How to measure emotions by body pose data?

This document shows the theoretical background for choosing pose data and map it to Laban Movement components. The first table maps Laban components to the data explained by Aristidou et al. (2015) [1]. The second table shows how 6 basic emotions described by Paul Ekman are calculated in this project.

Table 1: How can Laban motor elements be measured following Aristidou 2015?

Laban element	What is measured	Index in Aristidou (2015)	What to measure	Notions
Body	Displacement/Orientation	f1	Feet to hips distance	Average of both sides
		f2	Hand to shoulders distance	Average of both sides
		f3	Right hand to left hand distance	Average of both sides
		f4	Hands to head distance	Average of both sides
	Pelvis height	f5	Distance of root joint from ground	For jumps or kneels or falling
		f6	Different displacements	For see if laying on the ground with legs, Average of both sides
	Centroid	f7	Distance of ground and centroid	
		f8	Distance centroid and pelvis	Style and balance of performance
	Gait size	f9	Distance right foot to left	Motion expression, style
Effort	Head orientation (**Space**)	f10	Angle between head orientation and body path (trajectory of root joint)	See orientation and direction of motion; moving in same direction as head orientation -> direct movement
	Deceleration of motion **(Weight**)	f11	Calculate deceleration of root joint	Peaks in deceleration means strong weight; no peaks -> light weight
	Movement velocity **(Time**)	f12	Distance of root joint over time period	
		f13	Average velocity of hands	
		f14	Average velocity of feet	

	Movement acceleration **(Time)**	f15	Derivative of hip velocities with respect to time	
		f16	Derivative of hand velocities with respect to time	
		f17	Derivative of feet velocities with respect to time	
	Jerk **(Flow)**	f18	Derivative of f15 with respect to time	Rate of acceleration or force. Large discontinuities with high jerk -> Bound Few peaks -> Free
Shape	Volume	f19	Bounding volume of all joints	
		f20	Volume upper body	
		f21	Volume lower body	
		f22	Volume left side	
		f23	Volume right side	
	Torso height	f24	Distance head and root joint	See if crouching and torso bending
	Hands level	f25	Relation of hand's position to body	Over head -> upper level Between head and chest -> middle level Low level -> below chest
Space	Distance	f26	Length of projection of root joints trajectory to ground	Distance coverage over time
	Area	f27	Area of polygon formed by projection of root joint on ground	

Table 2: Which values are measured for which emotions in this project?

(Note: Die Laban elements for Happiness, Sadness, Fear, Anger are mentioned in Melzer 2019, values for Disgust and Surprise in Gunes 2015)

Laban elements (Melzer 2019[2] and Gunes 2015[3])	**Emotion**	**Values (Aristidou)**	**What is measured**	**Source**	**Number of features**
Jump	Happy	f5	Distance of root joint from ground	Melzer	1
Rhythmicity	Happy	f18	Derivative of f15 with respect to time	Melzer	1
Spread	Happy	F20	Volume upper body	Melzer	1
Free and Light	Happy	f11, fF18	Calculate deceleration of root joint, Derivative of f15 with respect to time	Melzer	2
Up and Rise	Happy	f24	Torso height	Melzer	1
Rotation	Happy	f22, f23	Changing volumes of left/right side	Melzer	2
Passive Weight	Sad	f13, f15	Average velocity of hands, Derivative of hands velocities with respect to time	Melzer	2
Arms to upper body	Sad	f25	Relation of hand's position to body	Melzer	1
Sink	Sad	f24	Torso height	Melzer	1
Head-drop	Sad	f24, *(head level)*	Torso height. *Instead of feet distance, I additionally will measure the head height in position to root point height*	Melzer, myself	2
Retreat	Fear	z-Axis	Measure changing in z-position	Melzer	1
Condense and enclose	Fear	f20	Volume upper body	Melzer	1
Bind	Fear	f18	Derivative of f15 with respect to time	Melzer	1
Twist and back	Fear	f22, f33, z-Axis	Changing volumes of left/right side, measure changing in z-position	Melzer	3
Strong	Anger	f11	Calculate deceleration of root joint	Melzer	1
Sudden	Anger	f13	Average velocity of hands	Melzer	1
Advance	Anger	z-Axis	Measure changing in z-position	Melzer	1
Direct	Anger	f10	Angle between head orientation and body path (trajectory of root joint)	Melzer	1
Hands to head	Surprise	f4, f25	Hands to head distance, Relation of hand's position to body	Gunes	2

Hands above head	Surprise	f4, f25	Hands to head distance, Relation of hand's position to body	Gunes	2
Body shift/backing	Surprise	f20, z-axis	Volume upper body, measure changing in z-position	Gunes	2
Head shake	Surprise	f10	Angle between head orientation and body path (trajectory of root joint),	Gunes	1
Hands to body	Disgust	f25	Relation of hand's position to body	Gunes	1
Orientation changing to right/left	Disgust	f10, f22, f23	Angle between head orientation and body path (trajectory of root joint), Volume left side, Volume right side	Gunes	3
Hands to head + backing	Disgust	f4, z-axis	Hands to head distance, measure changing in z-position	Gunes	2
Hands up + backing	Disgust	f25, z-axis	Relation of hand's position to body, measure changing in z-position	Gunes	2
Features to measure: f4, f5, f10, f11, f13, f15, f18, f20, f22, f23, f24, f25, z-Axis. Total: **13**					

Reference:

1. Aristidou, A., Charalambous, P. & Chrysanthou, Y. Emotion Analysis and Classification: Understanding the Performers' Emotions Using the LMA Entities. *Computer Graphics Forum* **34**, (2015).
2. Melzer, A., Shafir, T. & Tsachor, R. P. How Do We Recognize Emotion From Movement? Specific Motor Components Contribute to the Recognition of Each Emotion. *Frontiers in Psychology* **10**, (2019).
3. Gunes, H., Shan, C., Chen, S. & Tian, Y. Bodily Expression for Automatic Affect Recognition. in *Emotion Recognition* (eds. Konar, A. & Chakraborty, A.) 343–377 (Wiley, 2015). doi:10.1002/9781118910566.ch14.