eNTERFACE'15 Project Proposal

January 2015

1 TITLE AND PRINCIPAL INVESTIGATORS

Title: Analysis of the qualities of human movement in individual and joint action

Principal Investigators : Paolo Alborno (DIBRIS-InfoMUS), Ksenia Kolykhalova (InfoMUS), Damiano Malafronte (DIBRIS-InfoMUS)

Abstract: The goal of the project, which is set in the framework of the European H2020 ICT DANCE Project[1], is to investigate methods for analyzing human movements in their expressive qualities. We will analyze single performers as well as performers groups. Performing arts, and in particular mime, dance, and music are source of inspiration and candidate test-bed for the research. When analyzing single performers, we will mainly concentrate on the quality of motion and on elements suggesting different emotions. Instead, on the performers group analysis, we will mainly try to capture non verbal social signals, in particular entrainment (in its affective and temporal components) and leadership.

[1] The DANCE EU project aims to investigate techniques for sensory substitution in blind people to overcome their own cognitive emotional blindness. The main objective is to study and develop novel techniques and algorithms for the automated measuring of non-verbal bodily expression and the emotional qualities imparted by human movement, to permit the perception of non-verbal, artistic whole-body experiences to blind people.

2 PROJECT OBJECTIVES

The objectives of this project can be summarized in the following way:

- **Analysis of single subject performances**. The aim is to study the qualities of movements and try to find a way to understand the emotions conveyed by them. We are also planning to set up experiments on sensory substitution by associating appropriate interactive sonifications to the movements.
- **Analysis of multiple subjects (two or more) involved in joint action**: We will explore novel techniques to evaluate the entrainment of a group during joint performances.

More specifically we aim at acquiring a deeper understanding of the computational models and of the theories meaningful to achieve these goals. With these objectives in mind, we will develop a working system able to describe different types of movements qualities.

The project is multi-disciplinary: we will primarily address technological issues, but always take into consideration artistic elements of the underlying application (aesthetics ..) and, more importantly, the knowledge provided by psychologists on the relationship between body movements and state of mind.

3 BACKGROUND INFORMATION

Automatic capture and analysis of human motion is a multidisciplinary active research area with countless of potential applications and challenges. Motion capture started as an analysis tool in biomechanics research, but has grown importance increasingly as a source of motion data for computer animation as well as education, training and sports and recently for both cinema and video games (Thomas B Moeslund, 2006).

- **Point light displays**: One very good example of the visual system's ability to recover object information from sparse input is the phenomenon known as biological motion. Specifically, a number of point-lights attached to the joints of a human actor evoke a vivid percept of action when the body is in motion. By using point-light displays in (Dittrich 1996), has been studied whether it is possible to judge the emotional state of a human body from motion information alone.
- **Multimodal Analysis of expressive movements**: Based on this fundamental work of Rudolf Laban (1947) who describes the most significant qualities of movements in "Theory of Effort", several systems for analysis of expressive gestures were developed (e.g. Camurri et al., 2003,2005 ; Bernhardt et al., 2007).

- **EyesWeb platform**: We propose to use the EyesWeb platform that supports the design and development of real-time multimodal systems and interfaces (developed by Casa Paganini research center). The EyesWeb multimodal software framework and its recently developed libraries for real-time analysis of expressive and social signals will be adopted to perform experiments and feature extraction. The work that will be carried on for this project will be possibly integrated into the platform through the creation of new ad-hoc modules.

- **Synchronization**: In recent years, several measures of synchronization have been proposed and applied successfully to different types of data relative to events. Delay patterns are shaped by the time series extracted from the signals. Through the analysis of those patterns it is possible to define some rules to perform an evaluation of leadership and synchronization grade

- **Data analysis and machine learning**: Machine learning provides us methods for representing data adaptively and achieving a good tolerance to change and noise. The challenges of understanding automatically emotions or feelings are many: such high level concepts cannot be describe in deterministic ways and cannot be represented as simple models. Learning from examples paradigms are a powerful and mature field which may allow us to describe the nuances of a given emotion by means of an appropriate set of examples.

