This deliverable provides a detailed overview of the 3D Acrobatics experiment definition and requirements for both the experiment venue and EXPERIMEDIA facility operators. This document has been prepared considering particularly information contained in deliverables D2.1.1 (First EXPERIMEDIA Methodology), D2.2.1 (EXPERIMEDIA Baseline Components) and D4.2.1 (CAR Experiment Design and Plan).
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1. Executive Summary

This document describes the 3D Acrobatic Sports experiment to be implemented and driven at the CAR Venue within the EXPERIMEDIA project. The document deals with the description of the proposed experiment, its technical requirements and the description of the practical issues related to its implementation at CAR Venue.

The document is organized in several sections starting by this executive summary covered in Section 1. Section 2 includes an introduction to the 3D Acrobatic Sports experiment. In Section 3 a detailed description of the experiment is presented including the definition of the experiment goals, the procedure to be followed in the experiment implementation at the CAR Venue, the experiment background, assumptions and preconditions, measurement parameters and known constraints. Privacy and ethical issues are tackled in Section 4; input from D5.1.2\(^1\) was used as orientation for this section, as was done in other deliverables within the project. In Section 5 the details of the experiment design are highlighted. Section 6 contains the description of the practical implementation of the proposed experiment and an approximated timeline for the experiment implementation is included. Section 7 deals with the risk associated to the conception and deployment of the proposed experiment. Finally Section 8 collects the conclusions of the whole document in a comprehensive manner.


2. Introduction

EXPERIMEDIA is a collaborative project aiming to accelerate research, development and exploitation of innovative Future Media Internet (FMI) products and services through test beds that support experimentation in the real world which explore new forms of social interaction and experience in online and real world communities. Within this framework the 3D Acrobatics experiment focuses on high quality content production for assessment and improvement in gymnastic exercises by the use of motion capture technologies. The goal of this experiment is to record training sessions of gymnastics at CAR and automatically generate assessment data for helping the athletes improve their performance. These 3D motion capture data will also be used to compute metadata which will be synchronized and saved with the athlete’s motion in order to provide a valuable 3D graphics and augmented reality experience. The experiment will make use of the connectivity and storage facilities available at the CAR Venue.

3D Acrobatics will make use of 3D graphics as well as augmented reality and synchronization with external video. The experiment will perform research on synchronization of 3D motion capture, video and metadata. The experiment will lay emphasis on the quick delivery of data to the athletes and trainers. To this end it will make use of mobile devices (such as tablets, laptops, etc.) in order to collect data from the inertial sensors and provide feedback to the users in real-time on almost any platform (computers, tablets, laptops, smartphones, etc.). The information gathered by the inertial sensors will be transferred to a local computer, laptop or tablet. This device will store locally the motion capture data and will connect through a Wi-Fi connection to the server. A data manager (software module) will manage this information in the cloud making it available to the community (to whom the administrator or athlete will grant access). In this way the athlete will have the possibility of sharing her/his data with trainers, colleagues and mates who might be geographically distributed, thus enlarging her/his experience in training and gymnastics.
3. Experiment description

The 3D Acrobatics experiment focuses on high quality content production for gymnastic training sessions including 3D motion capture based on inertial sensors and 3D biomechanical analyses.

The use of inertial sensors for motion capture in training sessions for gymnastics and other sports can be an important improvement for the assessment and training of athletes. Thanks to its reduced size (see Figure 1) inertial sensors can be easily attached to the athlete’s body without compromising her/his mobility in anyway.

Another important characteristic of these sensors is that each one includes its own Bluetooth antenna which allows it to connect directly to the device hosting the antenna. This feature
facilitates dramatically the task of fixing the sensors on the athlete’s body since no wires are required at any moment (see Figure 2).

3D Acrobatics will carry out research on synchronization of motion capture data gathered from the inertial sensors, video obtained from the cameras available at the CAR Venue and metadata. The experiment will concentrate on the use of all those elements in the training process and on the improvement of the athlete's technique. In the event that the training session is recorded using stereoscopic (3D) HD cameras this video will also be stored on the sessions' repository. The input will come from the collaboration with the EXPERIMEDIA experiment CONFetti.

