# WHOLODANCE

Whole-Body Interaction Learning for Dance Education

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## Deliverable 5.2

## Beta Prototype, Testing & Validation Data Management Platform Report

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# Executive Summary

Deliverable "D5.2 Beta Prototype, testing and validation data management platform report" describes the architecture and functional specifications of the WhoLoDancE platform, focusing both on the data management infrastructure of the WhoLoDancE Movement Library and the User Interface used to access the platform functionalities.

Particularly, this deliverable reports on the outcomes of four main tasks of WP5 at a preliminary stage, a) T5.1 Building and deployment of data management platform, b) T5.2 Conceptual Modelling and Annotation of Data, c) T5.3 Data Modeling, integration and management, (although some details concerning the Data Management are described in D5.1 Data Management plan), as well as d) T5.7 Platform testing, validation and maintenance plan specifications.

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 an attractive interface for the end-user. Section 2 provides an overview of the architecture of the platform and Section 3 the specifications of the offered functionalities. The main functionalities 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 keywords that are included in the of the metadata of the recordings.

The second part of the document, Section 4, presents the testing and validation activities of the platform that have taken place in the reporting period.

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# 1 Introduction

The WhoLoDancE Work Package 5 is responsible for the overall data management infrastructure with the objective to collect, store, pre-process and manage the multimodal data acquired in the project.

This report describes the architecture and functional specifications of the WhoLoDancE platform, focusing both on the data management infrastructure and the WhoLoDancE Movement Library, the User Interface used to access the platform functionalities.

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 an attractive 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 keywords that are included in any of the metadata of the recordings. The WML can be accessed here:

http://dl132.madgik.di.uoa.gr:8084/WhoLoDancE_Movement_Library

The WML is built on top of the WhoLoDancE repository and data management system developed in the context of T5.1 Building and deployment of data management platform with the objective to support integrated access to the project motion capture data. Additionally, the WML realizes the outcomes of T5.2 Conceptual modeling and Annotation of Data as indexing and annotation methodologies will be implemented on 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. As described in the following sections, the WML offers to the user an organized view of existing data and metadata, and an effective interface which allows the enriching of the metadata by user annotations, based on specific vocabularies that have been discussed, developed and iteratively evaluated with dance experts.

In addition, the WML implementation reflects the outcomes of T5.3 Data modeling, integration and management. This task deals with the data modeling 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). The task specifies and implements the data management plan that will capture all related tasks starting from data acquisition, transformation, curation and validation, to data storage and maintenance. Multiple data flows and procedures have been implemented depending on the data source, type, and processing requirements. Data provenance has been taken into consideration at all levels.

Section 2 provides an overview of the architecture of the platform and Section 3 the specifications of the offered functionalities. Section 4 presents the testing and validation activities of the platform that have taken place during the reporting period.

# 2 WhoLoDancE Movement Library Architecture

In this section, we describe the main components of the WhoLoDancE Movement Library and the technologies used to develop both the interface and the back-end system. The WML serves several roles and integrates a number of core software components in the WhoLoDancE project. The components of the platform (Data Management System, Search API, Media Server) are not only developed to deliver the functional and non-functional requirements for end-users (search, browse, view and annotate the recordings), but they also serve as middleware components which facilitate the needs of various other web-based and non-web-based components and provide access, and further enrichment of the content for the Learning Scenarios using both experts annotations and automated algorithms. Figure 1 shows a conceptual map of the various WhoLoDancE software component interactions and interdependencies, which resulted from the collaboration of the various technical partners. The approach goes towards an integrated but flexible architecture which relies on the interoperability of the various components in order to deliver the functional and non-functional requirements of the various Learning Scenarios.
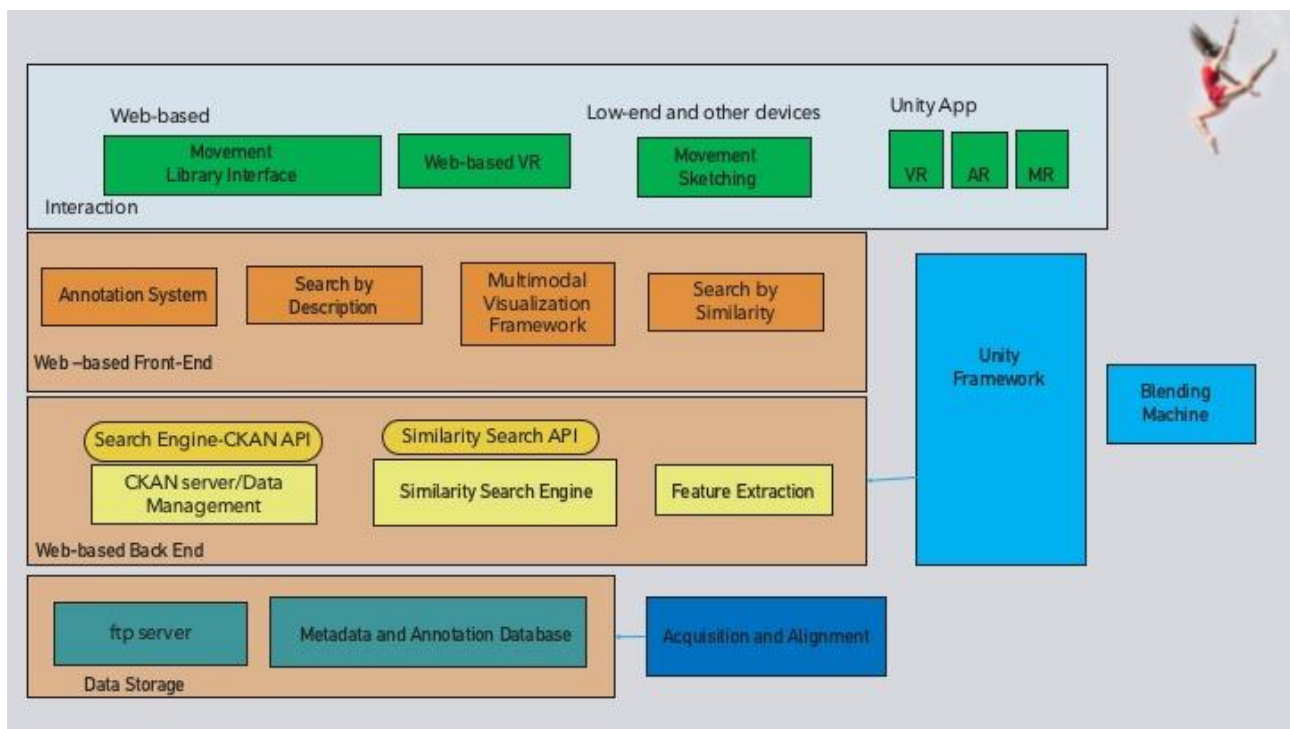


**Figure 1 . A conceptual map for the various components of WhoLoDancE tools and software towards an integrated, but flexible architecture.**

As shown in Figure 1, the WhoLoDancE Movement Library consists of several layers and components, including:

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- Data storage layer
- WML Back-end, including the Metadata server and search engine
- WML Front end
- User interface layer

These components are presented in Section 2.2, after an overview of the WML Data model approach in Section 2.1.

## 2.1  WML Data model

In this section we describe, how the resources, i.e., the different files that were produced during the Motion Capture and multimodal recording sessions are organised in recording entities.  The conceptual organization of the data is explained in detail in deliverable "D5.1 Data modelling, data integration and data management plan" [7]. Nevertheless, some enhancements have been applied to the organization of the data in order to serve the needs of the Learning Scenarios, and the various applications of the project. Whereas in [7], the organization of the data is "dataset" oriented, which means that the resources have been organised in datasets that reflect a conceptual classification of the recording, in our new approach, we follow a "recording" oriented perspective. This change allows us to organize more efficiently the various resources that are in different formats (fbx, c3d, mp3, mp4, txt, json) into Recording entities which are synchronised and viewed simultaneously by the user. For more details refer to the deliverable D3.6 First Report on Software platform and Libraries [6].

The basic terminology that has been used in the organisation of the data is:
   o *Resource*: It represents a file and its metadata.
   o *Recording*: It is a group of resources as well as some metadata that describes the resources.
   o **Collection**: It is a group of recordings that have some characteristics in common.

In the current version of WML repository there are 786 recordings in total. These recordings have been categorized by dance genre (Figure 2) in the WML User interface to provide a clear categorization and browsing approach to the users. Currently in the repository there are the following collections:

   o Ballet: It contains 130 recordings.
   o Contemporary:  It contains 426 recordings.
   o Flamenco:  It contains 49 recordings.
   o Greek Folk:  It contains 181 recordings.

