SIGNIFICANCE OF BODILY MOVEMENT FOR DETECTION AND ANALYSIS OF EMOTIONS: A REVIEW

Saurabh Singh[1], Nidhi Sethi[2], Vishal Sharma[3]

[1]*Department of Computer Science and Engineering, DIT University, Dehradun, India*
[2,3]*Assistant Professor in Computer Science Department , DIT University, Dehradun, India*

ABSTRACT

Through this paper we are trying to convey that there is a need of unified body language framework so that we can infer and reveal the underlying emotions. We can apply a verity of psychology inspired body language features to describe bodily emotion through posture. With the advancement in Affective Computing there is progress in the field of facial, vocal and physiological emotion detection. Humans communicate primarily through bodily movements. But the detection of emotion through the body is limited and the development in this field is comparatively down because of the absence of the proper equipments and coding scheme's, dedicatedly designed and prepared for bodily movement expression. A lot of researchers criticize to work on body expressions. However, work-done by the psychologist's provide knowledge and shows the bright side by presenting that the emotions shown by the body are as accurate as we get them from face. Recent researches in automatic bodily emotion detection have also shown promising results. The primary purpose of this review is to provide positive view and prepare a platform for emotion detection using bodily emotions. We will look at Laban Movement Analysis as a prominent and a promising method for movement representation in this field.

Keywords: ***Affective Computing Unified Body Language Framework, Gesture Recognition, Facial Action Coding System, Gestures.***

I INTRODUCTION

Communication is an important aspect of daily life; it helps us to connect with others as individuals or as groups. Without communication life would be non-existent, we communicate to others verbally and non-verbally. It helps us in the development of relationships, education and work. But when we communicate, our communication is less than 20% verbally; percentage is ranging from 55% to 80% when we communicate through non-verbal behavior.

First ever research done on human emotion, was done by W. James [1] in the year 1884. From that time and till now a lot work has been done by the psychologist and provided us with the knowledge about the origin[2,3] and categorization[4,5,6,3] of emotion. The study of emotion has moved from psychology to computing, remarked by the book of Picard[7], which created a new field called Affective Computing. This book provides us with standards and ideology to create smart and intelligent emotion detecting system. The influence of emotion detection covered a wide range including medicine[8], education[9], health[8] and at a grater extent in Human Computer

Interaction[10,11]. Usually emotion detection system takes input either in the form of audio, image or visual and then provides appropriate results produced according to the input given. Visual emotion detection was established by the classical study of Darwin[12]. Using the visual detection, Darwin gave us an idea of how emotions can be recognized from face and body; it created two broad fields for detecting emotions: facial and bodily emotions. Scientists and researchers have shown a keen interest to work on facial expression[13]. Detection using facial expression has a successful history due to the work done by Ekman and Friesen who introduced us to Facial Action Coding System (FACS)[14]. This system has provided us with the standard and outlines for facial emotion detection[15], and using this system a lot of face recognition and facial emotion detection system have been evolved. As compared to the facial expressions bodily expression were not addressed by the researchers. Ekman stated that bodily emotions could not indicate the emotions of a person whereas facial expressions can be read and understand by most of the people, most of the scientists agreed with him[16,17]. Most researchers have a notion that emotion is only the secondary signatures. Most of the work done in emotion detection, facial expression covers the major proportion while the bodily expression has only a minute proportion. Most of the researchers don't even consider bodily expression.

Whereas psychology support the bodily expressions by providing evidences [18] and nonverbal communication gestures[19]. Bodily expressions are important as inferred from the evidences [20,13] and they are as important as facial expressions. The evidences provided but the psychology made scientist and researchers to ponder over it again and work in this area of emotion detection. This survey will cover two primary purposes. Firstly, we will re-view evidences that support the importance of human body, in opposing with face for emotion recognition. Secondly to study the existing emotion detection system that works on bodily emotions. Finally, the paper will give some discussions and suggestions about how to effectively use bodily expression as a signal for building emotion recognition systems.