4 DETAILED TECHNICAL DESCRIPTION

The aim of the project is to develop a working system to automatically analyze and evaluate the qualities of single and joint performances.

The research activity will be organized in the following main themes:

- Data preparation - acquisition, editing, cleaning and categorizing benchmark data. It includes deciding the type of data and possibly a preparation of a dataset to be shared with the community (through a descriptive web page for example)
- Low level analysis - computing local and global features capturing space-time evolution and setting the basis for further analysis. Novelty keywords: periodicity, multi-scale (different temporal scales)
- High level analysis - exploit the human motion system global features to visualize and elaborate information about recurrent movements and synchronization.
- Design of a model for a single performer analysis - highlight qualities of interest, computation and visualization. Classification of basic emotions.
- Design of a model for performers group - highlight the qualities of interest (social-signals) computation and visualization.

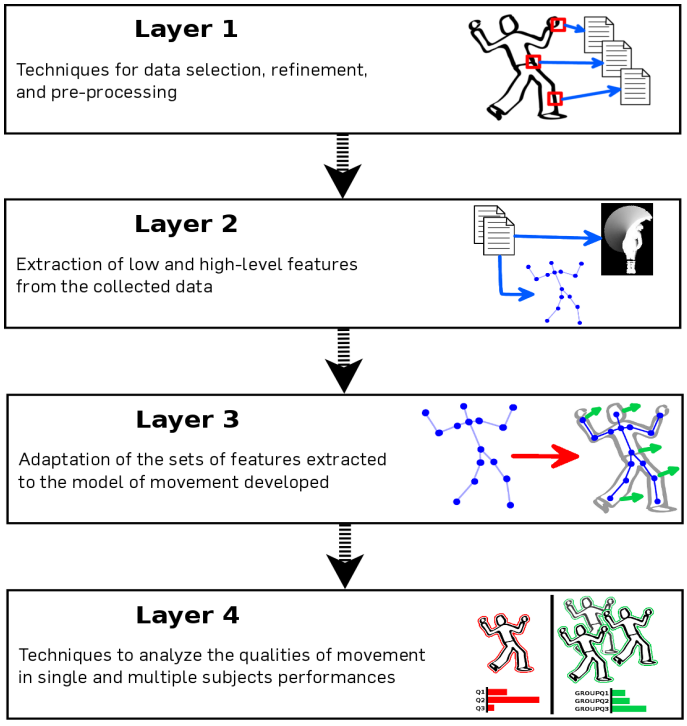

Figure 4.1: possible overall system architecture, organized in 4 main conceptual layers

4.1 RESOURCES NEEDED

DATA

Our project is based on the availability of data which could be acquired on the site thanks to the use of the equipment available at the NUMEDIART Lab in Mons. Complementary equipment (e.g. markers, suits) will be brought by the project investigators, if it is not available onsite. We will also take some pre-recorded data to be used as an initial benchmark.

HARDWARE AND SOFTWARE

We are planning to use our personal computers during the workshop, therefore we are taking responsibility for installing all needed software:

1. **The multimedia software platform Eyes Web Platform** - designed, and developed by Casa Paganini – InfoMus Lab.
   In short Eyesweb is a Microsoft Windows based tool for creating interactive digital multimedia applications. The tool enables the possibility to form digital sound and images real-time, through use of various Human-Computer Interactions (HCI). These interactions include but are not limited to: Object Identification, Segmentation and Recognition, Face Recognition, Gesture Recognition and Motion Tracking.

2. **Qualisys Track Manager (version 2.9) - QTM**

   This is a Qualisys proprietary tracking software that designed to work seamlessly with any model of Qualisys camera, ensuring fast and precise data collection. The system allows users to perform 2D, 3D and 6DOF capture of data in real-time, with minimal latency. Since the NUMEDIART Lab in Mons owns a Qualisys Mocap system and possibly has a newer version of QTM, we would kindly ask about possibility to use it.

3. **Matlab MoCap Toolbox**

   It is a Matlab toolbox that contains functions for the analysis and visualization of motion capture data, developed by University of Jyväskylä, Finland

4.2 PROJECT MANAGEMENT

The project should be carried out by a 3-to-6 people team, plus two senior researchers which will provide insights either remotely or by participating to the initial and final part of the workshop.

