

# EMOTION RECOGNITION : A SURVEY

## I.INTRODUCTION

The goal of this paper is to give a clear idea about emotions and the ways in which they can possibly be recognized by a system. It is not necessary to recognize emotions when computers are used just as tools for a computational purpose. But it is becoming important to impart to system, the ability of understanding the user. This can reduce the frustration of the user (if any), develop applications and build tools to develop social-emotional skills.

## II.EMOTION

The word emotion, meaning to stir up or a movement towards the outside, dates back to 1579. Its origin is seen in French word 'emouvoir' and Latin word 'exmovere'. The dictionary defines emotion as an intense , affective state characterized by physical and mental disturbance, which is seen as a result of some stimulus. It can be majorly divided into two classes namely primary emotions and secondary emotion.<sup>[7]</sup>

According to Paul Ekman, a research scholar, the primary emotions are anger, disgust, fear, happiness, sadness and surprise. These emotions are called primary because they appear to be universally recognized even in cultures that are preliterate. Another researcher named Robert Plutchik added a few more emotions to this list that could be considered primary such as trust,distrust and anticipation. A blend of these emotions in turn lead to secondary emotions. For example, anger and disgust can lead to contempt.

## III. RECOGNIZING EMOTIONS

Emotion recognition is an active field of research that forms a part of affective computing which deals with the study and development of systems and devices that can recognize, interpret and simulate human affects. Affect refers to the experience of emotion. Professor Picard defined affective computing as "the computing that relates to, arises from and deliberately influences emotions" when he introduced it in 1995. It imparts knowledge to the system that it devises through artificial intelligence.

Emotion recognition begins with the task of acquiring data from the human based on which emotions are to be recognized. For classifying or labeling emotions, a model of emotion is needed based on which classification can take place. With the data and pattern of recognition in hand, these details are given to the classifier as input as a consequence of which it identifies the emotion experienced by the human. Emotions can be recognized from various categories of details such as facial expressions, quality of speech produced, physiological signals of the human body and gestures that are expressed. Let us discuss about each of these categories in detail.

### 3.1 FACIAL EXPRESSIONS

Recognizing emotions from facial expressions is perhaps the easiest and earliest known technique. It has a long history as it is believed that they hint on the important aspects of emotions. Hence many approaches have been introduced to classify emotions based on facial expressions. The main idea behind all these approaches lies in the fact that emotional signs can be found out from the spatial positioning of specific points and regions of the face.<sup>[8]</sup> The table below gives the facial expressions of primary emotions.

EMOTION	FACIAL EXPRESSION
Happiness	Corner of lips widened Raised cheeks
Sadness	Skin below the eyebrow triangulated Upper eyelid drawn in
Anger	Stare in eyes Dilated nostrils Lips pressed firmly
Fear	Eyebrows raised Mouth open
Disgust	Raised lips Wrinkled nose
Surprise	High curved eyebrows Eye white more visible

Table 1 : Facial expressions corresponding to each emotion

### 3.2 SPEECH

The voice in speech not only conveys a semantic message but also the information about the emotional state of the speaker. There are many features of speech based on which classification can be made. The main source of energy in speech is the vibration of the vocal cords. The rate at which the cords vibrate is called the fundamental frequency of the acoustic signal. It corresponds to the pitch of the voice. The variations of pitch and its intensity together forms the prosody. The acoustic parameters of speech are pitch, intensity, duration of speech and spectral properties.<sup>[4]</sup> Other parameters include the contour, base of tone, quality of voice.

PARAMETERS	HAPPINESS	SADNESS	FEAR
Pitch rate	Fast or Slow	Slow	Much Fast
Range	Wide	Narrow	Wide

Intensity	High	Low	Normal
Quality	Breathy	Resonant	Irregular Voicing
Articulation	Normal	Slurring	Precise

Table 2 : Acoustic parameters compared for 3 emotions

### 3.3 PHYSIOLOGICAL SIGNALS

Physiological signals though are not related to emotion directly, information from such signals can be used for the purpose of emotion recognition. It can be broadly classified into two, based on the point of origination.<sup>[6]</sup> The first category of signals originate from the peripheral nervous system such as heart rate(ECG), skin conductance(EMG) and the second originates from the central nervous system such as the brain signals(EEG).

