Project Number: 688865

Project Acronym: WHOLODANCE

Project title: Whole-Body Interaction Learning for Dance Education

Periodic Technical Report

Part B

Period covered by the report: from 01/01/2016 to 30/06/2017

Periodic report: 1st

Table of Contents

1. Explanation of the work carried out by the beneficiaries and Overview of the progress

1.1 Objectives

WhoLoDancE aims at developing and applying breakthrough technological tools that will assist dance teachers, students, choreographers, professional dancers and researchers in their desktop and dance-studio work, stimulating their innovative thinking and creativity. The main objectives of the project are summarized below:

1. **Develop a large library of dance movements** based on data acquired through motion capture (mocap) sessions and annotated in a manner that allows data interpolations, extrapolations and synthesis, making it possible to preserve cultural heritage, and in the long-term creatively enrich it.

2. **Develop a 'blending engine'**: a powerful tool that will allow choreographers and dance teachers to blend and assemble an infinite number of dance motions from the library of movements, stimulating the development of novel choreographic methods.

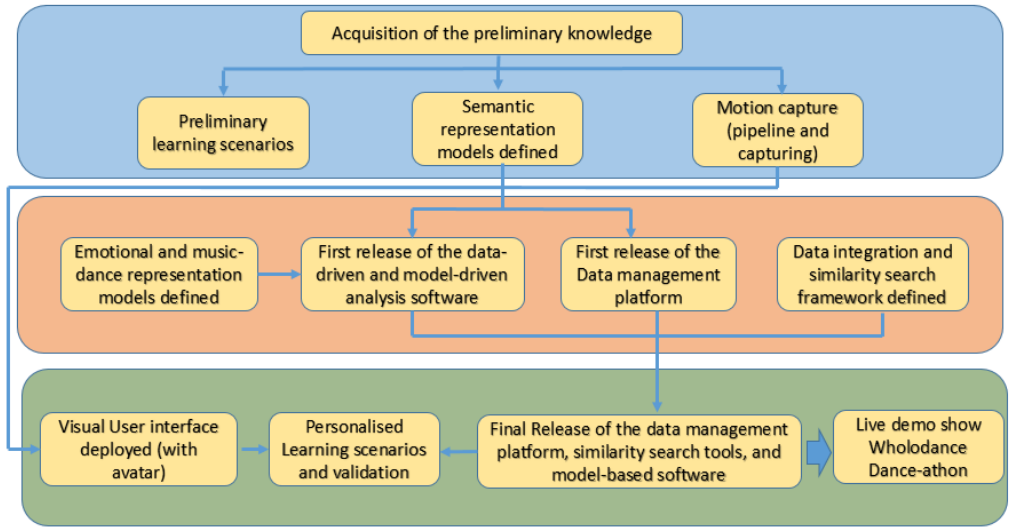
3. **Automate the analysis of expressivity and movement qualities in non-verbal dance data** by applying similarity search tools and techniques for expressivity analysis, opting to facilitate the investigation of movement principles and vocabularies, mental imagery and simulation connected to dance practises, and stimulate the development of new research domains.

4. **Develop life-size volumetric displays (avatars)** of dance masters' motions that will enable dancers to self-assess their own body alignment and technique by comparison, stimulating the development of novel teaching and learning methods.

5. **Provide access to the developed library of movements through commercially available consumer grade motion capture devices** like the MS Kinect, Intel's real sense and others that will be easily accessible by a wide audience.

1.1.1 Work plan and milestones

In order to achieve these objectives, a work plan was developed that organises the project in three phases.



WhoLoDancE work plan

Phase I, that ran from January to December 2016 (M1-M12), dealt with the acquisition of the preliminary knowledge coming from the end-users, allowing for the definition of learning scenarios and the users' profiles. At the same time, an embryonic definition of the semantic representation models was deployed. Finally, the pipeline for the motion capture process was developed and the data acquisition stage of the capture was completed. At the end of this phase, the first Milestone was reached (Milestone 1 – Preliminary definitions and ground-truth data acquisition).

Phase II, which is currently halfway (M12-M24), will lead to the definition of the emotional representation and music-dance representation models, as well as to the preliminary deployment of data-driven and model-driven analysis software (with relevant libraries defined). Furthermore, the data management platform has been released and is currently being tested in its alpha version (http://dl132.madgik.di.uoa.gr:8084/Wholodance_Movement_Library/), while the data integration and similarity search framework is nicely progressing, ensuring that the Second Milestone will be reached in time (Milestone 2 – Models, platform and similarity search basic development).

Phase III, which is the final phase of the project (M24-M36) will mainly deal with the deployment of the software and hardware adaptation needed for the deployment of the visual and interactive user interface (with the multi-modal avatar). The GUI dveloped on the second phase will be finalised. The interface will be subsequently validated through learning experience scenarios completed on-purpose. Furthermore, during this phase, the different systems (data management platform, similarity search tools, model-based software, with final libraries) will be delivered. Finally, the WhoLoDancE Dance-athon will be organised to disseminate the project results in a public event, conceived of as an artistic performance and demo-live show of the system. At the end of this phase, the Third Milestone will be reached (Milestone 3 – Visual User interface and data-driven models, tools and platform deployed – learning scenarios validated – final dissemination event for public outreach).

1.1.2 Briefing of progress towards the objectives

The first Milestone of the project (M12) was successfully reached and the use of resources was accurately managed. The current developments towards the completion of Phase II and the achievement of the second Milestone of the project (due in M24) appear as well to be nicely on track. The actions that were taken to address each one of the aforementioned five objectives are described below.

Objective 1: After a thorough analysis of the end-users needs, and a comprehensive preparatory work by the dance partners, three extensive motion capture sessions took place, during which large amounts of dance data were acquired, laying a solid foundation for further developments. An Alpha version of the platform was already released in Phase I by Athena RC in collaboration with PoliMI which allowed the navigation of the data repository thanks to use of a specific metadata server (CKAN Based). Within the first half of Phase II a web-based users' interface of the **Library of Movements** was created, supplemented by a data annotation tool, which is currently used by the dance partners for the annotation of selected movement qualities.

Objective 2: A first prototype of UNICA's **Blending Engine** created by MOTEK was ready by M12 and was altogether presented during the first WhoLoDancE Users' Board Session in Milan in December 2016. A second release took place in February 2017. In order to smooth the coordination and collaboration among technical partners, the technical details regarding the development of the blending engine were provided to all partners involved. This prevented the risk of a lack of collaboration between partners or any compatibility issue in the second phase of the project. On this direction, particular efforts have been allocated to ensure the sharing of the data format, as well as of the frameworks and programming language used for the project, leading to Athena RC drafting a common agreed document for all partners on how to overcome possible compatibility issues. The functionalities of the software have been continuously tested by all the partners, and feedback for hoped for improvements was provided to all technical partners in the course of dedicated webinar sessions.

Objective 3: With regard to the **Similarity Search tool,** Peachnote and PoliMi have been busy with research and development in this area. Peachnote initially focused on identifying elements in the music algorithms that can be transferred in the dance domain and the modifications that they need to undergo in order to fit WhoLoDancE purposes. An exploratory web-based interface was created in collaboration with PoliMi that allowed to evaluate the algorithm performance. The prototype was meant to demonstrate the principles at work behind the similarity search, which made it easier to discuss further improvements and extensions of the similarity engine, such as e.g. the inclusion of high-level features that UniGe and PoliMi are able to compute from raw motion data. The discussion also helped in the implementation of a standalone service that the partners designing the high-level feature extractors and the user interface will rely upon. This service was successfully completed by June 2017. In order to optimize the functioning of the similarity search tool, algorithms need to be trained to detect relevant similarities in data. To this end UniGe and PoliMi are currently working on the analysis of data acquired through the manual annotations by the dance partners.

Objective 4: The work on life-size volumetric displays is officially part of WP6, which starts in M21. In the meantime, a variety of motion visualizations have been investigated either for desktop work or for holographic experiences. A device that is being contemplated for integration is the Microsoft HoloLens. The WhoLoDancE partners had the opportunity to experiment with it during the second motion capture session in Amsterdam in July 2016. CovUni acquired additional insights for potential developments from a series of interviews with end users within the first half of Phase II. Athena RC developed the Choreomorphy Interface, which allows users to see themselves within different avatars in real-time. Dancers that participated in a pilot

evaluation of this tool seemed to be highly appreciating such a possibility. The findings of these initiatives shall be taken into account within the further developments of WhoLoDancE displays.

Objective 5: Within the first year of WhoLoDancE the technical partners contemplated various low-end motion capture tools that can be used for teaching and learning purposes. Based on feedback provided by the dance partners, a number of prototypes were further developed by UniGe and PoliMi by M13, which were subsequently integrated into the **'Movement-Sketching' software'**. While the library of movements is based on high-quality motion capture and other multimodal data, the 'movement sketching' paradigm allows a non-verbal access to the library of movements. Through movement sketching, dance practitioners, students, and professionals are able to create their own recordings of dance sequences by performing them, and query the repository in order to find similar dance segments. A first prototype by the Movement-Sketching software was released by UniGe in June 2017, and it is currently being improved based on regular feedback provided by the dance partners. Athena RC has been experimenting with the use of the MS Kinect to develop simple exercises that can support learners improve specific movement principles and qualities.

1.2 Explanation of the work carried per WP

WP1 Learning Models and Technical Requirements – (M1 - M18)

Lead Partner ATHENA

Participant number	Participant short name	Planned person months	Actual person months	TOT PMs
1	LYNKEUS	0	0	
2	ATHENA RC	12	19,72	
3	MOTEK	3	2	
4	POLIMI	2	1	
5	UNIGE	2	2,08	
6	Peachnote GmbH	2	1	
7	COVUNI	7,5	8,36	
8	STOCOS	1,5	2,68	
9	K. Danse	1,5	2,23	
10	Lykeion Ellinidon (LCGW)	1,5	1,88	

Deliverables due within Month 18	**Submitted (Y/N)**
D1.1. State of the Art Survey M 6	**Y**
D1.2. Interviews Report M6	**Y**
D1.3. Workshop Report M8	**Y**
D1.4. Definition of Learning Scenarios M 12	**Y**
D1.5. Data Acquisition Plan M10	**Y**
D1.6. HLF Definition for the Learning Scenarios M 11	**Y**
D1.7. User Profiling M16	**Y**

Brief overview

Progress

WP1, led by ATHENA RC, is the work package where the users' needs, learning objectives and Scenarios, and technical requirement are defined based on current learning (formal and informal) practices and approaches for dance teaching. As Dance Learning is a very complex and wide field in terms of objectives, methodologies and practices, which are usually genre specific, school or company specific, it is crucial to clearly define use-case and learning scenarios to be implemented throughout the project. Taking into account the lack of standardization in Dance Learning in general, as well as the fact that ICT-based Learning for Dance is a new field and there is limited previous work to build upon, the output of WP1 is of fundamental importance for the whole project.

WP1 has successfully accomplished all related tasks and activities that were due within the first reporting year. To meet the objectives of the WP1, a number of activities was organized as a close collaboration of the involved partners such a) literature survey of the state of the art on dance learning, b) questionnaires, online surveys, and interviews with dance practitioners c) workshops, working sessions and focus groups, and d) interdisciplinary discussions between dance and technical partners to achieve common understanding and vocabulary. As a result of the successful collaboration with MOCO16 (3rd International Conference on Dance Computing) the WhoLoDancE Workshop was organized, as well as a workshop for dance practitioners at the Researcher's Night in Athens. All relevant deliverables have been submitted on time (D1.1, D1.2, D1.3, D1.4, D1.5, D1.6, D1.7).

In addition, a Whole-Body interaction interface has been designed and developed, as a prototype to record the actual needs of dancers using different motion capture devices such as, Synertial mocap suit, Kinect (ChoreoMorphy), aiming at setting sessions with dance experts in the lab and recording actual needs of such experience through observation, recording (following consent forms) interviews and short questionnaires.

Key results

- A detailed analysis of the state of the art in dance education which served as the basis of a future survey publication on this domain (currently in progress).
- The work within WP1 aiming at defining users' needs has been disseminated in the "HCI and the Education Technology Revolution" Workshop @ AVI2016 and the related short paper was published in an academic journal. (HCI challenges in Dance Education. K.El Raheb, A. Katifori, Y. Ioannidis, EAI Endorsed Transactions on Ambient Systems 16(9): e7") and other dissemination events (please see table below).
- Identification and recording of the dance community needs in a theoretical and technical context.
- Dissemination of the project results to the community through successful events which established a two-way communication channel.
- The ChoreoMorphy tool which consists a whole-body interaction interface, developed by Athena allows both the visualizations of the WhoLoDancE motion capture recordings and real-time visualization of a dancer movements. The interface has been tested in real-time mode both using an inertial motion capture suit (synertial) and Kinect and allows the user to change in real time the avatars and different 3D visualizations (such as traces of movement, interaction with objects, etc). The interface has been tested in the lab with dancers, choreographers and dance teachers and the

pilot evaluation focusing on three objectives: 1) validating the hypothesis of using 3D visualisations and avatars to support and enhance the creativity in dance improvisation, 2) provide insight on the different aspects of the visualizations and characteristics of avatars that make the experience effective and attractive, 3) evaluate the experience as a whole. Last but not least, the demo of ChoreoMorphy (using both Motion Capture and the Kinect) have been presented as demo in various dissemination events targeted to wide audience with great success. The first version of the software has been presented as a paper (Tsampounaris, G., El Raheb, K., Katifori, V., & Ioannidis, Y. (2016, November). Exploring Visualizations in Real-time Motion Capture for Dance Education. In Proceedings of the 20th Pan-Hellenic Conference on Informatics (p. 76). ACM.), while the evaluation and enhanced version is under publication.

Issues

COVUNI have exceeded their PMs on this WP as some initially unexpected activity was also performed, in terms of online survey.

Tasks – detailed assessment

T1.1. State of the Art Survey [M 1-6] ATHENA RC- Stocos-K. Danse-LCGW-CovUni-UniGe:

Summary of progress towards objectives and details

The task had as main outcome a survey on: 1) the existing learning methodologies for the selected dance genres, as described in the DoA, and 2) a systematic overview of previous work and related projects (EU or other) in using ICT for Dance. This survey was reported in deliverable D1.1 State of the art survey.

Clearly significant results

D1.1 State of the art survey (M6): Taking into account the lack of formal and fully described methodologies for each dance genre and context, this report selected the state-of-the-art approaches, needs and contexts to serve as a basis for the rest of the project activities. The deliverable consists of two parts: a) Part A- Dance Learning Models and b) Dance and Technology State of the Art (SoA). Part A presents recent advancements in dance education in relation to general contemporary learning approaches, hhighlighting the most significant models, and discusses the potential benefits of the use of interactive technologies based on relevant literature. The second part presents the outcomes of recent research advancements in the design and development of tools to support dance teaching in learning through different technologies (Interactive whole-body experiences, Motion Capture, Virtual and Augmented Reality, Sonification, Annotation tools, Desktop and Mobile apps,). This presentation includes references to these recent advancements in relation to WhoLoDancE main objectives.

Reasons for deviations from DoA and impact of this deviation on other tasks/resources availability

N/A

Reasons for failing to achieve critical objectives and impact of this deviation on other tasks/resources availability

N/A

Corrective Actions

N/A

T1.2 - Interviews of Learning Experts, Dance Practitioners and Technology Providers – Covuni - ATHENA RC-UniGe-Stocos-K. Danse-LCGW [M1–M6]

Summary of progress towards objectives and details

Based on the State of the Art Survey, COVUNI organized 19 interview sessions with Dance Learning Experts, Dance Practitioners as well as Technology Providers. In addition, the COVUNI team developed an online survey where 38 responses were received and these fed into the deliverable D1.2. The aim of this task was to complement the outcomes of D1.1 with input from the wider community, including the perspective of actual practitioners. The results of this activity have been reported in deliverable D1.2.

Clearly significant results

D1.2 Interviews report (M6): This Interviews Report focuses on presenting the research findings carried out primarily by COVUNI, and includes work as well from other consortium partners such as ATHENA, Lynkeus, LCGW, K. Danse and STOCOS. The above-mentioned partners contributed in the recruiting of professional dancers and teachers and distributed and collected a number of questionnaires that were used for this deliverable. An examination of how dance, technology and movement principles align is at the crux of this document and the data generated from this work, will directly feed into later parts of the project. A significant segment of the dance community appeared to be intrigued by the WhoLoDancE approach, though there were also members of the dance community that appeared to be resistant to it.

Reasons for deviations from DoA and impact of this deviation on other tasks/resources availability

Comparing with the DoA, a minor deviation was incurred while fulfilling this task: it was decided to include an online survey to further enrich the data and reach a wider audience. The impact of this addition was subsumed within the research already being conducted.

Reasons for failing to achieve critical objectives and impact of this deviation on other tasks/resources availability

N/A

Corrective Actions

N/A

T1.3 - Dance and ICT-based Learning Workshop ATHENA RC - CovUni-Stocos-K. Danse-LCGW [M3-M6]

Summary of progress towards objectives and details

The objective of this task was to organize an interdisciplinary event workshop, which would include the presentation of WhoLoDancE objectives and the initial outcomes as well as talks by various invited speakers such as Dance Educators and Learning Experts, Technology Providers, Whole Body Interaction and HCI Researchers, Movement Analysts, and Dance-related Researchers. The workshop was meant to bring together an interdisciplinary attendance, raise questions on the topic of the project, generate feedback, and clarify the actual needs of the community. The WhoLoDancE Workshop was organized in Thessaloniki, Greece, as part of the MOCO 2016 Conference. The results of the workshop are reported in deliverable D1.3.

Clearly significant results

D1.3 Workshop report (M8): The workshop took place on the 6th and 7th of July in Thessaloniki, and was entitled "Dancing with Technologies: Interact to learn, analyse to create". It was mainly organized by ATHENA RC, with the collaboration and support of all WhoLoDancE partners, and it was a Satellite event

of the 3rd International Symposium on Movement Computing. Overall, the WhoLoDancE workshop was a successful event and fulfilled all three objectives that had been set: a) communicate the objectives of the project, b) network with the wider community, c) get concrete feedback on the primary conceptual frameworks of WhoLoDancE. The collaboration with MOCO16 significantly contributed to the achievement of these objectives, and the venue proved to be an excellent choice for the event. The mixed background of the participants, from choreographers and dance practitioners, to science technologists, artists and designers, led to fruitful discussions and fertilized the hand-on sessions with new perspectives. Finally, the attendance to the workshop was satisfying (31 participants), even though the two days of MOCO16, which had taken place prior to the WhoLoDancE workshop, had already been highly loaded: https://moco16.movementcomputing.org/index.php/2016-06-07-07-05- 20/workshop.html.