3 team members have already identified, they are already acquiring the background necessary to carry out the work and they will attend all 4 weeks. Each of them will be responsible of one research line:

- Ksenia Kolykhalova: coordination of the *Mocap Acquisition and Data Collection* phase
- Paolo Alborno: coordination of the *High-level Data and Social Signal Analysis* phase
- Damiano Malafronte: coordination of the *Low-level Feature Extraction and Development of Movement Models*

5 WORK PLAN AND IMPLEMENTATION SCHEDULE

We suggest this set of work packages in which to divide the work for the project:

- **WP0: Project coordination**
- **WP1: Computing and Evaluating Motion Cues**
- **WP2: Individual Subject Analysis**
- **WP3: Groups / Joint Action Analysis**
- **WP4: Experiments Design and Development**
- **WP5: Evaluation, Testing and project finalization**

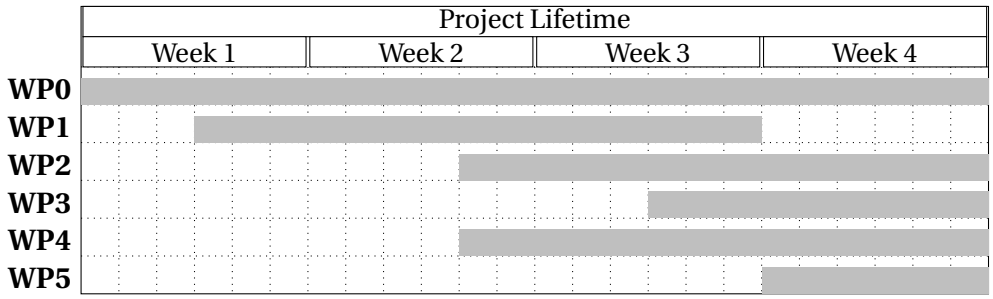

Figura 5.1: Gantt chart of the project (supposing the project will last for 4 weeks).

Details about work packages:

WP0: the work package is divided in three sub-activity:

- forming sub-teams considering each member's personal skills
- defining project system requirements
- sub-teams coordination for the whole period

WP1: low and high level feature extraction and data collection using Mocap system.

WP2 - WP3: design of single performer or joint actions models and algorithms to compute movement qualities and classify emotions.

WP4: definition and design of experiments and of an evaluation protoco.

WP5: implementation of a demo and preparation of the final report for the project.

6 BENEFITS OF THE RESEARCH

- Survey of techniques for analysis of qualities of movement in both individual and social groups
- Development of EyesWeb modules for real-time analysis
- Detailed design of experiments
- Preliminary results from data analysis and (if possible) the construction of a dataset
- Plan for joint publications

7 PROFILE TEAM

Damiano Malafronte holds a Master Degree in Computer Science (University of Genova, Italy); currently a PhD student in Computer Science and Systems Engineering (University of Genova): with academic background and proficient in computer vision techniques for human movement analysis and the development of natural user interfaces

Paolo Alborno holds a Master Degree in Computer Engineering (University of Genova, Italy); currently a PhD student in Computer Science and Systems Engineering (University of Genova)): skilled software development, problem solving amd modeling of complex systems. Actual studying social signal extraction techniques.

Ksenia Kolykhalova holds of a Double Master Degree in Robotics Engineering (Ecole Centrale de Nantes, France and University of Genova, Italy); currently a PhD student in Computer Science and Systems Engineering (University of Genova)

During several years the Casa Paganini lab made a substantial contribution for multimodal analysis, focusing on significant emotional expression conveyed by expressive full-body movements, and working in a direction of a deeper understanding expressive qualities and analyzing emotions expressed by body movement. Most of the research has been carried out within EU projects:

- FP7 ICT ASC-Inclusion (STREP, 2011-2014) - the goal of the project was to develop interactive software to help children with Autism understand and express emotions through facial expressions, tone-of-voice and body gestures.
- ICT FET ILHAIRE (STREP, 2011-2013) - the goal of the project was to study of cognitive and emotional foundations, development of computational models of laughter in human-computer communication and future multimedia systems.