As the experiment will take place in the CAR Venue the interaction between athletes, trainers and other professionals involved in the preparation of the athletes will be ensured. This interaction will enable athletes to improve their performance.

Mobile devices such as tablets or laptops will be used to collect the data from the inertial sensors. Motion capture data will be displayed on those devices in real-time providing in this way instantaneous feedback to trainers; athletes will benefit as well of this display since they will get feedback immediately after the exercise is performed. An example of the use of such devices is depicted in Figure 3.

![Figure 3. Use of tablets for collecting motion capture data.](image)

3D motion data will be collected by a computer connected to mobile devices using a Wi-Fi access point. This computer will upload the information to a repository in the server. This data will be analysed in order to generate metadata that will be used for generating rich augmented reality contents by the use of advanced 3D graphics.

Finally the 3D motion capture data and the synchronized video and metadata will be stored in the cloud. A data manager module will allow the athlete to access her/his data and share it with trainers, colleagues and mates who might be geographically distributed. In this way the athlete will be able to share experience with a large and distributed community. The athlete will be able to get advice from other trainers as well as remarks from other athletes. To this end it is foreseen the development of a user interface in order to support the use of mobile devices, such as tablets, etc.
3.1. Learning objectives
The learning objectives for the 3D Acrobatics experiment are grouped in four different categories depending on the stakeholder considered in the experiment.

3.1.1. CAR venue
CAR focuses on the application of new technologies to the training process. In order to achieve this goal CAR makes available a set of technological assets for supporting the training activities of athletes and trainers. Therefore the main goal of the 3D Acrobatics experiment for the CAR will be to verify that technological assets provided to trainers and athletes are adequate. It will be verified that the infrastructure available at CAR provides full support for the deployment of the experiment and makes it possible to obtain the desired results in terms of improvement of training facilities. This assessment will be done by verifying the following points:

- Experience on the use of the inertial motion capture system at the CAR Venue.
- Reliability of the results obtained with the inertial motion capture system.
- Use and reliability of the connectivity of local network.
- Practical experiments on the use of GigE cameras available at the training rooms jointly with the inertial motion capture system.

In addition the use of FMI products will be verified and the benefits which can be derived from its use in the area of training high performance athletes will be investigated.

3.1.2. Trainers and athletes
The main goal of trainers and athletes in gymnastics is to improve the individual technique of the athlete in order to be in the best position to win the competition. For achieving this goal athletes and trainers make use of all the elements which are made available by the training centre where they develop their activities. Trainers and athletes are not particularly interested in the principles or the operation of the technological assets that are made available by the training centre. Instead they are more concerned about the practical results that can be achieved by the use of the technology. Keeping these concepts in mind the main goals for trainers and athletes are included in the following list:

- To verify that the inertial motion capture system can be comfortably used by the athlete performing a training session.
- To verify that the results delivered by the motion capture system provide additional value to the current training methods; trainers and athletes have to corroborate that the data provided by the inertial motion capture system are reliable and useful for improving the athlete's technique and the trainer's approach to training.
- The athlete's understanding about her/his own motion and technique is significantly increased.
- The time required to improve a given exercise or technique is decreased if compared with "more traditional" training methods or tools.
- The cooperative environment provided by the FMI tools significantly increases the training potential for both the trainer and the athlete.
3.1.3. EXPERIMEDIA modules

The 3D Acrobatics experiment will make use of two modules developed within the EXPERIMEDIA general architecture:

- the ECC (Experiment Content Component) which will be used for monitoring data and
- the AVCC (Audio Visual Content Component) which will be used to synchronize the motion capture data with video and metadata.

In addition the 3D Acrobatics experiment will interact with the stereoscopic (3D) HD video recorded by the CONFetti experiment. 3D Acrobatics will provide motion capture data while CONFetti will record 3D video images. The combined information will be stored in the experiments' repositories.

3D Acrobatics will also interact with the software developments made by ATOS in the CAR experiment. In this way it will be possible to provide the trainers and athletes a common look and feel for the graphic user interface (GUI) of the different experiments carried out at the CAR Venue.