More details about the process of collecting these data in a systematic way, in order to meet the needs of the Learning Scenarios for the different dance genres, can be found in D1.5 Data Acquisition [4], as well as in D2.3 [5] and D5.1 [7] and the paper by the WhoLoDancE partners [1].
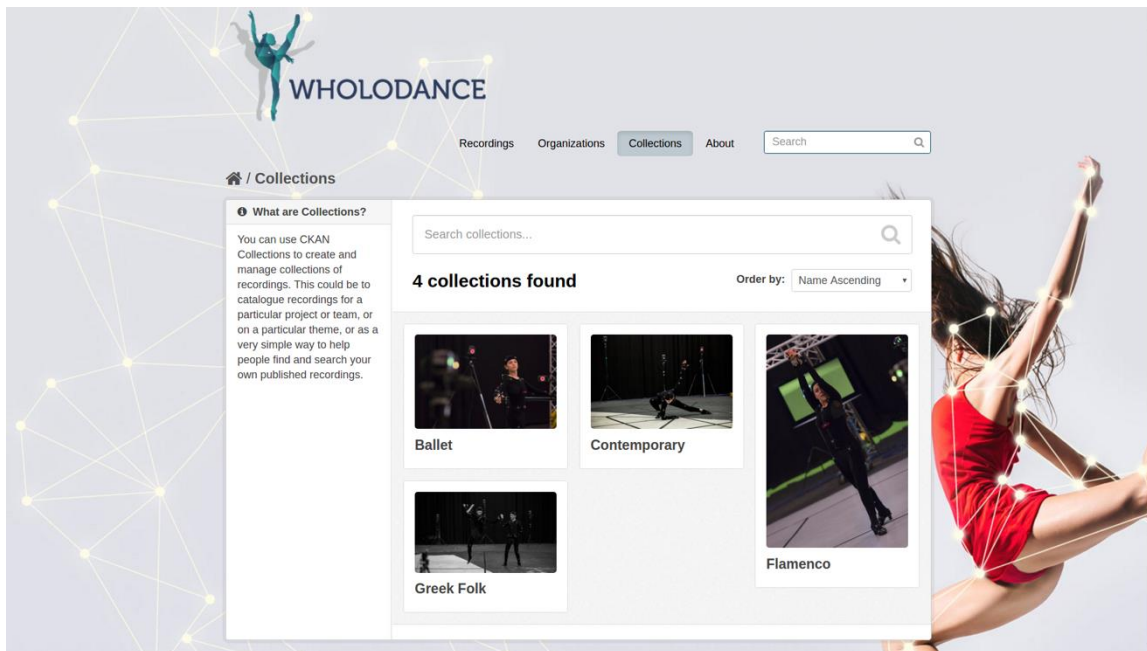
**Figure 2 The main screen of WML – The user can access the four collections based on dance genres**

Each recording represents a specific dance sequence which has been selected and recorded as described in detail in D1.5 Data Acquisition [4]. In order to have a full description, at this stage, a recording contains the following files (Figure 3 and Figure 4):

- o A motion capture file in a variety of formats, such as c3d, fbx and json.
- o One or more videos in high definition quality using mp4 or avi, as well as a lighter version in mp4 format.
- o An audio file in wav or mp3 format.
- o A synchronization file that highlights the offset of the above files.

Some of the recordings have extra files as a description. These files are in txt or csv formats.
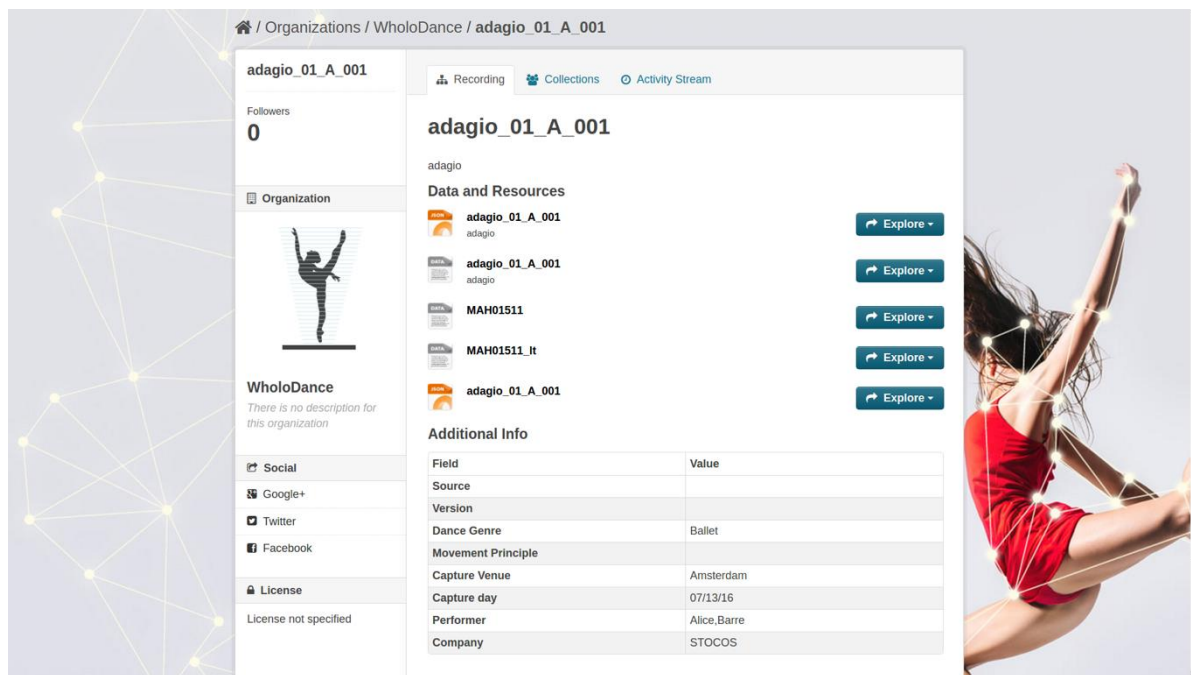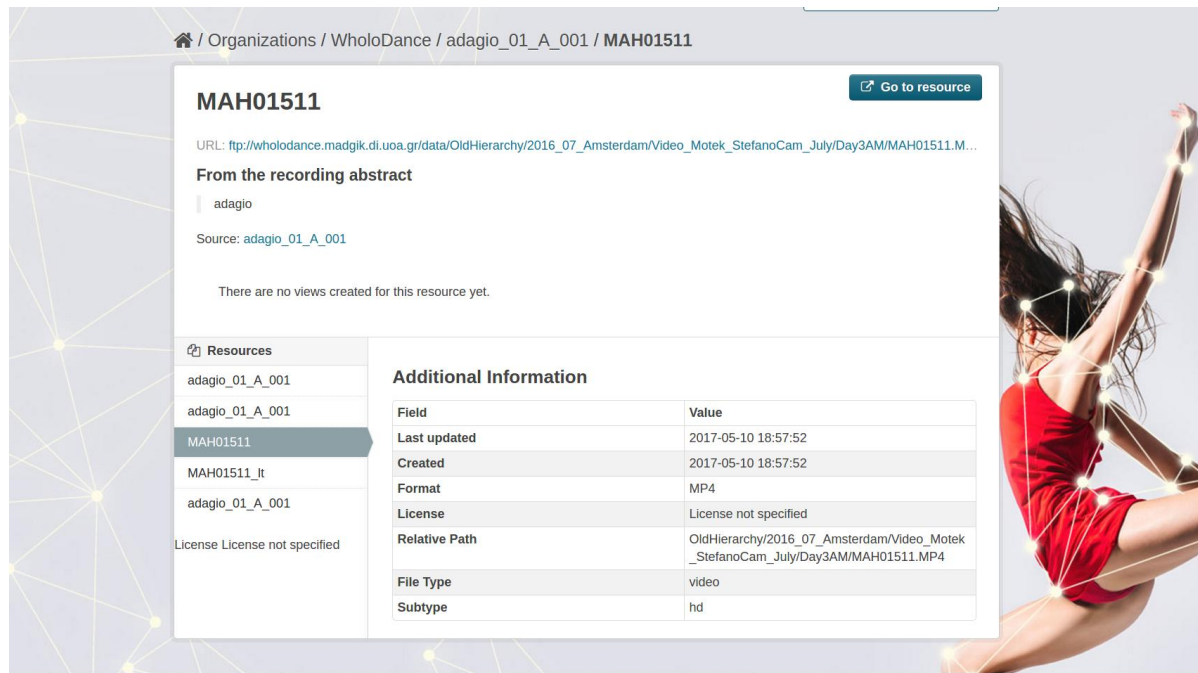
**Figure 3.CKAN interface: Recording information**

As it is also described in detail in D5.1, each resource and recording is described by a set of metadata (Capture Venue, Capture Date, Performer, Dance Genre, Name, etc) which allows to search the recording by any of these values through the CKAN server API, and of course through the WML interface.

**Figure 4. CKAN interface, metadata related to video files**

The WML offers the possibility to search and browse the movement recordings through additional tags that relate to movement descriptors such as Movement Principles, Qualities and Actions. As an on-going work we are investigating ways of linking these tags through ontologies and to infer knowledge from existing ones, through reasoning on specific syllabi [3] and temporal relationships of the annotations [2].  In this way, the WML aims not only to organize the data and concepts that are needed in the framework of WhoLoDancE, but also to address some of the key issues of enriching movement data and dance archives in a meaningful way, in order to support findability, accessibility, interoperability and reusability of data and content and comply with H2020 FAIR principles[1].

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[1]    http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/oa_pilot/h2020-hi-oa-data-mgt_en.pdf

## 2.2 Movement Library Layers and Components

One of the main goals of WML is to provide a Data management system to organize both the resources and the metadata of the multimodal recordings in a repository.  As shown in Figure 5, the WhoLoDancE Movement Library consists of the following layers and components:

