easily influenced by many factors such as the human body and external environment which makes it difficult for data acquisition [56].

**Table 5: Emotion Recognition by Physiological Signals**

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Signal</th>
<th>Emotions</th>
<th>Database</th>
<th>Technique</th>
<th>Recognition Rate in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>[55]</td>
<td>ECG &amp; GSR</td>
<td>Arousal &amp; Valence</td>
<td>AMIGOS</td>
<td>DCNN</td>
<td>Arousal-76 Valence-75</td>
</tr>
<tr>
<td>[56]</td>
<td>ECG, GSR, EMG &amp; PPG</td>
<td>P, F, S, A</td>
<td>Sensor Data</td>
<td>KPCA &amp; GBDT</td>
<td>93.42</td>
</tr>
<tr>
<td>[57]</td>
<td>RSP &amp;</td>
<td>H, S, A</td>
<td>Sensor</td>
<td>CNN</td>
<td>94.02</td>
</tr>
</tbody>
</table>

Some of the methods to recognize emotions using deep learning are discussed in Table 6.
Table 6: Emotion Recognition using body postures and gestures

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Emotions</th>
<th>Gestures</th>
<th>Database</th>
<th>Technique</th>
<th>Recognition Rate in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>[59]</td>
<td>H, S, A, F, D, S</td>
<td>Jump, Squat, Throw, Stand, Recede, Turn &amp; Walk away</td>
<td>Captured Images</td>
<td>TSN, ST-GCN, FCN</td>
<td></td>
</tr>
<tr>
<td>[61]</td>
<td>H, S, A, F, U</td>
<td>Jump, Sit, Walk</td>
<td>University of York emotion action dataset</td>
<td>FDCNN</td>
<td>94.2</td>
</tr>
</tbody>
</table>

(U - Untrustworthy, TSN - Temporal Segment Network, ST-GCN - Spatial-Temporal Graph Convolutional Networks, FCN – Fully Connected Network, RNN-LSTM – Recurrent Neural Network Long Short-Term Memory, FDCNN - Feed Forward DCNN)

G. Emotion Recognition using Daily Activities

As we discussed earlier, Moods influence all activities of individual including day to day activities. Life logging is digitally recording user’s daily lives for various purposes and in a variety of details. Such information can be recorded to identify daily life activities and boost the person’s experience. Daily lifelog including sleep quality, diet, physical activities, and our environment influence our moods and emotions [62]. Table 7 gives recent study on emotion recognition using daily activities.

Table 7: Emotion Recognition using Daily activities

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Emotions</th>
<th>Database</th>
<th>Technique</th>
<th>Recognition Rate in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>[62]</td>
<td>Happy, Anxious, Content, Depressed</td>
<td>Daily Lifelog</td>
<td>SVM &amp; C4.5</td>
<td>SVM C 4.5 Valence 75.43 71.92 Arousal 89.03 83.33</td>
</tr>
</tbody>
</table>

III. COMPARATIVE ANALYSIS OF DIFFERENT MOOD DETECTION MODALITIES

We have discussed briefly about different modalities to recognize different emotional states of human. Each Modality has some pros and cons. Some has great background of research however; some has not so explored. Among all studies facial and speech recognition for emotion detection has been explored and studied widely by researchers. All methods are compared on basis of dependency, complexity and applications as shown in Table 8.

Table 8: Comparative Analysis of Different Mood Detection Methods

<table>
<thead>
<tr>
<th></th>
<th>Depends on</th>
<th>Complexity</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neuroimaging</td>
<td>Small Movements</td>
<td>More</td>
<td>Medical Diagnosis</td>
</tr>
<tr>
<td>Speech</td>
<td>Speaking Style, Culture, Environment</td>
<td>Less</td>
<td>Call Centers</td>
</tr>
<tr>
<td>Text Based</td>
<td>Language, Writing Style</td>
<td>Moderate</td>
<td>Opinion Mining</td>
</tr>
<tr>
<td>Facial</td>
<td>Culture, Gender, Age, Person</td>
<td>Less</td>
<td>Mental Healthcare, Education, Security</td>
</tr>
<tr>
<td>Physiological S/G</td>
<td>Person &amp; Time</td>
<td>More</td>
<td>Personal Robots, Mental Healthcare</td>
</tr>
<tr>
<td>Body Postures &amp; Gestures</td>
<td>Culture &amp; Gender</td>
<td>Moderate</td>
<td>Video Surveillance</td>
</tr>
<tr>
<td>Daily Activities</td>
<td>Person</td>
<td>Less</td>
<td>Sleep Monitoring</td>
</tr>
</tbody>
</table>

IV. MOOD REGULATION METHODS

In the last decade, mood regulation has received increasing attention and has become one of the most studied topics within the psychological field. Mood regulation is a dynamic process that every person implements to down-regulate or up-regulate positive and negative emotional states to reach desirable states [63]. Based on interaction there are two types of regulations first is self-regulation and the other is regulation using digital technology.

