PROJECT PERIODIC REPORT

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Periodic report: 1st **X** 2nd ☐ 3rd ☐ 4th ☐

Period covered: from   01/09/2010   to 31/08/2011

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Project website[1] address: www.mirorproject.eu

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[1]   The home page of the website should contain the generic European flag and the FP7 logo which are available in electronic format at the Europa website (logo of the European flag: http://europa.eu/abc/symbols/emblem/index_en.htm logo of the 7th FP: http://ec.europa.eu/research/fp7/index_en.cfm?pg=logos). The area of activity of the project should also be mentioned.

1. PUBLISHABLE SUMMARY

The MIROR project is funded by the European Commission under the 7th Framework Programme, Theme ICT-2009.4.2, Technology-enhanced learning. MIROR is a three-years project and started on September 1st, 2010. All information regarding MIROR is available through the MIROR Portal at http://www.mirorproject.eu.

1.1. Concept

The MIROR Project deals with the development of an adaptive system for music learning and teaching based on the reflexive interaction paradigm. The system is developed in the context of early childhood music education. It acts as an advanced cognitive tutor, designed to promote specific cognitive abilities in the field of music improvisation, both in formal learning contexts (kindergartens, primary schools, music schools) and informal ones (at home, kinder centres, etc.). The reflexive interaction paradigm is based on the idea of letting users manipulate virtual copies of themselves, through specifically designed machine-learning software referred to as interactive reflexive musical systems (IRMS). By definition IRMS are able to learn and configure themselves according to their understanding of learner's behaviour. In MIROR the IRMS paradigm is extended with the analysis and synthesis of multisensory expressive gesture to increase its impact on the musical pedagogy of young children, by developing new multimodal interfaces. The project is based on a spiral design approach involving coupled interactions between technical and psycho-pedagogical partners. MIROR integrates both psychological case-study experiments, aiming to investigate cognitive hypotheses concerning the mirroring behaviour and the learning efficacy of the platform, and validation studies aiming at developing the software in concrete educational settings. The project contributes to promoting the reflexive interaction paradigm not only in the field of music learning, but more generally as a new paradigm for establishing a synergy between learning and cognition in the context of child/machine interaction.

1.2. Objectives

The MIROR project aims primarily at developing the potential of IRMS for the benefit of *music education*. More precisely, MIROR's primary goal is to develop an adaptive and intuitive system for music education, based on the reflexive interaction paradigm. This includes:

1. The design and implementation of a platform, the **MIROR platform**, including the core technological modules needed to implement the reflexive interaction paradigm (e.g., modules for analysing the musical behaviour of learners, modules for analysing expressive full-body movement and gestures, modules for session and interaction management, and so on).

2. The design and implementation of three **MIROR prototypes**, grounded on the MIROR platform, addressing different aspects of music education and exploiting different qualities of the reflexive interaction paradigm:

    a. The **MIROR-Improvisation prototype**, addressing music improvisation

    b. The **MIROR-Composition prototype**, addressing music composition

      c.   The **MIROR-Body gesture prototype**, exploring how full-body movement and gesture can enhance music learning in the framework of the reflexive paradigm.

3. The **validation** of concrete pedagogical scenarios in which IRMS organise and stimulate the learning/teaching processes in the domains of music improvisation, composition, and body performance; the validation of the MIROR platform and prototypes in such scenarios.
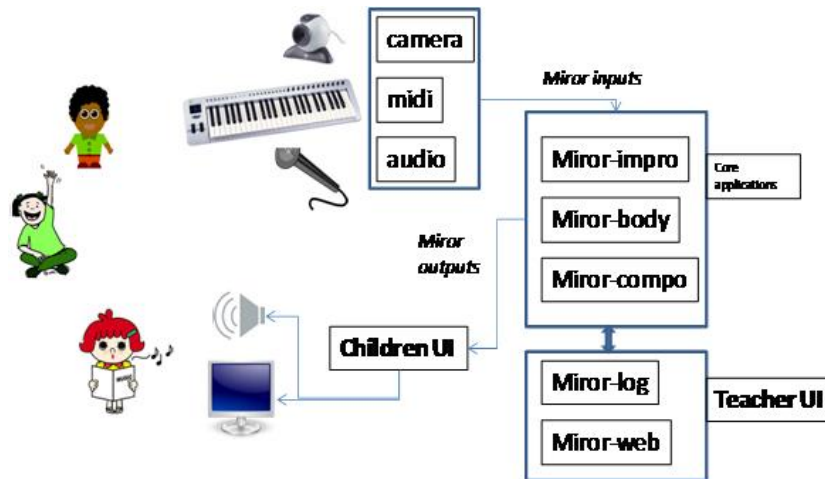
Fig. 1 – Overall architecture of the MIROR Platform

1.3. Consortium

- Alma Mater Studiorum-Università di Bologna (UNIBO), Italy – Coordinator.

