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Interactive Musical Humanoid Robots
– seen by an European researcher in Japan

EUROPA HOUSE, TOKYO, JAPAN
DECEMBER, 11, 2015
1. **My research work**  
   - musical interacting robots

2. **My experience in Japan**  
   - why, how  
   - grants  
   - plus and minus of international mobility  
   - personal feelings, working atmosphere

3. **My relation to Europe while in Japan**  
   - cooperation going on, or planned  
   - next employment  
   - short comparison between work environments in Japan and Europe
Entertainment

- provides amusement or enjoyment  [1]
- holds the attention of an audience
- intrinsically motivating

Social interaction = Entertainment

- Users not satisfied with the role of pure observer
- want to be involved and have an influencing role  [2]

Applications:

- Educational  [3]
  - Rehabilitation  [5]
  - Psychological support  [6]

[1] Oxford English dictionaries
[7] Statista (online, 2013)

Estimated global entertainment market value from 2014 to 2018 (in trillion U.S. Dollars)
**ENTERTAINMENT ROBOTICS**

### Problems

1. Non-humanlike interaction abilities
2. No feedback from audience
3. Fixed performance

- *Vocal* commands recognition few languages
- *Wave* and *Point* recognition rate ~ 50%
- Smile and Frown recognition rate ~ 100% but 10s continuous signal → non-natural

- No interaction
- Coordination signals expression
- Creative interaction with visual signals recognition

**WASEDA entertainment robots**

- Facial and body emotional expression

**References**

Human interaction:

1. **MULTIMODAL**
2. **CONSCIOUS** and **UNCONSCIOUS**
3. **ADAPTIVE** - changes depending on feedback

Humans → Media:
- Social and natural
- Like interaction in real life \([1]\)

Problem 1: non-humanlike interaction abilities
• Limited to simple direct verbal commands
Solution
  – Complex language

Problem 2: not multimodal
• Limited to one communication channel
Solution
  – Several simultaneous communication channels

Problem 3: no emotional adaptation
• Limited to conscious, direct commands
Solution
  – Emotional communication of the human partner
HUMAN COMMUNICATION ANALYSIS

1. MULTIMODAL
2. CONSCIOUS and UNCONSCIOUS
3. ADAPTIVE - changes depending on feedback

Non verbal communication

Conscious signals
- Vocal paralanguage
- Codified gestures

Unconscious signals
- Emotional
- Creative gestures

Kinesics

Verbal communication
**Problem:** synchronized detection and measurement

- **Conscious**
  - [active control]
  - [aware]
  - [external]
  - [visible]

- **Unconscious**
  - [unaware]
  - [uncontrolled]
  - [invisible]
  - [internal]

**Interaction**

- Vocal emission
- Face expression
- Body movement
- Blood pressure
- Skin conductance
- Respiration
- Heart rate
- Brain activity

**Physiological Interaction**
HUMAN PARAMETERS SENSING TECHNOLOGIES

• Audiovisual sensors

**PROS**
- Low cost
- Background
- Ecological

**CONS**
- Not robust
- Multiple tracking
- Noise affected

- Vocal emission
- Face expression
- Body movement

• Wearable sensors

**PROS**
- Multiple tracking
- High precision
- Light computation
- Robust

**CONS**
- Not portable
- Expensive
- Non ecological
- Difficult to integrate

- Blood pressure
- Skin conductance
- Respiration
- Heart rate
- Brain activity

Interaction

Physical

- Microphone
- Camera
- IMU
- EMG

Physiological
Development of a multi-sensor system to obtain real-time objective data on human state:

- **Inexpensive** – compared to current solutions
- **Portable** – Untethered and lightweight, allows ecological human data monitoring
- **Reconfigurable** – Use interchangeable modular sensors that can be added or removed as needed.
REAL-TIME NON-VERBAL ARTISTIC INTERACTION

WF4-RVI

Robot – musician direct interaction

Musician

Robot – conductor indirect interaction

Conductor

WF4-RVI

Robot – dancer intuitive interaction

Dancer

WAS3
INDIRECT INTERACTION
PERCEPTION RESULTS

• Perception survey
  – questionnaire Likert scale 10 points

• Performance comparison
  – robot playing “as is”
  – robot following the artist using the interaction system
  – professional musician following the artist

