Social reinforcement learning using VR avatar

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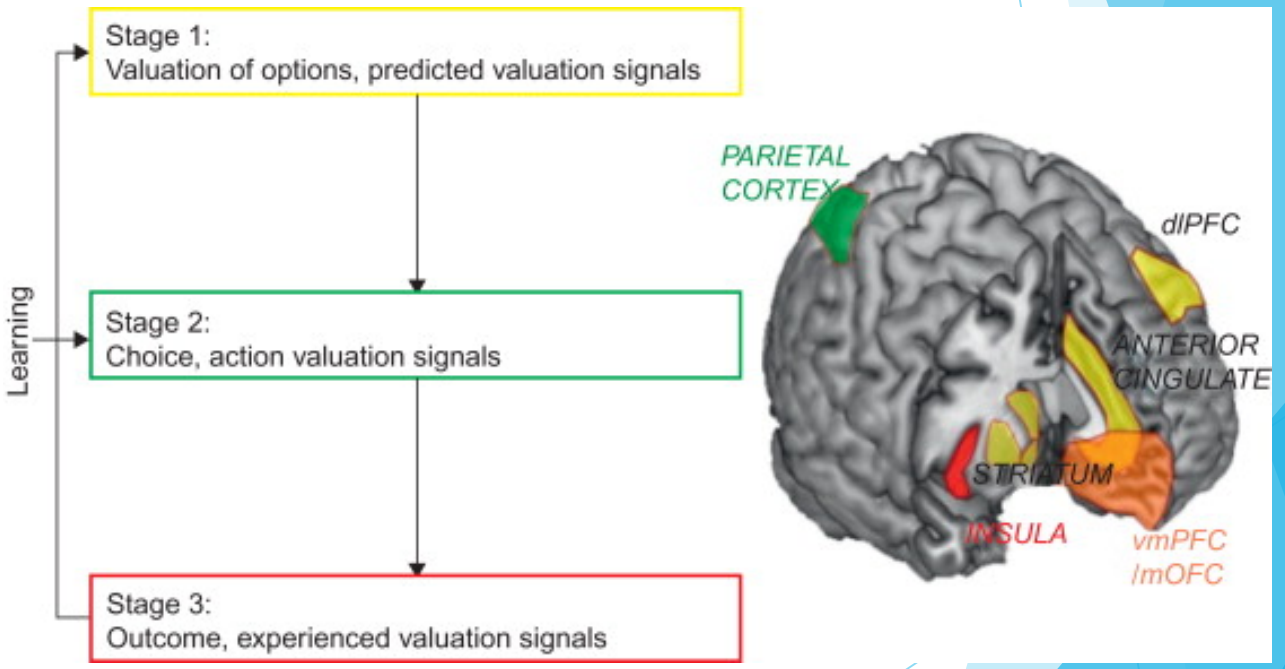
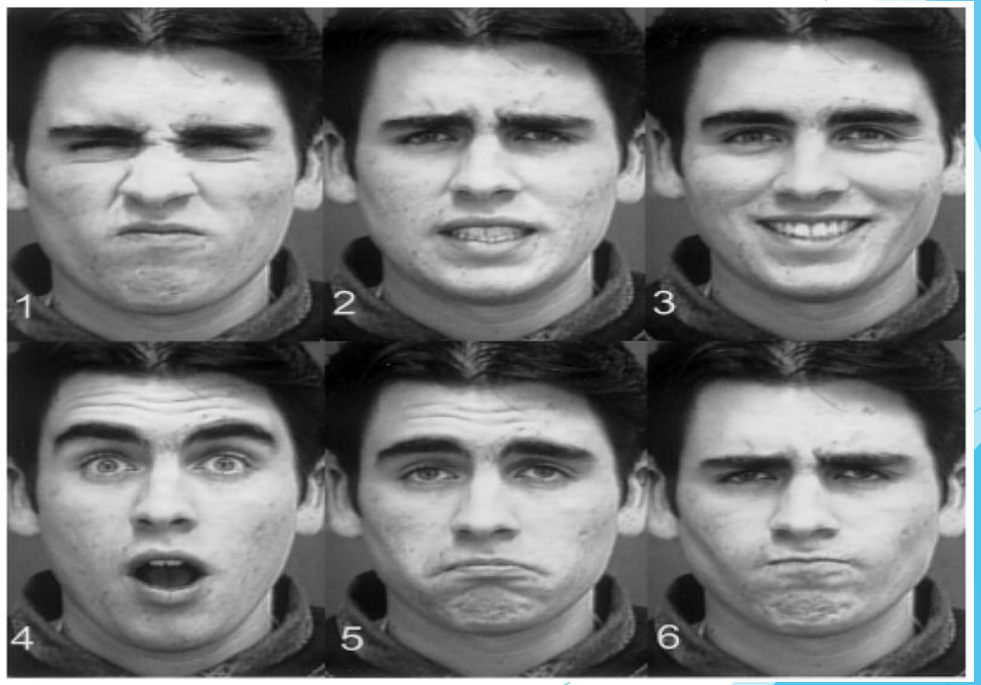
Social reinforcement learning