II AFFECTING BODY EXPRESSION

The human body plays a significant and an important role in expressing the emotions felt by the person, which can be used for emotion detection. There has been a lot of study and work-done on non-verbal communication and human behavior. The detection of emotions felt by a person can be studied in two ways either by the facial expression (a lot of work-done) or by the bodily movements and gestures. According to Darwin[12], his studies inferred that along with the facial expression, human body movements and the gestures made also represent the state of mind and the emotions of a person. Both facial and bodily gestures can be taken into account for affect detection.

Body gestures include hand movements, shoulder position, torso alignment, head position and leg movements. Working alone on the body posture (hiding hand and face) we can predict the emotions of a person accurately, the results found are accurate as we get it form the analysis of facial expression as stated by Walter and Walk[18]. Meeren et al.[21] stated that the facial expression and the body movements are related and their affect on each other. Similarly, if we work on each body part individually we will get to know about the emotions felt by the person not

exact but almost correct and each body part is somehow connected to some or the other emotion[13,22]. According to the fact that the body parts have a posture that's static or our body has a static configuration. Posture is usually defined by the position and orientation of specific body parts. Orientation can be relative. Mehrabian [20] et al. he used a few global descriptors such as relative orientation of a partner during a conversation, closeness or openness and symmetry of body limb. Harrigan et al. reported that human body posture can be decoded using the following common descriptors: trunk lean (upright, forward or backward), trunk orientation (facing, turned), arms and leg positions and configurations.

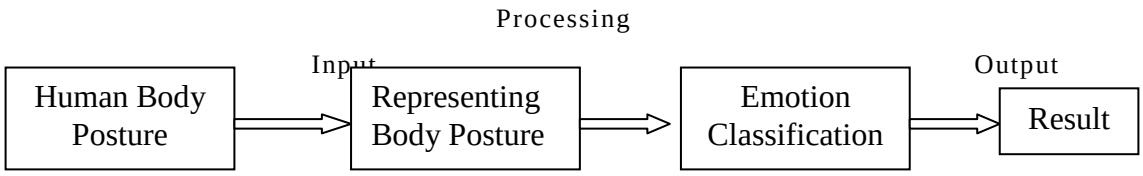

Fig. 1 Phases of bodily emotion detection system

As compared to the static gesture detection as lot of work and research has been done in the field of dynamic configuration. According to the primitive research done we have found that every motion and position of human body can express the emotions felt by the person for example: interested/bored, agreed/disagreed, defensive etc Bull[24]. Lagerlof worked on recognizing the emotions felt by kids and he did experiments on 4-year-old children, and he found that children too show emotions according to their likes and dislikes and revealed that, children can distinguish four emotions: anger, fear, joy and sadness[25].

III GESTURE REPRESENTATION AND DETECTION

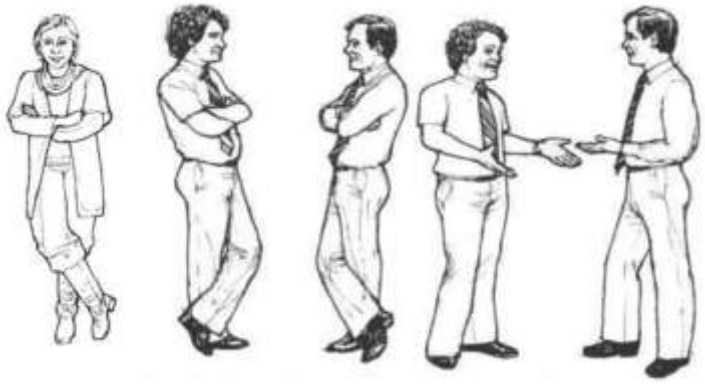

Fig.2 (a) Defensive standing position; (b) Closed body and closed attitude; (c) Open body and open attitude

Every movement is not a gesture but every gesture is a movement. While communicating or interacting with a person either a face to face or telephony a person shows gestures and movements which represents his/her mind state and emotional level. Gestures can be intentional or fake. A lot of research suggests that in a verbal communication a person uses hand and arm to express his thoughts. These gestures can be can be categorized as the following: emblems, illustrators and adaptors[26,27].