Confirming the strong collaboration links established between the MOCO community and WhoLoDance, there was also a STOCOS performance at MOCO 2016, combining stochastic processes and artificial life-based simulations aimed at creating mutual aesthetic and behavioural dependencies between dancers, simulated entities, music and imagery, so that all the activities of dancers, music and visuals appeared to be correlated through underlying processes of Brownian movements and flocking behaviour.

In the context of the same MOCO 2016 Conference, also another WhoLoDancE partner, K. Danse, provided an extensive amount of creative material: research material and proposals for the workshop, proposals to work on one dance movement principle, "Directionality", in order to use that one principle for a clear advancement on the many layers of the entire WholoDance project, presentation of an array of video excerpts of performances mixing dance and digital interactive technology.

Reasons for deviations from DoA and impact of this deviation on other tasks/resources availability

N/A

Reasons for failing to achieve critical objectives and impact of this deviation on other tasks/resources availability

N/A

Corrective Actions

N/A

T1.4 - Definition of Learning Scenarios CovUni - ATHENA RC-Stocos-K. Danse-LCGW

Summary of progress towards objectives and details

This task includes the drafting of particular use-case scenarios for the various Learning approaches and modes of interaction, aiming at two main concrete outcomes a) to assure the user-centred perspective of the system and its use in different contexts according to the needs of the dance communities (T4.1.1 Needs Analysis) and b) to define the technical requirement and specifications for the various functionalities to be offered to the users (T1.4.2 Requirements elicitation for Application Scenarios and Interface Definitions with Respect to framework Integration). The results of this task are reported in deliverable D1.4.

Clearly significant results

D1.4 Definition of learning scenarios–needs analysis (M12): This report presents a detailed analysis of user needs and elaborates on identified learning scenario types for dance, concluding with the selected scenarios to be implemented throughout the project. In order to compile these scenarios, D1.1 State of the art survey was taken into account in combination with a number of activities that were organised,

involving dance experts and practitioners. These include the distribution of questionnaires targeting different aspects of WhoLoDancE conceptual framework and the practitioners' relation to technology tools for dance, the organization of two workshops (WhoLoDancE Workshop and the Researchers' Night Workshop) as well as several focus groups involving practitioners from within and without the consortium.

Reasons for deviations from DoA and impact of this deviation on other tasks/resources availability
N/A

Reasons for failing to achieve critical objectives and impact of this deviation on other tasks/resources availability

N/A

Corrective Actions
N/A

T1.5 - Technical Requirements for Data Acquisition - ATHENA RC - Motek-PoliMi-UniGe [M1-M9]

Summary of progress towards objectives and details

This task provided the specification of 1) methodologies of acquiring motion capture data, 2) dance expert representatives who participate in data collection, 3) a plan for selecting data from each Dance Institution Partner using the appropriate methodologies to address the needs of the different use-cases. The work was carried out in collaboration with Coventry University and the Dance Companies and in coordination with WP2 and resulted in deliverable D1.5.

Clearly significant results

D1.5 Data Acquisition Plan (M8): This deliverable, according to the project time-plan, had a delivery date later than the conclusion of the motion capture sessions as foreseen from the same time-plan. As a result, the deliverable reports both the data acquisition plan, as it had been formulated before the realisation of the sessions, and it also gives an overview of the results of the process. More than 1600 segments of dance movement were recorded using Motion Capture, video and other devices in two venues. 8 different expert dancers (3 male, 5 female) have been recorded. The sequences were recorded after thorough selection, preparation and rehearsals, in order to create a library of movements that is representative of the dance teaching for each one of the genres (e.g., syllabus, repertoire, folk dances of different regions, etc.). MOTEK has defined for this plan a custom marker setup suited for capturing dancer's movement subtleties. This marker set served as a template for all capture sessions in WP2.

Reasons for deviations from DoA and impact of this deviation on other tasks/resources availability
N/A

Reasons for failing to achieve critical objectives and impact of this deviation on other tasks/resources availability

N/A

Corrective Actions
N/A

T1.6 - Definition of High Level Features Required for the scenarios - ATHENA RC - PoliMi-Peachnote-CovUni-Stocos-K. Danse-LCGW[M3-M9]

Summary of progress towards objectives and details

The main outcome of this task is a list of the main categories of High Level Features that it is worth

considering for addressing the needs of users within the scenarios. Deliverable D1.6 HLF Definition for the Learning Scenarios presents the methodology and outcomes of T1.6.

Clearly significant results

D1.6 HLF Definition for the Learning Scenarios (M11) This includes the lists of the various vocabularies to be used for describing the different characteristics of movement, mood and context of dance (e.g., syllabi, movement qualities, mood, movement principles, formal vocabularies etc.), and the rationale of selecting specific approaches, among the existing ones. The aim was to provide a detailed framework for understanding general movement and learning principles, as well as the particularities of individual dance syllabi, and promote a deeper understanding of user needs in view of acquiring a solid and appropriate theoretical framework and technical specifications for the technologies to be developed. The four dance genres WhoLoDancE focuses on, represent a variety of dance practices that range from academic, historical and theatrical systems of dance (ballet), to traditional art forms of intangible cultural heritage (Greek Folk, Flamenco), and contemporary practices that embrace creativity and experimentation (Contemporary dance). The characteristics and syllabi of these dances were examined in this report and relevant HLFs were reported. Furthermore, the report presents a set of ten Movement Principles which summarize the most fundamental and essential learning objectives, beyond the limitations of each genre, and could summarize the higher-level features and embodied concepts that each dance learner deals with, more or less, in each dance class. This first list of Movement Principles was validated with the wider community of dancers, dance educators, practitioners and choreographers of different styles through different means. The movement principles were thoroughly analysed to present their main characteristics and features. They were complemented with movement qualities as well as several common actions that are likely to characterize any movement sequences.

The work reported in D1.6 was used to guide the learning scenario definition work in D1.4 and the development of appropriate representation models for dance in the context of WP3.

Reasons for deviations from DoA and impact of this deviation on other tasks/resources availability
N/A

Reasons for failing to achieve critical objectives and impact of this deviation on other tasks/resources availability

N/A

Corrective Actions
N/A

T1.7 - User Profiling and Modeling for the Personalized Learning Scenarios - ATHENA RC - CovUni-Stocos-K. Danse-LCGW [M10-16]

Summary of progress towards objectives and details

The objective of this task was to describe and document the foreseen WhoLoDancE users and to define the user model that is to form the basis for the implementation of the personalization and adaptivity algorithms.

Clearly significant results

Deliverable D1.7 User Profiling focuses on the specific characteristics of the identified user groups and attempts to analyse them in relation with the functionality to be offered by the WhoLoDancE tools. In

addition to the plan, additional lab sessions and focus groups were organized.
Reasons for deviations from DoA and impact of this deviation on other tasks/resources availability **N/A**
Reasons for failing to achieve critical objectives and impact of this deviation on other tasks/resources availability **N/A**
Corrective Actions **N/A**

WP2 Multimodal Sensing and Capturing Analysis – (M2 - M23)

Lead Partner MOTEK

Participant number	Participant short name	Planned person months	Actual person months	TOT PMs
1	LYNKEUS	0	0	
2	ATHENA RC	2	1,73	
3	MOTEK	20	32	
4	POLIMI	3	2,6	
5	UNIGE	15	11,29	
6	Peachnote GmbH	1,5	0	
7	COVUNI	2	5,47	
8	STOCOS	1,5	3,76	
9	K. Danse	1,5	2,97	
10	Lykeion Ellinidon (LCGW)	1,5	2,22	

Deliverables due within Month 18	**Submitted (Y/N)**
D2.1. Recruitment protocol and informed consent form M 3	**Y**
D2.2. Outcome of the pipeline development M6	**Y**
D2.3. Outcome of the capture process M8	**Y**
D2.4. Trimmed linear database of curated data sequences M 10	**Y**
D2.5. 3D avatar scenes M16	**Y**
D2.6. Motion capture sequences and skeleton avatar	**Y**

Brief overview

Progress

Work package 2 aims at developing, creating, implementing and executing an optimal production pipeline setup of multimodal Sensing and capturing of a comprehensive motion capture dance repository. Next to the development and actual recording of the data, WP2 also had an analysis component that consisted of

annotation, curation, metadata gathering and grouping of the data based on the guidelines and movement principles decided on in WP1. There were 3 motion capture sessions in total. The 1st one, carried out in Genoa March 2016, was an exploratory small pilot that was predominantly dedicated to exploration of motion qualities in one of the four dance genres chosen (Contemporary, Classic, Flamenco and Greek). The 2 sessions that followed at Motek facilities in Amsterdam, were the main production sessions (10 days each), and during those sessions a total of over 6000 separate motion segments of the 4 dance genres were captured. The motion capture data was recorded using high end Vicon system, next to multi camera video documentation.

Key results

Recruitment protocols: At the start of the work package, the Recruitment protocol and the informed consent forms were designed and sent to all the parties involved. Those were also agreed upon and signed by the performers engaged in the work of the motion capture recordings.

Pipeline creation: A custom marker setup that is optimal for capturing dance was developed. It consisted of 53 optical markers placed on anatomical landmarks on the dancer's body. Special attention was given to accurate capture of fingers and toes. A large capture volume (10 X 8 meters) was created at the Motek facility in Amsterdam and equipped with 24 high definition Vicon cameras, sound system and video documentation simultaneous recording setup. Several avatars were created and tested for the motion capture sessions, one avatar that was designed to visualize body part directionality, a second one that displayed a motion envelope, and a third that used particle trails to show movement over time in the captured volume.

Motion capture sessions: (1) Classic dance motion capture repository. 2 Dancers (male and female) execution of the classic dance routines and steps that are used in classic dance teaching classes. In addition, some repertoire moves were captured and some improvised classic dance. (2) Contemporary dance motion capture repository. 3 Dancers performed a large variety of dance segments based on the decided motion principles and movement elements and criteria that are used in contemporary dance teaching classes. In addition, repertoire moves were captured and improvised dance pieces. (3) Greek traditional dance. Those were performed by 4 dancers (2 male and 2 female dancers). A large variety of traditional Greek dances were captured, in single dancer or simultaneous dance of pairs. The basic motive, the variations and the improvisations of the leader dancer for each dance, were captured in full and segmented based on the chosen movement principles and teaching needs. (4) Flamenco dance. Here a large variety of Flamenco dance from different regions and tempos were captured and segmented based on the movement principles.

Data processing and analysis: Once all the data was captured, several post processing stages were performed. First the data were converted from RAW format to a 3D format (FBX) that is widely used in the 3D industries for offline and real-time visualisations. Then the data were segmented to create a repository based on the different movement principles. This was done also in preparation of the creation of the custom blending engine that enables assembly of new choreographies, and blending of different segments and body parts from different motion capture sequences. The data were curated by several partners, and metadata was extracted and added to the different sequences.

Blending engine development: One of the large blocks of WP2 was the development of a customised blending engine of the motion capture data in such a way that makes it possible to blend any specific motion element with any other motion element within the database. This development was done to

enable WhoLoDancE to deliver any combination of dance moves contained in a teaching syllabus and it's Multimodal Rendering. The blending engine was written in C++ and FLTK, it is currently in the hands of all project's partners as a beta cycle benchmarking and optimisation stage.

Issues

One issue that was encountered in the development of the blending engine, was that it took longer than expected to implement the underlying biomechanical structure that eliminates motion blends resulting in movements that would be beyond the range of movements of the human body.

Tasks – detailed assessment

T2.1. Recruitment protocol and informed consent form - COVUNI [M1-3]

Summary of progress towards objectives and details

A number of dancers were invited to perform set sequences of movement in a variety of dance genres for both video and 3D capture. Most dancers were drawn from the project consortium. Any dancer who was not a member of the WhoLoDancE project team received a Participant Information Sheet and was required to sign an Informed Consent Form as a mandatory precondition for their involvement in the study. Both these documents were approved by each participating research organisation's ethics committee before distributing to participants. Gaining ethical approval ensures that the project team is proceeding responsibly with due care for the participants and the storage of data that was produced as part of the data capture process. Whilst it is not possible to anonymise the video recordings, these recordings were made as part of the research process for internal visual reference, to assist in the database creation process and to define the shot-lists for the 3D motion captures and did not enter the public domain without prior permission being specifically sought from the participant. All video and 3D records were retained securely and no personal data of the participants was stored.

It is the duty of all researchers to ensure that any research activity meets the highest ethical standards. The project team submitted the research protocol and associated documents for ethical review and clearance to Coventry University's research committee in line with its requirement that all subject related research obtain ethical approval before undertaking any research involving human participants. Ethical review and approval was sought and confirmed by other participating research organisations as appropriate. WhoLoDancE falls under Coventry University's requirement that ethical approval is required for any research, design studies, artistic studies, experiments, survey work, questionnaires, interviews, focus groups or case studies.

Clearly significant results

The COVUNI team created two key documents that have been used in a variety of contexts within the project. The participant information sheet and informed consent form were approved by the COVUNI ethical review committee prior to any motion capture sessions.

The Participant Information sheet included:

- Outline of the project, its aims and experimental procedures
- Duration of the project
- The nature of the participation
- Risks and benefits of taking part

- What will happen to the participant's data.
- Key Contact details
- Withdrawal Options

The Informed Consent Form included a number of statements that the participant needed to tick in order to proceed. The form was designed to be clear and straightforward, aimed at ensuring the participant understands and agrees to participation. The form required no sensitive data to be collected (such as age, health, sexual orientation, ethnicity, political opinion, religious or philosophical conviction).

Both the Participant Information Sheet and the Informed Consent Form were translated into French, Italian, Greek.

Reasons for deviations from DoA and impact of this deviation on other tasks/resources availability

Both the Participant Information Sheet and the Informed Consent Form were translated into French, Italian and Greek. This was an unforeseen situation and required the COVUNI team to pay for the translations. This was not listed in the DoA but the Consortium saw a need for the translations and so COVUNI proceeded, with approval from the Coordinator.

Reasons for failing to achieve critical objectives and impact of this deviation on other tasks/resources availability

N/A

Corrective Actions

N/A

T2.2 - R/D – development of the pipeline that will enable the proper creation of a blendable motion capture repository – Motek- ATHENA RC-PoliMi-PeachNote-UniGe-CovUni-Stocos-K. Danse-LCGW [M2 – M5]

Summary of progress towards objectives and details

The pipeline development started with a detailed staging of the phases needed to produce the motion capture repository. It started with pre-production, scripts were created for the shot-lists of capture sequences needed for each dance genre, seen from the context of dance teaching and choreography. A naming convention for the data was created and storyboards were developed. Strict mocap guidelines were set to ensure that the resulting data would become optimal for motion blending.

Clearly significant results

One of the most significant outcomes of this task is the release of the so-called Mocap pipeline "bible" document. This is described in detail in D2.2

Reasons for deviations from DoA and impact of this deviation on other tasks/resources availability

N/A

Reasons for failing to achieve critical objectives and impact of this deviation on other tasks/resources availability

N/A

Corrective Actions

N/A

T2.3 - Capture – Motek - ATHENA RC-PoliMi-UniGe-CovUni-Stocos-K. Danse-LCGW [M4 – M7]]

Summary of progress towards objectives and details

Rehearsals with performers and capture technicians were carried out on two different aspects, Creative and Technical. On the Creative aspect, the rehearsal was meant to focus on the best way of performing the specific motion. The Technical rehearsal was meant to assess the best way to capture the specific shot (performer placement, performer calibration and shot specific constraints). Pre-visualization of capture templates were tested on existing data sequences to ensure that the templates were good to use. Relevant music tracks were collected from the dance partners. The capture studio was customised and the capture systems and parallel video recording devices were tested through several rehearsals with the performers. Then, the capture process itself commenced. There were two 10-days sessions at the Amsterdam base Motek facility.

Clearly significant results

This task led to a comprehensive, multi-modal motion capture database of the 4 dance genres (Classic, Contemporary, Greek and Flamenco) comprising of over 6000 motion segments.

Reasons for deviations from DoA and impact of this deviation on other tasks/resources availability

N/A

Reasons for failing to achieve critical objectives and impact of this deviation on other tasks/resources availability

N/A

Corrective Actions

N/A

T2.4 - Data Curation – Motek - ATHENA RC-PoliMi-UniGe [M8 – M9]

Summary of progress towards objectives and details

The motion capture data curation in the context of the WhoLoDancE project involved the management of the selected sequences throughout their lifecycle, from creation and initial storage to the time when is the data are archived for posterity or become obsolete and are deleted. Selected sequences were checked to ensure that they were reliably retrievable for future research purposes or reuse. All the selected sequences were trimmed to include the motion start and end without the needed subject calibrated "T-pose" before and after the delivery of motion. Attention was also given to the repeatability of selected movements and their relevance to the given motion principals. In addition, metadata was extracted containing performer's name, length of sequence and motion principle relevance.

Clearly significant results

This task led to a trimmed and curated motion capture sequence repository set in a directory structure based on Dance Genre and movement principle.

Reasons for deviations from DoA and impact of this deviation on other tasks/resources availability

N/A

Reasons for failing to achieve critical objectives and impact of this deviation on other tasks/resources availability

N/A

Corrective Actions

N/A

T2.5 - 3D Avatar construction - Motek - ATHENA RC-CovUni [M9 – M15]

Summary of progress towards objectives and details

This task dealt with development and optimization of the 3D avatar scenes for the WhoLoDancE project. Each avatar that was created, was designed to cater for different principals of movement in dance. The movement principals defined at the start of the project served as the primary guideline for the types of avatars created. 3 types of different avatars were developed: (1) Directional guidance (The "Arrowman" avatar); (2) Time based motion volume (The "blob" avatar); (3) Articulated visual (The "robot" avatar). In addition, all 3 avatars were programmed to have the capacity to display particle trails from any chosen body part throughout the dance sequence.

Clearly significant results

This task led to 3D avatar scenes in SCN and FBX formats and a master scene containing all avatars that is built for real-time toggles between avatars during capture or offline.

Reasons for deviations from DoA and impact of this deviation on other tasks/resources availability

N/A

Reasons for failing to achieve critical objectives and impact of this deviation on other tasks/resources availability

N/A

Corrective Actions

N/A

T2.6 - Skeleton Fitting (retargeting) and visualization – Motek - Polimi[M16 – M17]

Summary of progress towards objectives and details

Generic inverse kinematic (IK) avatar skeletons for the WhoLoDancE project were developed for each of the avatars. The skeletons structure was derived from the guidelines and requirements that emerged from discussions with the dance partners from the project's start and through several dance partners and technical partners meetings in the last months. The creation of a unified performer IK Skeleton Fitting (retargeting) and visualization was also based on several practical conclusions that were reached during the capture sessions. The captured motions were analysed for (1) Global scale deviations between performers, (2) Range of motions rotational scope per performer, and (3) Unified mean deviation across all performers. Once this stage was complete, the data were used to determine the dimensions and internal scale of an empiric unified avatar skeleton that would fit the scaling of all the performers that were captured for the project.