- How does the human learn from social value?

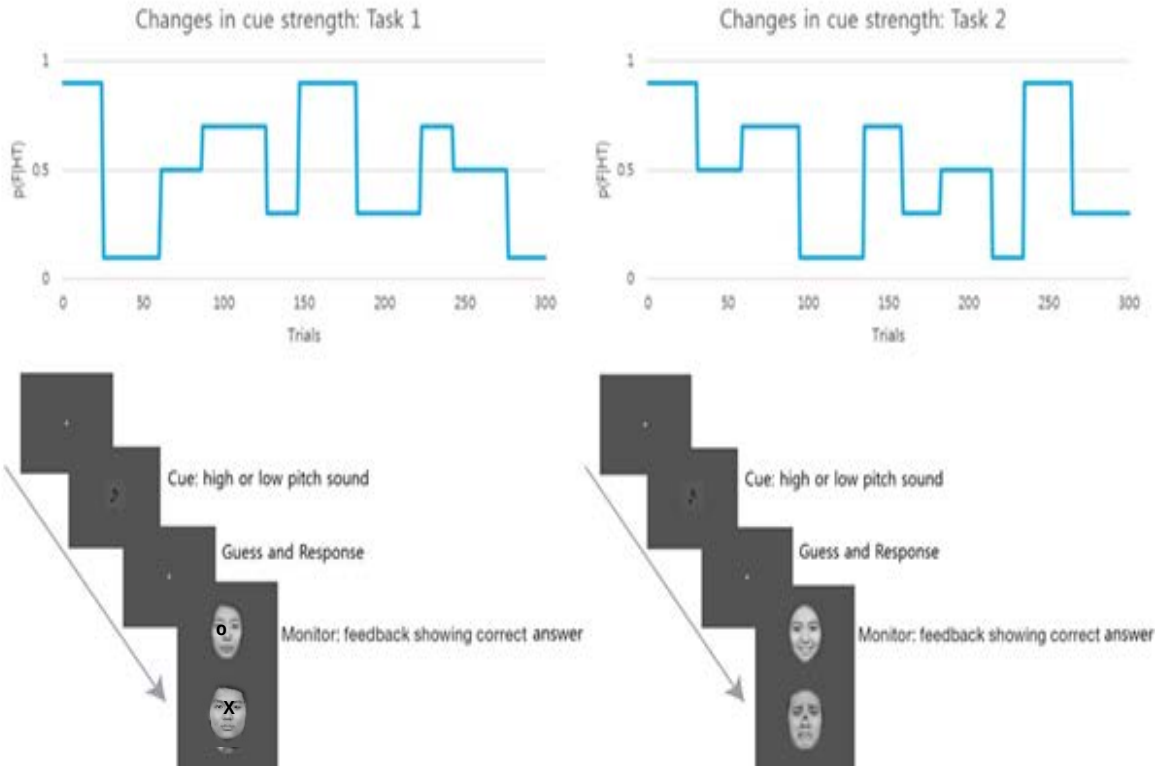


Shared Representations

- actions and sensory experiences in synchrony with those they observe in targets