We welcome new members in our team, in particular we are seeking participants with a background in:

- audio signal processing
- wearable sensors, kinect (technical specifics, drawbacks, advantages)
- hands-on experience on Mocap systems
- additionally, a background knowledge in psychology will be welcome

8 REFERENCES

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2. Mather, G. M. (1994). Gender discrimination in biological motion displays based on dynamic cues. Proceedings of the Royal Society of London Series B, 258, 273-279

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17. S. Piana, A. Staglianò, F. Odone, A. Camurri "Emotional Charades", ACM International Conference on Multimodal Inteaction - demo session

18. S. Piana, A. Staglianò, F. Odone, A. Verri, A. Camurri "Real-time automatic emotion recognition from body gestures", IDGEI International Workshop 2014.

Damiano Malafronte

Curriculum vitae

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Current Position & Education

November 2014 – Present

Università degli Studi di Genova, Italy

PhD in Computer Science

My current research is focused on understanding the state of the art regarding human movement analysis so that to be able to develop new methods in this field, with particular attention on human computer interaction contexts

March 2012 – July 2014

Università degli Studi di Genova, Italy

M.Sc. in Computer Science

Score: 110/110 cum laude

The aim of this master thesis was to develop a dynamic hand gestures recognition system with the aim to allow the creation of customizable Natural User Interfaces, that is the system could be tuned to work with a wide set of hand poses and the set of dynamic gestures could be modified

September 2008 – March 2012

Università degli Studi di Genova, Italy

B.Sc. in Computer Science

Score: 110/110

For this bachelor thesis I've been working on adapting a pre-existent software (originally developed to recognize hand-drawn sketches of UML Use Cases) to recognize hand-drawn sketches of rock carvings from Mont Bego

September 2003 – July 2008

I.T.C.G. Ruffini di Imperia, Italy

High School Diploma of Accounting Specialized in Computing

Score: 100/100

Communication skills

Italian	Native speaker
English	B2/C1 level (FCE obtained in 2013)

Publications

in press	**Good practices on hand gestures recognition for the design of customized NUI** *10th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications.*
2013	**An Holonic Multi-Agent System for Sketch, Image and Text Interpretation in the Rock Art Domain** *International Journal of Innovative Computing, Information & Control*
2012	**Rock Art Interpretation within Indiana MAS** *Agent and Multi-Agent Systems. Technologies and Applications*

Software skills

Proficient in	C, C++, Matlab
Good/Basic Level	Java, C#, SQL, Haskell, Python, PHP, Bash Scripting, Prolog, Caml
IDE	Eclipse, NetBeans, Visual Studio, Xcode
Typesetting	Microsoft Office Suite, Openoffice Suite, LaTeX

Personal Interests

- COMPUTER VISION
- HCI & NATURAL USER INTERFACES
- INTERACTION DESIGN

Curriculum Vitae

Name: Paolo
Surname: Alborno

Date and place of birth: 10 / 03 / 1988, San-Remo (IM), Italy.
Address: Via Braie 5/18, Bordighera, Imperia (IT).
E-mail: paoloalborno@gmail.com
Mobile: +393407991656

Actual position: PHD - student at Casa Paganini Research Centre (Genova, IT) [November 2014]

Education and training:

University: Polytechnic Institute of Genoa.
Title of qualification awarded:

- **Master degree**: Computer Engineering [March 2014]
  Marks: Full marks i.e. **110/110 cum laude** (2.1 graduate with honours).
- **Bachelor's degree**: Computer Engineering [June 2011]
  Marks**:** 101/110
- **Scholarship programme**: "Erasmus ai fini di studio" at UCC (University City of Cork) [Jan-Jun 2012]

High School: Liceo Scientifico Aprosio of Ventimiglia

- **Diploma**: Liceo Scientifico, PNI (Piano nazionale informatico) [June 2007]
  Marks**:** 95/110

Work experiences and projects:

- **Java EE Developer / Systemist consultant** at Reply (Milan, IT) 3 - months period
- **Multi-Touch developer and framework designer (MT4j and WPF) at** M3S S.r.l. (Genova, IT) as Master Degree thesis project
- **Network Service Developer (Web-service API Mashup)** at Computer Engineering Dept. (Genova university)
- **Google Android Developer and Security tester** at Computer Engineering Dept. (Genova university)
- **Database Manager** at Computer Engineering Dept. (Genova University) in cooperation with Siemens.
- **Web Designer** at Computer Engineering Dept. as Bachelor degree thesis project
- **Web Designer** as personal project for DH20 amateur kart association.