Clearly significant results

This task led to 3D hierarchical structure of avatar skeletons in FBX file format. Over 1500 annotated motion capture sequences connected to the avatar skeletons.

Reasons for deviations from DoA and impact of this deviation on other tasks/resources availability

N/A

Reasons for failing to achieve critical objectives and impact of this deviation on other tasks/resources availability

N/A
Corrective Actions N/A
T2.7 - Post processing - Motek [M18 – M22]
Summary of progress towards objectives and details Not started yet
Clearly significant results N/A
Reasons for deviations from DoA and impact of this deviation on other tasks/resources availability N/A
Reasons for failing to achieve critical objectives and impact of this deviation on other tasks/resources availability N/A
Corrective Actions N/A
T2.8 - Cross range devices, scalability and real-time data processing -Motek - PoliMi-PeachNote-UniGe] [M2-M7]
Summary of progress towards objectives and details Research of integration of suggested additional registration devices was executed. The issues encountered during the research yielded a set of recommendations for the optimal usage of multimodal sensors. Conclusions were implemented in the areas of (1) Optimal capture volume, (2) System accuracy, (3) Parallel recording devices, and (4) Target data accuracy.
Clearly significant results This task led to a set of conclusions and report encompassing the state of the art devices available for parallel recordings of motion capture data next to the primary mocap system. As yet, the outcome was not to make use of most of the devices that were initially considered as usable, because of their low data accuracy (both positional and rotational). This, however, did not imply any impact on other tasks or resources available.
Reasons for deviations from DoA and impact of this deviation on other tasks/resources availability N/A
Reasons for failing to achieve critical objectives and impact of this deviation on other tasks/resources availability N/A
Corrective Actions N/A

WP3 Semantic and Emotional Representation Models – (M1 - M30)

Lead Partner POLIMI

Participant number	Participant short name	Planned person months	Actual person months	TOT PMs
1	LYNKEUS	0	0	
2	ATHENA RC	8	6,04	
3	MOTEK	2	2	
4	POLIMI	16	14,5	
5	UNIGE	15	9,51	
6	Peachnote GmbH	2,5	0	
7	COVUNI	2	0,61	
8	STOCOS	1	1,37	
9	K. Danse	1	0,91	
10	Lykeion Ellinidon (LCGW)	1	0,5	

Deliverables due within Month 18	**Submitted (Y/N)**
D3.6 First report on software platform and libraries M 3	**Y**
D3.1 Report on semantic representation models M18	**Y**
D3.2. Report on emotional representation models M18	**Y**

Brief overview

OVERALL PROGRESS

WP3 concerns three main topics: (1) semantic representation models, (2) multimodal signal analysis and modelling, and (3) development platform and libraries.

Semantic representation models: Generic actions were collected (e.g., Turn, Jump, Step, Bend, Extend, Slide) and specific vocabularies of syllabi, and a set of Movement Principles and Movement Qualities, commonly used to describe dance movements, were selected. The formal definition of Movement Principles and Movement Qualities is an ongoing process and is part of the creation of an ontology, by means of Semantic Web technologies, starting with Directionality (e.g., the volumes, directions, body

parts, axes, planes, lines, the cube). The technologies used for the purpose is OWL (web ontology language) and Protege Ontology Server and editor which allows the collaborative creation within the consortium.

Multimodal signal analysis and modelling: Data were initially processedin order to provide a uniform dataset in terms of data format: C3D and FBX were used for motion capture data; a discussion is still ongoing within the consortium whether to adopt JSON format as the standard to represent structured data in web applications. For the purpose of multimodal analysis, a large set of low-level features were defined and extracted with the aim of providing an effective characterization for each type of data. The principle types of data considered here are: motion capture data, video and music. Motion capture systems generates a cloud of points, each associated with an absolute position. In order to make it easier to extract some information such as the orientations of the body parts, a hierarchical representation (rigid bodies) composed by clusters of markers is also produced. This allows to define a skeletal human model described by a fixed undirected graph. The vertices are identified by the positions of the joints (marker cluster's barycentres) specified at each frame. Analysis methodologies on this particular representation model are being investigated: intra-network driven solutions, with a particular focus to game theories enable the measurement of how energy propagates in body joints and to estimate the path along which energy flows through the "dancer body network". From the cloud of points and the hierarchical representation a set of low-level features were extracted such as trajectories of specific points in the space and orientation. Exploiting low-level features, preliminary models for the analysis of some Movement Principle, such as balance, have been built based on rule-based approaches. In certain conditions, video recordings could be used to measure movements of specific parts of the body and/or full-body movements. To obtain more accurate measures, e.g. on translation and rotations, sophisticated techniques based on the variation of the motion field such as optical flow and trackers based on pattern similarities (kernelized correlation filters - KCF) were also exploited, tracking learning detection (TLD).

As far as the joint music-dance analysis is concerned, the focus was mainly on the extraction of rhythmic information from video, mocap and music in Flamenco and Greek dances. As basilar steps of the analysis a set of tools was developed for the automatic matching, while multimodal streams related to the same session were bound and aligned, and multimodal streams related to the same session were synchronized. As a preliminary study on rhythm analysis, in order to extract rhythmic information from music, an automatic musical beat tracking was developed. The relationships between dance and sound/rhythm/musical elements relevant within each genre have also been explored by gathering feedback from the dance community through surveys and interviews. Motion capture sessions focusing on Flamenco dance highlighted the close connection between movement and rhythm within this genre and together with the feedback from respondents points to the way in which expressiveness, emotion and intention are features that might emerge in the dialogue between dance and sound/music.

Development platform and libraries: various libraries have been developed for feature extraction, data fruition, visualisation and annotation. The main platforms and languages used within the consortium are Unity, Eyes Web, Python and JavaScript.

KEY RESULTS

- Design and implementation of an initial prototype of the WhoLoDancE Ontology
- Development of a set of tools for low-level feature extraction for multimodal signal modelling and analysis

- Design and implementation

ISSUES

No issues occurred.

Tasks – detailed assessment

T3.1.1 - Development of semantic representation models [ATHENA RC] [PoliMI CovUni, Stocos, K. Danse, LCGW] [M 4-16]

Summary of progress towards objectives and details

The objective of this task was the development of representation models for dance: a first representation layer was based on semantic description, i.e. the construction of suitable ontologies for the description of all aspects of dance and its relation to music. Deliverable D3.1 summarizes the semantic representation models that have been developed in the context of WhoLoDancE for organizing the various concepts related to movement, needed for the Learning experiences to be developed during the project. In the document, the main focus is on the concepts that describe the movement itself.

D3.1 Report on semantic representation models: This deliverable presents the methodology employed and the movement principles defined as its first conclusions. Taking into account the diversity and heterogeneity of dance teaching and learning across genres and contexts, as well as the fact that WhoLoDancE deals with four completely different dance genres, Ballet, Contemporary, Greek Folk, and Flamenco, finding a balance between a generic framework while respecting the characteristics and needs of each dance genre, was a key challenge. Towards this direction, the consortium agreed on focusing on ten basic Movement Principles, which reflect the basic "chapters" of dance teaching or learning objectives to develop sensorimotor skills that are important in all kinds of dance independent of the genre. Within the project a Wholontology was developed, i.e.an ontology which essentially models the description of movement, with focus on dance movement. The primary objective of Wholontology is to provide a knowledge base that can be utilized in various tasks, in the context of the WhoLoDancE project, such as annotation of dance recordings, high-level features extraction, similarity search and searching and browsing the library.

Clearly significant results

The results of T3.1.1 are reported in detail in D3.1. In addition, Wholontology is implemented in OWL-2 (Web Ontology Language).

In addition, ontological representations of movement descriptions have been investigated by Athena RC, aiming at providing rich vocabularies and formal descriptions for annotating and searching movement, and have been tested within a web-based platform. The methodologies which have been developed will be integrated to serve the Learning Scenarios, and searching the movement sequences as both cultural and educational content. The results have been presented in the following papers:

1. El Raheb, K., Mailis, T., Ryzhikov, V., Papapetrou, N., & Ioannidis, Y. (2017, May). BalOnSe: Temporal Aspects of Dance Movement and Its Ontological Representation. In *European Semantic Web Conference* (pp. 49-64). Springer, Cham.

2. El Raheb, K., Papapetrou, N., Katifori, V., & Ioannidis, Y. (2016, July). Balonse: ballet ontology for annotating and searching video performances. In *Proceedings of the 3rd International Symposium on Movement and Computing* (p. 5). ACM.

T3.1.2 - Development of emotion representation models [ATHENA RC] [UniGe, CovUni, Stocos, K. Danse, LCGW] [M 7-18]

Summary of progress towards objectives and details.

The objective of this task was the definition of appropriate emotion models, including relations with (discrete as well as continuous) models of music emotions and of expressive movement and dance. Deliverable D3.2 presents the outcomes of this task, focusing on how, the WhoLoDancE consortium address expressivity in dance practice and teaching, in the framework of WhoLoDancE project.

D3.2 Report on emotional representation models: The aim of the deliverable is to define the appropriate models that will be used in the Learning scenarios through an innovative but also meaningful way for dance practitioners for the different dance genres that are investigated: contemporary, ballet, Greek folk and flamenco. In this context, dance expressivity to be conveyed through qualitative aspects of non-verbal communication was taken into account, and the analysis of "movement qualities" was a special focus, i.e. a term which is currently widely accepted by both dance practitioners (especially in contemporary dance) but also in movement and gesture computing and Human computer interaction. This term is used to describe, not the action per se or the shape of the movement, but the way the movement is performed, the dynamics of the movement which make it expressive and meaningful. Though it is true that movement can convey emotions, in none of the dance genres examined in WhoLoDancE there exists a one-to-one relationship between emotions and movement, not even Movement Qualities. In addition, though the term “movement qualities” is accepted by both the Dance and Movement Computing communities, they do not include a specific, unique, list of terms that is accepted by all dance practitioners in a universal manner. In this context, part of our work in WhoLoDancE is to define in cooperation with the dance experts (internal and external) an acceptable subset of Movement Qualities that are both meaningful and subject to computation through analysing the multimodal recordings.

As far as music is concerned, the music emotion representations adopted in Music Information Retrieval was explored and the models were adapted to the WhoLoDancE scenario. In particular, two models were considered: categorical and dimensional. The simple case of music emotion falls into the disjoint categorization. A common approach is to divide the emotion spectrum into a set of categories and then classify the emotional content of each song into one of these categories. In the categorical approach, the semantic domain is formalized as a set of multiple, independent high-level descriptors, where each descriptor is only used or not used for the description of a music piece.

Although a categorical approach is suitable to describe emotions in music and dance, emotions are more complex concepts and in many cases it is now sufficiently expressive. In order to overcome the limitations of the categorical approach, the dimensional approach was explored. This approach is based on the idea of having a continuous space where all emotions are modelled as points in the space. Distance between points is proportional to the semantic distance between relative emotions. The here adopted dimensional model is based on two real descriptors, the Valence and the Arousal. The Valence indicates the graded polarization of the sentiment, from negative to positive, whereas Arousal estimates the degree of energy, or activation, in the emotion, from low to high.

Clearly significant results

This task led to (1) the definition of an emotion representation model in relation with Movement Qualities, and (2) the definition of two music emotion representation models suitable to describe emotion in music for dance performances.

T3.1.3 - Joint music-dance representation models [PoliMI] [CovUni] [M 12-24]

Summary of progress towards objectives and details

As already reported, as far as the joint music-dance analysis is concerned, this task mainly focused on the extraction of rhythmic information from video, mocap and music in Flamenco and Greek dances. As basilar steps of the analysis a set of tools for the automated matching of multimodal streams related to the same session were developed (see the alignment and synchronization description related to T3.4.2)

As a study on rhythm analysis, to extract rhythmic information from music, an automatic musical beat tracking was developed. Techniques to extract rhythmic information from video and mocap are currently under development.

The relationships between dance and sound/rhythm/musical elements relevant within each genre have also been explored by gathering feedback from the dance community through surveys and interviews that provided input on the descriptions of dance and the suitability of the movement principles and therefore by implication any relationships between dance and sound/rhythm/musical elements relevant within each genre. Questions focused on different pedagogical models and drew on established terminologies and ontologies (such as LMA) that are familiar for many practitioners within the dance sector. Motion capture sessions focusing on Flamenco dance highlighted the close connection between movement and rhythm within this genre and together with the feedback from respondents points to the way in which expressiveness, emotion and intention are features that might emerge in the dialogue between dance and sound/music.

Clearly significant results

This task comprised a thorough investigation of the relationships between dance and sound/rhythm/musical elements relevant within each genre performed through a set of surveys and interviews. Furthermore, it led to the development of software for joint music-video-mocap rhythm analysis.

T3.1.4 - Inter- and intra-network representation models [UniGe] [CovUni] [M 7-12]

Summary of progress towards objectives and details

A novel representation model for the analysis of expressive full-body movement qualities was proposed, which exploits concepts and tools from graph theory and game theory. This model is based on the idea that “important” joints during a specific movement are those that separate parts of the body characterized by different motion behaviors. The human skeletal structure is modeled as an undirected graph, where the joints are the vertices and the edge set contains both physical and nonphysical links. Physical links correspond to connections between adjacent physical body joints (e.g., the forearm, which connects the elbow to the wrist). Nonphysical links act as “bridges” between parts of the body not directly connected by the skeletal structure, but sharing very similar feature values. The edge weights depend on features obtained by using Motion Capture data. Hence, the body movement is modeled in terms of a game built on the graph structure. Since the vertices and the edges contribute to the overall quality of the movement,

the adopted game-theoretical model is of cooperative nature.

Clearly significant results

This task led to the definition of a novel model to represent human bodies as interconnected graph of nodes.

T3.2.1. Musical signal modelling [PoliMI] [M 1-6]

Summary of progress towards objectives and details

Music signal modelling is a complex procedure and spans from acoustic stimuli analysis to modelling of human perception (higher-level information). In this project, a musical signal representation paradigm was adopted, composed by three levels of information: the physical level, which is related to the origin and propagation of the audio wave and can be analysed with signal processing techniques; the musical level that describes aspects from musical theory such as the rhythm and the harmony; and the perceptual level, which concerns how the human body and brain perceive and process the audio information.

The Music Information Retrieval (MIR) community developed and designed several techniques to describe the musical signal by means of automatic extraction of features, which capture different aspects of the sound at various levels of abstraction: Low-Level Features (LLFs) related to the physical level, Mid-Level Features (MLFs) related to the musical level and High-Level Features (HLFs) related to the perceptual level.

Low-Level Features (LLFs) capture the properties concerning the physical information (energy and timbre) by using a clear mathematical formulation. They are highly objective. In this project, a large set of descriptors (about 150) were selected as suitable for music adopted in dance performances.

Mid-Level Features (MLFs), instead, capture the musical properties by taking into consideration prior knowledge from musical theory, such as notes, chords and harmony, or information about beats, tempo and rhythmic patterns. The mid-level representation is closer to the knowledge musicians and composers use to understand music. In this project, new mid-level features for musical proprieties representations were developed: chord, harmony, rhythm and structure.

A further level (High Level) composed of the descriptors for the expressive and emotional analysis, can be then computed on LLF and MLF by means of machine learning techniques. Representation models related to High-Level Features has been already discussed in this report for T3.1.2.

Clearly significant results

The most significant results of this task are the following:

- Definition of a three levels musical signal representation paradigm.
- Definition of a set of Low-Level Features for the physical level.
- Definition of novel models for Mid-Level representation for the musical level.
- Definition of High-Level representation for the perceptual level.

T3.2.2 - Motion signal modelling [Motek] [ATHENA RC, UniGe] [M 1-12]

Summary of progress towards objectives and details

The work involved the proper pipeline development and preparation that would yield motion capture data (that was created in WP2) into data formats that are usable for the targets defined in the tasks. That involved converting the raw data into 2 main formats based on the set requirements: C3D and FBX.

Some of the work involved the post processing of the capture data to trim calibration and handle offsets and to create meaningful segmentation of the captured sequences.

Clearly significant results

This task led to the definition of the data formats and structure for motion signal representation.

T3.2.3. Modelling signals coming from body sensors and environment sensors [UniGe] [PoliMI Peachnote] [M 4-12]

Summary of progress towards objectives and details

One of the objectives of the project is to give tools for practicing dance at different levels of precision, simplicity and costs.

Professional motion capture systems are highly accurate and perform full motion capture, but are expensive and hard to configure and use, while cheaper input devices (i.e. RGB-D cameras, IMU sensors, etc…) may be easy to use but less precise than professional solutions.

Using motion capture devices, a human body model was developed as a humanoid skeletal structure, with a hierarchic structure where the root of the hierarchy is represented by joints in the trunk and the leaves are the limb joints. This representation is available only with motion capture system, while for other low-end devices there will be raw measurements of physical quantities only (i.e., accelerations, angular velocities, etc.)

The goal is to provide a set of movement descriptors that are scalable and can be applied on data coming from different devices leading to a shared set of movement features that can be extracted (with different degrees of approximation) from all the described devices. The features include low and high level movement descriptors (detailed in D1.6).

Clearly significant results

This task led to the development of a scalable set of movement descriptors that can be extracted from various input devices.

T3.2.5 Intra-and inter-network signal modelling [UniGe] [ATHENA RC][M 1-12]]

Summary of progress towards objectives and details

Starting from the hierarchical representation introduced in T3.2.3, a skeletal human model can be developed, being described by a fixed undirected graph.

Analytic methodologies on this particular representation model are currently being investigated. Intra-network driven solutions, with a specific focus to game theories, enable the measurement of how energy propagates in body joints and allow to estimate the path along which energy flows through the “dancer

body network".

Clearly significant results

This task led to new algorithms and analysis techniques, based on graph restricted game theory, have been developed and integrated in the EyesWeb Environment.

T3.3.1. Analysis methodologies: data-driven solutions [PoliMI] [Peachnote, UniGe] [M 4-24]

Summary of progress towards objectives and details

Using the index structure described in D4.1, the motion sequences have been organised as a tree structure that reflects the similarity of the contained sequences. The shape of the tree is defined by the data persisted in the index. Semantically-relevant similarity values have been derived using this purely data-driven approach. Further approaches are going to be evaluated with regard to improving the similarity computation relevance by using expert-provided annotations linear regression analysis on weighted dimension templates used for combining the similarity results of separate dimensions of multi-dimensional time series.

Clearly significant results

In this task, a purely data-driven similarity algorithm has been implemented. The work is ongoing.