Effect of emotional feedback in our previous study



- Association task between Low/High tone and Male/Female face
- Low or High tone appears and agent select one among two faces which is most likely to be associated with that tone
- **Feedback** provided with **O/X (task 1) or Emotional Face (task2)**
- Agent learns about environment through feedback
- Association Probability varies (volatile environment)
- **Hypothesis** : Emotional feedback would modulate behavioral model (Hierarchical Gaussian filter) parameter
- **Result :** Hyperparameter of behavioral model **didn’t varied** between two task

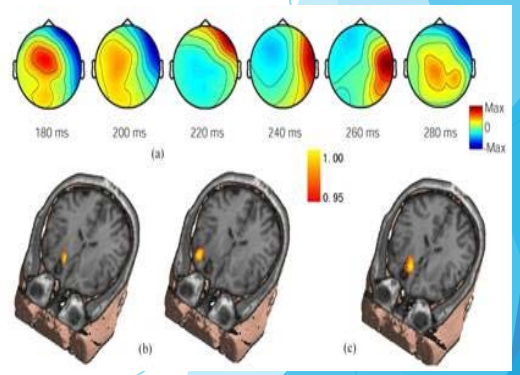
Why feedback had no effect?

- Maybe social feedback(smile) was not percieved as social reward
- **Task Stimuli**
  - Simple stimuli
    - fictional
    - Ceiling effect
  - Limited emotional responding
- **Real-Life Stimuli**
  - Multimodal
    - Visual, semantic, prosodic
  - Dynamic
    - Serially or simultaneously
  - Contextually embedded
    - Belief or past experience

Naturalistic Social Cognition

- capture the complexity of the real social world
  - **Virtual Reality** is to enhance social reward value
  - Multimodal stimuli
    I. **Facial expression**
    II. **Gesture**
    III. **Auditory stimulation**

- assessing perceivers' abilities to make accurate inferences about targets



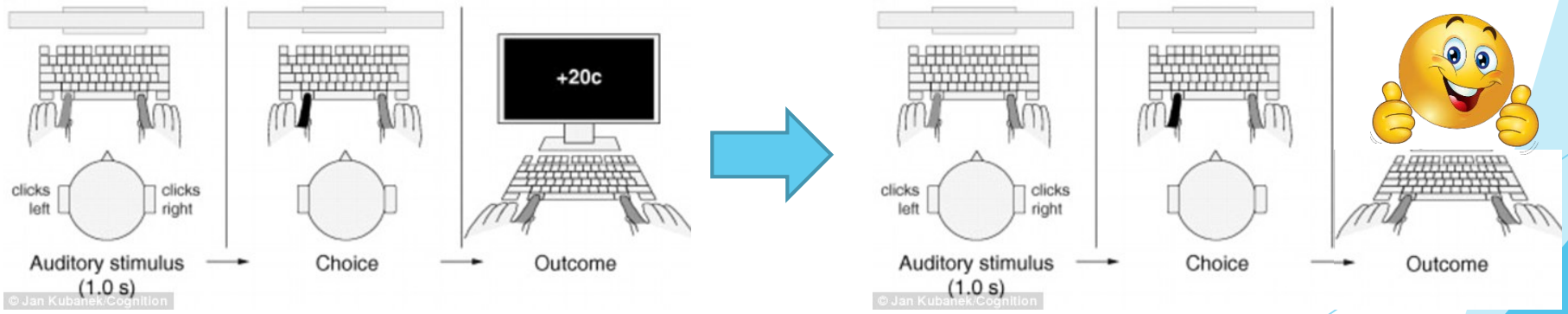
Social reinforcement learning

- Objective
  - Create the VR environment for the social reinforcement learning task