- Sony Europe Limited acting through Sony France Computer Science Laboratory (SONY FRANCE), France.

- Università degli Studi di Genova (UNIGE), Italy.

- Goeteborgs Universitet (UGOT), Sweden.

- National and Kapodistrian University of Athens (NKUA), Greece.

- The University of Exeter (UNEXE), United Kingdom.

- Compedia Software & Hardware Development Ltd. (COMPEDIA), Israel.

1.4. Work performed and major results achieved so far

The first year of the project was mainly devoted to the integration of background knowledge from partners, to the definition of the requirements for the MIROR platform and prototypes, and for their interfaces, to the development of the initial version of the MIROR platform and prototypes, to the performance of a first series of experiments in concrete pedagogical scenarios. Early results include the following:

- UNIBO, UGOT, NKUA, and UNEXE investigated several **theoretical aspects** dealing with IRMS, both in the context of music education and cognitive sciences of music, and in the more general field of learning in an interactive scenario. A review of relevant literature was carried out and the theoretical background concerning the cognitive and creative processes, which are implicated in IRMS, was discussed. In particular the following topics were

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considered: the mirroring interaction; the theory of Flow in reflexive scenarios; the cognitive processes of music improvisation in children; the learning/teaching processes in reflexive and interactive scenario; music therapy and community music settings.

- The **initial version of the MIROR platform** was developed to provide the consortium with running prototypes as soon as possible. SONY FRANCE and UNIGE carried out this work in close loop with the psycho-pedagogical partners who provided feedback on the outputs needed for the experiments, manipulation of musical parameters involved (rhythm, dynamics, texture, etc.), and development of specific settings, and with COMPEDIA who also provided feedback on exploitation issues. The following major results were achieved:

- New algorithmic solutions such as the novel musical sequence generation algorithm with constraint satisfaction scheme (SONY FRANCE) and the techniques for extraction and processing of movement and gesture features (UNIGE) were developed, successively tested, and integrated into the prototypes.
- Several core technological modules such as session management, session visualisation, music score display and export functionalities were developed and integrated.
- Future integration abilities were addressed in particular by developing various independent software libraries, which will be used in MIROR prototypes through evolving but clearly defined APIs.
- Hardware needs and compatibilities were studied and hardware selection was made.
- Tools for connecting the MIROR prototypes were investigated and an initial proof-of-concept of such a connection to generate musical outputs by gesture analysed in real time was developed and tested.

- The **initial versions of the three MIROR prototypes** were developed (SONY FRANCE and UNIGE) and provided to the psycho-pedagogical partners for early feedback. In particular:

- SONY FRANCE developed the initial MIROR-Improvisation prototype. Its focus is the basic musical level (notes, clusters, and sequences thereof). Since the early stages of the project eleven different versions were delivered to the consortium, and many new features, bug fixes, and comments, in particular concerning the user interface, were progressively integrated, including a session management tool to record, save, retrieve, and visualise the musical information exchanged during each session in an easy way.
- SONY FRANCE developed the initial MIROR-Composition prototype. MIROR-Composition grounds on MIROR-Improvisation and aims at teaching children how to reflect on a larger scale than the basic musical level.
- UNIGE developed the initial version of the MIROR-Body gesture prototype. This prototype is mainly a framework enabling children to perform exploration of sound and of musical concepts by their body movements and gestures. The framework integrates customisable exercises, with different levels of complexity, spanning over different dimensions of sound and over different music concepts.
- SONY FRANCE and UNIGE developed the initial versions of the interfaces for the MIROR prototypes, with particular reference to the MIROR-Improvisation prototype (Fig. 2). Following the feedback by the Consortium, COMPEDIA developed a mock-up for an improved version of the teacher interface for the MIROR-Improvisation prototype (Fig. 3)