Tongues: Mother tongue: Italian

Other tongues:

	Understanding				Speaking				Writing	
	Listening		Reading		Spoken interaction		Spoken production			
English	C1	High intermediate	C1	High intermediate	C1	High intermediate	C1	High intermediate	C1	High intermediate
French	A2	Beginning	A2	Beginning	A2	Beginning	A2	Beginning	A1	Beginning

English exams:

- First Certificate of English
- Business English Course (UCC)

Certificates:
- Statement of Accomplishment :
  Algorithms: Design and Analysis, (Coursera Online Course)
  Audio Signal Processing for Music Applications, (Coursera Online Course)

Programming Languages : C, C++, C#, Java (Java J2EE), Python, Google Android, Xna Programming (beginner), Php, Html, Xml, SQL, PLSQL, Java-script, Ajax, Pascal, Ampl, Spin/Promela, NuSmv, Adruino, Bash scripting (beginner).

Applications and tools and IDE : EyesWeb, Photoshop, Premiere, Office, Eclipse (Maven, Git, Ant), Android studio, Visual Studio 2013, Matlab, DevC++, Arduino IDE.

Curriculum Vitae

1. CONTACT INFORMATION

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2. PERSONAL INFORMATION

Date of Birth	*25.05.1990*
Place of Birth	Volgogard
Nationality	Russian
Sex	Female

3. EDUCATION, RESEARCH AND TRAINING

- December, 2014 – Present
  - **University of Genova, Italy**
  - Phd fellow at Casa Paganini Research Center
- September, 2012 – July, 2014
  - European Double Master Program in Advanced Robotics (EMARO)
  - 1 year – **Ecole Centrale de Nantes, France**
  - 2 year – **University of Genova, Italy**

  Master Thesis: Techniques for analysis of aesthetic quality of group martial art performances (In the field of Human-Computer Interaction)
- September, 2007 – June, 2011
  - **Volgograd State Technical University** (28 Lenina Av., Volgograd, Russia)
  - Bachelor Degree in Engineering and Technology in the field of "Automotion and Control"
- September, 1999 – July, 2007
  - Lycee #5 of Central District, Volgograd, Russia
  - Certificate of Secondary (Complete) General Education

4. AWARDS

September, 2012 – July, 2014 - Erasmus Mundus Scholarship

September, 2007-December, 2011 - Stipend from the Governor of Volgograd area, Russsia

July, 2007 – Golden medal “For Prominent Progress in Study”

5. PERSONAL SKILLS AND COMPETENCES

- Language skills
  - Mother tongue: Russian
  - Other languages: English (fluent), Italian (satisfactory)

- Computer skills and competences
  - Excellent knowledge of Microsoft Office™ tools
  - Very good command of integrated schematic editors and mixed analog/digital simulators (MicroCap 10, Electronics WorkBench, OrCAD 9.2)
  - Good command of a CAD software application (AutoCAD)
  - Experience in MathCAD, MatLab, EyesWeb (by UNIGE)
  - Basic knowledge of standard languages (C++, Phyton)
  - Excellent knowledge of softwares for MoCap Systems, Qualisys Track Manager

- Certificates
  - The Gaussian Process Winter School, University of Genova
  - Stat.2.1.x: Introduction to Statistics: Descriptive Statistics by BerkleyX, an online learning initiative of The University of California At Berkeley through edX
  - CS191x: Quantum Mechanics and Quantum Computation by BerkeleyX, an online learning initiative of The University of California At Berkeley through edX