#### 3.3.1 ElectroCardioGram(ECG)

It records the activity rate of the heart and is composed of three waves namely P wave, QRS complex and T wave. It can be associated with emotion on the basis of heart related indexes such as heart rate, blood volume pulse, stroke volume, cardiac output, peripheral vascular resistance and myocardial contractility.<sup>[5]</sup>

#### 3.3.2 ElectroMyoGram(EMG)

It measures the muscular activity and has been shown that it corresponds to negatively valenced emotions. Another signal that is associated with EMG is the Galvanic Skin Response(GSR) which is an indicator of skin conductance and it increases linearly with arousal rate. The results of both the signals are then combined to find out the emotion based on the valence arousal model.<sup>[1]</sup>

#### 3.3.3 ElectroEncephaloGram(EEG)

It is the recording of the electrical activity of the brain. It comprises of five waves that have been classified based on their frequency. The waves along with their frequencies and when they are predominant are given below.<sup>[9]</sup>

- Delta - meditation - ( 0 to 3 Hz)
- Theta - dream - ( 3 to 8 Hz)
- Alpha - calm - ( 8 to 12 Hz)
- Beta - active - ( 12 to 27 Hz)
- Gamma - extreme - ( 27 Hz and above)

Out of these waves, beta and alpha are ample for recognizing emotions. Beta waves are associated with alertness and alpha waves are related to calmness. Ratio between them gives an indication of arousal parameter. Positive and negative emotions are controlled by the left and right hemispheres of the brain. Ratio between them is a good measure of valence parameter. With the help of valence and arousal values, emotions can be identified.

### 3.4 MULTIMODAL INFORMATION

A combination of any of the above discussed techniques can also be used for recognizing emotions. When there are more than one type of data that is employed for the purpose of emotion recognition, then such data is said to be multimodal and hence has been called as multimodal data or information. For example, combining facial expressions and speech signals leads to a new type of data called as the audiovisual signal.

DATA	ACCURACY	ADVANTAGE	DISADVANTAGE
Facial Expression	90 %	Easy computation and most widely used technique.	People also act merely to deceive others in some situations.
Speech	70%	Experimental setup required is less	Speech cannot be associated to emotional status always
ECG	67%	The signal cannot be masked as it is not under the control of the user.	Labeling emotions with less intensity is difficult
EMG	-	Signal acquisition is comparatively easy	Valence and arousal measurements are obtained from two different signals.
EEG	98%	Results are more accurate as brain signals are used directly	Computation is complex and expensive
Multimodal	-	Accuracy is more as more than one data is used	Blending different data increases the cost and work needed.

Table 3 : A comparison of input methods used for emotion recognition

## IV. MODELS OF EMOTION

There needs to be a foundation based on which the classification of emotions can be made. These are called as the models of emotion and many of them have been proposed. They are be split into two classes namely discrete model and dimensional model<sup>[11]</sup>. The discrete model of emotion was proposed by Darwin states that emotions are fundamentally different constructs which are isolated from each other. This is called as the Discrete Emotion Theory.

On the other hand, the dimensional model of emotion states that emotions are characterized on a dimensional basis of groupings. Some researchers define emotions according to one or more dimensions, the first of which was put forth by Wilhelm Max Wundt, the father of modern psychology in 1897. He suggested that emotions can be described by three dimesions such as pleasure or displeasure ,arousing or subduing and strain or relaxation. Later in 1954, Harold Schlosberg renamed the three dimensions. The types of emotion models that fall under the dimensional category are given below<sup>[11]</sup>

#### 4.1 Circumplex Model

This model was proposed by James Russell and it is two dimensional. The two dimensions defined by the model are valence and arousal. Valence parameter indicates whether the emotion is a positive one or negative one and arousal parameter gives an indication of the intensity of the emotion experienced. Circumplex models are the most widely used when compared with other models.