    Natural experimental design
  - Replace “reward” in previous tests in to “social reward (emotional reward)”

    Money/grade *to* ***virtual emotion*** *from the avatar*
  - Perform an experiment through proposed environment

    Clinical validation and other feedbacks

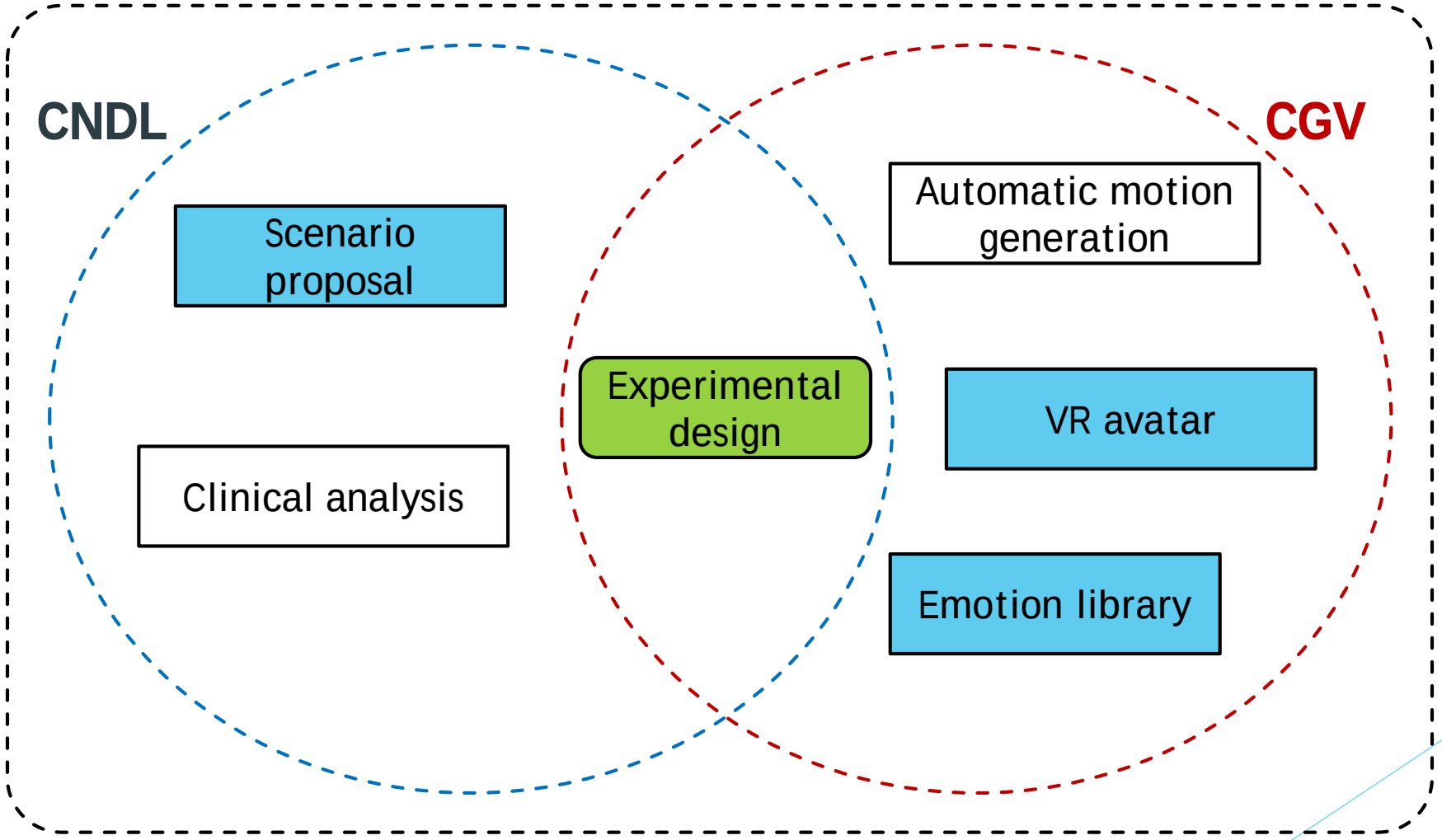


Social reinforcement learning

- Expected participants: KAIST students
- Analysis methods
  - Analyze participants' behavior using reinforcement learning model
  - Compare model parameter between monetary reward and social reward
  - Investigate correlation between psychological trait/state with model parameter