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- The interfaces will be evaluated and will evolve in the second year, taking into account industrial exploitation and demonstration requirements.
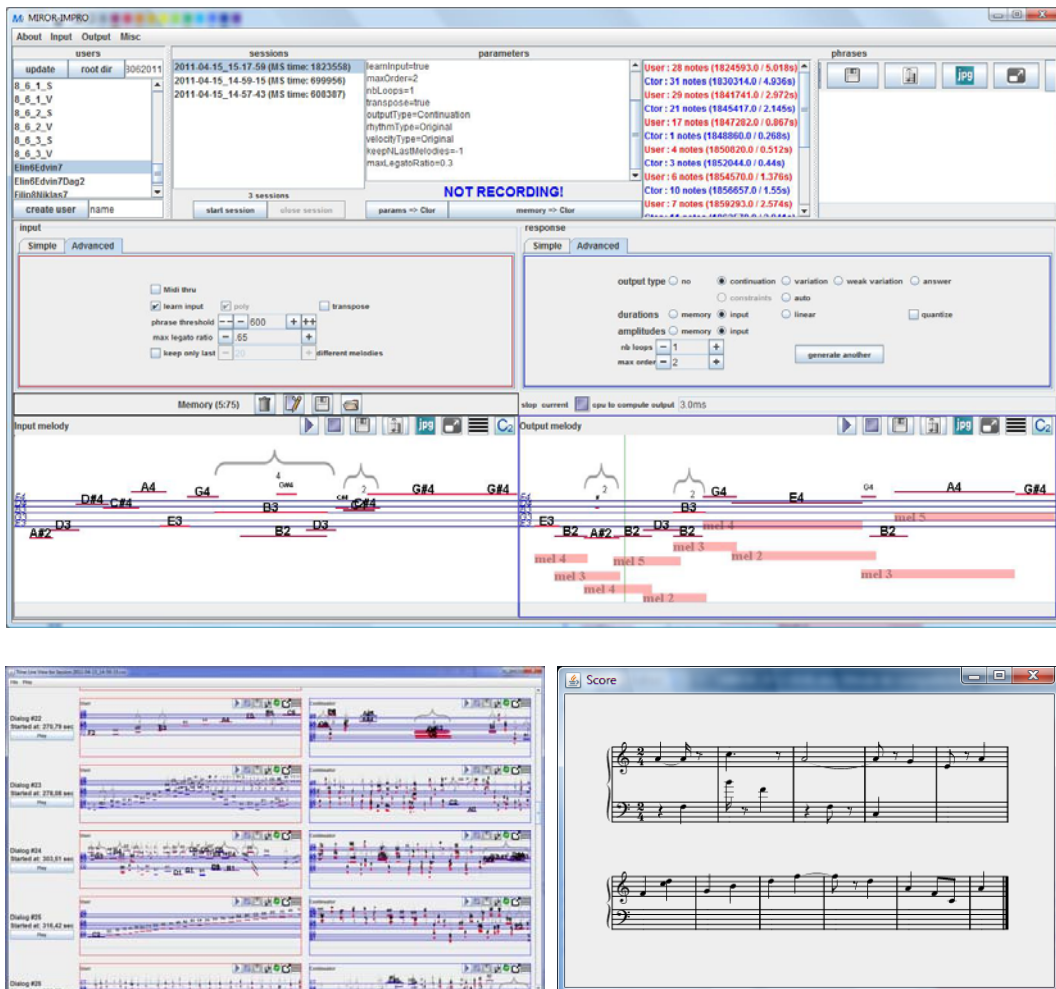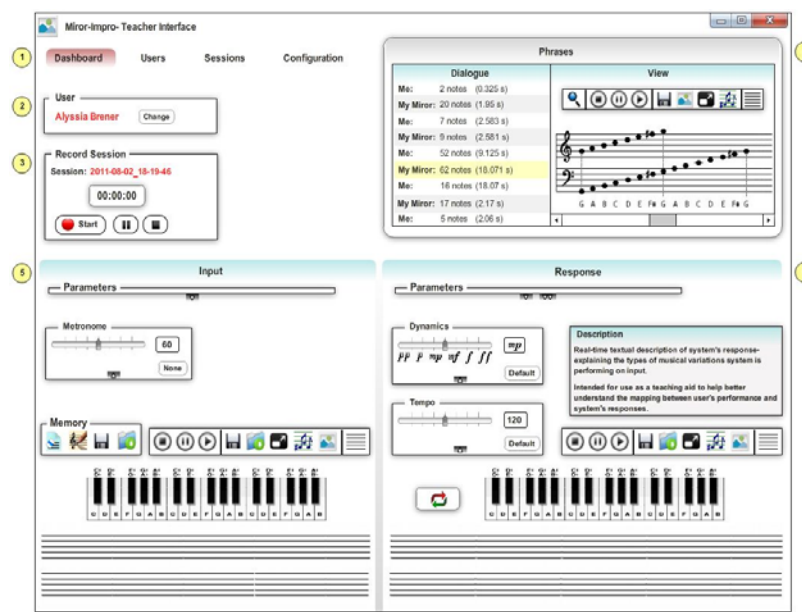