- Data Storage
- Back End-Search API and Media Streaming
- Frond-End User Interface
- User Management and Security
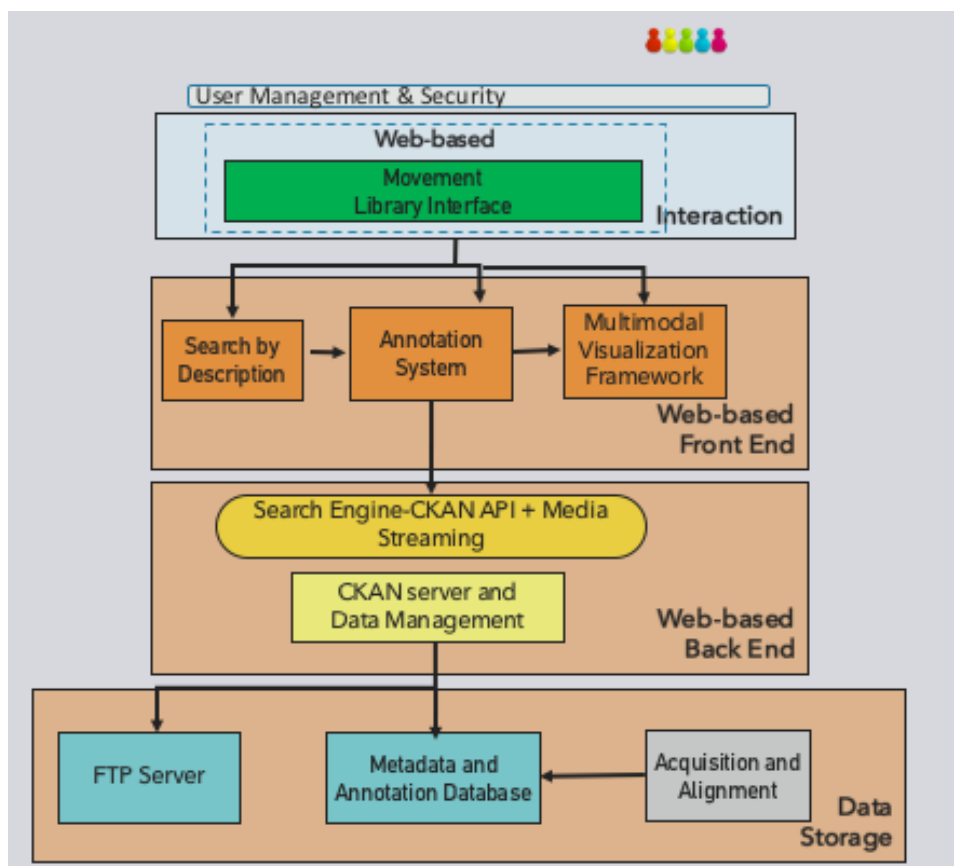


**Figure 5** Movement Library Architecture of main components: Data storage, Back-end, Interface and User Management System and security

### 2.2.1 WML Data Storage

The Data storage layer represents the infrastructure which implements the storage of the multimodal recordings, including the motion capture, video, audio, text, and other files in different formats, as well as the corresponding metadata and the archival system for the annotations. The Data storage layer consists of the following main components:

- o Recordings Repository Server: all the files that were created in the WhoLoDancE project are stored in the ftp server.
- o Annotations Database: this component is the archival system for the annotations that are and will be created to enrich the tags and metadata of the recordings. The annotation management system uses a relational database, implemented in PostgreSQL. It includes the following tables:

  1. Body parts: it contains the body parts that an annotation might refer to
  2. Categories: each category describes a group of labels (e.g. movement quality)
  3. Labels: it specifies the annotation (e.g. fluidity)
  4. Users: it contains all the users that have registered in the annotator tool
  5. Annotations: it contains all the annotations that have been done by the users with the annotator tool. Each annotation is described by a label and a body-part.

### 2.2.2 WML Back End

The WML back end system consists on the following main components:

- CKAN metadata management: The CKAN is used as a data and metadata management system. It provides tools for publishing, sharing and finding the data that are stored in the system.
- CKAN search engine: The CKAN provides a powerful search engine that is also used in the annotator tool.
- CKAN API: One of the advantages of CKAN is that it provides an API making it easier to access data from other systems. The annotator tool takes advantage of this feature and consumes the data needed by using the CKAN API.
- Media streaming: The WML back end system communicates with the CKAN using its API in order to get the needed information. It then uses this information to get the video and the motion capture files via the streaming server. Finally, it streams the synchronized files in the Viewer page.

### 2.2.3 WML User Management

User Management is an authentication feature that provides the administrator with the ability to control the state of the users in the system. This feature has been added to support the annotation feature of the platform. Each registered user has the possibility to add annotations on the recordings.

The User Management system is based on the concept of users logging in and out of the annotator tool. To become authenticated users, they firstly have to register in the platform (Figure 6).
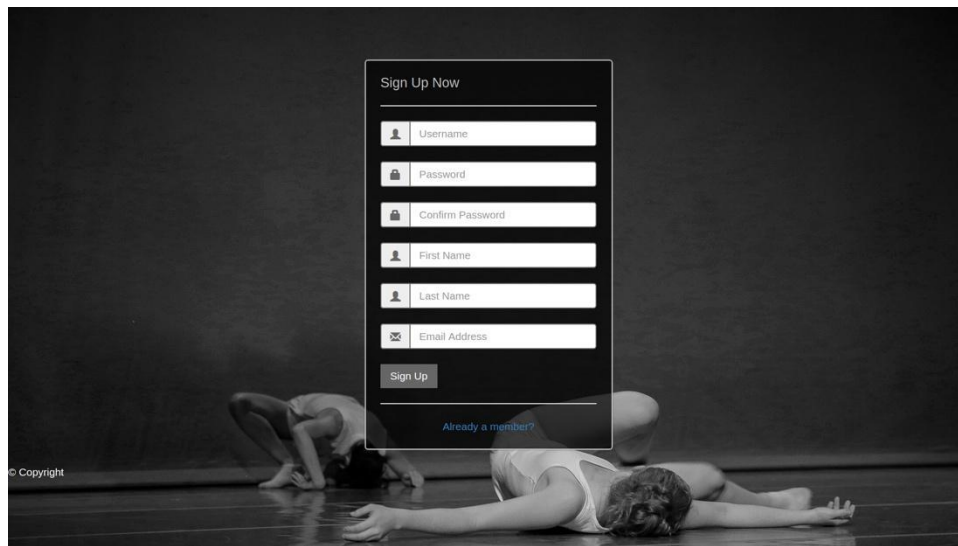
**Figure 6** The WML registration form

A user is registered in the system after successfully submitting a registration form (Figure 7).
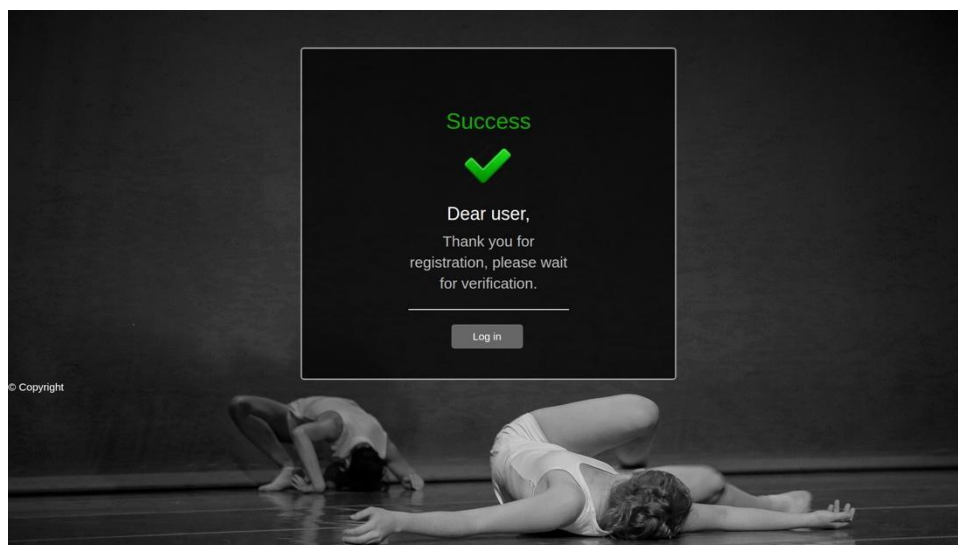


**Figure 7** WML Successful registration message

In order for the user to be able to interact with the tool, the administrator must approve the account. The administrator has the ability to enable or disable a user account at any point. After this process, the user is allowed to log in using the log-in form (Figure 8) and use the annotation tool.
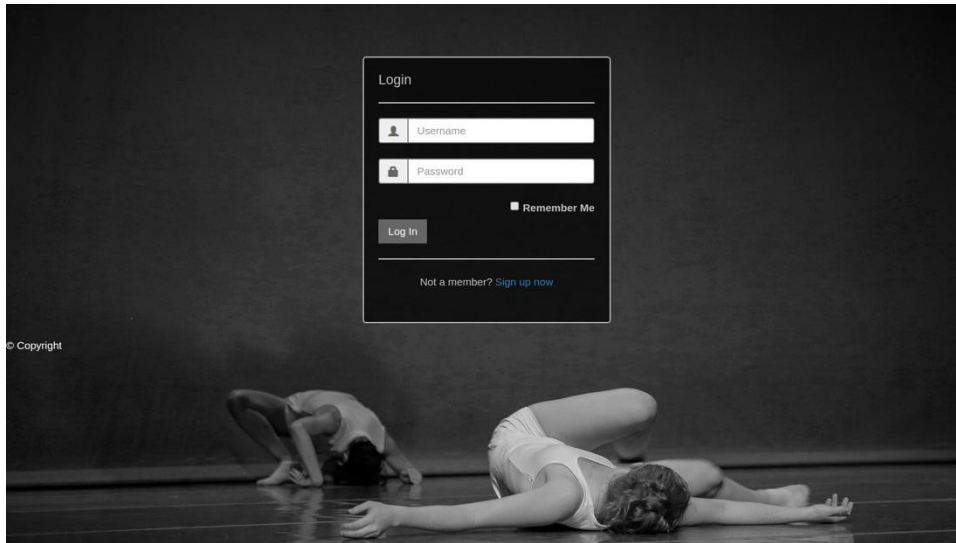
**Figure 8** The WML login form

### 2.2.4   WML User Interface

The WML is a web-based application that has been developed according to the principles of the MVC architecture. The Spring Web MVC framework, which provides Model-View-Controller (MVC) architecture, has been selected, so as to offer flexibility, during the development process.

Model–View–Controller (MVC) is a software design pattern for developing web applications. It divides a given application into three interconnected parts in order to separate internal representations of information from the ways that information is presented to and accepted from the user.

As far as the view component is concerned, it could be described as the presentation of data in a particular format, triggered by a controller's decision to present the data. More specifically, the JSP script based templating system, has been used as a view component, integrated with AJAX technology.