Reasons for deviations from DoA and impact of this deviation on other tasks/resources availability

Comparing to the planning of this task as presented in the DoA, there is a minor delay in the development of data-driven models. The data-driven approach to movement analysis adopts the use of machine learning algorithms that require a complex and onerous human annotation procedure. Unfortunately, there has been a delay in the annotation task, which has influenced the completion of this task.

T3.3.2. Analysis methodologies: model-driven solutions [PoliMI] [Motek, Peachnote, UniGe] [M 4-24]

Summary of progress towards objectives and details

A set of movement features derived from movement principles and movement dimensions (D1.6) was identified and the development of an algorithm to automatically extract such features from dance sequences is in progress.

Clearly significant results

This task led to the identification and extraction of movement features from dance sequences.

T3.3.3. Analysis methodologies: intra-network-driven solutions [UniGe] [ATHENA RC] [M 4-24]

Summary of progress towards objectives and details

Starting from the definitions given in T3.1.4, new techniques for analysis of expressive full-body movement were developed, with a particular focus on propagation and origin of movement. This approach is based on graph theory where the body of a dancer is modeled as an undirected graph, the edge weights depending on motion capture data. A mathematical game is constructed over the graph structure to represent communication channels between joints. The game theoretical concept Shapley value is used to evaluate the "importance" of each joint during a movement. Based on this technique, new software

libraries have been developed and integrated in the EyesWeb Platform.

Finally, multiscale analysis on the measures computed on the recorded data is being investigated in view of extracting relevant moments with respect to the chosen measure (e.g. acceleration or velocity).

Clearly significant results

The result of this task is the development of a new technique to evaluate the origin of movements and their propagation.

T3.3.4. Analysis methodologies: inter-network-driven solutions [UniGe] [ATHENA RC][M 4-24]

Summary of progress towards objectives and details

The method applied in T3.3.3 can be applied to multiple dancers, starting from a network representation of human bodies (see T3.2.5 and T3.3.3), and a set of techniques to measure the degree of synchronization, coordination and leadership are being applied and tested. Movement synchronization and coordination can be measured, for example, between two/multiple dancers, perceived each one as a single body.

Clearly significant results

This task constitutes a first preliminary investigation of the techniques described in T3.3.3, carried out on multiple dancers.

T3.4.1. Development of a SW library for emotional and expressive analysis from musical signals [PoliMi] [Peachnote, UniGe] [M 7-30]

Summary of progress towards objectives and details

The emotional and expressive analysis of music involves social information on the listener and the modelling of human intellectual perception, i.e., from acoustic stimuli to higher-level information. It is possible to extract semantic information on the emotional content or expressivity of the musical performance by means of machine learning techniques trained over a set of annotated examples. This approach, however, requires an intermediate representation of the musical signal that captures the most relevant properties of the musical content. With reference to the representations described in the sections of this report concerning T3.2.1 and T3.1.2, the development of a Python-based software framework for LLF, MLF and HLF extraction is underway. As far the LLFs and MLFs is concerned the framework includes a set of interfaces to interacts with well-known tools for music analysis: MIRToolbox, LibROSA and Sonic Annotator. Moreover, a set of novel techniques for MLFs has been developed.

In this stage of the project, the focus has been on automatic Chord and Key extraction, Beat and Tempo tracking and Structural analysis. As far as HLF extraction is concerned, since they are mainly based on machine learning, human annotation is required, which is still on going. For this reason, HLF extraction algorithm will be developed in the second part of the project.

Users can interact with the framework to provide annotations or visualize features and results by means of a web-based interface. The framework also communicates with other systems developed within the project by means of TCP or Open Sound Control (OSC) connections. OSC is widely supported by many tools, such as the EyesWeb and the Unity platforms, which will be both used in the project. The TCP connections are used over the internet to load data from or store preliminary results in the CKAN repository.

Clearly significant results

The results of this task so far involved building a framework for low-level, mid-level and high-level feature representation of musical signals

T3.4.2. Development of a SW library for Emotion Analysis from full-body movement and multimodal data [UniGe] [ATHENA RC, Motek, PoliMi] [M 7-30]

Summary of progress towards objectives and details

Synchronization between Video and motion Capture: During WhoLoDancE first phase, a large dataset of recordings was created, consisting of different formats and streams, such as motion-capture, video and audio. The large size of the dataset, which counts approximately 18 hours of recorded material, highlights the need of automating the processes of matching and synchronizing data streams from different formats and modalities. Such techniques could be used as pre-processing step for analysis algorithms that use multimodal data, such as for joint music-movement analysis or synchronized visualization and play of multimodal streams.

A technique for synchronizing video and motion capture data has been developed using low-level features extracted from the two streams (D3.6). The method extracts the optical flow of the video data in the horizontal and vertical directions. Similar information is extracted from the motion capture by differentiating successive positions of all the joints.

A synchronization algorithm for music and video has also been developed. The technique exploits the audio track of the video recorded during the acquisition of Greek and Flamenco performances. The dancers performed their pieces with some musical accompaniment. These musical pieces have been captured by the video camera. Audio tracks acquired by the camera and the original music pieces are matched and synchronized by using audio fingerprint technique.

Development of a software library for multimodal analysis from multimodal signals is in progress, the modules will be released as new movement analysis libraries for the EyesWeb XMI platform and distributed for free with the EyesWeb XMI Development environment.

Clearly significant results

New mocap-video and music-video matching and synchronization algorithms were developed.

New software modules for multimodal analysis are in development and refinement.

T3.4.3. Development of a Software Library for Non-Verbal Social Signals Analysis [UniGe] [ATHENA RC] [M 7-30]

Summary of progress towards objectives and details

In its first phase, WhoLoDancE started developing algorithms and software libraries to analyse inter personal synchronization and social signals: synchronization can be used to measure the degree of entrainment between multiple users to measure collaboration and coalition between them.

In the first version of the WhoLoDance Software Library a collection of algorithms was developed,

implemented as a software module and integrated in the EyesWeb platform.

Dynamic Time Warping – Real Time

Dynamic Time Warping (DTW) measures the degree of similarity between two time series that vary their structure over time. A time series can present a pattern that had an evolution in a certain range of time. The same pattern can be contained as well in the second-time series presenting, for example, a speed or amplitude variation. This particular implementation of the algorithm was introduced in the WhoLoDancE platform with the characteristic of being computed in the real time.

Multi Event Class Synchronization

The Multi-Event-Class Synchronization (MECS) computes the degree of synchronization between several time-series containing several types of events. Since events are no longer of the same typology, they belong to different classes of events. The algorithm evaluates the synchronization degree for each class of event. MECS relies its computations on the temporal distances between the timings at which events belonging to the different classes appear. Moreover, the algorithm allows to establish time constraints between events and to define events hierarchies. In the context of the WhoLoDancE project, the original implementation was modified by introducing several kernel functions of the algorithm (the original version provided only a linear computation). The design of different kernel functions allows to better adapt the calculus of the synchronization degree to different application contexts.

Clearly significant results

Development of inter personal social signals analysis libraries.

T3.4.4. Multimodal analysis of qualities in individual dance [UniGe] [M 7-30]

Summary of progress towards objectives and details

A number of software prototypes to measure different individual dance qualities based on the movement principles and dimensions (D1.6) were developed. Various approaches and demonstrations were investigated to exploit the qualities and principles.

Dynamic Symmetry: A computational model and software module were developed aiming to compute movements Symmetry. Symmetry is a movement quality that is considered important in dance teaching (D1.6), and more generally in movements learning.

Symmetry can be computed from the dancer's silhouette in 2D or in 3D (including depth measurement from RGB-D sensors) or in terms of a cluster of body markers in a motion capture setting. This measure has been implemented and is available in the WhoLoDancE EyesWeb library.

In order to take dynamic and temporal dimensions into consideration, UNIGE developed analysis modules of Dynamic Symmetry as a higher-level feature Dynamic Symmetry is an important aspect of several physical activities for example in sport (e.g., synchronized swimming, rowing), and in motoric rehabilitation. The ability to maintain the dynamic symmetry (but also dynamic asymmetry, i.e., independency of movement of different parts of the body) is very important especially in contemporary dance.

This computational model led to several sonification models developed by STOCOS in order to transfer the degree of Dynamic Symmetry to the auditory channel. This served as a learning tool and a way to

increase the body awareness in order to explore a movement quality between body parts or between a dancer and the teacher. These models are based on the equivalence of symmetry and periodicity, regarding symmetry as repetitions in space and periodicity as repetitions in time. In one of this models dynamic symmetry is connected to the frequency spacing of the components of harmonic spectra. As symmetry decreases these components are spectrally stretched breaking the integer multiple relationship with the fundamental thus breaking the symmetry among them. Three possible states cane here be distinguished, in connection to various degrees of symmetry i) harmonic perceptual fusion of partials ii) inharmonic spectra iii) noisy spectra.

Software Prototype of teaching tool based on Laban's "Cube": This software module, implemented in EyesWeb, measures the direction of body parts (arms, trunk and head) and shows in real-time the visualisation of the dancer's orientation. The teacher can define the setup for the exercise, by choosing the number of target directions in the Cube (possibly random) and which parts of the body should be used (e.g., left or right forearm, head). The exercise is then presented to the student who has to perform it. A second, downscaled prototype of the exercise has been developed: this version uses IMUs instead of mocap sensors. In this prototype, a number of IMUs are placed on the body of the dancer. Three IMUs are located on the back (hips, trunk, and shoulders planes), and other four IMUs are placed on wrists and ankles. The direction of each sensor is used to extract the direction of the corresponding body plane and is visualised by arrows. One of the many possible exercises can be similar to the previous one: the teacher specifies a number of different directions of the various body planes, then the dancer can try to orientate the hips, trunk, and shoulders towards those directions. Moreover, the configuration of the IMUs enables the measure further features under development.

Both prototypes are a starting point for possible serious games to help the dancers to train their orientation towards different points, directions, and planes, both relative and absolute, and ultimately to enhance their directionality awareness.

In details, these software modules developed by UNIGE are based on their proposed "movement sketching" framework, aiming at enabling the user to build non-verbal movement queries to search the WhoLoDancE movement repository. This Movement Sketching paradigm is based on a downscaled version of the features available starting from the MoCap data, including features developed in DANCE (as previously mentioned), to build real-time WhoLoDancE exercises.

Clearly significant results

Development of software libraries to analyse individual dance qualities and design and development of demonstrations.

As an artistic dissemination or demonstration of these analysis of dance qualities STOCOS produced the PIANO&DANCER performance, an interactive piece for a dancer and an electromechanical acoustic piano. This piece was presented at MOCO 2017 and at IDEM Festival. The techniques and methodologies developed in order to relate the expressive movement qualities of a dancers to the creation of musical material by the mechanical movements of the piano, have been detailed in the following publications:

- PALACIO, Pablo and BISIG, Daniel``Piano&Dancer- Interaction between a Dancer and an Acoustic Instrument` In Proceedings of the 4th Symposium of Movement adn Computing. (MOCO 2017)
- BISIG, Daniel, and PALACIO, Pablo. ``Piano&Dancer``. In Proceedings of the 19th Generative Art Conference

Firenze, Italy, 2016.

In the context of the motion capture sessions that globally took place in WhoLodancE, and specifically for WP3, a large amount of preparatory choreographic material, as part of the creative research done by K. Danse over many years, has been put at the disposal of the project, in particular a specific research on Qualities of movement, set as a complete map of Semantic Units of Time (SUT) containing mixed qualities organized as semantic clusters. This body of work has been nourishing the dance and choreography related components, which are part of the results underlying the present achievements, and will constitute the ground base for the continuation of the work planned in the near future.

WP4 Automated Analysis of Multimodal Features and Similarity Search – (M3 - M30)

Lead Partner Peachnote GmbH

Participant number	Participant short name	Planned person months	Actual person months	TOT PMs
1	LYNKEUS	0	0	
2	ATHENA RC	9	4,43	
3	MOTEK	5	5	
4	POLIMI	10	8,34	
5	UNIGE	11	6,64	
6	Peachnote GmbH	15,5	9	
7	COVUNI	0	0	
8	STOCOS	0	0	
9	K. Danse	0	0	
10	Lykeion Ellinidon (LCGW)	0	0	

Deliverables due within Month 18	**Submitted (Y/N)**
D4.1 Data Integration, Algorithm and System Analysis, and Framework Description M 18	**Y**

Brief overview

KEY RESULTS

The requirements for automated analysis and multimodal search algorithms for motion sequence data were collected and analysed. Search and similarity algorithms for high-dimensional time series data were developed and implemented. A REST API providing access to the search and similarity algorithms was implemented, documented and deployed. The high-level features were evaluated regarding their applicability to the targeted use cases.

Tasks – detailed assessment

T4.1.1. Base algorithms and generic functionality for similarity search, live-indexing and clustering methods [Peachnote] [ATHENA RC] [M4-10]

Summary of progress towards objectives and details

An efficient algorithm for multi-dimensional time series search and similarity estimation was implemented. The algorithm consists of two parts: the one-dimensional search and similarity computation and the multi-dimensional combination step. The one-dimensional step is the most computationally expensive one, but the computations can be run in parallel for different dimensions, and this, given the high number of dimensions which need to be dealt with (68-168), is an important property.

Based on former Peachnote experience with music similarity algorithms, an efficient algorithm was implemented, which allows to find all pairs of most similar motion sequences in the collected data set in a linear time (instead of quadratic, which would be infeasible given the size of our data set). One can scan through the leaves of the tree-based index which is built with leaves containing similar sub-sequences, and count the number of sub-sequence co-occurrences across all dimensions. This procedure works surprisingly well, providing meaningful results linking the large amount of collected motions within WhoLoDancE.

Clearly significant results

A Java-based implementation of the search algorithm that is exposed by the REST API (see T4.1.4). The algorithm is described in detail D4.1. A clustering method for indexed motion sequences was implemented offline and its results were demonstrated at the WhoLoDancE general meeting held in Milan in December 2016.

T4.1.2. Consolidation of HLF data sources for consistent model building [ATHENA RC] [Motek-PoliMi-UniGe][M11-18]

Summary of progress towards objectives and details

Motek participated in the discussion and work that led to deciding on a unified data structure and the guidelines for visualization of the chosen model.

UniGe identified various kinds of data sources for movement analysis, allowing to have a scalable system; the devices include optical motion capture systems (Vicon, Qualisys), Notch sensors, IMU devices, RGB-D sensors allowing us to propose different setups of different costs.

Following the needs analysis as defined through the work performed in WP1, all partners, both technical and dance experts, have selected a subset of the HLF which seem appropriate and satisfying to analyse the movement of the recordings to deliver meaningful Learning Scenarios. This selection was based on the work reported in D1.6 HLF Definitions for the Learning Scenarios, as well as on the results of focus groups and questionnaires. Taking into account the identified lack of standard universal features to be used in movement analysis and appropriate for dance learning in different dance genres, based on previous relevant work, the selection was based on a) research work in non-verbal communication and movement expressivity and b) user-centred methodologies (focus-groups and questionnaires).

Following this approach, it was decided to focus on specific Movement Qualities and Movement Principle descriptors. These concepts are described in detail in D1.6 HLF questionnaires, while additional information about the process and detailed conceptual modelling can be found in D3.1 Report on semantic representation models, and D3.2 Report on emotional representation models. Within this framework, the WhoLoDancE Movement Library interface, which was designed and developed by Athena and PoliMI provides an annotation interface which integrates these concepts as controlled vocabularies offered to the end-users. The annotation interface allows the dance experts to annotate specific sequences in order to

collect ground-truth data for validating the HLF extraction algorithms. In addition, the selected HLF, as well as the related concepts and their relationships (as described in detail in D3.1) can be used as similarity metrics, in order to filter the dimensions of similarity in a more meaningful way. The same user interface has provided the basis to develop the user interface to assess the similarity search algorithm for LLF and MLF during the first period of the project.

Clearly significant results

UniGe identified a set of devices for motion capture, while Athena, in collaboration with both technical and dance partners and following the needs analysis as defined through the work in WP1, selected a subset of the HLF which seem appropriate and satisfying in order to analyse the movement of the recordings to deliver meaningful Learning Scenarios. This selection was based on the work reported D1.6., as well as on the results of focus groups and questionnaires

Following an approach based both on research work in non-verbal communication and movement expressivity and on user-centred methodologies, it was decided to focus on specific Movement Qualities and Movement Principle descriptors (see D1.6 HLF questionnaires, while additional information about the process and detailed conceptual modelling can be found in D3.1 and D3.2.

The WhoLoDancE Movement Library (WML) interface provides an annotation interface which integrates these concepts as controlled vocabularies offered to the end-users. The annotation interface allows the dance experts to annotate specific sequences in order to collect ground-truth data for validating the HLF extraction algorithms.

In addition, the selected HLF, as well as the related concepts and their relationships (as described in detail in D3.1) can be used as similarity metrics, to filter the dimensions of similarity in a more meaningful way.

The same user interface has provided the basis to develop the user interface to assess the similarity search algorithm for LLF and MLF during the first period of the project.

T4.1.3. Definition and evaluation of suitable structuring of search indices for application scenarios [Peachnote] [ATHENA RC][M11-18]

Summary of progress towards objectives and details

An important application scenario relevant to the structure of search indices is the ability to easily submit, manage and use additional low- and high-level features by the project partners. Since the search algorithm operates on the separate indexed dimensions in parallel, one can add or remove time series dimensions easily without having to rebuild the whole search index from scratch.

Another important property of a search index is the ability to support features collected or computed at different sample rates. Having separated search indices for different dimensions, this is supported by being able to translate between the dimensions/features having different sampling rates.

Clearly significant results

The evaluation of the requirements has informed our design of the search index data structure and the algorithms.

T4.1.4. Implementation of suitable components to encapsulate common similarity search and indexing contexts [Peachnote] [ATHENA RC] [M12-24]

Summary of progress towards objectives and details

A REST API was developed, which encapsulates the search and similarity functionality and provides both up- and down-stream components access to it. A continuous deployment process was set up, deploying the latest code revision and making them available to the project partners, allowing for quick iterations in feature development, as well as testing and bug fixing. The API hosts its own documentation which can be accessed over the browser. The documentation not only describes the API endpoints, but also allows for real-time testing of its endpoints straight from the documentation webpage, whereby users can conveniently change the request parameters and get the real responses from the backend. The API endpoints can be password-protected.