Fig. 2 - Initial version of the interface

Fig. 3– MIROR Impro Sample of the new suggested UI design

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- UNIBO, UNEXE, UGOT, and NKUA prepared and carried out **experiments with children** and the MIROR-Improvisation prototype. From September 2010 to April 2011 the experimental partners planned, in strict collaboration with the other Partners SONY FRANCE, UNIGE, and COMPEDIA, two protocols and several exploratory studies to be carried out with children in kindergarten and primary schools. In April-August 2011 the experiments and further minor exploratory studies were performed in Athens (NKUA), Bologna (UNIBO), Gothenburg (UGOT), and Birmingham (UNEXE). Almost 100 children were involved in the experiments. Whereas the final results will be available in Year 2, initial considerations can be made as follows:

- The collected archives represent a rich data collection.
- The results obtained so far show that the MIROR-Improvisation prototype works and can have a positive effect on the level of Flow of the child while improvising, proving a reach interaction context.
- The results indicate several suggestions in order to further improve the system, the interface, the equipment and the setting, and suggest new experimental hypotheses to be tested.
- The results suggest new interesting experimental ideas to be implemented with the next versions of MIROR-Improvisation and with the recent MIROR-Composition prototype.
- The results raise interesting theoretical aspects concerning perceptual and cognitive issues on the reflexive scenario with young children, music perception and music analysis, music therapy, and different socio-pedagogical contexts.
- An overview of the data and results partners collected underlines how carrying out different protocols in a range of contexts is positive and enriching for the project.
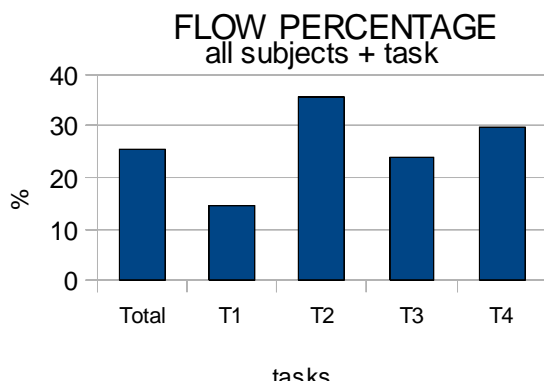

Fig. 4 – Some experimental result (May 2011, Bologna, Italy). Percentage of the Flow state recorded in the subjects observed (n=24, 4 and 8 years old children): The trend of Flow is higher when children play with the MIROR-Impro (T2 and T4) than without the system (T1 and T3).

- During months 9-12, starting from the results of the experiments carried out with MIROR-Improvisation and analysing the literature about composition with children, the Consortium started the preparation of the experiments with MIROR-Composition and MIROR-Body gesture that were delivered at the end of August. Experiments will be carried out in Year 2.

- The Consortium organised **two workshops** (Paris, November 2010; Gothenburg, March 2011) to work on experimental designs, requirements of the platform and prototypes, hardware and technical equipment. The goal was to transfer the results of user testing to the prototype implementation and vice versa.

- The **MIROR website** has been delivered on Month 3 (UNIBO) (www.mirorproject.eu).
- **The logo of the project** was created by UNIBO on the basis of a writing made by a child of 5 years old who was asked to write the word MIROR on a yellow and a red

line (as from the medieval musical score). In spontaneous way, the child wrote the last letter "R" in reverse, and giving the idea of mirroring effect and of the reflexive paradigm.

- Secured video sharing service was enabled by COMPEDIA that will be used for both – sharing the video , comments among researchers and use a sub set of approved videos for demonstration and exploitation purposes.
- The project was **disseminated** to the scientific community through presentations at conferences. Initial results of research were published or submitted for publication. A special issue of Musicae Scientiae on MIROR topics is planned for publication at the end of the project.

1.5. Expected final results and their potential impact and use (including the socio-economic impact and the wider societal implications of the project so far)

The expected final results of the project are a fully functional MIROR platform and prototypes, assessed with experiments with children and grounded on solid theoretical bases. Impact is expected on education and learning, starting from music education, but possibly extending to other fields. Moreover, MIROR aims to:

- Develop a detailed analysis aiming at assessing the impact of the reflexive interaction paradigm for both music learning and general cognitive/learning processes.

- Promote an active approach to musical culture, based on "music-making" concept, rather than "music-consuming"; promoting the use of the MIROR Platform in children and adults, enabling a wider access to music by experts as well as non experts, and enhance the diffusion of music culture in EU society through experiments with the MIROR Platform in several European countries, producing an User Guide and Teachers' Guide.

1.6. The address of the project public website

Relevant information and updates about the MIROR activity can be found the project URL: www.mirorproject.eu