By using the JavaServer Pages (JSP) technology, dynamically generated web pages were created, based on HTML.

Bootstrap, an open-source front-end web framework, was preferred as the best option, in order to design and implement the interactive web application, WhoLoDancE Movement Library. Bootstrap was utilised, as it contains HTML and CSS based design templates, as well as optional JavaScript extensions.

Finally regarding the functionalities that are supported in the client-side, the scripting language, Javascript, has been used. Its use is primarily for DOM Manipulation, AJAX Calls and Validation. Features such as the player's functions, synchronisation between the video and the mocap, as well as services supported by the annotations table, have been all developed with Javascript.

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## 2.3  Security

One of the basic components of the system is the authentication of the users accessing the platform to ensure the security of the data that are saved in the ftp server repository. A user can access the data by using either the sftp or the http protocol. In order to secure the data, there is an authentication step before accessing the ftp server.

Another component is the CKAN data and metadata management. Following the same method, a user must be authenticated in order to access the metadata for each recording in the system. Finally, the annotator tool has to follow the same principles. For that reason, a user management system has been developed. To ensure the protection of the data within the annotator, user roles where created as well as an administrator role. The administrator has the ability to accept or decline a newly registered user and also has the ability to enable or disable a registered user.

# 3 Functionality

Data management is one of the most significant needs that have emerged during the WhoLoDancE project. Towards this direction, the development of WhoLoDancE Movement Library aims to serve as the interface between users and the WhoLoDancE repository. More specifically, the application is a web-based platform, which provides access to the WhoLoDancE repository through a friendly and versatile interface. The current web application supports several discrete functionalities, such as searching, browsing and viewing recordings. Regarding the visualization functionality, a special player has been developed to allow the synchronised playback of a video and its corresponding motion capture file. Finally, not only the users have the opportunity to view the recordings but also to annotate them.

Future work includes several new functionalities to address the users' expectations. A timeline that will operate as viewer for the positions on annotations, as well as, personal channels and playlists, are two examples towards that direction.

## 3.1 Search by keywords and Browse using Dance Genre

### 3.1.1 Description

Figure 9 demonstrates the Movement Library's main interface. The home page has been designed and developed in order to offer two fundamental functionalities, searching and browsing the WhoLoDancE recordings.

The home page serves as the medium that allows users to search and browse the WhoLoDancE repository with the dance genre as the starting point. On the top of the page, the navigation bar is located. The navigation bar includes the WhoLoDancE icon (link to the home page), the search bar in the middle and the users' "Log out" option on the right corner. Regarding the browsing process, four circle icons have been included in the middle of the page, in order to cover that specific need.
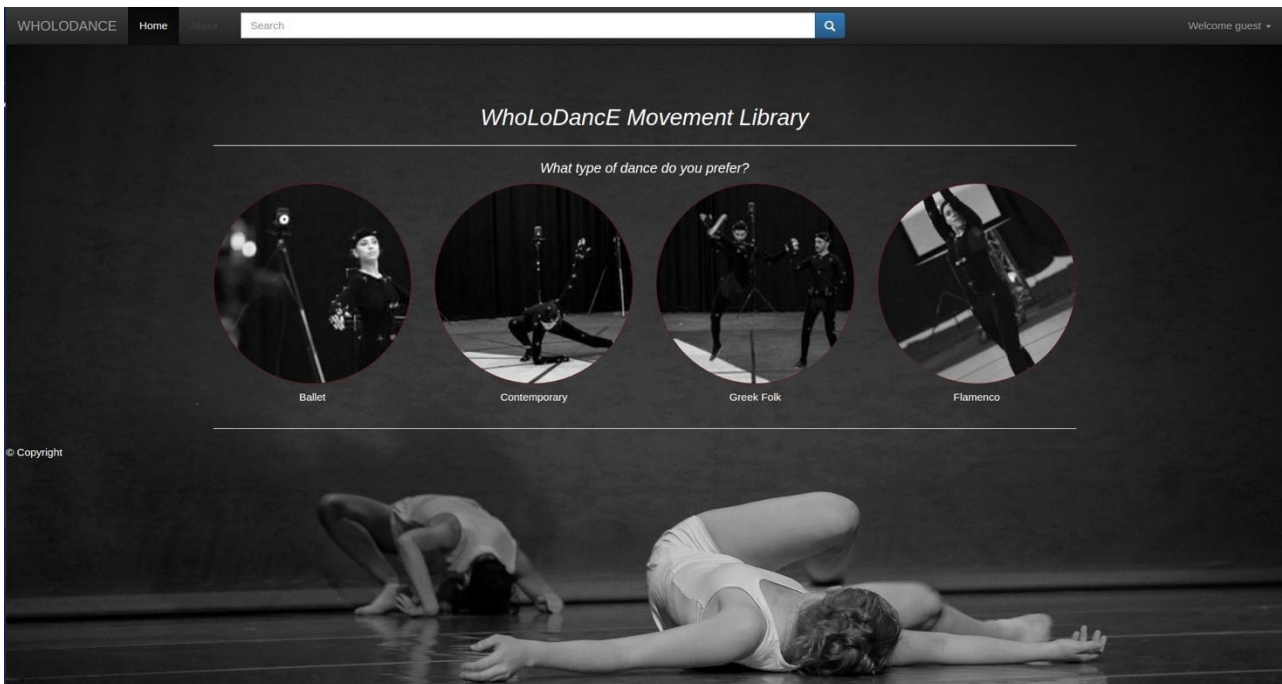
**Figure 9** The WhoLoDancE Movement Library's Home page

### 3.1.2 Related Requirement

The WhoLoDancE Movement Library satisfies the users need for both fast and effective data search through keywords that refer to the recordings characteristics.

However, in many cases, there are also several users that might be interested simply to obtain an insight into specific dance genres through browsing and then watching the recordings.

### 3.1.3 Status

The WML search by using keywords functionality, as well as browsing the data through the dance genre, are features that have already been completed.

### 3.1.4 Specifications

The WhoLoDancE Movement Library works as a search engine, as well as, an efficient viewer for the users. By using the current application, users are able to search and browse the WhoLoDancE repository.

Each recording includes several discrete characteristics, such as "Title", "Dance genre" and "Performer". Taking advantage of the search bar, users are able to track the necessary recordings, by simply using keywords that refer to the file's traits. More specifically, the search process takes place by using the metadata as keywords. Title of the recording, keywords in the title of the recording (syllabi terminology, body parts, concepts connected to Movement Principles etc.),

dance genre, movement principles and performer, can be used as valid input in the search bar field.

However, users are also able to browse the data, through the four circle-image buttons that are located in the center of the page. Each circle refers to a specific dance genre. Clicking on one of them redirects users to the next page that gathers all the results that are related to the selected dance genre.

### 3.1.5 Future work

Future work includes important modifications that are related to the home page's interface, as well as the search bar functionalities.

Considering the fact that viewers are prone to examine a layout by following the F rule (F-Layout refers to specific design rules that are related to the UI and UX improvement), the search bar will be moved in the center of the home page.

Regarding the search bar functionalities, advanced search will be provided to the users. The search bar will be able to support both search with keywords, as well as search with combination of keywords. Those functionalities will play a decisive role in providing an effective search engine.

## 3.2 Explore the search results

### 3.2.1 Description

After searching or browsing by using the dance genre as a starting point, users are able to browse the results. More specifically, users are redirected to the search results page, in order to select the recordings that they were looking for (Figure 10).

The results page is able to help users in obtaining an insight into specific recordings. Users are informed for the total number of results that are produced by their search. Moreover, each recording is combined with several details, such as "Title", "Genre", "Performer" and "Date of recording". In order to assist the viewing process, the results page, has been enhanced with functions for filtering and paging the results.



**Figure 10** Search Results page

### 3.2.2 Related Requirement

After searching by using the metadata as keywords or after browsing by using the dance genre, users need to view the related recordingsand learn more about them through their related metadata.

In several cases, the number of the returned recordings is enormous. To this end, additional functionalities are needed to assist the users in locating the recording that interests them.

### 3.2.3 Status

The functionality of presenting and filtering all the recordings that have been produced by the search action has been completed.

### 3.2.4 Specifications

The result page assists users to manage the data that came out as a result of the search or browsing process.

On the top of the white panel (under the search results title), the number of the results that were found for a specific keyword, is written. Under the number of results, the recordings are shown. Each row corresponds to a distinct recording. Every recording is presented with a title, the performer's name, the dance genre and the date that it was recorded. Moreover, users are informed, which of those results are already annotated and how many annotations have been made.

Furthermore, the search results page, offers the opportunity to filter the results considering their unique traits. For instance, users can select only those recordings that have been mentioned as annotated. Three filter categories have been already implemented and they refer to their annotations, the dance genre and the performer's name.

### 3.2.5 Future work

Regarding the search results page, most of the expected features have already been implemented. The future work involves adding more complex filters, such as filters that refer to the time, during which the recordings or the annotations were modified.