3.1.4. Experimenters

The experimenters are interested in the development of the 3D Acrobatics experiment in order to look into the application of inertial motion capture systems in the training methods of high performance athletes as well as to explore the possibilities of FMI in sports training. From this perspective it can be considered that the goals pursued by the experimenters are a compendium of the particular goals listed in previous sections for each different actor in the proposed experiment. The following list summarizes the most relevant goals for the experimenters:

- Comfort on the use of the inertial motion capture system in practical training sessions.
- Reliability of the motion capture data recorded in a practical training session.
- Experience of the practical use of inertial motion capture systems in the training facilities of a high performance centre.
- Relevance of motion capture results for the trainer and the athlete for the improvement of the athlete's individual technique.
- Time required for the application of the motion capture results for the improvement of a practical training session.
- Practical helpfulness of sharing the motion capture data video and metadata through FMI products in order to improve athlete's individual technique.
- Investigation on the use of this technology for the improvement of the technique of non-professional athletes.
- Research on the benefits for non-professional athletes derived from the use of FMI technologies.

3.2. Background

The High Performance Centre (in Catalanian, Centre d'Alt Rendiment, CAR) is an organisation which gives support to sport so that it can be competitive at an international level, optimizing
resources of the highest technical and scientific quality. CAR is a public rights organization according to the regulations in Chapter III of law 4/85, 29 March, which was made by the law 13/88, 31 December (DOGC 1088). It has its own legal requirements which works as a commercial organization and is autonomous. It is linked with the General Secretary of Sport, and has a financial agreement with the High Sports Council.

This centre aims at providing the athletes with everything necessary for their complete training so that CAR can share the knowledge of their activities. CAR considers the academic and humane training of each individual just as or even more important than the sports training. With this as a priority CAR gives athletes all the necessary help needed for their educational development. Athletes at CAR can attend classes of "Batxillerato" and "ESO" (compulsory secondary education) in the secondary school which is situated in the sports facilities, with a highly qualified staff. CAR has a hall of residence for training camps. An important number of national and international sports teams use CAR for their preparation and training in many different specialities: football, handball, volleyball, hockey, tennis, swimming, gymnastics, taekwondo, etc.

CAR is always looking at providing the best tools and techniques to the athletes and trainers who make use of its premises. As a confirmation of this motivation it can be mentioned the new building which has been recently integrated in CAR's infrastructure. Every single training room in this building is equipped with one or more GigE cameras integrated in the network, Wi-Fi connection, an involving sound system individually controlled, etc. Particular mention must be done of the installations in the swimming pools, the gyms, the gymnastic training rooms and the weightlifting facilities. It's in this framework of commitment with excellence where the experiments carried out at CAR venue are integrated.

The second party involved on the 3D Acrobatics experiment is STT Engineering and Systems. This is a SME located in San Sebastian (Spain). STT was founded in 1998 and since its origin has been committed to the development of motion capture systems and motions analysis software aimed at the improvement of the technique of both high performance athletes and non-professional sports practisers.

Besides CAR and STT, the development of 3D Acrobatics will require the interaction with ATOS. 3D Acrobatics will make use of the AVCC module for which ATOS is undertaking the development activities. In addition, ATOS is working with CAR in the development of the CAR experiment. It is considered that it will be worth establishing a close level of the collaboration between the two experiments in order to provide the final users (trainers and athletes) applications with similar GUIs.

At last but not least the collaboration between the CONFetti (developed by PSNC) and 3D Acrobatics (developed by STT) experiments is also considered. Experiments can benefit from the results of each other: CONFetti experiment can share 3D video with 3D Acrobatics while the latter can provide 3D motion data to the former.
3.3. Experiment procedure

3.3.1. Preliminary usage scenario
The story on which the scenario usage is based is described in the following lines. George and Michael are two young boys who live in a small village located in the north of Spain. They are very good friends and have been class mates until the end of the last course. They share the same enthusiasm for gymnastics and they have been part of the same club in the small village where they live. They are taking gymnastics very seriously, training very hard and devoting a lot of time to this activity. They both share the same dream: participating in gymnastics contest at the Olympic Games.

Last year they finished the secondary school and they are facing a tremendous change in their lives: they got the grants they applied for attending a High Performance Training Centre (HPTC). Michael was accepted in a HPTC in London while George was accepted in CAR in Sant Cugat. The two friends are now in different towns. They keep in touch through Facebook, Whatsapp and email.