Clearly significant results

The main API is deployed at http://search.wholodance.peachnote.com, and the partner deployments are available at
http://polimi.search.wholodance.peachnote.com
http://polimi2.search.wholodance.peachnote.com
http://UniGe.search.wholodance.peachnote.com
http://UniGe2.search.wholodance.peachnote.com
http://athena.search.wholodance.peachnote.com
http://athena2.search.wholodance.peachnote.com
http://motek.search.wholodance.peachnote.com
http://motek2.search.wholodance.peachnote.com

T4.2.1. Adaptivity & Personalization Algorithm implementation [ATHENA RC][UniGe] [M12-M30]

Summary of progress towards objectives and details

(Athena) This specific task is still in progress. Preliminary work has been done in two directions: 1) Conceptual definitions of personalization specifications and user profiling within the Learning Scenarios, 2) research on the recommendation algorithms that can be implemented in the case of WhoLoDancE learning.

Details on the user profiling and the learning scenarios can be found on "D1.7 User profiling" and "D1.4 Definition of Learning Scenarios and Needs Analysis", respectively.

The first results on the investigation on recommendation systems have been presented in the following paper: Kyriakidi, M., Stefanidis, K., & Ioannidis, Y. (2017, May). On Achieving Diversity in Recommender Systems. In *Proceedings of the ExploreDB'17* (p. 4). ACM.

T4.2.2. Generic middleware architecture design and implementation [PoliMi] [Motek-ATHENA RC-Peachnote] [M7-20]

Summary of progress towards objectives and details

Motek delivered input pertaining to the implementation of the architecture design in the area of choosing the optimal file formats for the repository (FBX / JSON)

PoliMI has first collected the requirements for this task from the dance partners, and the corresponding use-case scenarios for the final applications. The stage of the analysis of the requirements was run in collaboration with the definition of the learning scenarios as defined in WP1 (see deliverable D1.4), led by Athena RC.

The middleware architecture was first designed as the set of main components to analyze, process and visualize the data from WP2 (data capture and 3D visualization) also with the regard to the work done through WP3 (software platform and libraries). The architecture includes many components highlighted in the stage of collection of the requirements, such as semantic search, storing and retrieving of data, possible conversion of the data in different formats, extraction of low-level and expressive features from the data, and similarity search through sequences of features.

The relations between components were then drawn as the channel of communications required from them. The standard for data transmission of such channels was defined and two components were implemented: the CKAN server for data management (also discussed in deliverables D5.1 and D5.2 for WP5 Data Integration and Data Analytics) and the similarity search system. A set of APIs to access the service provided by the two components were finally implemented and published.

In order to achieve low-time response, most of the real-time applications rely on an offline stage to initialize and populate the systems (for example, the similarity search engine requires to process the features in advance to store it in a convenient format for fast indexing). For this reason, a Python package for the offline communication with the aforementioned APIs was implemented.

Clearly significant results

Motek distributed to all consortium partners an alpha version of the WhoLoDancE blending engine that uses the repository of motion capture data to blend and assemble dance sequences for teaching and choreography.

PoliMI implemented many of the components of the middleware, which are currently working and communicating among them and with other applications from other WPs (WP3).

The Python package was tested with the prototype of the similarity search engine (see next task T4.2.3), fetching the data from the CKAN repository and initializing the similarity search system. Peachnote has implemented the search and similarity component that is self-contained and can be accessed by the other components (both data providers and consumers) on demand.

Reasons for deviations from DoA and impact of this deviation on other tasks/resources availability

Due to the complexity of application scenarios and the continuous evolution of the learning scenarios in order to follow a user-centred perspective as described in WP1, the definition of specifications took more time than planned, which caused delays in the design of the middleware and in the definition of the standards for communication.

This ultimately led to delays in the implementation of some of the components involved in the middleware and therefore in the software libraries as described in WP3.

Corrective Actions

The final applications were indeed meant to be used for learning and artistic purposes, where the creative

process needs to be unpredictable to be effective. Therefore, the middleware architecture requires a high degree of flexibility, upgradability and resilience.

In order to satisfy such requirement and as a corrective action to mitigate the delays that occurred during the completion of the task, it was decided to adopt an Agile development strategy for the design of the middleware and the implementation of (and communication among) the components. For this reason, such design and implementation will need to be regularly updated, also beyond M20, in view of keeping track of changes in the requirements or use-case scenario as suggested by the dance partners.

T4.2.3. Component specification and implementation for application scenarios [PoliMi] [Motek-ATHENA RC-Peachnote] [M12-24]

Summary of progress towards objectives and details

Motek contributed to this task in terms of the setup and structure of the WhoLoDancE blending engine. The files that are in the repository are arranged in a directory structure according to the agreed upon movement principles. Strict naming convention was used across the full repository to enable similarity search based on all sequence respective body parts, across any given dance motion of any genre.

Athena provided the CKAN API, through which all the data (mocap, video, audio) in different formats (C3D, fbx, mp4, mp3, JSON, etc) as well as their corresponding metadata of the recordings, were curated and organised in the ftp server of the repository. The CKAN API, provides online access to the files through unique IDs. From the initial datasets, both through scripts and manually when needed, the datasets have been cleaned and enriched with useful metadata (mocap venue, date, performer, name, description, references to Movement principles, body parts, syllabi). In addition, Athena designed and implemented the front-end for searching and browsing the recordings, and providing a user-friendly manual annotator interface to enrich the recordings with additional knowledge about the movement. The WML front-end has provided the basis for the similarity search front-end component which is described in the following section.

PoliMI: The middleware defined in the task T4.2.2 is only part of the back-end required to develop the final applications. In this task, the focus was on the definition of the architecture for the front-end of the applications. The main components were defined as follows: a multimodal visualizer, to simultaneously visualize the different recordings of a session (Motion Capture, Video, Music); a system for real-time extraction and visualization of features from the motion capture (WP3); the front-end for the search by similarity system, for the search by description system and for an annotation tool to annotate the expressivity perceived in the performances. Please refer to deliverable D3.6 for further details on the components.

The relations among the components, with the multimodal visualizer as a key high-level block for the other three components, were then defined. Such front-end architecture was also combined with the previously described middleware. In this stage, the required integration between the front-end and back-end was also defined, taking into account the final applications and use-case scenarios. Further details on this stage will be provided in deliverables D4.3 and D4.4.

From this step, some of the components were implemented following, as a first stage, a web-based approach which provides high flexibility with regard to deployment, and helps avoiding the need of platform-specific implementations. The components following the communication standards defined in

the task T4.2.2 were also implemented.

Finally, tall these components were shared among the partners for the implementation of final applications using the same high-level approach. This included application-driven variations of the same component. As an example, a similarity search engine and an annotation tool use the same visualizer, where the former uses a variation to highlight in the progress bar the segment under analysis for similarity search, and the latter shows different dancers (in the motion capture visualization) in different colors, in order to assist the users to separately annotate the qualities expressed by each performer.

Clearly significant results

PoliMI implemented a first prototype of the similarity search user interface, which is based on the aforementioned tasks on similarity and indexing, on the collection of physical and expressive features (WP3) and the design and integration of the middleware. The details on the similarity search system are discussed in deliverable D4.2.

PoliMI in collaboration with Athena implemented the similarity search as a web-based application, that is therefore universally accessible and does not require any further installation from the user. In this prototype, the system allows the users to set a great number of parameters and therefore to test the similarity search with a corresponding high degree of freedom in the selection of the criterion (low- vs high-level similarity, whole-body vs single-limb similarity, etc.). An internal review and a public demonstration of the system received a great deal of attention and curiosity from the partners and the community, and helpful comments on which criteria might be more effective in the retrieval of similar performance were collected.

Interestingly enough, many choreographers expressed the opinion that the possibility of making use of the similarity system could become a helpful tool supporting them in the creativity process. The key for creativity is the unpredictability, and one of the best ways to achieve it is to “think outside the box” and explore relations among entities that were unseen before. By using the similarity search, it commonly occurs to have non-trivial associations among performances. For example, our dance partners found interesting that the pas de cheval (a common step in ballet) was meaningfully matched with many steps from Greek folk dance. The exploration of these kinds of similarities can help the artistic creation of choreographers and dancers by triggering new unseen associations in their mind, for example by inventing cross-genre choreographies.

T4.2.4 Parametric functions of time in affine space [UniGe] [M 7-24]

Summary of progress towards objectives and details

For this task, Movement segmentation was performed, i.e. the process of identifying “motions of interest” within long sequences of human movement data and of reducing them to smaller components.

A methodology was developed, which combines multi-scale analysis and event synchronization techniques. Such methodology aims at being completely independent from any assumptions on the input data: i.e., it is independent of length, speed and movements shape. This makes our technique easily applicable to different categories of motion data.

Given a set of input motion features (for example the acceleration of the performers’ limbs), the algorithm, at first, evaluates the entire signal, then detects and isolates relevant events and assign a rank to each of

them, and finally computes the synchronization between events with the highest ranks. The events characterized by high enough synchronization values are considered significant (i.e., the movement presents a clear transition that may represent a start or end of the movement).

A visualizer of the generated segments is available at http://mir.deib.polimi.it/ballet/

Clearly significant results

A first version of the automatic segmentation algorithms has been developed and first results of the work are presented at the following link: http://mir.deib.polimi.it/ballet/.

WP5 Data Integration & Data Analytics – (M1 - M36)

Lead Partner ATHENA RC

Participant number	Participant short name	Planned person months	Actual person months	TOT PMs
1	LYNKEUS	0	0	
2	ATHENA RC	14	13,46	
3	MOTEK	2,5	1,5	
4	POLIMI	6,5	4,46	
5	UNIGE	3,5	1,88	
6	Peachnote GmbH	3	0	
7	COVUNI	0	0	
8	STOCOS	0	0	
9	K. Danse	0	0	
10	Lykeion Ellinidon (LCGW)	0	0	

Deliverables due within Month 18	**Submitted (Y/N)**
D5.1 Data Modelling, data integration and data management plan report M 12	**Y**
D5.2 Beta Prototype, testing & validation Data Management Platform Report M18	**Y**

Brief overview

OVERALL

WhoLoDancE WP5 is in charge of the overall data management infrastructure, to be built and deployed by ATHENA RC, with the objective to collect, store, pre-process and manage the multimodal data acquired in the project. The main results of the work within Work Package 5 in the reporting period include the following:

1. Conceptual recording of dataset information.

The process of comprehending and driving conclusions on data sources related to the project is an integral part of the WhoLoDancE data management approach. For gathering information from partners, a special questionnaire has been designed and implemented by the project's data management team and has been populated by the individual data-providing partners, resulting into a set of dataset descriptions that were

used to plan the data management infrastructure.

2. Data storage set-up and FTP server

An FTP server with appropriate storage capacity has been set-up and made available to the consortium for the storage of the motion capture, and other data generated during the project.

3. Definition of the metadata model

Following the completion of the motion capture sessions, the resulting material has been examined in order to propose an appropriate metadata schema that will make it accessible among the consortium, by both technical and user partners. The WhoLoDancE data model covers:

- element referencing approach (i.e. how dataset/metadata elements are cross referenced)
- descriptive metadata that allow datasets to be discovered and consumed by end users (and services)
- structural metadata that allow datasets to be handled by the system and consumed and explored by services (and users)
- semantic extensions: the approach of project for handling semantic metadata

The metadata model has been defined and implemented in a CKAN metadata server installed and configured for the needs of the project.

4. Data management system

A set of dataset management practices and tools, which can be used for storing, delivering, preserving and licensing the data evaluated for the needs of the project, complying with best practices, and generally acceptable paradigms in the context that the project activates, were defined. Data management was implemented with an FTP server along with a CKAN metadata server to organize the files in appropriate metadata schemata and ensure access through search and browsing. More specifically, the following data storage elements and repositories are included in the WhoLoDancE platform:

- A file-based object store for depositing binary data objects. The repository is implemented over a redundant store with one delayed replica and is accessible via a number of standard protocols such as FTP and HTTP, while special protocols are also available depending on the data type (e.g. streams for media objects). Items in the repository obtain URLs that can be disseminated via standard web means, yet access may be provided only with granted credentials.
- CKAN metadata repository tailor made w.r.t. configuration and plugins, to fit WhoLoDancE project data and metadata servicing needs. Offers full web UI for managing and accessing metadata and a rich set of REST web services for consuming/exploring projects datasets.
- A relational database management system (PostgreSQL) for managing dataset metadata, behind the CKAN repository and pilot-specific services.
- This work is recorded in D5.1 Data modelling, data integration and data management plan report, which provides technical information about the type of data which are being produced, managed and maintained by the data management platform and the methodologies applied for the data integration and management in order to deliver the various applications of the project. The deliverable presents also the data model of the project data and the policies for ensuring data interoperability and integration across project's services, be it data management or end-user ones.

- - The WhoLoDancE Movement Library (WML) The main purpose of the WhoLoDancE Movement Library (WML) is to provide access to the repository of the multimodal recordings of the different dance genres through a usable interface for the end-user. The main functionalities that are provided are browse, search, view/play and annotate the multimodal recordings. Through this web-based platform the user can browse the recording by dance genre, and search by using key-words that are included in the any of the metadata of the recordings. Deliverable D5.2 Beta Prototype, testing and validation Data management platform Report describes the architecture and functional specifications of the Beta prototype WhoLoDancE platform, focusing both on the data management infrastructure and the UI used to access the platform functionalities. The second part of the document presents the testing and validation activities of the platform that have taken place in the reporting period.

KEY RESULTS

CKAN data management interface: http://dl132.madgik.di.uoa.gr/

WhoLoDancE Movement Library :
http://dl132.madgik.di.uoa.gr:8084/Wholodance_Movement_Library/login

ISSUES

N/A

Tasks – detailed assessment

T5.1 Building and deployment of data management platform [8PMs] [ATHENA RC] [Peachnote-UniGe] [M1–M36]

Summary of progress towards objectives and details

The platform which has been deployed, aims to acquire, store, integrate, manage and process heterogeneous multimodal content as well as application specific data. The term data management platform is used here to describe the whole infrastructure which has been designed and developed in order 1) to store all the data produced by the project (the FTP server, and all the relational databases systems), 2) to manage the multimodal recordings and provide meaningful metadata, 3) to organize and synchronize the files, 4) to integrate the appropriate metadata management system and search engine and API (CKAN system and API) and 5) to provide with a usable interface for the end users with functionalities such as search, browse, annotate. This web-based interface (WhoLoDancE Movement Library) provides the basis for the implementation of Learning Scenarios.

Clearly significant results

The WhoLoDancE Movement Library is accessible online, used already by the dance experts to collect the annotations, and presented in both the user board and MOCO17 conference as a demo.

T5.2. Conceptual Modelling and Annotation of Data [2.5 PMs] [ATHENA RC] [PoliMi-UniGe][M1 – M24]

Summary of progress towards objectives and details

This task includes the design of the architecture of the repository and system within the platform to support the integration of the different formats of data. Indexing and annotation methodologies have been implemented to the data, exploiting the semantic models that are prepared in WP3, taking into account the needs to deliver Learning Experiences. The overall work of this task aims at transforming the “ground truth”

data, as acquired in WP2 in different formats and granularities, into meaningful data elements that may serve as Learning Material for different personalized scenarios.

Clearly significant results

Both metadata schemas and annotations vocabularies are based on the needs of the dance learning community as defined in the outcomes of WP1. A usable interface has been developed to allow the dance experts to enrich the data with tags and annotations that are meaningful for each dance genre. In addition, in alignment with the outcomes of WP3, models of Semantic Representation are further investigated, reasoning on existing annotations and development of ontologies to describe movement characteristics and dance syllabi (see relevant publications).

T5.3. Data modelling, integration and management [5.5 PMs] [ATHENA RC] [Motek-PeachNote-PoliMi-UniGe] [M1– M24]

Summary of progress towards objectives and details

This task deals with the data modelling and integration of the heterogeneous multimodal data acquired by different methodologies (Motion Capture, audio, audio-visual, and verbal description data) as well as dance genre and scenario specific data and application specific data (user/learner profiles for personalization, data generated by semantic and similarity search based on particular High-Level Features, data transformations, pre-processing and mining flows, and other related parameters). As described in detail in D5.1 and D5.2, all the recordings have been organized into Recordings which contain all the various files, i.e. Resources in different formats (e.g., fbx, c3d, mp3, mp4, json). The files have been synchronized (the implementation is described in D3.6) and described with metadata that are a) generic such as recording information, venue, date, performer, etc. and b) specific to the dance genre, e.g., local name of the dance.

Additional semantic descriptors are going to be integrated in the next months to organize the recordings into content for the Activities and Courses of the Learning Scenarios.

Clearly significant results

All the developed modules are integrated and accessible through the web-based platform: http://dl132.madgik.di.uoa.gr:8084/Wholodance_Movement_Library/login

T5.4. Integration and interoperability with external services, systems and applications [3 PMs] [ATHENA RC] [PeachNote] [M13-M30]

Summary of progress towards objectives and details

The WhoLoDancE Movement Library provides the appropriate API which facilitates access to the repository of the Recordings, Resources and metadata, through the CKAN search engine.

Clearly significant results

All authenticated users can access the recordings and the content of the ftp server through the CKAN API, which is available online (http://dl132.madgik.di.uoa.gr/apihelper/get).

T5.5. Integration of EyesWeb platform [3PMs] [UNIGE] [Motek] [M6- M30]

Summary of progress towards objectives and details

The EyesWeb XMI software platform has been updated to be able to read and write MoCap files of various

types (.c3d, .fbx, etc) in order to compute motion features from motion capture sessions captured by partners. The platform has also been updated to communicate with the online platform, similarity search server and Unity Environment. A more in-depth integration will be implemented in the next months.

Clearly significant results

Implemented communication protocols, new MoCap files formats support. The latest version of the platform is available at: www.infomus.org

T5.6. Global integration within the WhoLoDance data management platform [4PMs] [ATHENA RC] [Motek- PoliMi- PeachNote-UniGe] [M13 – M32]

Summary of progress towards objectives and details

The WhoLoDancE Movement Library architecture is built upon the idea of integrating various modules and components. From day one of the design of the platform, all technical partners involved have worked together in order to ensure the interoperability and extensibility of the developed modules.

Clearly significant results

The current version of the WhoLoDancE Movement Library integrates a 3D player-visualizer which allows the simultaneous view of the skeleton avatar and the video (the implementation of the skeleton-video visualizer is described in D3.6), within the Annotation System. A prototype of a similarity search system (WP4, described in deliverable D4.2) was also implemented, based on the access to the recordings stored in the Movement Library.

T5.7. Platform testing & validation and maintenance plan specification [3.5PMs] [ATHENA RC] [Motek-PoliMi- PeachNote] [M1 – M32]

Summary of progress towards objectives and details

The first version of the platform, WhoLoDancE Movement Library (WML), has already been released and used internally, following a testing procedure and a formative usability evaluation. Following the Scrum Agile methodology and principles the development of the various modules has been implemented into smaller sprints that can be incrementally added, tested and evaluated. Following this approach, the risk of interdependencies and long-term planning can be minimized. The early release of the software allows to identify the actual issues that might appear while in use and act on time with changes and modifications. For both testing and validation, as well as the user evaluation (WP7) an iterative approach will be followed.