## 3.3 Viewer/Player

### 3.3.1 Description

It was essential to allow users to both search for specific recordings as well as view their content. For that reason, a special player was developed. The player is responsible to synchronise the video and the motion capture files that refer to the selected recording, offering the opportunity to simultaneously watch and handle both the mocap and the video (Figure 11).
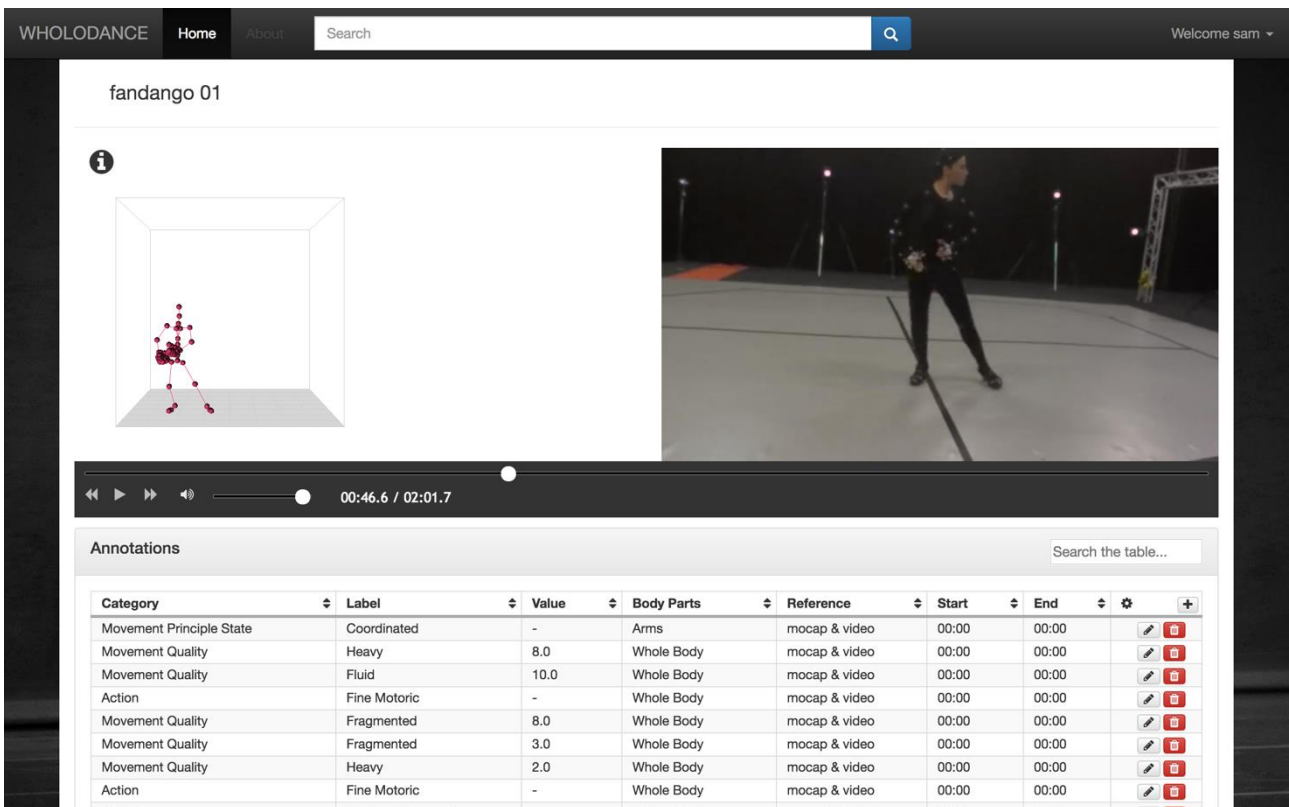


**Figure 11** Viewer/Player
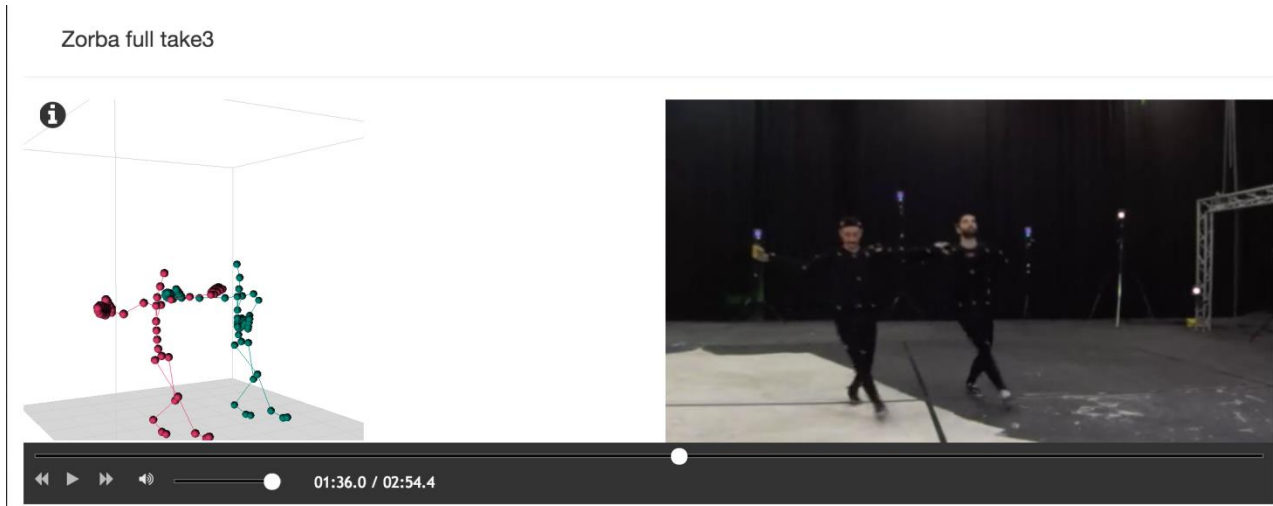
### 3.3.2 Related Requirement



**Figure 12. Synchronized view of the motion captured movement with two dancers using a skeleton 3D model, and the video**

Users need to access the WhoLoDancE Movement Library in order to watch their selected recordings. The player is able to support the synchronised playback of a video, as well as the matching 3D avatar of the mocap. Play, pause, move forward and backward, are some of the most important needs. Moreover, specific guidelines that explain the interaction with the player structure also play a decisive role.

The 3D skeleton of the mocap is capable to improve the process of watching and analysing the motion of a dancer. This is why it is useful to provide interaction features, such as rotate, move, zoom in and zoom out the cube of the avatar.

### 3.3.3 Status

The basic structure of the player has already been completed.

### 3.3.4 Specifications

The player that was implemented, provides a view for the synchronised playback of the 3D skeleton of the mocap and the video. The player is combined with fundamental functionalities that allow users to handle the recordings. Users are able to play or pause the recording. Moreover, they are able to rewind or forward the media moving with precision of tenths of a second. A slider that allows regulating the volume of the sound has been included. Finally, there is a seek slider that allows users to seek a specific timestamp of the recording.

The player allows the users to interact with the 3D skeleton of the mocap. More specifically, users can interact with the 3D avatar that appears in the cube in order to watch the skeleton's motion

from a specific angle, as well as to analyse the dancer's movement. They have the opportunity to zoom, rotate and move the 3D avatar, by simply using some short-keys and their mouse. The player includes an information button that can help users to obtain an exhaustive knowledge on how they should use the player and interact with the 3D skeleton.

As it was already mentioned the 3D avatar appears in the cube. If the recording involves more than one performer a special function is responsible to present the 3D avatars with different colours, allowing users to distinguish the dancers, as well as to annotate their movements separately (Figure 11). The small spheres that are combined with the 3D skeleton are used to separate the dancer's joints.

### 3.3.5 Future work

Even though, most of the basic functionalities have already been implemented, some extra features will be developed in the future.

The first feature is related with the parallel monitoring of the video and the 3D skeleton. It would be useful, to offer a button that will allow independent viewing of a video and a mocap file.
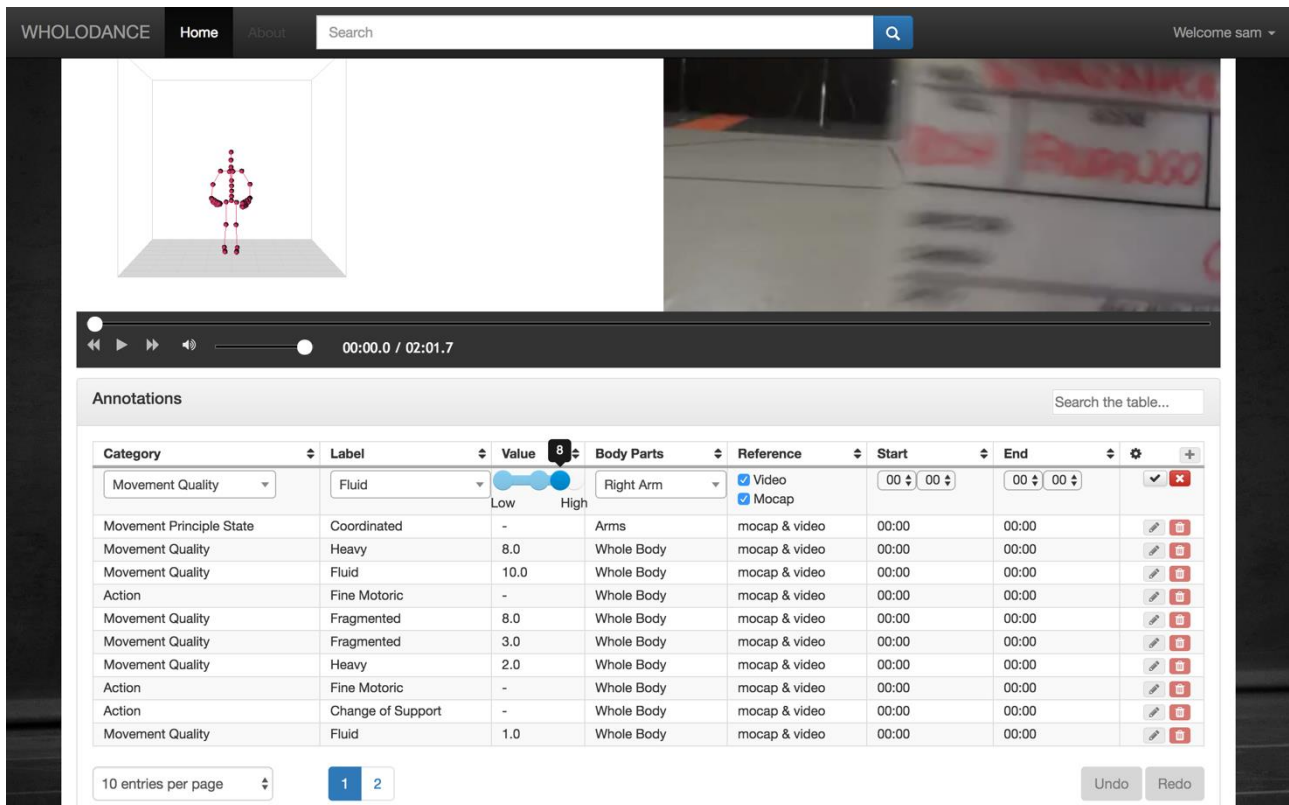
The second feature will provide users with time points, when a specific point on the seek bar is hovered by the mouse.