After a few weeks Michael is getting frustrated because he is not able to improve his technique. He tells his friend that he has difficulties understanding the explanations of the trainer. Michael is not able to visualize in his mind the explanations given by his trainer about corporal expression, motion technique, etc. George tells his friend about a new technique he is using in his training sessions at CAR: motion capture. This technique is based on the use of small wireless sensors which capture the motion of the different segments of the body of the athlete and save the digitalized motion in the cloud. A software displays the motion of the athlete in real-time on the computer screen thus allowing to visualize what the actual motion has been during the training session. Using this tool the trainer explains to George how to improve his technique and George understands everything instantaneously. George says he was afraid of wearing the sensors for the first time. He was not sure how those sensors could affect his ability to perform a motion. However since the very first time he used the sensors he felt very comfortable with them; he realized that the sensors did not affect his mobility at all. Now he is using this system every day. His training sessions are saved in a server so he can access them at any time. His trainer uses the software on a laptop or tablet to show George how to improve his technique. In this way George can visualize the improvements after specific training exercises and over a given period of time. George explains to Michael other benefits of this tool such as getting advice from other trainers or colleagues who can access the motion files from the cloud from anywhere. These fellows can analyse George’s technique and evolution and provide him with useful advice.

Using the cloud George can share his motion files virtually with anyone in the world no matter where this person is located. George shows his friend how to access the cloud and visualize George’s training sessions. Michael finds this application amazing since its use allows understanding in a very simple way all the complexity of gymnastic training and techniques. He would like to have the same tool in London. In this way he is sure he will improve his technique; moreover he would have another way to exchange his experiences with his friend George even if they are in the opposite corners of the world.
3.3.2. Detailed procedure description

The scenario which describes the way in which the 3D Acrobatics experiment will be conducted is explained in the following points:

1) Setup of the inertial motion capture system at the CAR Venue. This step requires the availability of a set of inertial sensors and a computer or tablet running the motion capture application.
   a) In the setup the inertial sensors are linked to the Bluetooth manager of the host computer (either a laptop or tablet). This step only needs to be done once since the inertial sensors have a unique ID and the Bluetooth manager keeps track of the Bluetooth devices that have been linked to the manager in the past.
   b) Inertial sensors have to be switched on.
   c) Host computer is switched on and linked to CAR's LAN.

2) Inertial sensors are attached to the athlete's body. Inertial sensors are fixed to the athlete's body using straps with velcro or similar elements suitable to fix the sensors on the right anatomic positions. These anatomical positions will depend on the particular motion to be monitored and the particular type of analysis to be performed.

3) The athlete will perform the training exercise.

4) Motion capture data are collected and displayed on the host computer in real-time.
   a) Data collected by inertial sensors is composed of the rotations of the body segments to which the inertial sensors are attached to.
   b) Data from inertial sensors are collected in real-time.
   c) Data from inertial sensors are also processed in real-time so as to animate in 3D an avatar representing the motion of the athlete.
   d) Motion of the 3D avatar is displayed on the screen of the motion capture computer or tablet.
   e) Data are saved locally in the computer once the athlete finishes her/his exercise.

5) Once the training session is over, the motion capture files are uploaded to the server; eventually these files are uploaded with video files recorded by cameras available at the training room (or by stereoscopic 3D HD cameras if available).

6) The trainer or the athlete will have the option to create a video using the motion analysis tool provided with the inertial motion capture system; this video can be uploaded as the videos recorded as described in the previous point.

7) 3D motion capture data and video files (if available) will be copied from the motion capture computer to a repository located in a server available in CAR’s LAN or to the cloud.

8) Using the tools available in the AVCC component metadata will be created and stored with the motion files and videos files (if available).

9) 3D motion data and metadata will be shared among the individual athlete and the trainers and technicians involved in the development of this experiment.

10) Steps 2) to 9) will be repeated several times for each single athlete participating in the experiment in order to validate the proposed approach.
3.4. Assumptions and preconditions

The development of the 3D Acrobatics experiment is based on the following assumptions and preconditions:

- Technical infrastructure
  - Wi-Fi connection at CAR is available and working properly.
  - GigE cameras at CAR are available and working properly.