Emblems are gestures that help the speaker used to express their meaning to the listener. They are conventional symbols that convey the meaning i.e. folding hands – defensive, showing palm – stop etc[28].

Illustrators are the gestures that a person uses or they are just accompanied in the verbal communication. It includes simple and repetitive movements; these movements might be related to the communication. It can be further divided into: deictic, iconic and metaphoric gestures. Deictic includes pointing towards an object and expressing themselves to the listener. Iconic and metaphoric are gestures that represent inherited qualities of an object or action such as representing the object and mimicking etc[29].

Fig. 3 (a) Raised steeple; (b) Lowered steeple.

According to the recent work done by Dael [30], a new system has been proposed that would provide the coding of body and body-parts positions, movement and communicative intent of gestures. The Body Action and Posture Coding System (BAP), it includes wide range of coding approaches to study emotions by using a multilevel coding.

The anatomical level is used to specify which body parts are concerned by a movement. Available articulators are the neck, the trunk (including spine and chest), the upper and lower-arms (including shoulders, elbow, wrist and fingers) and the legs. The form level describes the form of the movement of a set of articulators.

Scientifically gestures can be divided into two broad fields static and dynamic gestures. Gesture recognition and detection is a process of recognizing and interpretation of the input (static and dynamic gestures) provided which is evaluated over the time.

IV BODY POSTURE EMOTION DETECTION

Due to insufficient knowledge of body posture very little work is done in the field of postural emotion detection. Schindler et al.[9], stated that according to his study he found that emotions shown by the body posture can be understood using the low-level visual data, without using the posture representation method. They took images of

body posture, and then turned the problem into object recognition. This approach of considering the body posture as an object and then decoding the emotions is reliable. Using this method which included low level processing alone the system still had a recognition rate of 81.6%. They stated that there model can be extended further by using motion analysis which can be taken from the model of action perception [31]. To the best of my knowledge, to present, this is the only work that detects emotion directly from postural images.

In contrast, Kleinsmith et al. [32,33] suggested an approach that detects postural emotion by building a complicated representation of human body parts. This approach captures exact position of different body parts and therefore, can produces richer feature set. 24 features were generated directly from distances and angles between body parts (e.g. head, shoulder, and elbow). The results were accurate, 70% of affective postures were correctly classified. Unfortunately, this work did not include an automatic process for generate these features. This study is more valuable than the work of Schindler et al. [9].

TABLE 1
Expressive elements of posture.

Emotion	Body Posture
Anger	Head backward, no chest backward, no abdominal twist, arms raised forwards and upwards, shoulders lifted.
Joy	Head backward, no chest forward, arms raised above shoulder and straight at the elbow, shoulders lifted.
Sadness	Head forward, chest forward, no abdominal twist, arms at the side of the trunk, collapsed posture.
Surprise	Head backward, chest backward, abdominal twist, arms raised with straight forearms.
Pride	Head backward or lightly tilt, expanded posture, hands on the hips or raised above the head.
Fear	Head backward, no abdominal twist, arms are raised forwards, shoulders forwards.
Disgust	Shoulders forwards, head downwards.
Boredom	Collapsed posture, head backwards not facing the interlocutor.