## 3.4 Annotations table

### 3.4.1 Description

Each recording that is stored in the WhoLoDancE repository, can be accompanied by several annotations that describe and analyse the dancers' motion. For that reason, it was essential to develop a specialised structure, which allows users to quickly add or alter annotations.

More specifically, during the development of WML, a new table structure was developed, in order to support the necessity to manage annotations (Figure 13).

**Figure 13. Annotations table**

### 3.4.2   Related Requirement

Users would like to be offered the possibility to add and edit their own annotations on the content in an easy and efficient manner.

### 3.4.3   Status

The "Annotations Table" structure has already been completed.

### 3.4.4   Specifications

In WML, users have also the opportunity to add annotations that refer to the dancers' movement.

For that purpose, a specialised structure has been developed. The "Annotations Table" provides an efficient way to add, edit and delete annotations. However, it also includes several useful traits, such as searching the table with keywords, regulating the number of annotations that will emerge in each page, as well as sorting the columns of the table. Finally, undo and redo methods have been implemented, in order to provide flexibility and safety.

The table is customised to support several features with Adding new annotations, editing and deleting the most ones. Add, edit and delete functionalities are possible in-line on the table structure, thus offering both flexibility and effectiveness.

The users can refresh the table content and search it, by using keywords. On the table's top-right corner, a search bar has been placed, in order to allow searching for annotations with specific keywords. Moreover, users can define the number of annotations that will appear in each table's page. Sorting the table's columns is also possible. Last but not least, the table provides error validation for every new insert, as well as undo and redo methods.

## 3.5   Add Annotation

### 3.5.1   Description

The table structure has been created, in order to collect the annotations, as well as to allow users to alter its content. The add row method is essential to help users to provide an easy way of adding new annotations. The process is possible inline by simply extending the table with a new row, which appears on the top (Figure 14).



**Figure 14** Add new annotation

### 3.5.2   Related Requirement

 Adding annotations is an important functionality and it should be taken into consideration that users are meant to add annotations, while the playback of the recording takes place.

Offering error checking is also important.

### 3.5.3   Status

The "Add Annotation" functionality has already been implemented.

### 3.5.4   Specifications

One of the most significant features provided by WML is the opportunity given to the user to add annotations. For that purpose, an add button has been placed on the top right corner of the table. By clicking the add button a new row appears, allowing users to describe the new annotation.

The procedure of adding a new annotation is driven by the application so as to help inexperienced users. The user is allowed to select the following options:

- Annotation Category

- • Movement Quality Descriptor

- • Movement Principle Descriptor

- • Action

- Annotation Label that corresponds in the category's selection

- Define a timestamp by choosing start and end time. The granularity of time is in [min, sec]

- Grade the "intensity" of the Movement Quality

- The Body Parts, in which the annotation refers to

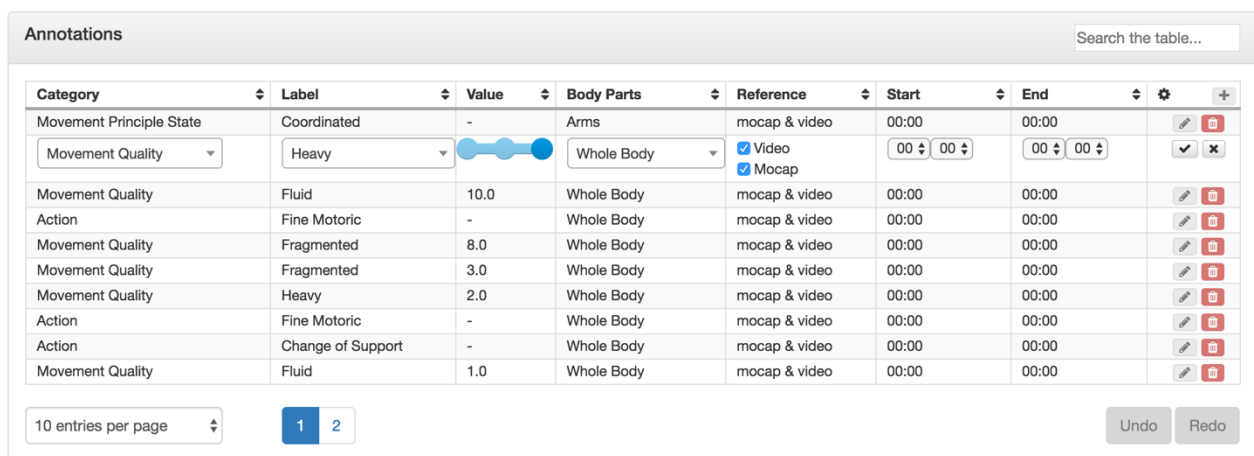The annotation's Category, Label, Body Parts and Timestamp are selected from a dropdown list. If the user decides the Movement Quality Descriptor, a slider appears in order to help them define the "intensity" of the Movement Quality. Of course, users can save their new annotation or cancel the operation. In case of an error, the structure provides error validation, as well as undo and redo methods.

## 3.6 Edit-Delete Annotation

### 3.6.1 Description

Another significant feature provided by the table of annotations is the opportunity to edit or delete annotations. Users are capable of editing or deleting their annotations with the simple procedure of pressing a button (Figure 15). During the edit process, which is available in-line with"autofocus" and "error validation".



**Figure 15** Edit Annotation

### 3.6.2 Related Requirement

Users need to be able to edit and delete annotations simply and efficiently. It is significant to assist users during the process of editing and deleting, with error validation and functionality, such as undo and redo.

### 3.6.3 Status

The "Edit Annotation" and "Delete Annotation" functionalities have already been completed.

### 3.6.4 Specifications

The process of editing an existing annotation resembles the adding process. Both methods are available inline, in order to provide clear, flexible and fast content management. Each user can modify their own previous annotations, by simply selecting the "edit" button, which corresponds to the annotation line.

The procedure of editing an existing annotation is also driven by the application, in order to help the inexperienced user. Error validation would protect the user from mistaken insert actions. The user is allowed to modify all the following categories:

- Annotation Category

- Movement Quality Descriptor

- Movement Principle Descriptor

- Action

- Annotation Label that corresponds to the selection of the category

- Start and end time.

- The grade of "intensity", if the category corresponds to the Movement Quality Descriptor

- The Body Parts, to which the annotation refers

With regard to the process of deleting an annotation, the procedure is simple and occurs by clicking the "delete" button that corresponds to the annotation. Both methods (edit and delete), are supported with the undo-redo feature, in order to allow the user to correct her actions.

## 3.7 Annotation Viewer

### 3.7.1 Description

For viewing the annotations, a timeline structure is going to be developed. The timeline viewer will be synchronised with the player. During the playback of the recording, a vertical line will mark the annotations that occur at a specific point in time (Figure 16).
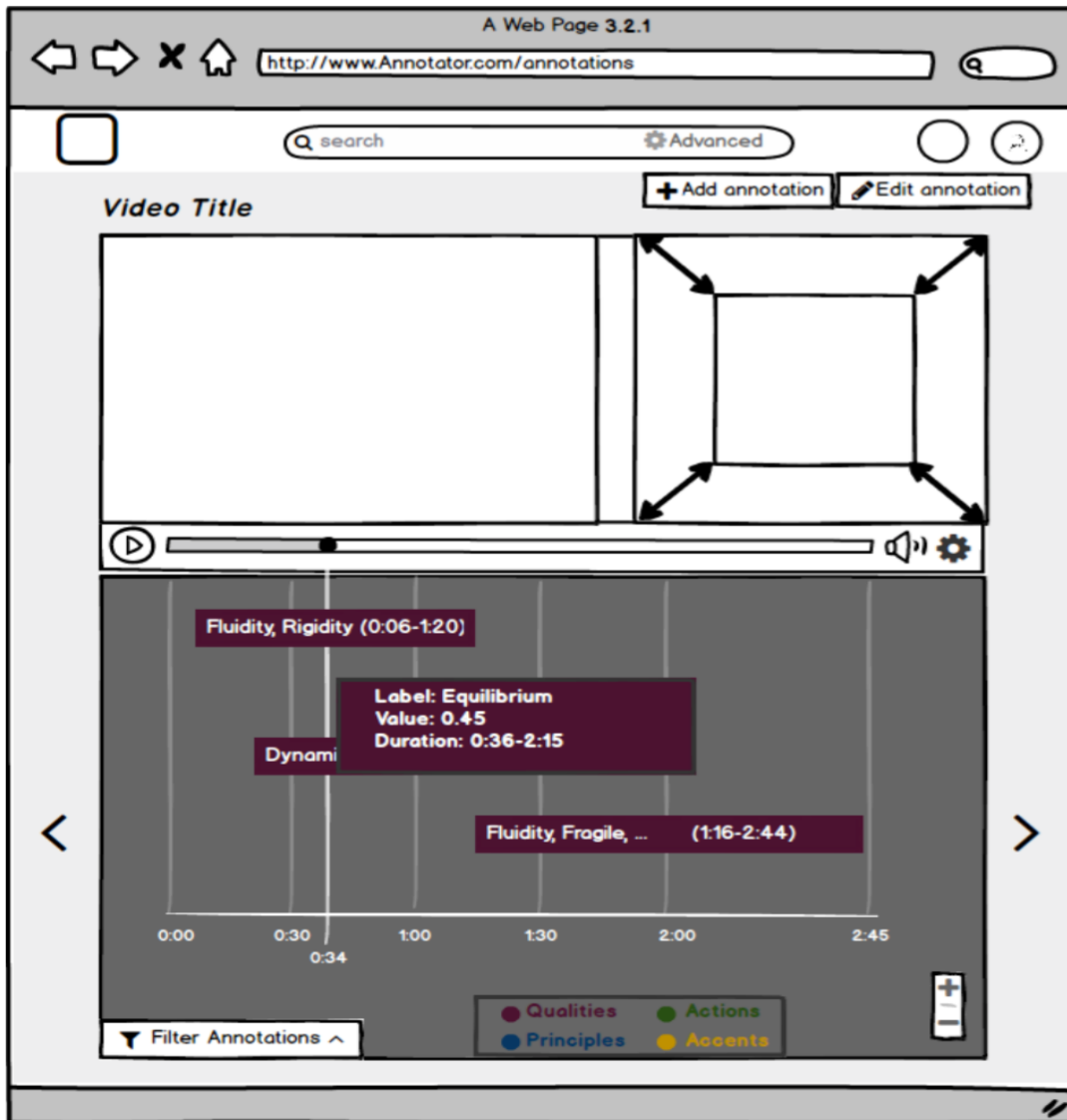