A. Self-Regulation

Human regulates their mood through cognitive processes such as Distraction, Rumination, Reflection, Reappraisal, and Acceptance and using modulation like
Discharge, Emotion suppression and physical modulation [64]. Patients with mental health issues take some medications like Cholinergic Medication and Nicotinic Medication. These medicines are used to change the activities of the autonomic nervous system and to cope up with feelings such as depression [65]. Mindfulness is another method to overcome negative emotions. Mindfulness means focusing on present body sensations, thoughts, and feelings without judging them [66]. It can also be mindful eating or drinking so as focus on present. Sometimes a person seeks help from another person to cope up with anxiety and stress through social contact [67]. These methods are Human-Human Interaction.

B. Regulation using Digital Technologies

With the advancement in science and technology, there are methods to regulate mood using Human-Machine Interaction. The therapies using advance technologies are mentioned below.

1) Virtual Reality and Augmented Reality

Augmented Reality (AR) is a set of techniques and tools that add information to the physical reality. In AR, virtual elements provide the real-world view, hearing, smell and touch with remarkable and valuable information. These tools have used to reduce anxiety and fear by psychologists [68]. On the other hand, Virtual Reality (VR) allows generating real-life simulated scenarios that may provide a contextualized situation to measure a certain construct through significant environments, though controlled way [63]. In Virtual Reality Exposure Therapy (VRET) system, the therapist can manipulate the exposure elements in a safer, manageable and cost-effective way, So, this method is used by therapist to treat social anxiety, Social Stress and Fear [69].

2) Biofeedback techniques

Biofeedback Technique comprises an effective and noninvasive procedure, whose fundamental operating principle is the conscious registration of normally unconscious body procedures (e.g., brain activity, physiological signal etc.) [70]. Biofeedback with mobile app and gaming style app are used to capture changes in skin conductivity. This method provides greater reductions in psychological and physiological levels of stress [71]. Heart Rate Variability biofeedback has used to reduce stress and anxiety effectively [72]. Neuro feedback signals have used to control activity of brain to regulate emotions [73].

3) Wearable Sensors and Devices

Wearable devices have become popular in everyday life, which serve a range of functions, from measuring physical activity and physiological variables to providing feedback on emotional states. The ‘doppel’ wearable device delivers an on-demand, discrete, user-controlled, heartbeat-like vibration applied through a wristband. It is used to provide calmness in case of high anxiety and stress [74]. A recent mHealth technology, ‘Calm Mom’, included of a mobile app and a wrist-worn sensor band for the ambulatory measurement and alerting of increased electrodermal activity (EDA), a physiological measurement of stress has become an integral tool for managing stress [75].

4) Mobile applications

Smartphones have been and are part of a technology revolution that has deeply changed people’s daily life. Mobile apps such as mental health mobile (mHealth) applications, Emotional help assistant chatbot, self-care, mood trackers and mindfulness-based applications are used to regulate emotional states [76]. Almost all mobile phones provide music player or FM Radio. Music is often used for regulating emotions in everyday life and they have both beneficial and harmful effects on emotional health. Person can regulate mood by listening music. Music can increase positive emotions and reduce negative emotions. Music therapy has been used with depressed and non-depressed people for mood regulation [64].

V. CONCLUSION

Emotional Intelligence has attracted increasing attention in last few decades by psychiatrists, researchers, academicians, automobile industries and many more. Researchers are still working on this topic to optimize existing methods and to increase their accuracy. The objective of this research paper is to provide brief introduction towards methods, applications and limitations of mood detection and regulation based on the available work in literature. As we mentioned earlier, mood or emotional state can be recognized using one or more modalities from Neuroimaging, Speech, Facial Expressions, Text, Physiological Signals, Body Postures or Gestures and Our Daily Activities. Mood has great impact on human’s personal and interpersonal life. This mood has to be regulated time to time otherwise it may turn into a serious mood disorder. In this paper we have reviewed two methods of regulation i.e. self-regulation and regulation employing digital technology.
REFERENCES