4.1 Method for Detecting Body Expressions

Emotion detection looks familiar to the gesture recognition if we are not using the motion representation methods and this approach is similar to the approach of Schindler [9]. A lot of work and research has been done on gesture recognition but we haven't used automatic gesture recognition techniques. Researchers have directly process each segment of bodily motions alone instead of mapping emotions with the gestures. By using the motion capture equipment's the study on bodily movements has reached to new platform which provide better, reliable and efficient results [34]. The most widely used equipment is the VICON system, it uses magnetic markers on the joints and on the body to get and create a 3d image of the body. Using this device, Bernhardt and Robinson [35] developed a model for emotion detection from day today life. Complex motions were classified primitively into motion primitives. Feature representations were done with the help of the motion primitives and then this output serves as the input for SVM-based classifier. The system gave classification result at 81% .Using the artificial neural network

in this classification will provide classification results above 90%. Kapur and Virji-Babul [36] used the VICON system with only 14 markers in place of standard number of markers (the standard system regularly has more than 30 markers) that made the problem more sophisticated and hard. This experiment was done on 40 acted videos that constitute the recognition of emotion: joy, anger, sad and fear. Even though they have used only 14 markers but the results were promising and provided results with 93%.

Motion emotion representation is an issue which was raised a long time back i.e. even before when the computers came into existence. Methodology used for coding on movement are: the Bernese system [37,38], Laban Movement Analysis (LMA) and Labanotation [39,40]. LMA is the best methodology used for bodily emotion detection.

4.2 Expressing Emotions through Movement and its Analysis

The study of nonverbal movements is called as Kinesics. It argues that the body movement is enough to reveal the underlying emotional state. Both objective (using motion-capture data) and subjective studies showed that velocity, acceleration and jerk are movement variable that are particularly affected by an emotional state. Kinesics has a-lot of focus on the orientation and movement of the whole body. Angry movements tend to be large, fast and relatively jerky, while fearful and sad movements are less energetic, smaller and slower, so it's easy to understand the underlying emotional state of a person. Kipp and Martin (2009) [41] et al. stated that there is a correlation between the handedness and emotion: for two hand-righted actors, the right hand was more used when experiencing anger and the left hand when experiencing relaxed and positive feelings.

LMA is used by most of the scientists to work on the unified representation method to analyze bodily movements. LMA is a method used to observe, describe and notating the human movement. LMA consists of four components: Body, Effort, Shape and Space. Body: it focuses on the structural states of human body, movement of body parts. Space: it focuses on the movement the pathway used by the person. Effort: it focuses on the dynamic attribute of the body and attitude of movement i.e. swift, fast, jerky or slow. Shape: describes the changing forms that body. A significant characteristic of LMA is that it captures emotional state of a human according to his/her movements. Camurri [42,43] and the Info Mus Lab et al. worked on the emotion detection from dance and music performers, using a regular 2-D camera [22,10,12]. They used a four-level framework to work on and focused on Effort component. Experimental results revealed that the framework provided the same results as they got from the spectators [44]. In contrast, to the best of my knowledge, there has not been any work dealing with Body component. LMA still shows it's great possibly to be extended to use in emotion detection.

V CONCLUSION

In this paper, through evidences from psychology, we got an idea that tells us that there is a significant role of human body expression in emotion detection. We have discussed about the existing approaches that are used for automatic emotion detection which provided us with a new notion that we should have a unified framework for motion representation so that we can infer and reveal the underlying emotions. There is a need to work a-lot in the field of bodily emotion as we are lacking if compared to facial emotion detection. In fact, according to a general

overview we have not worked on the human body in emotion detection, regardless evidences from psychology. As we have a framework for facial emotion detection FACS[14], we need to have a similar framework that provide us with all necessary tools so that we can get a unified bodily movement representation framework. However, recent approaches in applying Laban Movement Analysis (LMA) for emotion detection are promising, although only a part of LMA is implemented.

According to our survey we have found that, the emotion detection was done in two ways: Firstly, we used image to detect emotions, using the low-level visual data [9] and by building a complicated representation of human body parts [32,33] the results were satisfactory 81.6% and 70% respectively. The results found by Kleinsmith [32,33] were more important as the affective postures were correctly classified. Secondly, we used the motion capture equipment to create a new platform to get reliable and accurate results. We used classifiers [34] and artificial neural networks [35] to get more efficient results, 81% and 90%

Using the psychological studies and the research done till now, we will be working on multimodal interaction so that we can infer the emotion of the people while they interact or work. The work will be based on bodily movements excluding the facial expression, as we have inferred from the above discussion that the body movements also reveal the underlying emotions.