Clearly significant results

First results of the testing and validation process are reported in "D5.2 Beta Prototype, testing & validation Data Management Platform Report".

WP 6 Multimodal Rendering, Holographic / volumetric displays Development, and Whole-Body Interaction Interfaces – (M21- M36)

Starts at M 21

DISCLAIMER: WP2 and WP6 are closely related, as the needed motion capture repository formats has to be compliant with holographic projection methods. Therefore, though WP6 is formally not started yet, several R&D actions belonging to WP6 were carried out as part of WP2.

WP7 Evaluation and Validation of ICT-based Learning – (M5 - M36)

Lead Partner COVUNI

Participant number	Participant short name	Planned person months	Actual person months	TOT PMs
1	LYNKEUS	0	0	
2	ATHENA RC	6	2,9	
3	MOTEK	2	2	
4	POLIMI	1	0,7	
5	UNIGE	0	0	
6	Peachnote GmbH	3	0	
7	COVUNI	13	5,77	
8	STOCOS	3	0	
9	K. Danse	2,5	0	
10	Lykeion Ellinidon (LCGW)	2,5	0,29	

Deliverables due within Month 18	**Submitted (Y/N)**
D7.1 Usability and Learning Experience Evaluation report M 15	**Y**

Brief overview

OVERALL

WP7 Evaluation and Validation of ICT-based Learning is responsible for the user testing and evaluation of the WhoLoDancE framework and produced algorithms and tools. It will take place throughout the duration of the project to inform the conceptual framework and development of learning tools with the feedback of the dance education community.

This deliverable includes the evaluation plan for the tasks of WP7, and reports on the methodologies to be used for the User Interface and User Experience of the interfaces. The plan describes the concept of a -two- phase iterative evaluation, completing a formative (preliminary) and summative (final) evaluation, which will be documented in D7.2 and D7.3 respectively.

Tasks – detailed assessment

T7.1 Usability and Learner's Experience Evaluation [10,75PM] [ATHENA RC] [Motek-Polimi-Peachnote-CovUni-Stocos-K. Danse-LCGW] [M7-36]

Summary of progress towards objectives and details

An evaluation plan is in place and documented on D7.1, it includes a formative and summative process of evaluation. The process of carrying out the formative evaluation is currently underway.

At present, the technical partners are developing the relevant functionalities needed for testing. These include: advanced search and browsing, movement sketching to access the repository, the blending machine, synchronised presentation through different visualisations and the content annotator. At the Users' Board meeting on the 27th June 2017 these functionalities were presented and got encouraging feedback. In addition, a demo was scheduled at MOCO 28-30 June where Users were asked about their experience.

Clearly significant results

- The Heuristic Evaluation is underway.
- All partners have access to the annotator and blending machine to use.
- The dance partners have been annotating the motion capture files with movement qualities and actions.
- The technical partners have access to the similarity search tool to integrate with their work.

T7.2. Evaluation of Learning process through the interfaces [12,25PM] [CovUni] [ATHENA RC-PoliMI-Peachnote- Stocos-K. Danse-LCGW] [M7-36]

Summary of progress towards objectives and details

This task aims at assessing the impact through the interfaces and at defining requirements for the Enhancement of the tools - testing over time, measuring change in learning and teaching methods – self-reporting, observation and analysis. Beta testing by Dance teachers and Dancers on 1) Bug reporting, 2) Feature suggestions, 3) Comparative to conventional techniques (reporting).

The COVUNI team in association with Athena and the dance partners started initial planning of the User Interface and User Experience evaluation. This will include organizing a sample of users from all dance genres, designing questionnaires, organizing semi-structured interviews, focus groups and workshops.

Clearly significant results

From previous execution of questionnaires and interviews, the lesson has been learnt that short questionnaires work best and semi-structured interviews glean the material wanted from the participants. These methods will be used going ahead.

No other significant results thus far.

T7.3 Personalization Evaluation [10 PMs] [ATHENA RC] [CovUni-Motek-Peachnote-Stocos-K. Danse-LCGW] [M7-36]

Summary of progress towards objectives and details

This task involves the evaluation of the personalization modelling, algorithm and implementation. It starts with a primary Evaluation of User Modelling and Profiling which were prepared in WP1, in the form of questionnaires or interviews (where applicable) with actual users (learners and teachers). The conclusions will feedback into the adoption and adaption of elements of the technology as developed in WP 5.

At the project meeting on the 26th & 27th June 2017, a list of artists, teachers and educators to work with the tool in their studio for a limited time has started being compiled. The expectation is that they will kindly provide quality feedback on the use of the tool at the formative and summative evaluation stage.

WP8 Communication, Dissemination & Exploitation – (M1 - M36)

Lead Partner LYNKEUS

Participant number	Participant short name	Planned person months	Actual person months	TOT PMs
1	LYNKEUS	18	9,49	
2	ATHENA RC	1	0,68	
3	MOTEK	1	0,7	
4	POLIMI	1	0,7	
5	UNIGE	3	0,79	
6	Peachnote GmbH	1	0	
7	COVUNI	1	1,15	
8	STOCOS	2	1,1	
9	K. Danse	2	0,34	
10	Lykeion Ellinidon (LCGW)	2	0,31	

Deliverables due within Month 18	**Submitted (Y/N)**
D8.1. Dissemination and exploitation strategy plan and preliminary materials M 3	**Y**
D8.2. Updated Dissemination materials M18	**Y**
D8.4 First dissemination Event M18	**Y**
D8.5 Outcomes of the strategic Exploitation seminar and First Exploitation Plan M 18	**Y**

Brief overview

OVERALL There has been a good agreement among all partners on Dissemination steps, as well as on Exploitation issues.
KEY RESULTS The Dissemination and exploitation activities started from the beginning of the project and at the end of M 3 the D8.1 Dissemination and exploitation strategy plan and preliminary materials was submitted.

The whole Consortium has contributed to the Dissemination communication, at the beginning, and then to dissemination of the results to peers (e.g. relevant tech and dance experts), while the exploitation of the results, mainly (but not exclusively) in the form of products and services ready for commercialisation will still undergo further and more in-depth discussion, beyond the outcomes of the first Exploitation seminar held in London on 26th June 2017. (see D8.5). The dissemination materials, logo and project website, were released by Lynkeus within the first month.
ISSUES None.

Tasks – detailed assessment

T8.1 Dissemination strategy, preliminary Materials [2PMs] [LYNKEUS][M1-4]
Summary of progress towards objectives and details WhoLoDancE has adopted the best practices identified by the EC1, such as defining the key audiences, preparing specific messages for each of them, engaging the stakeholders also to contribute to the expected dissemination. Furthermore, the Consortium is continuously refining the key messages of the project, and carefully choosing the most effective means of communication and dissemination, according to both audiences and to specific contents.
Clearly significant results During the Capture Sessions in Genoa and Amsterdam a significant number of photos and videos were taken in order to record the process and produce materials to be delivered through the activated dissemination channels. Two different layouts of the poster were tailored for different audiences and formats. The first one, to be used for poster presentations at conferences, technology fairs and dance performances, printed in A3 format or bigger, while the second version can be used in different formats (e.g. A4) due to the different font size of the text and delivered also as brochures.
T8.2 Project Web-site [3PMs] [LYNKEUS] [M1-36]
Summary of progress towards objectives and details WhoLoDance website has been very soon up and running, and has been regularly updated. Some particular features have been added to the website and further dissemination channels have been developed and implemented. (see D8.1) The updated website highlights also the most significant activities performed within the first 18 months of the project. The events' section of the website includes the details of each event in which WhoLoDancE

[1] European Commission, *Communicating EU research and innovation guidance for project participants*, 25 September 2014. Available online: http://ec.europa.eu/research/participants/data/ref/h2020/other/gm/h2020-guide-comm_en.pdf

partners participated.

In the media section of the website, relevant videos have been uploaded that describe the 3 Motion Capture Sessions, the General meeting and the workshop which took place in partnership with MOCO 2016 in Thessaloniki and the two Users' Board sessions held in Milan in December 2016 and in London in June 2017.

Clearly significant results

WhoLoDancE website has proved to be a useful communication channel, providing a rich image of the project's progress.

T8.3 Social media [1,5PMs] [LYNKEUS] [M 1-36]

Summary of progress towards objectives and details

As stated in the D 8.1 Dissemination strategy Plan, delivered at month 4 of the project, WhoLoDancE has made extensive use of social networks and social media with a particular focus on Twitter and Vimeo, which were identified as effective social tools for raising interest in the target audiences of the project.

In the past 18 months, dissemination material was produced and delivered through the above dissemination channels.

Clearly significant results

The Twitter account has been in constant growth, reaching overall 223 followers, with 328 tweets, more than 125,000 tweet impressions (i.e. visualisation of threads in which WhoLoDancE was involved), 5200 unique visits to the Twitter profile and 262 mentions.

The Facebook channel was set up at M5 in order to operate as a bridging junction between the Website, Twitter and Vimeo. It reached more than 200 followers and the project Facebook wall has been used to share all videos and other media produced during the project.

T8.4 Dissemination events [10,25PMs] [LYNKEUS] [Peachnote-UniGe-CovUni-SOCOS-K.Dance-LCGW][M12-36]

Summary of progress towards objectives and details

During the first Reporting Period, as planned in the DoA, WhoLoDancE organised two specific workshops aimed at demonstrating its approach, engaging intended end-users and gathering useful feedback for the further refinement of the results. The first one in Thessaloniki, during the MOCO 2016 Conference, in July 2016, the second at Coventry, on January 2017. Furthermore, two WhoLoDancE User's Board sessions were held, the first in Milan in December 2016, the second in London, in June 2017, with in both cases a significant active attendance of choreographers, dancers, and experts.

Clearly significant results

A significant amount of encouraging feedback was gathered from the relevant expert community.

T8.5 Seminars, Workshops, Concertation Activities with Other ICT Funded Projects, and Community Liaison and Feedback [M1-M36] [5,75PMs] [LYNKEUS] [ATHENA RC-Peachnote-UniGe-CovUni-Stocos-K. Danse-LCGW]

Besides the already mentioned dedicated workshops (Thessaloniki and Coventry) and Users' Board sessions in Milan (see D9.5 for details) and in London, in coincidence with MOCO 2017, where on each occasion around 10 External experts were invited in order to obtain an intermediate validation and testing of the results and achievements of WhoLoDancE (see D8.4 for details), various Partners took part in several events around Europe, with audiences ranging from general public to academics. Several papers were presented as well (for a complete list see section 2. Dissemination activities, within the present Periodic Report)

Clearly significant results

An extensive interaction with academia and with the dance community, and MOCO participants, has taken place, raising a significant amount of interest on WhoLoDancE developments.

T8.6 Newsletter [3PMs] [LYNKEUS][M8-M36]

Summary of progress towards objectives and details

The first issue of WhoLoDancE Newletter was released and published on the Project website http://www.wholodance.eu/wholodance-newsletter-issue-1/ as well as distributed in print-version at dissemination events.

This first issue was meant to provide a general description of the project goals, as well as an update regarding the attended events, the workshops, and the advancements attained by the end of the first year of activity, including the capture-motion sessions outcomes, the progress of the various tools implementation, the relevant prototypes, together with some comments and impressions gathered from a panel of experts in the field.

Clearly significant results

The Newsletter seems to have been widely appreciated, and was considered to have attained a good readability level.

T8.7 Exploitation [4,5PMs] [LYNKEUS] [ATHENA RC-Motek-Polimi-Peachnote][M12-36]

Summary of progress towards objectives and details

In view of the preparation of the forthcoming First Exploitation Plan (due in M24), an Exploitation Seminar, aiming at identifying the most likely scenarios within which to position the project's expected exploitable outcomes (as per the DoA), was held in London on 26th June 2017, during the biannual internal review meeting of WhoLoDancE.

Besides gathering basic information about individual exploitation expectations, an ambitious collective exploitation approach was also taken into account, as a preliminary proof-of-concept exercise, inspired by the multi-sided platform (MSP) concept, as developed by the 2014 Nobel Laureate for Economics, Jean Tirole.

As is well known, Tirole's theory establishes that, in such multi-sided platforms, one "side" will cross-subsidise the other, with the outcome that such MSP appear to be the organisation model showing the

greatest capacity to scale. This happens precisely because the MSP model is based on the implicit support that the network effect achieved on "one side" determines on the similar network effects developing "on the other sides" served by the platform. Challengers developing comparable technologies will then have a hard time trying to topple the incumbent, having to compete with an apparently zero price, where the original platform developer and content provider takes advantage of the network effects and captures all profits downstream.

All WhoLoDancE partners agreed that an attractive and sustainable solution, based on the technical developments which have already taken place, would be an integrated Unity-based platform, taking advantage of Unity being the cross-platform game engine which is primarily used to develop video games and simulations for computers, consoles and mobile devices. Enabling also a wider use of the relatively less costly low-end devices would be, however, an additional and highly important goal, for which reason it was decided to take into account, among others, the option of a multi-layered software licensing approach. This would allow, in fact, to distinguish between a freemium general access policy, allowing browsing and some limited usability of the platform, topped by a fee-based access for a more extended usage of all WhoLoDancE functionalities. These fees would trigger a feedback mechanism to support further acquisition of motion captures, broadening the database of the platform, and ensuring its continuous maintenance, while providing, possibly through blockchain and smart contracts applications, an economic return not only to the technological developers, but also to the artists who would have contributed in the first place to the motion capture sessions.

Clearly significant results

An initial approach at developing a Lean Launchpad methodology was put in place, as entrepreneurship methodology for testing and developing business models based on querying and learning from customers, collecting feedback around alternative hypothetical solutions.

Reasons for deviations from DoA and impact of this deviation on other tasks/resources availability

None.

Reasons for failing to achieve critical objectives and impact of this deviation on other tasks/resources availability

None.

Corrective Actions

None.

T8.8 IPR management [2PM] [LYNKEUS][M6-18]

Summary of progress towards objectives and details

It was in the first place agreed that WhoLoDancE will consider the possibility of drafting a specific Memorandum of Understanding among the partners for regulating the use of specific backgrounds, in order to avoid that the inaccessibility to such backgrounds might hinder the good prosecution of WhoLoDancE damaging the collective interests of the Consortium.

Additionally, it was agreed to attentively analyse a specific conceptual approach: that it would be desirable that also artists involved in the testing and validation of the platform could eventually enjoy an

adequate protection with regard to the ownership and use of the records of their performances.

To this end, a blockchain solution for claiming individual artists' IPR will be contemplated, based on the assumption that Blockchain and Smart Contracts (executable pieces of code, electronically stored on the blockchain for future algorithmic execution) have demonstrated to be particularly suitable for protecting Intellectual property rights.

The idea is to hopefully be able to make use of the smart contracts' capacity of automatically activating a transaction (e.g. payment of a fee or royalty) at the occurrence of a specific event (e.g. the usage of a particular IP), so that also the artists IP can be automatically protected and rewarded, without requiring any further direct human involvement after the smart contract has been encoded and integrated in the distributed ledger (which is what makes these contracts "smart" or self-enacting).

Clearly significant results

A highly innovative approach to IPR issues was detected, and agreed upon, and will now require attentive analysis in order to check whether the operational requirements can be met.

Reasons for deviations from DoA and impact of this deviation on other tasks/resources availability

N/A

Reasons for failing to achieve critical objectives and impact of this deviation on other tasks/resources availability

N/A

Corrective Actions

N/A

WP9 Coordination & Management – (M1 - M36)

Lead Partner LYNKEUS

Participant number	Participant short name	Planned person months	Actual person months	TOT PMs
1	LYNKEUS	14	8,375	
2	ATHENA RC	1	0,54	
3	MOTEK	1	0	
4	POLIMI	1	0,7	
5	UNIGE	1	0,66	
6	Peachnote GmbH	1	0	
7	COVUNI	1	0	
8	STOCOS	0,5	0,45	
9	K. Danse	0,5	0,23	
10	Lykeion Ellinidon (LCGW)	0,5	0,09	

Deliverables due within Month 18	**Submitted (Y/N)**
D9.1 Kick-off meeting report M2	**Y**
D9.2 Project Presentation M3	**Y**
D9.3 Self-Assessment Plan M4	**Y**
D9.4 Quality Assurance Guidelines M8	**Y**
D9.5 First Intermediate Report M12	**Y**
D9.7 First Periodic Report M18	**Y**

Brief overview

OVERALL

During the first reporting period, several management activities were conducted to keep the project on track, to align the activities performed by the various partners, to solve emerging issues, and to ensure the accomplishment of the key intermediate results.

Four general meetings were organised in this period:

- the kick-off meeting at M1
- the first half-yearly meeting - at M6
- the first annual meeting with the users' board involvement - at M12
- the first annual review meeting, with the second users' board session - at M18

Besides these general meetings, dedicated technical and dance partners' meetings were organised, both in conjunction with the motion capture sessions, as well as separately (as at M13 in Coventry), with the aim of aligning the motion capture activities with the other technical developments and of taking into account the dancers' feed-back).

The management team provided the consortium with the formal tools for producing consistent deliverables while ensuring a thorough quality control of the produced documents, as well as checking the necessary alignment with the self-assessment goals.

The management strategy was implemented following an agile approach, focusing on the early implementation of working pieces of software, made available for testing and refinement by all the other partners, also building on the expertise of the dance partners. This approach made it possible to demonstrate, during the Users' board meetings, held in Milan in December 2016 and in London in June 2017, the progress of a number of software solutions, presenting a variety of working features, such as the blending machine, the similarity search, the low-end feature extraction, the sound-movement alignment, etc.).

The early involvement of several Dance and Technology experts, thanks to the two Users' Board Sessions organised at M12 and M18, made it possible to gather interesting feedback on future enhancements and to better understand the needs of some key stakeholders, thus helping WhoLoDancE to be more focused on the technological solutions which are more likely to respond to the community expectations. Additionally, the Users' Board sessions allowed to disseminate the first project outcomes to a selected audience.

Finally, project teleconferences were regularly organised during the period, substantially on a monthly basis, after the initial and highly intensive face to face interaction started with the kick-off meeting and the three motion capture sessions.

KEY RESULTS

- Kick-off meeting

- Project presentation produced and circulated
- Self-assessment plan and Quality Assurance Guidelines issued (including a standard form for the Deliverable Review Process)
- Half-Yearly meeting
- Annual meeting
- First annual review meeting
- Two Users' board sessions
- Several meetings for specific areas of the project
- Organization of 16 teleconferences

ISSUES

Feature extraction and ontology development are still open issues for which an ongoing debate is still ongoing among the Dance and the Technological Partners.