  - Separate effect of arousal and valence of social reward on value computation by varying degrees of arousal and valence of avatar

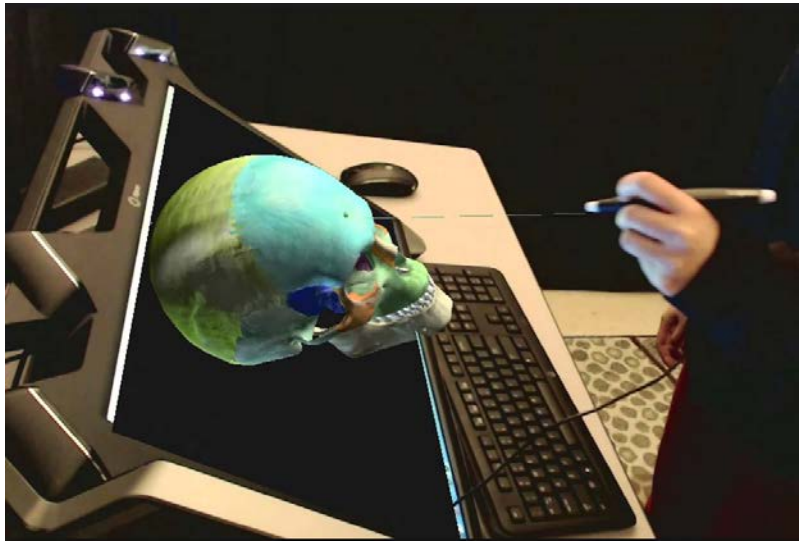
Overview

Social reinforcement learning in VR environment



- ***On going***
- ***Done***
- ***In course of preparation***

Experiment Environment



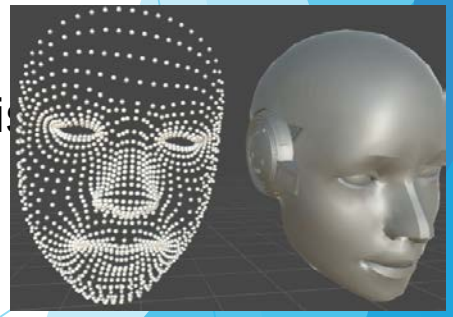
zSpace + 3D Glass + (EEG)

VR(HMD) + (EEG)

Avatar Reaction

Upper body gesture

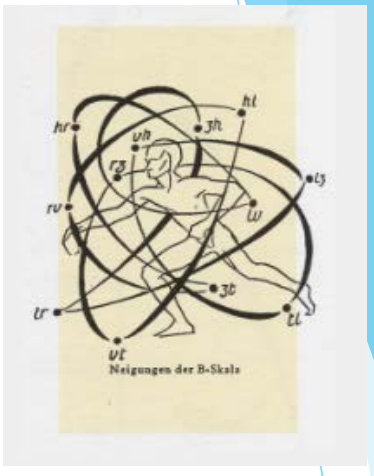
Facial expression



- Avatar reacts to patient using gesture and facial expression as social reward or puni
- Capture facial expression using Xbox one Kinect
- How to transform gesture according to affection of patient?