REFERENCES

[1] James, W. “What is an Emotion?”. “Mind” 9, 34 (1884),188–205.

[2] Rauterberg, M. “Emotions: the voice of the unconscious.” Entertainment Computing-ICEC 2010 ,205–215.

[3] Russell, J. “A circumplex model of affect”. “Journal of Personality and Social Psychology” 39, 6 (1980), 1161.

[4] Ortony, A., and Turner, T. J. “What’s Basic About Basic Emotions?”, “Psychological Review” 97 , 3 (1990),315–331.

[5] Ekman, P. “An argument for basic emotions”. “Cognition and Emotion 6” (1992), 169–200.

[6] Gunes, H., Schuller, B., Pantic, M., and Cowie, R. “Emotion representation, analysis and synthesis in continuous space: A survey”. “In Automatic Face &Gesture Recognition and Workshops (FG 2011), 2011 IEEE International Conference on, IEEE” (2011), 827–834.

[7] Picard, R. “Affective Computing”, “1st ed. The MIT Press”, 2000.

[8] Wright, B., Clarke, N., Jordan, J., and Young, A. “Emotion recognition in faces and the use of visual context Vo in young people with high-functioning autism spectrum disorders”. “Autism the international journal of research and practice” 12 , 6 (2008), 607–626.

[9] Schindler, K., Van Gool, L., and de Gelder, B. “Recognizing emotions expressed by body pose: a biologically inspired neural model”. “Neural networks: the official journal of the International Neural Network Society” 21, 9 (Nov. 2008), 1238–1246.

[10] Cowie, R., Douglas-Cowie, E., Tsapatsoulis, N., Votsis,G., Kollias, S., Fellenz, W., and Taylor, J. "Emotion Recognition in Human-Computer Interaction". "IEEE Signal Processing Magazine" 18 , 1 (Jan. 2001), 32–80.

[11] Hudlicka, E. "To feel or not to feel: The role of affect in human computer interaction". "International Journal of Human-Computer Studies" 59, 1-2 (July 2003), 1–32.

[12] Darwin, C. "The expression of the emotions in man and animals", 2nd ed. London, 1980.

[13] Wallbott, H. "Bodily expression of emotion. European journal of social psychology" 28 , 6 (1998), 879–896.

[14] Ekman, P., and Friesen, W. "Facial Action Coding System: A Technique for the Measurement of Facial Movement". "Consulting Psychologists Press", 1978.

[15] Fasel, B., and Luettin, J. "Automatic facial expression analysis: a survey". "Pattern Recognition" 36 , 1 (2003),259–275.

[16] Ekman, P. "Differential communication of affect by headand body cues.Journal of Personality and Social Psychology" 2, 5 (1965), 726–735.

[17] Ekman, P., and Friesen, W. "Detecting deception from the body or face". "Journal of Personality and Social Psychology" 29, 3 (1974), 288–298.

[18] Walters, K., and Walk, R. "Perception of emotion from body posture". "Bulletin of the Psychonomic Society" 24, 5(1986), 329–329.

[19] Dittman, A. T. "The Role of Body Movement in Communication. In Nonverbal Behavior and Communication", "2nd ed. Lawrence Erlbaum Associates", Publishers, 1987, 37–64.

[20] van Heijnsbergen, C. C. R. J., Meeren, H. K. M.,Gr`ezes, J., and de Gelder, B. "Rapid detection of fear in body expressions, an ERP study". "Brain research" 1186 (Dec. 2007), 233–41.

[21] Meeren, H. K. M., van Heijnsbergen, C. C. R. J., and de Gelder, B. "Rapid perceptual integration of facial expression and emotional body language". "Proceedings of the National Academy of Sciences of the United States of America" 102, 45 (Nov. 2005), 16518–23.

[22] Coulson, M. "Attributing emotion to static body postures: Recognition accuracy, confusions, and view point dependence". "Journal of Nonverbal Behavior" 28 , 2 (2004), 117–139.