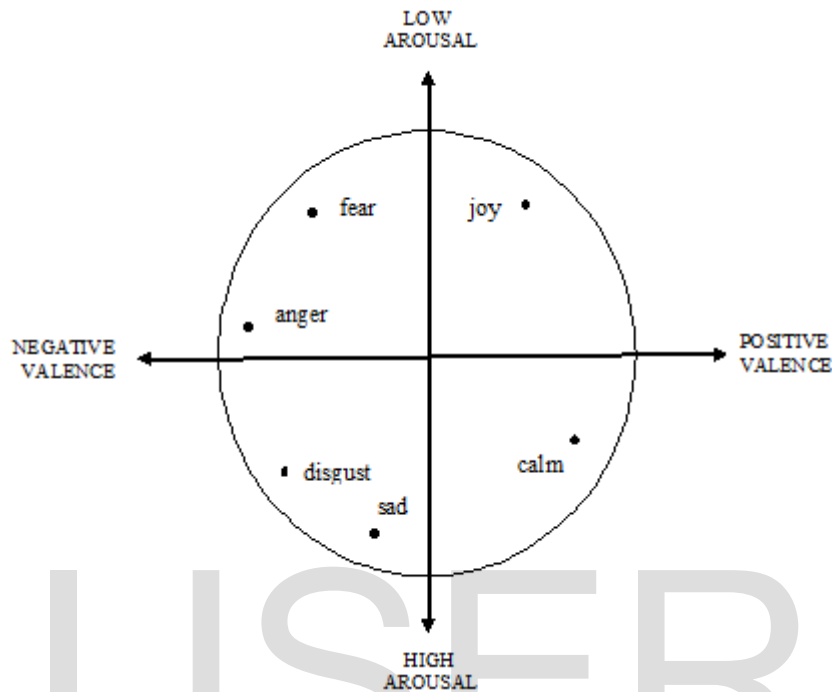


Fig 1. Circumplex model

#### 4.2 Vector Model

This model is also two dimensional but it is represented in a boomerang shape. It consists of two vectors each pointing in a different direction. The model is based on the assumption that there is an arousal dimension that is always persistent. It is only the valence dimension that decides the emotion whether positive or negative. At the meeting point of the two vectors is the low arousal state and the high arousal states are determined by their valence.

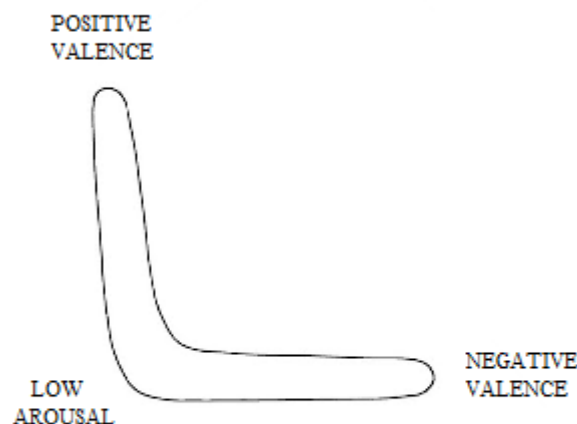


Fig 2. Vector model

### 4.3 PANA Model

The Positive Activation – Negative Activation(PANA) model otherwise called as the consensual model proposes the idea that positive ad negative emotions are two separate systems. The arousal dimension is similar to that of the vector model.The vertical axis is spanned by low to high positive affect and the horizontal axis by low to high negative effect.

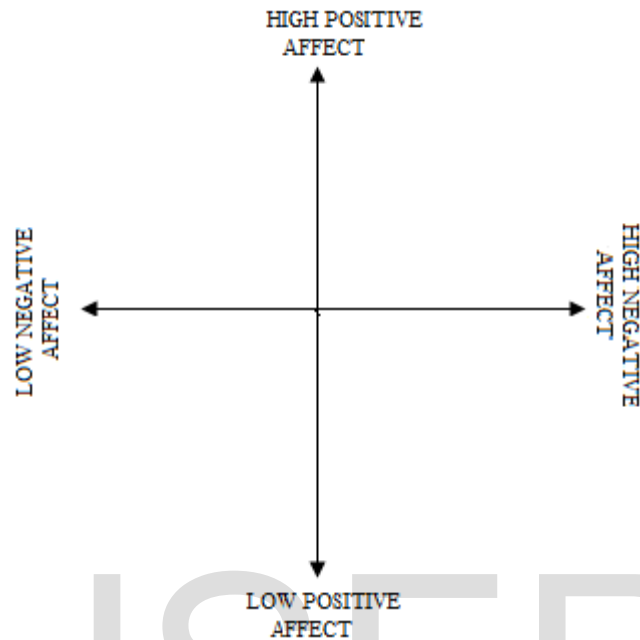


Fig 3. PANA model

### 4.4 Plutchik's Model

This is a three dimensional model put forth by Robert Plutchik. Emotions according to this model are arranged in layers of concentric circles where the inner circles represent basic emotions and the outer circles, the more complex emotions. It suggests that outer circles are formed by blending the inner circles.