Related Works

Laban Movement Analysis(LMA) : Body, Space, Shape, Effort, Relationship



Space: attention to the surroundings	
Indirect:	flexible, meandering, wandering, multi-focus
Examples:	waving away bugs, slashing through plant growth
Direct:	single focus, channeled, undeviating
Examples:	pointing to a particular spot, threading a needle
Weight: sense of the impact of one's movement	
Light:	buoyant, delicate, easily overcoming gravity, marked by decreasing pressure
Examples:	dabbing paint on a canvas, describing the movement of a feather
Strong:	powerful, having an impact, increasing pressure into the movement
Examples:	punching, pushing a heavy object, expressing a firmly held opinion
Time: lack or sense of urgency	
Sustained:	lingering, leisurely, indulging in time
Examples:	stretching to yawn, stroking a pet
Sudden:	hurried, urgent
Examples:	swatting a fly, grabbing a child from the path of danger
Flow: attitude towards bodily tension and control	
Free:	uncontrolled, abandoned, unable to stop in the course of the movement
Examples:	waving wildly, shaking off water
Bound:	controlled, restrained, able to stop
Examples:	moving in slow motion, tai chi, carefully carrying a cup of hot liquid

Table 1: Motion Factors and Effort Elements

Horizontal	
Spreading:	affinity with Indirect
Examples:	opening arms to embrace, sprawling in a chair
Enclosing:	affinity with Direct
Examples:	clasping someone in a hug, huddling in the cold
Vertical	
Rising:	affinity with Light
Examples:	reaching for something in a high shelf
Sinking:	affinity with Strong
Examples:	stamping the floor with indignation
Sagittal	
Advancing:	affinity with Sustained
Examples:	reaching out to shake hands
Retreating:	affinity with Sudden
Examples:	avoiding a punch

Table 2: Shaping Dimensions and Affinities

Laban Effort and Shape analysis of affective hand and arm movements

- Ali-Akbar Samadani, SarahJane Burton. University of Waterloo

Quantify these components based on measurable physical features

Ex) Weight : the maximum of the sum of the kinetic energy of the moving body parts

- Light or Strong

$$E(t_i) = E^{Hand}(t_i) + E^{Arm}(t_i), \text{where}$$
$$E^{Hand}(t_i) = \sum_{j=Fingers} E^j(t_i) \quad (1)$$
$$E^{Arm}(t_i) = E^{UpperArm}(t_i) + E^{Forearm}(t_i).$$

$$E^{Forearm}(t_i) = \alpha_{Forearm} v^{Forearm}(t_i)^2, \quad (2)$$

aForearm : the mass coefficient
vForearm(*ti*) : the speed of the forearm at time *ti*.

So, weight Effort for a movement of length *T is* the maximum energy over time

$$Weight_{Q1} = \max(E(t_i)) \ \forall i \in [0, T]. \quad (3)$$

Ex) Time : weighted sum of the accelerations of the moving body parts

- Sustained or Sudden

The acceleration for the *kth* body part at time *ti* is:

$$a^k(t_i) = v^k(t_i) - v^k(t_{i-1}). \quad (4)$$

So, the Time Effort for a movement of length *T is* net acceleration accumulated at the body parts

$$Time^k_{Q2} = \sum_{i=2}^{T} \frac{|\mathbf{v}^k(t_i) - \mathbf{v}^k(t_{i-1}))|}{t_i - t_{i-1}}. \quad (5)$$

Laban Effort and Shape analysis of affective hand and arm movements

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Experiment

1) Certified movement analyst(CMA) design 6 hand and arm motion paths and they used to convey 6 emotions.
   - A total of 44 movements were conducted

2) Annotation questionnaire was designed with CMA where Effort components were rated on 5-point Likert scale

3) The correlation between the quantified and CMA-annotated Effort components are computed based on the Pearson linear correlation coefficient.