- Training facilities
  - Training facilities for gymnastics sports are available and ready to use.
  - Trainers are ready to use the inertial motion capture system.
  - Athletes are ready to use the inertial motion capture system.
  - CAR's technical staff is ready to train trainers and athletes on the use of the inertial motion capture system.

- Motion capture equipment
  - STT will provide inertial sensors.
  - STT will provide software for inertial motion capture.
  - STT will provide software for motion analysis.

- EXPERIMEDIA resources
  - ECC software module will be available during the experiment execution.
  - AVCC software module will be available during the experiment execution.

- Collaboration with CONFetti experiment
  - 3D model of an avatar will be shared between PSNC and STT.
  - An implementation of a VRPN server will be implemented.
  - Simultaneous recording of gymnastic sessions will be planned. PSCN will record the training sessions using stereoscopic and simultaneously the athlete's motion will be recorded using STT's inertial sensors.

3.5. Parameters

The parameters that will be measured in the experiment will provide a metric for objectively determining the level of success achieved in the learning objective defined in Section 3.1. The following parameters will be considered:

1) Number of training sessions successfully carried out using the inertial motion capture system.
2) Number of training sessions successfully carried out using simultaneously video and the inertial motion capture system.
3) Degree of comfort expressed by the athletes.
4) Number of sessions on which the analysis provided by the motion analysis software is successfully used to provide useful feedback to the athlete.
5) Time required to provide useful feedback to the trainer and/or athlete in a training session.
6) Number of training sessions uploaded (using ECC).
7) Average time required to upload a training session (using ECC).
8) Average time required to retrieve a training session (using ECC).
9) Number of training sessions with annotated metadata (using AVCC).
10) Number of training sessions with stereoscopic HD video (collaboration with CONFetti).

3.6. Constraints
This section deals with the potential constraints which have to be considered in the execution of the 3D Acrobatics experiment. These constraints can have different origins: physical constraints may be derived from the environment while other constraints may appear due to human factors.

- Physical constraints
  - Environment conditions must be tested before the use of the inertial motion capture system in order to verify that the training facilities are adequate for the use of such a system. For instance, it must be verified that there is no magnetic distortion in the training room.
  - Access to the training rooms must be ensured in the right periods of time for testing purposes.
  - It must be verified that the local network provides enough bandwidth to transfer motion files and video once those are recorded.
  - It must be verified that video can be recorded from the GigE cameras installed in the training rooms by using a trigger signal.

- Human factors
  - Trainers and athletes should be able to adopt the use of the inertial motion capture system during the practical training sessions.
  - It must be possible for athletes to use the inertial motion capture system during practical training sessions without affecting athlete's performance.
  - Training groups participating in the experiment have to be representative in order to allow deriving meaningful conclusions.
  - Part of the QoE experimental data will be collected by using questionnaires. These questionnaires have to be carefully designed in order to allow collecting meaningful data on the selected population.
4. Ethics and privacy

D5.1.2 and D5.1.3 have delivered a detailed discussion of ethical guidelines considering the EXPERIMEDIA project and its specification. The Privacy Impact Assessment (PIA) detailed in D2.1.1 is also an important source of principles. As all EXPERIMEDIA experiments need to be conducted in accordance with the EXPERIMEDIA ethical oversight procedures those principles will be integrated in an adequate way into the design of the 3D Acrobatics experiment as follows:

Informed consent

Before participants will be asked to join 3D Acrobatics experiment they will be informed of the research objectives and all aspects of the research that might reasonably be expected to influence willingness to participate. The participants in the 3D Acrobatics experiment will also be informed of all other aspects of the research about which they enquire. If personal data of the athletes will be processed informed consent is needed.

Deception

The experimenter will never intentionally deceive, mislead or withhold information from participants over the purpose and general nature of the experiment.

Data collection

The experimenter will only store user data necessary for the experiment. The users will be informed about what data is being stored and how it is being used in the experiment. User data will be anonymised in aspects where personalisation is not needed. There will be no commercial usage of the user data.