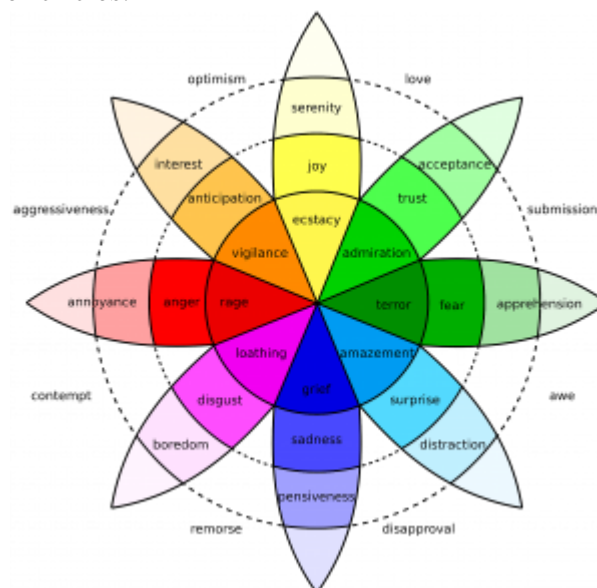


Fig 4. Plutchik's model

#### 4.5 PAD Emotional State Model

Albert Mehrabian and James Russell jointly proposed the PAD model of emotion where PAD stands for pleasure, arousal and dominance. Pleasure measures whether the emotion is positive or negative, arousal measures the intensity of the emotion as to it is high or low and dominance measures the nature of the emotion whether it is dominant or submissive.

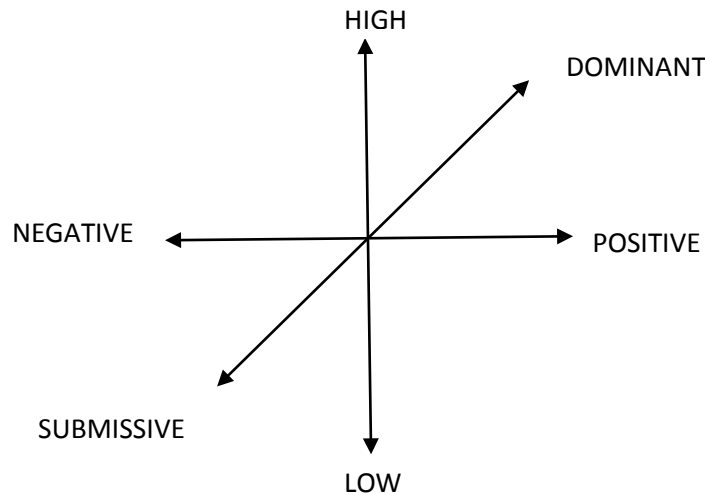


Fig 5. PAD model

#### 4.6 Lovheim Cube of Emotion

This model is different from the others in a way that it directly relates the combination of neurotransmitters such as dopamine, noradrenaline and serotonin to the basic emotions. It is a three dimensional model where the hormones stated above form the three axis and the emotions are placed in the corners of the cube as shown below.

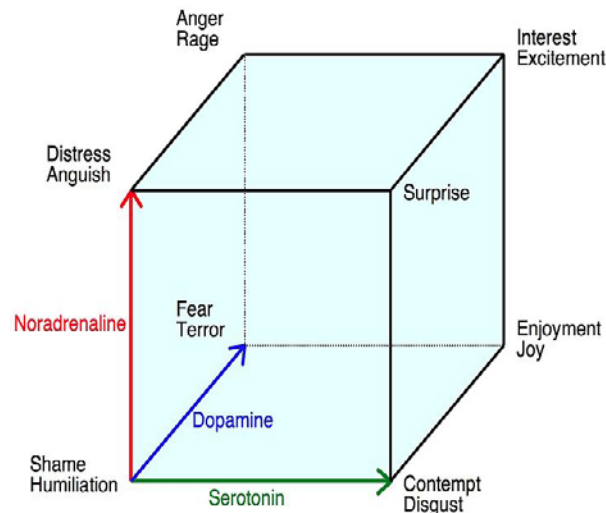


Fig 6. Lovheim cube

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