Toward new expressive movement characterizations

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Abstract. Our aim is to characterize expressive movements provided by motion capture systems: its dynamics, spatial extent and trajectory. To reach our aim, we need to describe expressive movements in a fine-grained fashion taking into account several description levels including anatomical, directional, static/dynamic levels. Our main goal is to use this set of features to drive the animation of virtual characters enhancing their motion expressivity, in particular when displaying emotional behaviors.

Keywords: motion capture, expressive movements, movement characteristics

1 Introduction

While many researches have been conducted for the description of facial and vocal emotional behavior, emotional body behaviors have received less attention. Despite the presence of several approaches for coding nonverbal body behaviors, there is no consensus on a general framework describing them. This can be explained by the complexity of the body structure and body parts synchronization, as well as by the variety of domains that require the description of body movement (like bodily expression of emotion, dance, social interaction, verbal and non-verbal behavior relationship).

Several coding systems have been elaborated to describe accurately body movements along the dimensions of body anatomy, direction of the movement, body position or action units, or movement quality [5] [6] [4]. While the anatomic description level defines the body parts or modalities involved in the movement, the directional level defines the spatial dimensions in which movement is possible. Body position and action units refer to the set of movement components responsible for the creation of movements with regard to the anatomic and directional dimensions (see The Body Action and Posture Coding System [5]). Coding systems based on the movement quality focus on how body movements are performed [4]. That is they encode information such as dynamic movement or body shape. One such method describing the quality of human movement called LMA (Laban Movement Analysis) was developed by Laban [4].

Emotional body behaviors description depends on the perspective used to code body movement. Scholars tend to use framework based on the type of

movement, describing a set of body postures and/or actions accompanying affective states [7], or on the movement characteristic in term of dynamic movement quality [9] (such as velocity, action duration) or postural characteristics [8].

Despite the importance of existing studies on emotional behavior encoding, scholars tend mostly to focus on some particular dimensions. In our work, we aim to elaborate a more global framework that describes body expressivity taking into account body postures at global and local levels and movement quality including direction and dynamic information.

2 Body movement characterization

We propose a set of features that describe body shape and postural changes during movement which are; global body shape, directional changes, local body shape, arms shape, hands relationship, feet relationships and elbow flexion. We base our work on study by [5] to define a set of sub parameters for each feature. Segments involved in the definition of each feature are different from one direction to another:

- Global body shape;
  Global body shape feature refers to the global openness of the whole body in the sagittal, vertical and lateral direction. The mean of body shape in each direction is compared to the correspondent neutral and maximal body shape. Thus we consider the mean of movements in 8 dimensions, namely advancing, retreating, spreading, enclosing, rising and sinking movements.
- Directional changes;
  Based on the 2D bounding box that surrounds the body in each of the three directions (lateral, sagittal and vertical), directional changes correspond to the mean of global postural changes related to each dimension during a sequence of movement.
- Local body shape;
  Unlike the two previous parameters, local body shape concerns the shape of a set of segments in the most important relative directions (such as the amount of torso backward movement). Both global and local body shape are inspired from Shaping movement component of Laban Movement Analysis (LMA) [4].
- Arms shape;
  While Shape Flow movement component refers to the movements that are directed inward or outward the body center in LMA, this arms shape feature corresponds to the distance between the arms and the body center. This parameter concerns both hands and elbows.
- Hands relationship;
  Hands relationship is defined as the 3D distance between hands. The mean as well as the variation measures of this distance are estimated.
- Feet relationships;
  Similarly to the previous feature, the 3D distance between feet is used to estimate the mean of stride length (the openness of lower body parts) and

the mean of feet postural changes (the step duration in a walking activity). The foot stride was proposed in [3] to characterize emotional walk.

- Elbow flexion;
  The use of angular and round postures was proposed in the work of Aronoff [2]. We estimate the mean of angular and round flexion angles related to the elbows.

3 One example: Expressive walks analysis

To study if the proposed features can easily discriminate between different expressive movements (from the same category, e.g. walking) and regroup movements that are similar in term of quality, we use the Mockey Database [1] which contains different expressive gaits. We use only the styles that are the closest to emotional behaviors: Proud, Cool, Decided, Sad, and Afraid walks. We segment each walk sequence to allow us to keep only the straight walk cycles by removing the turn stage.

We use the Principal Component Analysis to reduce the data and to extract the most important movement characteristics. Eighteen factors (principal components), that have an eigenvalue greater than 1, are retained. In order to find the prominent features that contribute to the linear combination of the resulted factors, we keep only the features that have a coefficient higher than 0.3. The first factor, that is the most important one, explains 51.44 % of the total variance. It groups the lateral global openness, distance between hands and body center and hands distance. The linear combination of the second and the third principal component refers to the angular flexion, the foot stride length, the variation of hands distance, the amount of head downward movement, and the amount of torso forward. Only few parameters are considered as less important (their coefficients were below to 0.3) which are the global body openness in the vertical direction, the amount of leg forward, leg backward and torso backward movement. The directional changes feature participates only to the last principal components.

The afraid style is highly distinguishable from the other styles with regard to the first component. This finding suggests that the combination of lateral body openness, the arms shape and the hands distance can be considered as a meaningful feature to discriminate between the afraid walks and the other walk styles. Sad walks differ from the other walk styles along the first and third principal components. That is it is characterized by large head downward and torso forward movement with low body openness as found also in previous works [7]. The decided style, which is close to an angry style, receives the highest values of angular elbow flexion and foot stride length making this cluster distinguishable from the other clusters on the second component. The increase of elbow angles was reported also in [10] with angry expressive walks while the use of long strides was assigned to angry walks in other studies [3]. Cool walks and proud walks were often characterized similarly with slight differences on the variation of hands distance, lateral global body openness and upper body forward movement.

4 Conclusion and future work

In this work, we propose a set of postural and dynamic features that characterize body movement. So far we have used these features to characterize expressive walks. Our analysis shows that this set of features is good enough to discriminate between the expressive walks in the database. The afraid, decided and the sad style, in particular, are highly distinguishable from the other walk styles mainly on the first, second and third principal components.

In our future work, we aim to enhance the proposed set of movement characteristics. Other features such as the synchronization between body parts, the symmetry of arms posture and movement need to be considered as well as the dynamic features to describe the quality of dynamic movement. Our aim is to apply these features to animate a virtual character making its animation more natural and expressive.

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