TABLE III. HAND AND ARM MOTION PATHS*

Motion path	Description
A	From Self, right arm down along side to forward mid Level, reaching to take something, palm up palm remains open.
B	Similar motion as A, but in the reverse direction.
C	Right palm open on upper chest, opening and extending right arm fully directly in front of the right shoulder at forward mid-level, with the palm facing left, perpendicular to the floor similar to the hand-shake position.
D	Similar motion as C, but in the reverse direction.
E	Right arm is extended forward at mid-level with open palm facing down and the hand parallel to the floor. Moving backward ending with the open palm facing forward near the right shoulder.
F	Similar motion as E, but in the reverse direction.

* During these movements, the wrist and finger orientations remain constant.

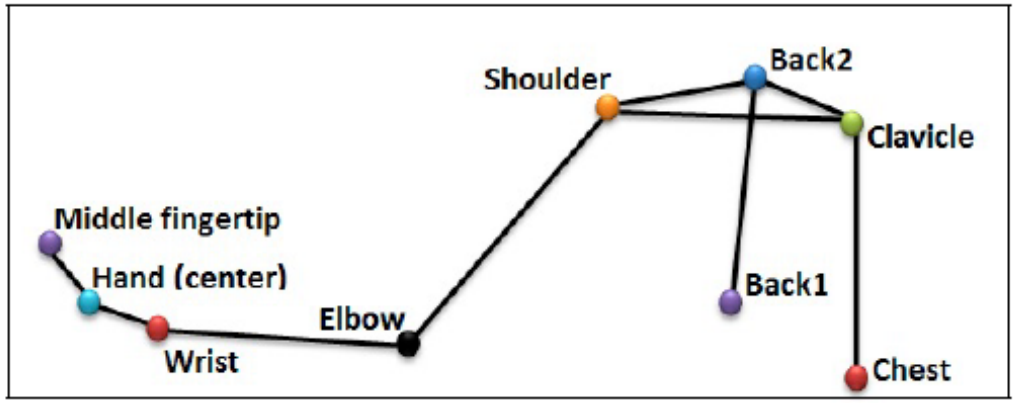


Fig. 1. Upper body model used in Laban quantification.

Other researches

- Other quantification methods

Ex) For judging ‘Space’, minimum rectangle bounding box surrounding the body, maximum distance of hand and elbow can be used
(Bernhardt and Robinson 2007, contraction index, Mancini and Castellano 2007)

- Using Effort & Shape components describe association between personality and body motion

(PERFORM: Perceptual Approach for Adding OCEAN Personality to Human Motion using Laban Movement Analysis
  - FUNDA DURUPINAR(University of Pennsylvania), MUBBASIR KAPADIA(Rutgers University) et al.)

* Diverse combination of Effort components

Research Plan

Subject's Emotions

1. Basic emotions of patient like joy, angry are transferred to avatar

Modified Body gesture

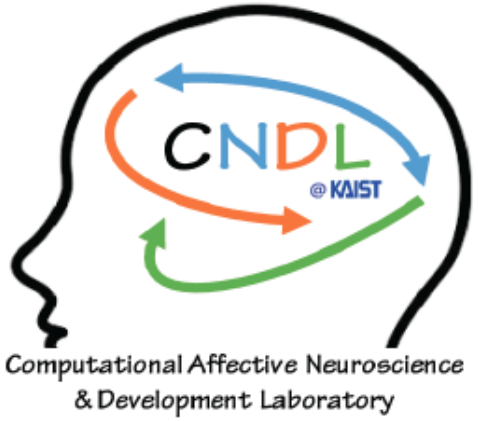
2. Original body gesture which strongly express feeling is prepared

3. Gestures is selected by input emotion

4. Selected gesture is modified through intermediate components and mapped physical properties
(adapted to our approach)

* Gesture can be changed according to emotion level or for other emotion

THANK YOU ☺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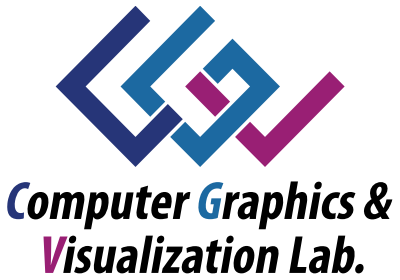
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