Withdrawal from investigation

Participants will be informed about their rights to withdraw from the experiment at any time and to require the destruction of generated data collected with their contribution.

Observational research

CAR is a private venue, so this clause is not applicable.

Data Protection Regulation

The 3D Acrobatics experiment will use the components provided by the EXPERIMEDIA project to store user data, thus ensuring accordance with EU directives.

Consortium Partner Responsibility

EXPERIMEDIA partners are invited to monitor and follow 3D Acrobatics experiment. In case of any concern, it will be consider and treated accordingly.
5. Experiment design

5.1. Experiment requirements
The requirements for the execution of the 3D Acrobatics experiment are summarized in the next points:

- Availability of CAR Venue infrastructure.
- Availability and cooperation of trainers and athletes.
- Availability of an inertial motion capture system.
- Availability of EXPERIMEDIA resources (modules ECC and AVCC).

The above list summarizes the technical requirements as well as the human resources needed to carry out the proposed experiment. This list is explained in more detail in Section 3.4.

5.2. System architecture
Figure 4 depicts graphically the system architecture to be implemented in the 3D Acrobatics experiment.

The functional building blocks of this architecture are the following:

- Inertial motion capture system
- Generation of video contents
- Synchronization of motion capture data with video and metadata
- Visualization of motion capture data for training purposes
- VRPN server

Figure 4. System architecture.
5.2.1. Building blocks description

5.2.1.1. Inertial motion capture system
The inertial motion capture system is a key element in the development of the proposed experiment. This application integrates three main functions which are explained in the next paragraphs.

Data collection
This is a function of the software application which is able to connect to a given set of inertial sensors and collect the raw data generated by the triaxial sensors integrated on it: a triaxial magnetometer, a triaxial accelerometer and a triaxial gyroscope. These triaxial sensors provide a set of nine degrees of freedom (raw data) which are converted into three-dimensional rotations by using a Kalman filter. Figure 5 shows the main window of the inertial motion capture application. In this picture the position (rotations) of a set of inertial sensors is depicted and the actual values of the rotation angles are shown as 2D plots.

Biomechanical models
The second function of the inertial motion capture application is the biomechanical module. This software component is in charge of analysing the data collected from the inertial sensors and translating it into a coherent kinematic skeleton of the human body. This kinematic model is in turn used to compute the biomechanical parameters relevant for the type of analysis that the trainer or athlete want to perform.

The output of the kinematic model is a set of biomechanical parameters which allow the trainer to evaluate the performance of the athlete during the execution of a set of exercises. Typically these biomechanical parameters comprise the elements described in the following points:
• Relative angle in the joints
  - Flexion/extension angles.
  - Abduction/adduction angles.
  - Internal/external rotation angles.

• Absolute angles
  - Internal/external angles frontal (coronal) plane.
  - Internal/external angles in the sagittal plane.
  - Internal/external angles in the transversal plane.

The type and number of biomechanical parameters provided by the biomechanical module depend on the number of inertial sensors used by the data collection module and the body segments where these sensors are located on the athlete's body.

In the scope of the 3D Acrobatics experiment the gymnastic exercise selected for the experiment validation is pommel horse. In this gymnastics speciality the most relevant parameters to be evaluated by the jury are:

• Flexion/extension angles at shoulders.
• Flexion/extension angles at hips.
• Flexion/extension angle between dorsal and sacrum (see Figure 6).
• Angle of athlete's trunk with respect to the vertical axis.
• Angle of athlete's trunk with respect to the perpendicular of the pommel horse.

In order to compute the parameters included in the above list the corresponding biomechanical models will be implemented using the biomechanical module. A model for the whole human body will require the use of 15 sensors. For the sake of simplicity during the practical evaluation several models will be implemented for the analysis of different effects using a reduced number of sensors. In this way the total number of sensors the athlete has to wear in a given test will be
kept reduced thus facilitating the practical execution of the proposed test. The models to be implemented are summarized in the following list:

- Model 1: 3 sensors to compute:
  - flexion/extension angles at shoulders

- Model 2: 4 sensors to compute:
  - flexion/extension angles at hips
  - abduction/adduction angles at hips
  - internal/external rotations at hips
  - angle between sacrum and dorsal
  - vertical and horizontal angle of dorsal with respect to the pommel horse
  - vertical and horizontal angle of sacrum with respect to the pommel horse
  - relative angle between dorsal and sacrum

- Model 3: 6 sensors combining models 1 and 2 in a single model
- Model 4: 7 sensors for physical evaluation of the lower train
- Model 5: 15 sensors for physical evaluation of the full body

**Motion analysis**

The third and last function of the inertial motion capture application is a software module which automatically generates a report for the captured motion. This module generates a 3D animation of the captured motion using a skeleton-like avatar. In addition this module can show the computed biomechanical data in the form of a report (see Figure 7).