*** : p<0.005

Result of questionnaire

<table>
<thead>
<tr>
<th>Metric</th>
<th>Human-human</th>
<th>Without interaction system</th>
<th>With interaction system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entertainment level of performance</td>
<td>***</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Phrase diversity</td>
<td>***</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Similarity to human-human performance</td>
<td>***</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Overall Impression</td>
<td>***</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

*** : p<0.005
**DIRECT HUMAN COMMUNICATION SIGNALS**

**Problem 1:** non-humanlike interaction abilities

**Experiment 1:** Direct signaling gestures

**Experiment 2:** Indirect conducting gestures

- Complex non-verbal language: codified, symbolic
  - Learn and recognize

The system can be used to detect and recognize human conscious gestural communication

**SUCCESS**
- Non-verbal language recognition
- Real-time interaction
- No equal previous system

**FAILURE**
- Performance perceived not completely natural
- Language not completely modelled
Problem 2: not multimodal
Problem 3: no emotional adaptation

Experiment 3: Dance interaction
– Two channels: body posture and movement velocity
– Creative gestures: not codified, intuitive
  • Perceive and interpret

The system can be used to detect and recognize human emotional creative communication

SUCCESS
– Multimodal non-verbal social communication
– Real-time interaction

FAILURE
– Performance perceived not completely natural
– Language not completely modelled
Journal articles (3):


International conferences (16). Main papers:


Workshop (1):


Invited Talks (6):

   Invited talk at University of Genova – DIBRIS laboratory, Genova, ITALY, February, 2015
   Invited talk at Facebook Inc. HQ, Menlo Park, Palo Alto, USA, October, 2014
   Invited talk at Aix-Marseille Universite’ Institut de Neurosciences de la Timone, Marseille, FRANCE, September 2014
   Invited talk at University of Birmingham IRLAB – Intelligent Robotics Lab, Birmingham, UK, September 2014
   Invited talk at University of Genova – DIBRIS laboratory Genova, ITALY, February 2015
   Invited talk at Carnegie Mellon University – InterACT laboratory, Pittsburgh, PA, USA, March 2014
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WHY JAPAN

• ROBOTICS!!!
• Vulcanus in Japan program

**WHAT IS VULCANUS IN JAPAN?**

The programme consists of industrial placements for EU* students. The whole programme takes place in Japan. **It starts in September and ends in August** of the following year in order to accommodate the academic year, in EU* Countries.

The students follow:
- a seminar on Japan;
- a four-month intensive Japanese language course;
- an eight-month traineeship in a Japanese company.

**PROGRAMME OBJECTIVES**

The objectives of the programme are to get acquainted with the range of advanced technologies employed by a leading Japanese host company, to learn Japanese and to understand and appreciate Japanese culture with a view to an enriching one-year experience abroad, to provide an opportunity for students to interact with Japanese business and people.
HOW JAPAN – GRANTS

• **StudyJapan**: general information to study in Japan

• **JASSO**: information on scholarships to study in Japan
  – [http://www.jasso.go.jp/study_j/scholarships_e.html](http://www.jasso.go.jp/study_j/scholarships_e.html)

• **MEXT and JSPS** scholarships
  – Information on the website of Japanese embassy in one's own country

• **EURAXESS**: general information for researchers mobility
PLUS AND MINUS OF INTERNATIONAL MOBILITY

• PLUS

- Stability
- Meaningful cultural exchanges
- Broader knowledge
- Exciting life experiences

• MINUS

- ?
PERSONAL FEELINGS

• Ph.D. in Japan
  – Independent work
  – Exciting and interesting
  – Frustrating and insane

• Working atmosphere
  – It depends on the environment and coworkers
  – It depends on one’s own disposition
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RELATION TO EUROPE WHILE IN JAPAN

• **Cooperation**
  – Research IS cooperation
  – Cooperation is networking
  – Networking might result in interesting offers

• **Comparison**
  – Japan
    • More precise
    • Stricter
  – Europe
    • More easy-going
    • More tutored
THANK YOU VERY MUCH FOR YOUR ATTENTION!