**Figure 16** Prototype for the timeline structure

### 3.7.2 Related Requirement

Users need to be able to view existing annotations both in a table format and on the player of the recording.

### 3.7.3 Status

The viewer's implementation has not started yet.

### 3.7.4 Specifications

The annotations view will be supported with the creation of a timeline structure. The timeline will be synchronised with the media player and it will show the annotation that corresponds to specific points in time. A seek bar is going to be included at the bottom of the timeline structure, allowing users to seek annotations that occur in specific time points. The annotations will be shown inside the timeline structure, above the seek bar's location.

Filtering the annotations that are projected in the timeline structure, as well as, zoom in and zoom out functionalities, should also be considered, in order to provide an efficient view of the annotation's table.

### 3.7.5 Future work

The annotations viewer is under design and development.

## 3.8 Playlist

### 3.8.1 Description:

WML offers a personalized playlist of the recordings.

The playlist, populated by the users' selected recordings will be combined with the player, in order to provide direct selection and playback, outside of the search process.

### 3.8.2 Related Requirement

Avoiding the repeated process of searching among several recordings, as well as the feeling of a personalised experience, are essential elements for a satisfactory user experience.

This observation highlights the necessity to create a unique personal channel for all users.

### 3.8.3 Status

The users' playlist and personal channel are still in progress.

### 3.8.4 Specifications

The personal channel assumes the role of a personal repository, offering users the possibility to create their own playlists. Each playlist is going to collect the user's selections, so as to provide to them a fast and efficient way of watching and annotating the recordings.

Users will be capable of tracking and saving recordings, in their personal playlist. Signing up will offer to all users a personal channel, in order to collect recordings and effectively manage their selections. Playlists will provide specific features, such as a "Play All".

The playlist is going to be combined and located near the recording's player box.

### 3.8.5 Future work

The playlist is currently under development.

# 4 Testing and Validation

This section presents the results of the testing and validation activities of the WhoLoDancE platform.

## 4.1 SWOT analysis

This section presents the SWOT analysis of the WhoLoDancE platform (Table 1).

Table 1 SWOT analysis of the WhoLoDancE platform

| Strengths | Weaknesses |
|---|---|
| WhoLoDancE Movement Library<br>■ Several functionalities are supported from the same platform, such as searching, browsing, viewing and annotating the WhoLoDancE recordings<br><br>Search/Browse<br>■ Accessing and searching the WhoLoDancE Repository, by using the metadata as keywords<br>■ Accessing and Browsing the WhoLoDancE Repository, by using the dance genre<br>■ Manages search results, with functions for filtering and paging the results<br><br>Viewer/Player<br>■ Provides a view for the synchronous playback of the 3D skeleton of the mocap and the video<br>■ Offers interaction with the 3D avatar of the mocap (zoom, rotate and move the 3D avatar)<br><br>Annotator<br>■ Annotates WhoLoDancE recordings<br>■ Inline adding, editing and deleting annotations<br>■ Provides fast and effective manipulation of the annotations<br>■ Searches the annotations with specific keywords | WhoLoDancE Movement Library<br>■ Offline use of the Platform is not supported<br><br>Search/Browse<br>■ Browsing is focused only on dance genre selection<br>■ Search process requires specific vocabulary<br><br>Annotator<br>■ Annotations are restricted on specific vocabulary |
| **Opportunities** | **Threats** |
| WhoLoDancE Movement Library<br>■ Could support specialized lessons, depending on the user's dance interests and skills<br>■ Could be used as a tool for dance lessons preparation<br>■ Able to provide integration with other dance tools<br><br>Search/Browse<br>■ Manage WhoLoDancE Repository, by | WhoLoDancE Movement Library<br>■ Users might find it difficult, to use the Platform from their personal devices, such as smartphones<br><br>Search/Browse<br>■ Users may not be positive towards a searching process with specific vocabulary<br><br>Annotator<br>■ Users might have difficulties, with annotating |

modifying the recordings' content

### Viewer/Player

- Project Annotations directly on the 3D avatar of the mocap
- Creation and manipulation of personalized playlists
- Provide suggestions depending on similar traits
- Provide suggestions depending on users' interests and dance skills

### Annotator

- Annotating by clicking on the 3D avatar
- Alter 3D avatar's appearance

on a table structure, while watching the recordings

## 4.2 Testing of the platform

The WML serves several roles and plays a key role in the WhoLoDancE project, as already discussed. This created the need to have, early on, some of the components ready at this moment in a beta version release, and iteratively enhance and improve these components, rather than setting a long-term deadline for a finalized product.  The approach we have followed, for the design, development and testing of WML, complies with the principles of Agile software development.
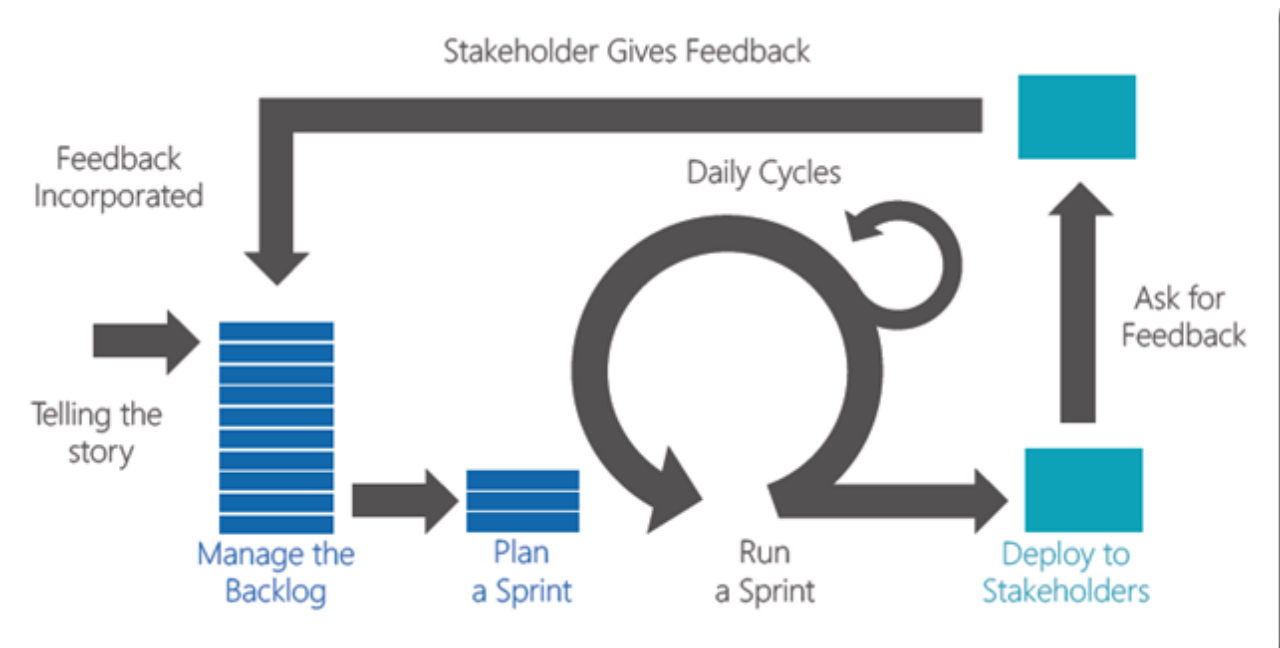


**Figure 17** Pictorial representation of the Scrum Agile development by Kishore Gaddam

Agile software development refers to a group of software development methodologies based on iterative development where requirements and solutions evolve through collaboration between self-organizing cross-functional teams. Agile methods or Agile processes generally promote a disciplined project management process that encourages frequent inspection and adaptation, a leadership philosophy that encourages teamwork, self-organization and accountability, a set of engineering best practices intended to allow for rapid delivery of high-quality software, and a business approach that aligns development with customer needs and company goals. Agile development refers to any development process that is aligned with the concepts of the Agile Manifesto. The Manifesto was developed by a group of fourteen leading figures in the software industry, and reflects their experience of what approaches do and do not work for software development. Read more about the Agile Manifesto.

Scrum is a subset of Agile. It is a lightweight process framework for agile development, and the most widely-used one. For example, the Scrum process framework requires the use of development cycles called Sprints

- A "process framework" is a particular set of practices that must be followed in order for a process to be consistent with the framework. (For example, the Scrum process framework requires the use of development cycles called Sprints, the XP framework requires pair programming, and so forth.)

