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On the Relation between Robot Bodily Expressions and their Impression on the User

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Outline

- Introduction and background on bodily expressions
- Overview of related works
- Considered scenario and research goal
- Expression vs. Impression
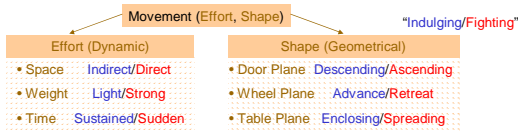- Experimental study
- Results and discussion
- Future work

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Background on bodily expressions

[Bartenieff & Lewis 80]

- Laban theory defines movement features

Movement (Effort, Shape)   "Indulging/Fighting"

Effort (Dynamic)		Shape (Geometrical)	
• Space	Indirect/Direct	• Door Plane	Descending/Ascending
• Weight	Light/Strong	• Wheel Plane	Advance/Retreat
• Time	Sustained/Sudden	• Table Plane	Enclosing/Spreading

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Previous work on robots bodily expressions

[Nakata et al. 2002]

- It is possible to quantitatively describe body movements that can leave an impression on people

[Breazeal 2002]

- Effect of distance on the interaction protocol. Far engages a calling behavior. Close, comfortable interaction. Too close, withdrawal response.
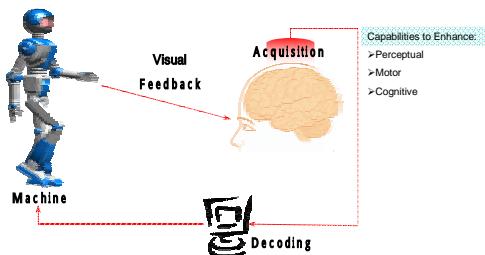
Calm	Interest	Angry	Sad	Surprise	Disgust	Happy

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Considered scenario and research goal

Visual

Capabilities to Enhance
➢Perceptual
➢Motor
➢Cognitive

What effect does robot bodily expressions have on the observer?

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Expression versus Impression

[Khiat et al. 2006]

Human   Impression   Expression   Robot
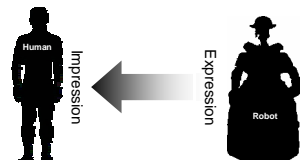
- Expression is what the robot's body movement is transmitting as a meaningful expression to the observer.
- The observer perceives the expression and interprets it using a priori knowledge.
- Impression is the effect that expression has on the observer depending on its strength, the observer attention and status, etc...

Experimental study

- Seven volunteers were shown 6 predefined motions executed by the receptionist robot ASKA.
- Questionnaires were answered concerning both robot's bodily expression and its impression.
- Brain activity was recorded from the users while observing the robot.

Results: Expressions and Impressions based on questionnaire

- Expression was classified into one of the four emotions (Happiness, Surprise, Sadness, Anger, or None).
- Impression was classified into the state of being "pleased" or "not pleased", as a basic classification. **[Shaver et al. 87]**
- Pleasant expressions resulted in pleasant impressions and vice versa.

	Pleased	Not pleased
Motion 1	65%	35%
Motion 2	30%	70%
Motion 3	68%	32%
Motion 4	19%	81%
Motion 5	100%	0%
Motion 6	47%	53%

	Happiness	Surprise	Sadness	Anger	None
Motion 1	4	3	0	0	0
Motion 2	1	0	2	0	4
Motion 3	0	7	0	0	0
Motion 4	0	0	7	0	0
Motion 5	7	0	0	0	0
Motion 6	1	1	0	4	1

Results: Impression based on brain activity

- Spectral and cross-correlation analysis was used to specify the most reacting parts of the brain.
  - Frequency-band selection: correlation between power spectra of neutral period and observation period $\Rightarrow$ a sub-band of α channel (8~13Hz).
  - Electrodes' reactivity: correlation between power spectra of each electrode position during neutral and observation periods.
- Alternation of activation between [P3,T3,T4] for pleased states and only [P3] for unpleased states for one of the observers.

Recorded electrode positions in the 10-20 International standard

Reactive electrodes for the case of User 4

	Reactive electrodes
Motion 1	O1,O2,P3,T3,T4
Motion 2	O1,O2,P3
Motion 3	O1,O2,P3,T3,T4
Motion 4	O1,O2,P3
Motion 5	O1,O2
Motion 6	O1,O2,P3,T3,T4
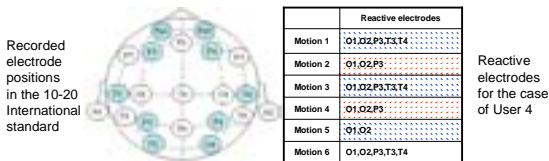
Discussion

- Results suggest the existence of a relation between robot's bodily expression and its impression on the observer (subjective self-reporting and brain activity)

- α-band has been used, in the literature, as a significant indicator of change in emotion/attention, while only a part of it was useful in our case.

- Only Fp1 and Fp2 electrode positions have been used in related work, but other positions could be of interest.

- Bodily expressions are interpreted in similar ways by people suggesting a common basic knowledge for interaction.

Future work

- Investigate the change in reaction between several sessions of the same experiment.

- Increase the number of motions to clarify the relation between bodily expressions and impressions.

- Generalize this approach for use in real-time applications.

References

- I. Bartenieff and D. Lewis, "Body Movement: Coping with the environment". Gordon and Breach Science Publishers, USA, 1980.

- T. Nakata, T. Mori and T. Sato, *"Analysis of Impression of Robot Bodily Expression"*. Journal of Robotics and Mechatronics, Vol.14, No.1, 2002.

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- A. Khiat, M. Toyota, Y. Matsumoto and T. Ogasawara, *"Investigating the Relation between Robot Bodily Expressions and their Impression on the User"*. Proceedings of the ACM Int. Conf. on Intelligent User Interfaces. January-February 2006 (to appear).