The Unity-based interoperability completion between all the developed applications will be a major focus in the next reporting period.

Exploitation perspectives still require some more in-depth discussion among all partners and a dedicated management effort, also in view of innovatively addressing the relevant IPR issues.

1.3 Impact

WhoLoDancE has been speedily progressing according to its initial plan, with only minor deviations. Phase I was completed successfully, while satisfactory progress has been made within the first half of Phase II, resulting in running prototypes of all the technical tools that constitute the backbone of WhoLoDancE's toolbox (i.e. Library of Movements, Blending Engine, Similarity Search, Sound-Movement Synchronization, Movement Sketching). Holographic rendering is the further technical development that remains as main challenge ahead, besides the general integration into a Unity platform of all developed tools. Holographic rendering belongs, however, to WP6, which is about to start in September 2017 (M21). For this reason, the expected impact of the project can be considered to appear as generally enhanced, depending also on its correlation with possible exploitation developments. In the following paragraphs, a brief overview of the impact described in section 2.1 of the DoA is given, with an explanation of how the to-date developments not only remain in line, but can possibly exceed the initial expectations.

1.3.1 Enhancing the development of digital learning and teaching

WhoLoDancE enables users to easily navigate and explore large collections of dance data through the Library of Movements. More than 6000 dance sequences representative of 4 different dance genres have already been catalogued. The Movement Sketching software allows users to record their own movements and through Similarity Search to compare them with those provided in the Library. Users have the opportunity to control the precision of their posture, or find out the quality of their movements. Using the Blending Engine they have the opportunity to compose new sequences in desktop, having avatars implementing any new choreographic concept, which can be studied digitally and memorised before practiced in the studio. Within the past 18 months, the WhoLoDancE consortium organised two Users' Board sessions, during which the abovementioned digital learning possibilities were discussed with dance experts. All participants of both sessions agreed that WhoLoDancE provides great possibilities to this end with innovative tools which go far beyond the classical learning and teaching practices. By the end of Phase II an ambitious exploitation plan is going to be released, which will aim at ensuring a proper outreach for maximising WhoLoDancE's impact.

1.3.2 Discovering the diversity of the European dance culture

WhoLoDancE Similarity Search tool, in its current state, enables users to identify structurally similar movements in the Library of Movements, while in the future it is planned to also detect similarity based on movement qualities, orientation of dancers in space, direction of their movements etc. This can prove to be a powerful tool for researchers, teachers, and learners, in the field of cultural heritage of all body-movements-based activities. Not only will it allow to detect, appreciate and analyse commonalities across different dance languages, dance genres, or even to study how a certain dance genre has evolved over time, but it will be able potentially to spread across all teaching practices of all types of dance. In order to adequately materialise this impact, the exploitation plan will specify actions to ensure that the Library of Movements shall keep being enriched with further data after completion of the EU-funded WhoLoDancE project.

1.3.3 Opening up new possibilities in the creative process of dance

The Blending Engine allows users to access the Library of Movements, pick up sequences of their preference and use them for the compilation of a new sequence. Two sequences can be combined serially in time, i.e. by positioning one after the other, or in a parallel setup, i.e. by combining the movement of a certain body part from one sequence with the movement of another body part from a different sequence, hence creating an original one that didn't exist in the repository before. This gives a unique new possibility to a

choreographer to compose and fully visualize a new choreography before entering the studio to work with dancers. Furthermore, it enables him or her to compile and view new movements, and maybe even come up with sequences that have never been thought of before. The dance experts that participated in WhoLoDancE Users' Board sessions, as well as dancers and choreographers present at WhoLoDancE demo in MOCO 2017 conference acknowledged the great range of possibilities stemming from this development. In the coming months, the consortium shall work on improvements in the users' interface of the blending engine, and on its Unity-based integration with the other developed tools, in order to ensure that the WhoLoDancE platform reaches a highly advanced operational capacity by the end of the project.

1.3.4 Stimulating research efforts in Cognitive Science

Within the past 6 months, WhoLoDancE dance partners specified a list of the most significant movement qualities in the four dance genres included in the project, and have started annotating the data in the Library of Movements accordingly. These annotations will be used in a machine learning process to train algorithms that will start to automatically specify movement qualities in new dance data. Once this step is completed, the extraction of higher level features will be attempted by means of extrapolation, giving information on emotional content, such as indicating whether a movement is showing "happiness" or "sadness". There are some doubts about the success of this step, as perceiving emotions in a movement is certainly a rather subjective deed. Yet the results of such an exercise can be useful to cognitive scientists for further research.

1.3.5 Transfer of the WhoLoDancE proof-of-concept to other domains

Once the WhoLoDancE paradigm and proof-of-concept development will be established for dance (possibly one of the most complex human bodily activities), a similar approach can be extended to arts, crafts, and professions which have long constituted a European specialty and now risk to get lost and disappear if they are not captured into appropriate 3D visualized databases. WhoLoDancE opens the way to an increased acknowledgement of the possibility of recording, reconstructing, preserving and conserving the representation and heritage of priceless traditional skills, which must not be allowed to fall into universal neglect, and should rather be re-proposed to be viewed and analysed in holographic performances or traveling exhibitions in selected venues, such as theatres, museums, and other appropriate public spaces.

2. Update of the plan for exploitation and dissemination of result (if applicable)

The plan for exploitation and dissemination of results as described in the DoA will be updated, in as far as WhoLodancE partners will move towards a joint exploitation initiative, which will be likely to materialise into a legal entity (a start-up) which will aim at introducing a distinction between a freemium general access policy, allowing browsing and some limited usability of the platform, and a fee-based access for a more extended usage of all WhoLoDancE functionalities. These fees – as already highlighted – would be meant to trigger a feedback mechanism in order to appropriately support further acquisition of motion captures, broadening the database of the platform, and ensuring its continuous maintenance, while providing, possibly through blockchain and smart contracts applications, an economic return not only to the technological developers, but also to the artists who would have contributed in the first place to the motion capture sessions. and give details.

The Dissemination plan will focus on a series of important public events where to demonstrate WhoLoDancE achievements, still ending up eventually in a Dance-athon final event, as foreseen in the DoA.

3. Update of the data management plan (if applicable)

A possible update of the data management plan will depend on the likely adoption of a blockchain approach for handling access to the WhoLoDancE platform while triggering Smart Contracts solutions to IPR issues.

4. Follow-up of recommendations and comments from previous review(s)

N/A

5. Deviations from Annex 1 and Annex 2

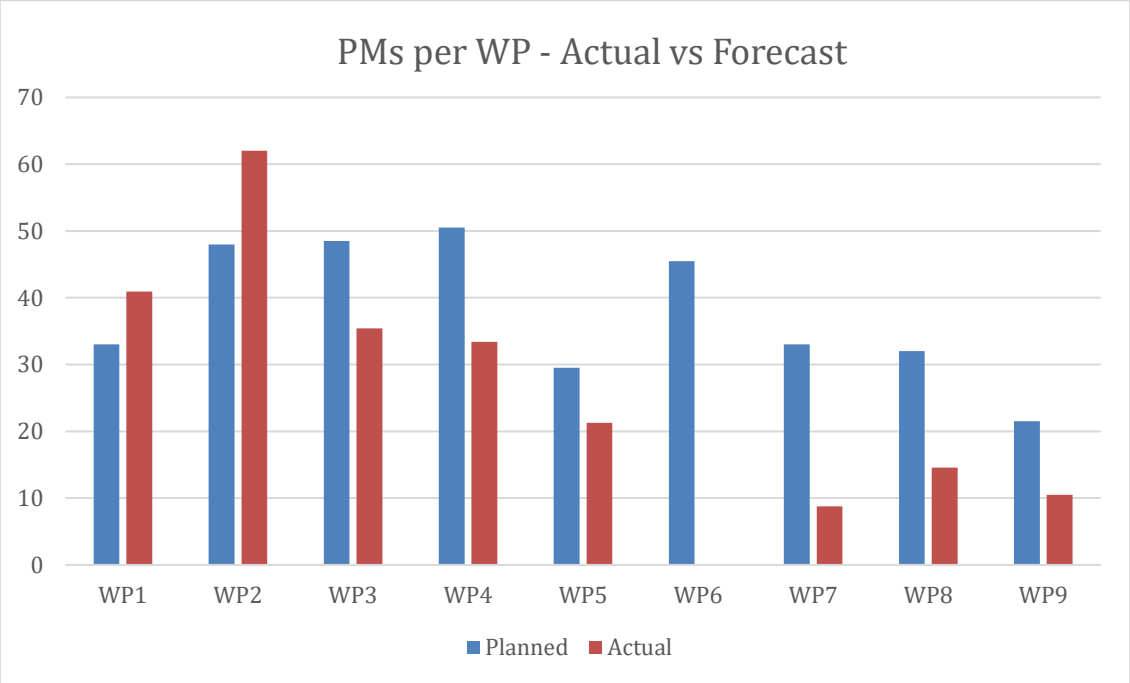
5.1 Tasks

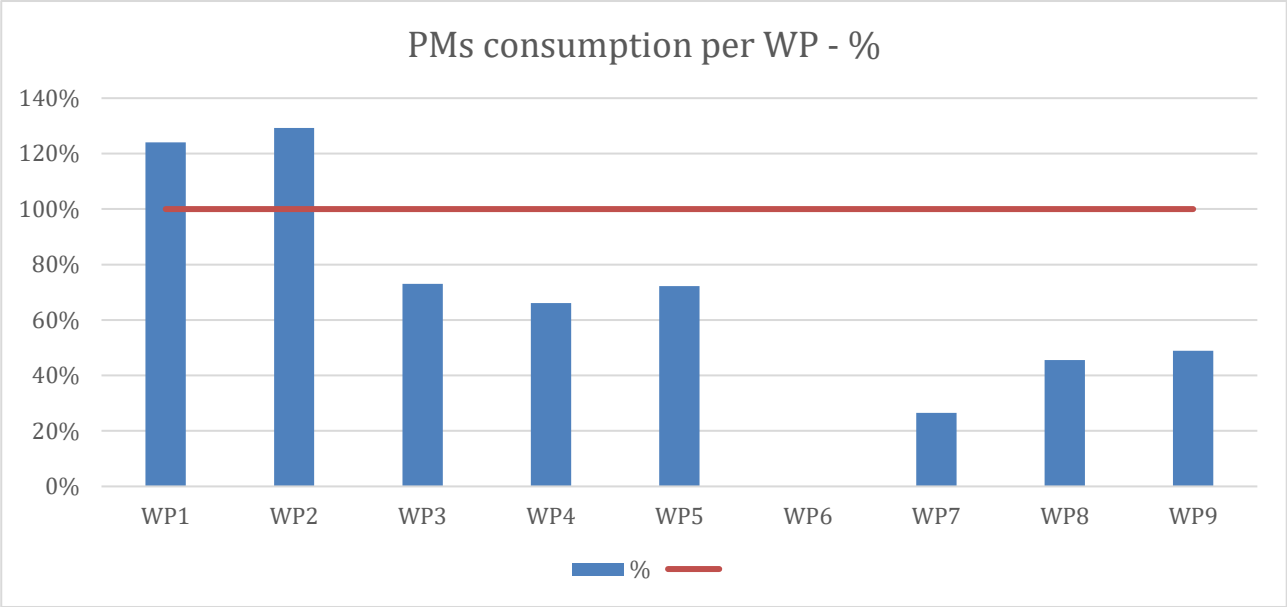
For the minor deviations highlighted in this report, please refer to the relevant sections in WPs1-2-3-4 and 8.

5.2 Use of resources

In the first reporting period, the Coordinator received the pre-financing from the EC, and subsequently duly distributed it to all WhoLoDancE partners.

The use of resources has been in line with the initial forecasts, but some deviations can be appreciated, with regard to the PMs consumption per WPs, as shown in the graphs below:





One can remark that WP1 consumed all of its resources and currently presents an overconsumption of PMs. It is worth noting that WP1 was due to be completed at M16. This justifies the complete consumption of the associated PMs, while the recorded overconsumption (around 20% more than the initial forecast) has been due to the intensive work required both for identifying and agreeing on the movement principles, as well as for involving the appropriate stakeholders. The Dance companies' involvement has been correlatively slightly higher than the initial expectation.

Also for WP2, some overconsumption needs to be highlighted, though it appears justified on three grounds.

First, this WP, due to be completed by M23, has required, a significant amount of additional efforts in order to be completed earlier than expected, taking into account the strategic decision to invest all needed efforts in avoiding any risk of jeopardising by any postponement the subsequent developments of core parts of the project's integration (largely relying on the outcomes of WP2).

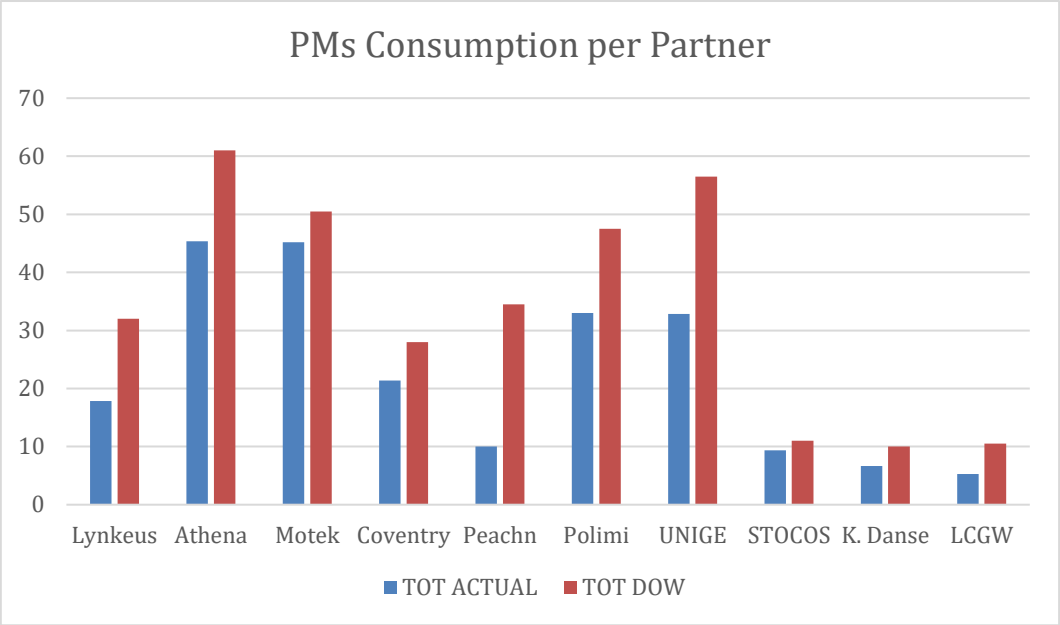
Second, as formerly explained, it took longer than expected to implement the underlying biomechanical structure that eliminates motion blends resulting in movements that would be beyond the range of movements of the human body.

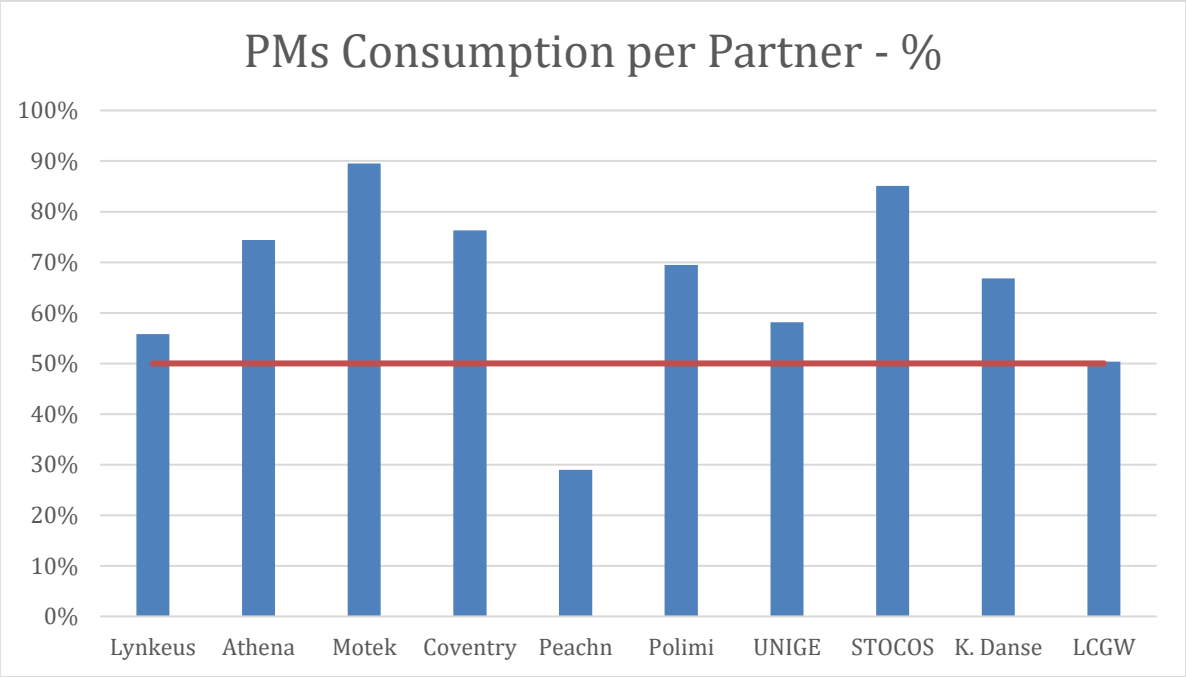
Third, as also already stated, WP2 and WP6 are closely related, as the needed motion capture repository formats have to be compliant with holographic projection methods. Therefore, though WP6 is formally not started yet, several R&D actions belonging to WP6 were carried out as part of WP2.

Lastly, also the dance companies' efforts have been somewhat higher that initially foreseen, in particular for STOCOS, which provided expertise and dancers for two dance genres (and not only for one, as initially foreseen).

Other WPs are in line with the initial forecast, although minor deviations may be spotted, mainly due to set-up effort.