"Lightweight" means that the overhead of the process is kept as small as possible, to maximize the amount of productive time available for getting useful work done.

Here below we describe how the twelve principles of agile development [10], are taken into account in the case of WhoLoDancE Movement Library design and development:

1. Customer satisfaction through early and continuous software delivery **–** Users are happier when they receive working software at regular intervals, rather than waiting extended periods of time between releases. In the case of WhoLoDancE, we substitute the word "customer", with our targeted user groups, dance experts and movement analysis researchers, and we implement smaller sprints, i.e., small parts of the software and functionalities that can be tested and presented early enough.
2. Accommodate changing requirements throughout the development process – The ability to avoid delays when a requirement or feature request changes. In the case of WhoLoDancE, we take into account the need for adjustments or modifications throughout the development.
3. Frequent delivery of working software – Scrum accommodates this principle since the team operates in software sprints or iterations that ensure regular delivery of working software. The first release of WhoLoDancE Movement Library interface was shared with all partners on M16.
4. Collaboration between the business stakeholders and developers throughout the project – Better decisions are made when the business and technical team are aligned. In addition, in WhoLoDancE, the decisions are taken in collaboration with the dance experts in the different genres.
5. Support, trust, and motivate the people involved – Motivated teams are more likely to deliver their best work than unhappy teams.
6. Enable face-to-face interactions – Communication is more successful when development teams are co-located. To comply with this principle in WhoLoDancE, the different teams including representative of all partners collaborate through regular skypes and meetings, when this is feasible.
7. Working software is the primary measure of progress – Delivering functional software to the customer is the ultimate factor that measures progress.

8. Agile processes to support a consistent development pace – Teams establish a repeatable and maintainable speed at which they can deliver working software, and they repeat it with each release.

9. Attention to technical detail and design enhances agility – The right skills and good design ensures the team can maintain the pace, constantly improve the product, and sustain the change.

10. Simplicity – Develop just enough to get the job done for right now. In the case, of WhoLoDancE, before implementing the interface we have exchanged a series of prototypes with the whole team.

11. Self-organizing teams encourage great architectures, requirements and designs – Skilled and motivated team members who have decision-making power, take ownership, communicate regularly with other team members, and share ideas that deliver quality products.

12. Regular reflections on how to become more effective – Self-improvement, process improvement, advancing skills, and techniques help team members work more efficiently. While WML is iteratively re-designed and developed, the first functionalities that are needed such as the Annotation system, are delivered and used by the dance experts. These provides the chance to have concrete feedback on 1) how the software delivers the functional and non-functional requirements and 2) Interface look and feel.

The remainder of this section presents the performance evaluation for the WhoLoDancE Movement Library. Four testers have applied the performance measures repeatedly throughout the development process.

The following tables present bug fixes identified as well as proposed improvements produced during the testing phase.

**Table 2 . Bugs fixed and Improvements related to Search/Browse Functionalities**

| Bugs\ Improvements | Status |
|---|---|
| Pagination | Done |
| Filtering results | Done |
| Show number of annotations in each result | Done |
| Show last time an annotation was added in each result | Done |
| Show the metadata in each result | Done |
| Show the duration of the recording in each result | Feature, Not Started |

**Table 3 Bugs fixed and Improvements related to Viewer/Player**

| Bugs\ Improvements | Status |
|---|---|
| Show two digits for minutes and seconds in timestamp | Fixed |
| Scale motion capture player | Fixed |
| Add annotation using a table row (inline) | Done |
| Undo / Redo functionality for table of annotations | Done |
| Sort table of annotations | Done |
| Search table of annotations | Done |
| View the title of the recording | Fixed |
| Synchronize video/motion capture based on video events | Done |
| Show timeline with the annotations | Feature, Not Started |

**Table 4. Bugs fixed and Improvements related to Annotator Functionalities**

| Bugs\ Improvements | Status |
|---|---|
| Initialize start time/end time of the annotation when you press the "add annotation" button with current time of the recording | Done |
| Scale motion capture player | Fixed |
| Streamlined input (when adding annotations, automatically select first field and move to the next when adding a value) | Done |

## 4.3 Evaluating design decisions

This section summarizes the process of reaching specific design and implementation decisions, after repeated testing and based on an Agile development methodology. The following section summarizes the outcomes of evaluating the design decisions and is part of the technical validation, whereas, a usability and user experience evaluation is planned as described in D7.1 [8].

### 4.3.1 Search/Browse

Browsing and searching are some of the most significant functionalities, provided by the WhoLoDancE Movement Library application. Regarding this process, several options have been investigated. Those tests were mostly focused on three aspects that are supported by the WhoLoDancE Movement Library.

Firstly, it was essential to define, which type of metadata would be more efficient to be used as a browsing criterion. More specifically, the Platform provides the opportunity, to browse the WhoLoDancE recordings, without searching. Before coming up with a decision, several different types of metadata had been evaluated, in order to decide the most useful and frequent trait, during the browsing process.

It was extremely important, not only to design a distinct and rapid way but also a method that uses the most important type of metadata as a mean for browsing. More specifically, it was essential to define the way, the structure, as well as the type of metadata that would be included in the browsing implementation, in order to ensure the users satisfaction.

Moreover, it was also important to develop a distinct, rapid and effective method that will serve as a step between the home page and the browsing-search results page.

Last but not least, defining the metadata that should be included as extra information in a search row, as well as serve as keywords during the search process, was also part of the evaluation measures.

After testing different approaches, the one that was selected was to provide browsing access through four circle image buttons, located in the center of the page. Considering the fact that many users might not be familiar with the application's dance vocabulary, the location and the view of the browsing method should be considered as essential elements. Each button corresponds to a specific dance genre, it has a title and a directly related image background. All those characteristics highlight the importance of that functionality.

Finally, through the evaluation process, the metadata that should be included as information in a search row, were defined. "Title", "Dance genre" and "Performer" were the final selections. Those were combined with extra details, such as the "Date" that the recording was created, as well as, the current "Number of annotations".

### 4.3.1.1 Viewer/Player

During the WhoLoDancE Movement Library's development, a custom viewer was implemented, in order to support the synchronised playback of the video and its corresponding mocap file. The Viewer-Player is an integral part of the WhoLoDancE Movement Library application. Player offers the opportunity to discover the content of recordings, as well as to watch them in combination with the 3D avatar of the mocap.

The formative evaluation process included tests to define solutions that refer to the player's layout and necessary controllers. Regarding the player, one of the most fundamental traits is the opportunity to handle both files by using a common toolbar. However, each file is also supported with its own functionality, such as zoom and rotation on the 3D skeleton of the mocap.

The necessity of simultaneously watching the video and the 3D skeleton was evaluated and carefully examined, during the implementation process. The evaluation process led to the construction of a custom player, combined with controllers that allow to handle effectively both files. The two views were placed side by side. The toolbar supports actions such as play, pause, move back and forward, as well as, handle the sound of the recordings.

Finally, the evaluation results highlighted the need both for common and distinct controllers. Not only does the Movement Library application support the above actions, but it also provides users with the opportunity to analyse the recordings, by focusing on the dancers' motion. The 3D avatar blends with additional controllers that allow users to rotate, zoom in and out, as well as alter the structure's position. Through those features, the Movement Library application totally meets with the users' expectations, offering a clear video analysis.

### 4.3.1.2 Annotator

The process of annotating, as well as managing the annotations that refer to a specific recording, was essential. Towards this direction, it was important to implement an effective way to allow users to manage the annotations with simple and fast actions.

Several approaches have been tested, before ending up with a table's structure that is able to support inline actions. Moreover, through the evaluation process, the need for additional functionalities, such as searching the table with keywords, emerged.

Speed and flexibility have been identified as crucial. Users should be able to annotate while watching the recordings playback. During the process of evaluation, several approaches were tested, in order to end up with the most appropriate structure. Firstly, the annotations management was the combination of a slideToggle (for the add annotation process) and a table (serving as a viewer with edit and delete functionalities).

However, after carefully examining all the options, the slideToggle structure was removed. In the final implementation, the annotating process was responsible to provide add, edit and delete

actions. More specifically, a table structure was designed that offers the opportunity to add, edit and delete annotations inline, simply by pressing a button on the table. Furthermore, users can take advantage of additional tools, also combined with the table's structure, in order to search and sort the annotations.

# 5 Conclusions - Future plans

The WhoLoDancE Movement Library application is a strong and innovative tool that could easily be extended, in order to support additional functionalities. Future plans include user evaluation to identify issues related both to usability and user experience and prioritize new features.

In the immediate next period, a timeline structure will be implemented in order to support the annotations visualisation. The timeline will be placed under the player's box to present the content of the "Annotations table" depending on specific timestamps.

Regarding the search process, advanced search is part of the future plans. This will be combined with additional filters that will enhance the results manipulation experience.

Future plans, also include actions that will offer users the opportunity to have a more personalised experience. Towards that direction, each user's account will be combined with a personal channel. Users will be able to save recordings, as well as to create new playlists. Furthermore, the application will provide users with recommendations, based on their dance skills and interests. Finally, as part of a more personalised experience, dance lessons will be designed. Taking into consideration each user's personal characteristics, the application will provide users with dance lessons and exercises, serving as a private dance teacher. Rates and statistics related to the users' dance skills and progress, will be part of the WhoLoDancE lessons.

Last but not least, integration with other dance tools is definitely a significant part of our future plans. More specifically, a system that is capable of providing new suggestions depending on similar traits is the first step. WhoLoDancE Movement Library functionalities will be also enhanced with a new tool that will allow further manipulation on the 3D avatar of the recordings. Altering the avatar's view, adding new textures and movement traits is just a small part of the new tool's features.

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