5.2.1.2. Generation of video contents

This function will be an add-on function which will be implemented in the motion analysis module. Using this function the user of the inertial motion capture and analysis application will
be able to generate a video sequence of the motion of the avatar from a given viewpoint. This video will be saved together with the motion capture files used to generate it.

For the sake of compatibility with the AVCC module this video will be generated in H264 format.

5.2.1.3. Synchronization of motion capture data with video and metadata
In order to synchronize motion capture data and video (either recorded by GigE cameras of stereoscopic 3D HD cameras) a trigger function will be implemented in the inertial motion capture application. This trigger function will be implemented using a SOA approach. The trigger will be captured by the software implemented by ATOS in the CAR experiment or by the software developed by PSNC in the CONFetti experiment and will serve to launch the recording function of the corresponding cameras.

For the purpose of synchronizing the motion capture data and the metadata investigation will be carried out so as to use the same application developed by ATOS for the CAR experiment will be used.

5.2.1.4. Visualization of motion capture data
The motion analysis function of the inertial motion capture application will be used as visualization tool for the purpose of visualization of motion capture data previously recorded.

5.2.1.5. VRPN server
In order to collaborate with the CONFetti experiment a VRPN server will be implemented using version 7.30 of VRPN. In addition the geometrical model of the skeleton will be shared between STT and PSNC (using OpenSceneGraph 3.0.1 format).

5.2.2. Building blocks interaction
The interactions between the experiment’s building blocks will be done through motion capture data files and video files.

5.2.3. Technical assets
The technical assets that will be used for the implementation of the 3D Acrobatics experiment are summarized in the following list:

- Set of inertial sensors STT-IBS.
- Laptop or tablet for recording motion data with Bluetooth antenna.
- CAR’s Wi-Fi for accessing the network.

5.3. Data collection
Data related to the Quality of Service (QoS) and Quality of Experience (QoE) will be collected during the execution of the experiment by using the ECC module.
5.3.1. **Quality of Service**

Quality of Service data will be collected by the ECC module by components registered with it. These components will measure the number of training sessions successfully uploaded. In addition, this component will measure number of successful transactions, average time per upload, average time per download, average size of transferred files.

5.3.2. **Quality of Experience**

Quality of Experience will measure the opinion of final users of the experiment: trainers, athletes and CAR's technical staff. QoE information will be collected by using the questionnaires that will be specially designed for this purpose.

5.4. **Content lifecycle**

5.4.1. **Content authoring**

The main contents created in this experiment are motion files containing the actual motions performed by the athlete in a training session. These motion file will be recorded in CAR's training rooms by using the inertial motion capture application. These files will be saved in the repository by using the API developed by ATOS for this purpose.

In addition to the motion files the analysis module will be able to generate video files created from the 3D graphic engine. These motion files will be created in the appropriate format (see Section 5.2.1.2) and will be saved in the same repository as the motion files.

5.4.2. **Content management**

Content management will be performed using the API provided by ATOS in the context of the AVCC.

5.4.3. **Content delivery: transmission**

Content transmission will be performed using the API provided by ATOS in the context of the AVCC.

5.4.4. **Content delivery: visualization**

Content visualization will be performed using the analysis function of the inertial motion capture application.
6. Plan for implementation

The practical implementation of the 3D Acrobatics experiment will be carried out according to the following tasks:

1) Experiment design and definition. This task deals with the detailed definition of the experiment. The results of this task are reported in this document.