[23] Mehrabian, Albert. 1972. "Nonverbal Communication". Transaction Publishers.

[24] Bull, P. "Posture and Gesture", volume 16 ed. Pergam on Press, 1987.

[25] Lagerl¨ of, I., and Djerf, M. "Children's understanding of emotion in dance". "European Journal of Developmental Psychology" 6 , 4 (July 2009), 409–431.

[26] Kendon, Adam. 1983. "Gesture and Speech: How They Interact." Nonverbal Interaction: 13–45.

[27] Ekman, P., and W. V. Friesen. 1969. "The Repertoire of Nonverbal Behavior: Categories, Origins, Usage, and Coding." Semiotica 1: 49–98.

[28] Efron, David. 1941. "Gesture and Environment." 1972. Gesture, Race and Culture. Mouton The Hague.

[29] David McNeill 1987. "The Role of Body Movement in Communication".

[30] Dael, Nele, Marcello Mortillaro, and Klaus R. Scherer. 2011. "Emotion Expression in Body Action and Posture."

[31] Giese, M. A., and Poggio, T. "Neural mechanisms for the recognition of biological movements". "Nature Neuroscience" 4 (2003), 179–192.

[32] Kleinsmith, A., and Bianchi-Berthouze, N. "Recognizing affective dimensions from body posture. Affective Computing and Intelligent" (2007), 48–58.

[33] Kleinsmith, A., Fushimi, T., and Bianchi-Berthouze, N. "An incremental and interactive affective posture recognition system". In Context (2005), 1–13.

[34] Shen, L., Wang, M., and Shen, R. "Affective e-Learning: Using Emotional Data to Improve Learning in Pervasive Learning Environment Related Work and the Pervasive e-Learning Platform". "Learning" 12, 2 (2009),176–189.

[35] Bernhardt, D., and Robinson, P. "Detecting affect from non-stylised body motions". "Affective Computing and Intelligent Interaction" 4738 (2007), 59–70.

[36] Kapur, A., and Virji-Babul, N. "Gesture-based affective computing on motion capture data". "Affective Computing" (2005), 1–7.

[37] Frey, S., and von Cranach, M. "A method for the assessment of body movement variability". "Social communication and movement" (1973), 389–418.

[38] Rosenfeld, H. "Measurement of body motion a and orientation". "In Handbook of methods in non verbal behavior research", K. Scherer and P. Ekman, Eds. Cambridge University Press, 1982, 199–286.

[39] Laban, R., and Lawrence, F. Effort . Macdonald & EvansLtd., London, 1947.

[40] Hutchinson, "A. Labanotation: The System of Analyzing and Recording Movement". "New Directions", 1954.

[41] Kipp, Michael, and J.-C. Martin. 2009. "Gesture and Emotion: Can Basic Gestural Form Features Discriminate Emotions?" "In Affective Computing and Intelligent Interaction and Workshops", 2009. ACII 2009. "3rd International Conference", 1–8.

[42] Camurri, A. "Recognizing emotion from dance movement: comparison of spectator recognition and automated techniques". "International Journal of Human-Computer" 59 (2003), 213–225.

[43] Camurri, A., Hashimoto, S., Ricchetti, M., Ricci, A.,Suzuki, K., Trocca, R., and Volpe, G. "Eyes web: Toward gesture and affect recognition in interactive dance and music systems". "Computer Music Journal" 24 , 1 (2000),57–69.

[44] Camurri A., Mazzarino, B., Trocca, R., and Volpe, G."Real-time analysis of expressive cues in human movement". Proc. CAST01, GMD, St. Augustin-Bonn (2001), 63–68.

[45] Scherer, K. "What are emotions? And how can they be measured?". "Social science information" 44, 4 (2005),695–729.

[46] Siegman, A. W., and Feldstein, S. "Nonverbal behavior and Communication", "Second ed. Psychology Press", 1987.