The Partners' PMs consumption follow the WPs, although some other deviations can be highlighted:



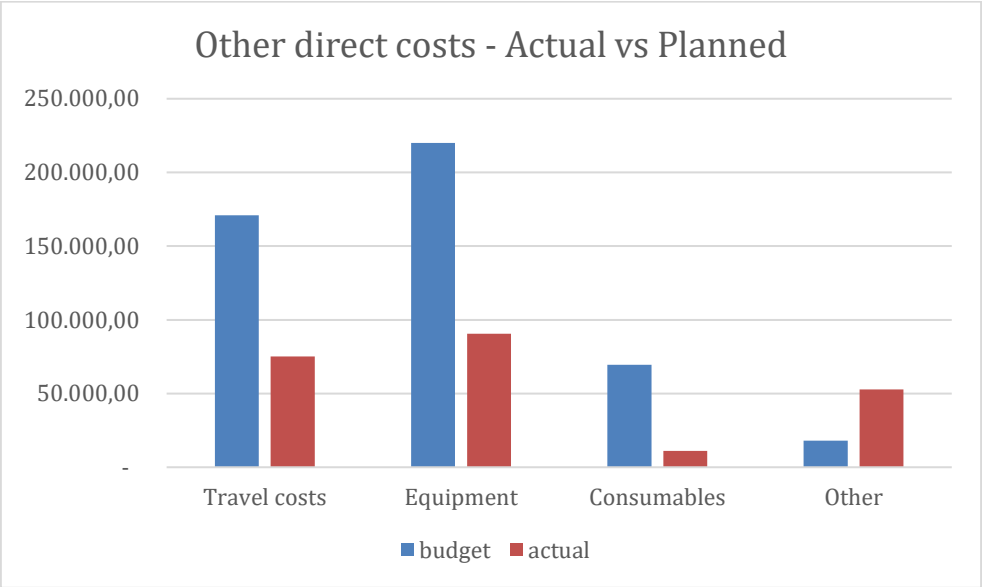


ATHENA, MOTEK and COVUNI have consumed more PMs than the expected 50% average in the first reporting period, due to their involvement in preliminary WPs such as WP1 and WP2.

POLIMI experienced a slight overconsumption in terms of PMs, due to the fact that the activities required a more intensive effort of junior personnel. Thanks to the fact that the average wages of these individuals are significantly below the initially expected average PMs cost for POLIMI, the relevant personnel cost has not subsequently increased.

Finally, dance companies experienced a more intensive involvement in the first year, mainly due to their role in the motion capture process and in the movement principles identification and discussion. STOCOS, in particular, was required to provide expertise for two dance genres, as mentioned above. Given the fact that the motion capture process has been completed, it is expected that the PMs consumption will slow down in the next reporting period.

Finally, concerning the other direct costs, the following scenario had been attained by the end of the first reporting period:



It can be noted that around 50% of the travel and equipment costs have been consumed in the first reporting period.

Consumables are significantly under the 50% (actually hitting just 16% of the total budgeted resources), while "other direct costs" have increased. This is due to the fact that some resources were moved from consumables to other costs: this is particularly true for MOTEK, which spent only 2,000€ in consumables but included over 30 thousand € in other costs, in order to cover a series of costs associated with the extended and very fruitful Motion Capture sessions.

Wholodance deliverables in the first 18 months of the project

Number	Title	Lead	Type	Level	Due Date (Months/Day)	
D9.1	Kick-off meeting report	Lynkeus	Report	Public	2	29th February
D9.2	Project Presentation	Lynkeus	Report	Public	3	31st March
D8.1	Dissemination and exploitation strategy plan and preliminary materials	Lynkeus	Report	Public	3	31st March
D2.1	Recruitment protocol and informed consent form	Covuni	Report	Public	3	31st March
D9.3	Self-Assessment Plan	Lynkeus	Report	Public	4	30th April
D2.2	Outcome of the pipeline development	Motek	Report	Public	6	30th June
D1.1	State of the Art Survey	Athena	Report	Public	6	30th June
D1.2	Interviews Report	Covuni	Report	Public	6	30th June
D1.3	Workshop Report	Athena	Report	Public	8	31st August
D2.3	Outcome of the capture Process	Motek	Report	Public	8	31st August
D2.8	Multi-sensor integration Report	Motek	Report	Public	8	31st August
D9.4	Quality Assurance Guidelines	Lynkeus	Report	Public	8	31st August
D1.5	Data Acquisition Plan	Athena	Report	Public	10	31st October
D2.4	Trimmed linear database of curated data sequences	Motek	Report	Public	10	31st October
D1.6	HLF Definition for the Learning Scenarios	Athena	Report	Public	11	30th November
D1.4	Definition of Learning Scenarios – Needs Analysis	Athena	Report	Public	12	31st December

D5.1	Data Modeling, Data integration and data management plan report	Athena	Report	Public	12	31st December
D9.5	First Intermediate Report	Lynkeus	Report	Public	12	31st December
D3.6	First report on software platform and libraries	4 - POLIMI	Report	Public	15	31/03/2017
D7.1	Usability and Learning Experience evluation report	2 - ATHENA RC	Report	Public	15	31/03/2017
D1.7	User Profiling	2 - ATHENA RC	Report	Confidential	16	30/04/2017
D2.5	3D avatar scenes	3 - MOTEK	Report	Public	16	30/04/2017
D2.6	Motion capture sequences and skeleton avatar	3 - MOTEK	Report	Public	18	30/06/2017
D3.1	Report on semantic representation models	2 - ATHENA RC	Report	Confidential	18	30/06/2017
D3.2	Report on emotional representation models	2 - ATHENA RC	Report	Confidential	18	30/06/2018
D4.1	Data Integration Algorithm and System Analysis, and Framework Description	6 - Peachnote GmbH	Report	Public	18	30/06/2017
D5.2	Beta Prototype, testing & validation Data Management Platform Report	2 - ATHENA RC	Report	Public	18	30/06/2017
D8.2	Updated dissemination materials	1 - LYNKEUS	Report	Public	18	30/6/2017
D8.4	First dissemination event	1 - LYNKEUS	Report	Public	18	30/6/2017
D8.5	Outcomes of the strategic exploitation seminar and First Exploitation Plan	1- LYNKEUS	Report	Public	18	30/6/2017
D9.7	First Periodic Report	1- LYNKEUS	Report	Public	18	30/6/2017

Dissemination Activities

Conferences and Presentations

Type of activity (workshop, conference, presentation, etc.)	Title	Date	Location/dissemination channel	Your role (speaker, exhibitor, author, etc.)	Type of audience
Presentation	Part of a panel entitled: Dance and Our Intangible Cultural Heritage Panel *Sustaining the Discipline: Embedding the Right to Dance in the C21st*	28th & 29th October 2016	DanceHE annual conference, Northern School of Contemporary Dance, Leeds, U.K.	Presenter	Dance academic community
Presentation	Movement Identity Through Motion Capture	4th – 6th November 2016	Lightmoves Festival of Screendance, Dance Limerick, Limerick, Ireland.	Presenter	Artistic community
Presentation	Part of a panel entitles: Human-Computer-Interaction: WhoLo DancE Project, Immersive Archives and Dance Data Panel	21st June 2017	Faculty of Arts and Humanities, Coventry University	Presenter	Research community
Presentation	Preserving the Intangible, Tools For Documenting and Sharing Folkloric Dance.	31st October – 5th November 2016	EuroMed International conference on Digital Heritage, Nicosia, Cyprus	Keynote	International community
Presentation	Machine Choreography	13th November 2016	Algo Mech Festival, Sheffield, U.K.		

Lecture	The moving body, technology and tools for analysis	25th May 2017	New University, Lisbon, Portugal.	Invited lecture	International research community
WhoLoDancE Workshop @MOCO16	"Dancing with technologies: interact to learn, analyse to create"	6th and 7th of July , 2016	WhoLoDancE Workshop	Organizer (Athena RC)	Scientific community + Dance researchers and experts
Athena presented the project	WhoLoDancE booth	6th-10th Apr 2016	Athens Science Festival	Presenter (Athena RC)	Wider audience of all ages
Presentation	"Wholodance: How state-of-the art technologies can support dance education and enhance the experience of dance learning" Katerina El Raheb	29th Jun - 3rd Jul 2016	CID 44th International World Congress on Dance Research	Author, presenter (Athena RC)	Dance Experts, Practitioners and Researchers
Demo	Dance and Technology Demo Katerina El Raheb, Vivi Katifori, Aristotelis Kasomoulis	27th and 30th Sept 2016	Researchers' Night 2016 (Athens)	Presenter (Athena RC)	Wider audience of all ages
Workshop	Dance and Technology Workshop, Katerina El Raheb, Vivi Katifori, Aristotelis Kasomoulis	30th Sept 2016	Researchers' Night 2016 (Athens)	presenter, workshop organiser (Athena RC)	Dance Experts and practitioners
Poster presentation	*WhoLoDancE project: Towards virtual and holographic dance learning experiences* *Katerina El Raheb; Vivi Katifori, Yannis Ioannidis; Antonio Camurri; E. Kostic Cisneros; Oshri Even-Zohar; Ruth Gibson, Amalia Markatzi; Jean-Marc Matos; Pablo Palacio; Stefano Di Pietro; Muriel Romero; Augusto Sarti; Vladimir Viro; Sarah Whatley*	22nd -24th Nov 2016	EuroVR2016	Author (WholoDancE partners), presenter (Athena RC)	Scientific Community

Presentation	Whole-body interaction learning for dance education, Katerina El Raheb, Vivi Katifori, Aristotelis Kasomoulis, Giorgos Tsampounaris	21st Dec 2016	ACM Greek SIGCHI	Presenter (Athena RC)	Scientific Community
Presentation	WhoLoDancE project: innovation and challenges	10th March 2017	Digital Echoes	Presenter (Athena RC)	Scientific Community, Dance practitioners and researchers
Booth-demo presentation	WhoLoDancE demo	29th March - 2nd April	Athens Science Festival	Presenter (Athena RC)	Wider audience of all ages
Presentation	Part of a panel entitled: Dance and Our Intangible Cultural Heritage Panel *Sustaining the Discipline: Embedding the Right to Dance in the C21st*	28th & 29th October 2016	DanceHE annual conference, Northern School of Contemporary Dance, Leeds, U.K.	Presenter (COVUNI)	Dance academic community
Presentation	Movement Identity Through Motion Capture	4th – 6th November 2016	Lightmoves Festival of Screendance, Dance Limerick, Limerick, Ireland.	Presenter (COVUNI)	Artistic community
Presentation	Part of a panel entitled: Human-Computer-Interaction: WhoLo DancE Project, Immersive Archives and Dance Data Panel	21st June 2017	Faculty of Arts and Humanities, Coventry University	Presenter (COVUNI)	Research community
Lecture	The moving body, technology and tools for analysis	25th May 2017	New University, Lisbon, Portugal.	Invited lecture (COVUNI)	International research community

Presentation	Machine Choreography	13th November 2016	Algo Mech Festival, Sheffield, U.K.	Presenter (COVUNI)	Artistic community
Performance.	*STOCOS. Interactive Dance & technology performance that closed MOCO 2016*	6th July 2016	MOCO2016, 3rd Conference on Movement Computing	Stocos. Authors and performers of the work	Scientific community
WhoLoDancE Workshop @MOCO16	"Dancing with technologies: interact to learn, analyse to create"	6th and 7th of July	WhoLoDancE Workshop	Organizer (Athena RC)	Scientific community + Dance researchers and experts
Conference	"Dancing Data. Digital Philosophy in Movement"	16th March, 2017	Dottorato di Ricerca in Musica e Spettacolo Dipartimento di Storia dell'Arte e dello Spettacolo, Sapienza Università di Roma	Edwin-Morley-Fletcher (Lynkeus): presenter	Scientific community
Workshop	Pablo Palacio, Daniel Bisig, Dance and Technology Workshop	20th-24th March 2017	Zurich University of the Arts (Switzerland)	STOCOS. Teachers	Dance Community .
EC Workshop	H2020 Participatory Meeting for Digital Learning projects	27th March, 2017	European Commission, Euroforum building, Luxembourg	Edwin Morley-Fletcher (Lynkeus) and Katerina El Raheb (ATHENA RC): presenters	European Digital Learning Projects
Workshop	A System to Support the Learning of Movement Qualities in Dance: a Case Study on Dynamic Symmetry	September 12, 2016	Heidelberg, Germany	UniGe speaker	Scientific
Presentation	Journée d'étude « L'acteur à travers le prisme du numérique: corporéité, avatar et spectacle vivant »	27th-28th October 2016	La Maison des Sciences de l'Homme Paris Nord, Paris, France	K. Danse Presenter	Scientific community + Live performance researchers and experts

Conference	Graph restricted game approach for investigating human movement qualities	June 30, 2017	London, Uk	UniGe speaker	Scientific/Artistic
Conference	Limbs synchronization as a measure of movement quality in karate	June 30, 2017	London, Uk	UniGe speaker	Scientific/Artistic
Conference	Robust music identification approach based on local spectrogram image descriptors	May, 2017	Berlin, Germany	POLIMI speaker	Scientific
Conference	Conferencias del Espacio de Creación e Investigación Sonora	6th of July	Universidad Autónoma de Madrid-UAM (Spain)	STOCOS. Author , presenter	Scientific/ artistic Community
Performance Demo	Pablo Palacio, Muriel Romero and Daniel Bisig.	30th of June	MOCO 2017	STOCOS. Author, Presenter, Performer	Scientific / Artistic community
Presentation	Recherche-création Arts numériques	July 6	Table ronde – Festival des Arts Numériques, Saint-Orens (Toulouse)	K. Danse Presenter	Large audience
Conference	A higher-dimensional expansion of affective norms for English terms for music tagging	August 2016	New York, USA	POLIMI speaker	Scientific
Journal	Multipath Beat Tracking	2016	Journal of the Audio Engineering Society	POLIMI speaker	Scientific
. Invited presentation	"Whole-Body Interaction tools for Dance Learning"	26th May 2017	"Digital Tools and Cultural Management" , organised by the General Secretariat of Information and Communication in Greece	Presenter (Athena RC)	Wider Audience

Invited presentation	"Managing and Enriching Dance Data & Movement Knowledge"	5-9th June 2017	"Gesture and & Artificial Intelligence in Industry and Arts"	Presenter (Athena RC)	Professionals and Young Researchers
Conference Demo	"The EU ICT H2020 WHOLODANCE dance learning applications"	28-30 June 2017	MOCO 2017	Author, Presenter (All Partners)	Scientific Community

Publications and Papers

Type of activity publication	Title	Date	Location/dissemination channel	Your role (speaker, exhibitor, author, etc.)	Type of audience
Workshop participation, Journal Publication	*HCI challenges in Dance Education*, K.El Raheb, A. Katifori, Y. Ioannidis, EAI Endorsed Transactions on Ambient Systems 16(9): e7, 2016	7th-10th Jun 2016	AVI2016 HCI and the Educational Technology Revolution AVI 2016	Author, Presenter (Athena RC)	Scientific community
Conference Publication	*Exploring Visualizations in Real-time Motion Capture for Dance Education*, G. Tsampounaris, K. El Raheb, V. Katifori, and Y. Ioannidis. In Proceedings of the 20th Pan-Hellenic Conference on Informatics, p. 76. ACM, 2016.	10th-12th November 2016	PCI2016, 20th Pan-Hellenic Conference on Informatics Special Session: HuBIC II – Human Behaviour, Interaction and Communication II	Author Presenter (Athena RC)	Scientific community
Conference short paper and poster	*WhoLoDancE: Towards a methodology for selecting Motion Capture Data across different Dance Learning Practice*, A. Camurri, K. El Raheb, O. Even-Zohar, Y. Ioannidis, A. Markatzi, J. M. Matos, E. Morley-Fletcher, P. Palacio, M. Romero, A. Sarti, S. Di Pietro, V. Viro, S. Whatley, MOCO 2016: 43:1-43:2	5th- 6th July 2016	MOCO2016, 3rd Conference on Movement Computing	Author Presenter (All Partners)	Scientific community

Conference Paper	Daniel Bisig and Pablo Palacio. “Neural Narratives – Dance with Virtual Body Extensions”	5th-6th July 2016	MOCO2016 3rd International Conference on Movement Computing	Stocos. "	Scientific and Artisitic Community
Conference paper	Pablo Palacio and Daniel Bisig PIANO&DANCER	15-17 Dec 2016	19th Generative Art Conference . Florence (IT)	STOCOS. Author, Presenter	Scientific / Artistic community
Conference Paper	Pablo Palacio and Daniel Bisig. Piano&Dancer – Interaction Between a Dancer and an Acoustiic Instrument.	29th June 2017	MOCO 2017	STOCOS. Author, Presenter	Scientific / Artistic community
Conference publication	Kyriakidi, Marialena, Kostas Stefanidis, and Yannis Ioannidis. "On Achieving Diversity in Recommender Systems." *Proceedings of the ExploreDB'17*. ACM, 2017.	19th May 2017	ExploreDB'17, ACM	Athena RC, Author, Presenter	Scientific community
Conference Paper	El Raheb, Katerina, Nicolas Papapetrou, Vivi Katifori, and Yannis Ioannidis. "BalOnSe: Ballet Ontology for Annotating and Searching Video performances." In Proceedings of the 3rd International Symposium on Movement and Computing, p. 5. ACM, 2016.	5th-6th July 2016	MOCO2016 3rd International Conference on Movement Computing	Author, presenter (Athena RC)	Scientific Community
Conference Paper	El Raheb, Katerina, Theofilos Mailis, Vladislav Ryzhikov, Nicolas Papapetrou, and Yannis Ioannidis. "BalOnSe: Temporal Aspects of Dance Movement and Its Ontological Representation." In European Semantic Web Conference, pp. 49-64. Springer, Cham, 2017.	29th May-1st June 2017	ESWC2016, 14th European Semantic Web Conference	Author, Presenter (Athena RC)	Scientific Community

Project Meetings

Meeting	Place	Object	Participants
General Meeting + Users Board session (in partnership with MOCO 2017)	London 26-29 June 2017		ALL + external invited
Lykeion Ellinidon (LCGW)	Athens	Introduction to the dancing group and teachers of the LCGW, in order to proceed with the questionnaires prepared by COVUNI, which had a great result with around 32 or 33 answers.	LCGW dancers and teachers
Lykeion Ellinidon (LCGW)	Athens	An introduction about WholoDance, our scope, and examples from the motion capture session.	LCGW dancing group and teachers of the LCGW– around 80 persons
WhoLoDancE partners	Coventry University 24 & 25th January 2017	For the technical partners to participate in dance workshops and for us to have a shared language and understanding. The technical partners shared progress.	LCGW, ATHENA, K.Danse, STOCOS, COVUNI, UNIGE, POLIMI, MOTEK, LYNKEUS
General Meeting + Users' Board Session	Milan POLIMI 5-6 December 2016	To share progress and discuss future developments	ALL
General Meeting + Workshop (In partnership with MOCO 2016)	Thessaloniki (GR) 4 -8 July 2016		ALL
3rd Motion Capture Session	Amsterdam (NL) 10- 20 July 2016		
2nd Motion Capture Session	Amsterdam (NL) Motek 1st-10th May 2016	Capture session	
1st Experimental Recording Session	Genoa (IT) 21st--23rd March 2016	1st Capture Session	
Kick-off Meeting	Rome – Lynkeus 18th-19th Jan 2016		ALL