2) Adaptation of the inertial motion capture application. This task consists of modifying the software modules that solve the problem of tracking human motion using wireless inertial sensors. Current modules have to be adapted to the particular conditions existing in gymnastics (pommel horse). Modifications will involve the number of sensors used as well as the biomechanical models required to run the experiment as described in Section 5.2.1.1.

3) Generation of video contents. The objective of this task is the generation of a video file from the 3D engine integrated in the inertia motion capture application, as described in Section 5.2.1.2.

4) Synchronization of motion capture data with video and metadata. The main goal of this task is the implementation of a software module which allows the synchronization of the metadata with the motion capture data and video (generated or recorded) collected with the tools developed in the previous task. This software module will make use of the AVCC tools developed by ATOS.

5) Visualization of motion capture data for training purposes. The goal of this task is the implementation of a 3D visualization module which will be run on the devices hosting the Bluetooth connection with the inertial sensors. This visualization module will allow trainers and athletes to visualize athlete’s motion in real-time. It also will provide instantaneous feedback to the athlete once she/he concludes the execution of her/his exercise.

6) Implementation of VRPN server.

7) Experiment tests and evaluation.

6.1. Experiment implementation

6.1.1. Experiment preparation

The experiment preparation requires completing the following tasks:

- Experiment design and definition
- Adaptation of the inertial motion capture application
- Generation of video contents
- Synchronization of motion capture data with video and metadata
- Implementation of VRPN server

6.1.2. Experiment execution

The execution of the experiment comprises the following tasks:
• Visualization of motion capture data for training purposes
• Experiment tests and evaluation

6.1.3. Analysis of results

The analysis of results will start once the practical tests in the training rooms are performed and the corresponding motion capture files are recorded. Analogously the data for QoS and QoE collected in the execution of the experiment will be analysed in this phase.

The obtained results will be reported in the deliverable 4.7.3 'Experiments results and evaluation'.

6.2. Experiment implementation timeline

Figure 8 contains the approximated timeline for the implementation of the 3D Acrobatics experiment.

<table>
<thead>
<tr>
<th>ID</th>
<th>Title</th>
<th>Project month</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Experiment design and definition</td>
<td>10/2012 - 11/2012</td>
</tr>
<tr>
<td>2</td>
<td>Adaptation of inertial motion capture application</td>
<td>12/2012 - 01/2013</td>
</tr>
<tr>
<td>3</td>
<td>Generation of video contents</td>
<td>02/2013 - 03/2013</td>
</tr>
<tr>
<td>4</td>
<td>Synchronization of motion capture data with video and metadata</td>
<td>04/2013 - 05/2013</td>
</tr>
<tr>
<td>5</td>
<td>Visualization of motion capture data for training purposes</td>
<td>06/2013 - 07/2013</td>
</tr>
<tr>
<td>6</td>
<td>Implementation of VRPN server</td>
<td>08/2013 - 09/2013</td>
</tr>
<tr>
<td>7</td>
<td>Experiment development and evaluation</td>
<td>10/2013 - 11/2013</td>
</tr>
</tbody>
</table>

Figure 8. Experiment timeline.
7. Risks

Three different levels of risk are identified within the proposed experiment:

1) CAR Venue infrastructure has to be ready and available for the development of 3D Acrobatics. This means that all the networks infrastructure, servers and storage need to be available for the experiment. Meetings with CAR managers shown that all these issues will be guaranteed and therefore this risk is very low.

2) The availability of trainers and athletes is an essential element to perform a good experiment. In the case that trainers and athletes are not available or not really interested in the project, the quality of the results could be low. CAR managers have stated that there is a big interest both from the trainers and the athletes so the risk here is also very low. CAR managers are committed to the successful development of the experiment as it is the case for the full EXPRIMEDIA project.

3) Finally 3D Acrobatics will make use of ECC and AVCC components. As long as these components are under development a risk is identified in the availability of those software modules. At the current stage of development of the ECC and AVCC software components this risk is low. This point will be monitored during the execution of the experiment.
8. Conclusions

This document contains a description of the 3D Acrobatics experiment to be developed within the EXPERIMEDIA project. The document aims at describing in detail the purpose of the experiment (including a description of the experiment, its main objectives and its background as well as that of the main participants on it), the experiment design, its implementation plan and the potential risks associated to its execution.