



## The RePlay Newsletter

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*Not for sale.*

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## Editorial

Welcome to the fifth edition of the RePlay newsletter. To recap, RePlay is an exciting EU research project that began in March 2013 that brings together eight participants from five countries across Europe including Vicomtech-IK4 and Eusko Jaurlaritza from Spain, Vicon Motion and IN2 Search from the UK, Insight Centre for Data Analytics and the GAA from Ireland, the University of Geneva from Switzerland and the Centre for Research and Technology, Hellas in Greece.

The goal of RePlay, in a nutshell, is to develop novel technology to allow capturing aspects of our intangible Cultural Heritage that has been often overlooked, specifically European Traditional Sports and Games. In this second newsletter, we provide an update on the recent activities of the project, including details of research publications, new technical demonstrations, pointers to RePlay appearances in the media and details of any upcoming events.

We hope you enjoy learning about the RePlay project, through this and subsequent issues. If you are interested in our project, please don't hesitate to get in touch and don't forget to follow the project on Facebook, Twitter and YouTube!



[https://twitter.com/Replay\\_fp7](https://twitter.com/Replay_fp7)



<http://www.youtube.com/user/fp7Replay>



<https://www.facebook.com/Replay.fp7>

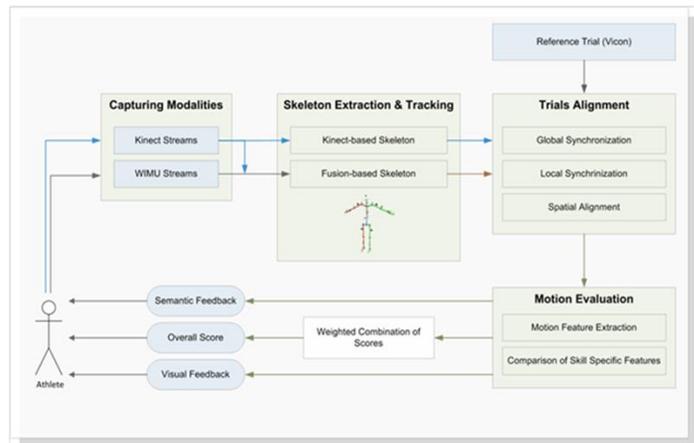
## Working towards the final RePlay prototype

### Short range motion capture

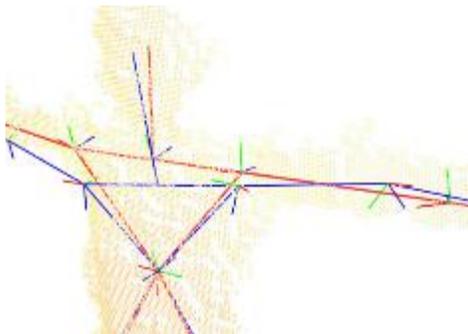
One of the key aspects of the RePlay platform is the need to extract an accurate and stable 3D skeleton of the athlete in real-time, as a combination of the different capturing modalities used within the RePlay platform (Microsoft Kinect devices, WIMUs, the VICON system, video-based approach). The fusion of different modalities provides several improvements when compared to the individual use, specifically considering the creation of an accurate animated 3D skeleton.

RePlay proposes a methodology to define the 3D skeleton of a human body, or a partial 3D skeleton using one Microsoft Kinect and several inertial sensors.

Such methodology applies the rotational estimation from the WIMUs datasets to animate a 3D reference skeleton.



The algorithms using the Microsoft Kinect sensor to estimate a 3D skeleton are used to determine the reference skeleton in a practical and automatic way. Moreover, the Microsoft Kinect is also used to track the global position of the athlete as the positions of the joints are not extracted from the WIMUs, except the ones induced by the rotation of the segments.



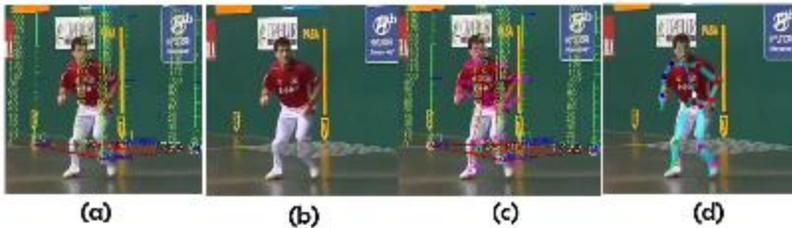
The performance of the Microsoft Kinect and the fused skeleton have been compared to the VICON system during the performance of knee flexion.

It was concluded that the fused skeleton is always closer to the results from the VICON system than the ones from the Microsoft Kinect.

### Video-based motion capture for legacy recovery

The main skills of National Heroes can be recovered also from traditional Sports and Games (TSG) video legacy recorded with non-calibrated monocular cameras. This reconstruction generates an animated 3D skeleton, representing the movements and poses of the player in a 3D environment. Once the skills of the players are extracted to an independent 3D environment, such 3D data can be used to generate digital virtual content to be shown in virtual museums, virtual immersive systems or videogames.

A reference element with known sizes is needed to define the floor. Field marks and billboards are good examples of reference elements. Such element is used to describe a rectangle over the field, defining the location of the player is defined by placing a set of 2D markers over the main body joints (head, shoulders, elbows, wrists, pelvis, hips, knees and ankles). A 2D human structure is used to define the location of the body joints in the image (c). The markers are used as the reference value in the reconstruction process (d).



The 2D positions of the scene elements (camera, ball and player) are computed in the key-frame in-between. The motion of the camera, the pose of the player and the trajectory of the ball are estimated for each frame using those 2D positions as input data for the 3D reconstruction.



To estimate the 2D position of the scene elements in the key-frame in-between, a combination of different cues (the texture-based tracking of visible body parts and objects, and the 2D projections of the interpolation of their 3D positions and orientations from key-frame to key-frame) is proposed. Such cues are weighted in accordance to the grade of occlusion. Constrained Inverse Kinematics (IK) are included in this process to reconstruct the player.

### Activity evaluation and comparison

The nature of the feedback depends on the targeted use case. For the PLAY & LEARN scenario, feedback will be in the form of numerical overall score, semantic feedback and visual representation of the 3D motion of the user next to the one of the National or Local Hero.

In the top-left case, the user (blue skeleton) just waved the hand instead of doing the underarm skill and the system responds about the irrelevant skill. In the top-right case, the user has performed a valid skill, but with less power than required. Thus, the system provides semantic feedback and overall score. A “very good” trial can be found in the bottom-left case congratulating about the progress, as the user bended more the elbow as previously suggested. On the left-bottom picture, the message is again the detailed feedback.



### Full body 3D reconstruction

The RePlay platform produces visually realistic 3D reconstructions of the athletes. The first partially-integrated RePlay capturing platform composed by the four Microsoft Kinect version 2 devices, has been used during the Oxford capturing session (6th – 10th October 2014) and the evaluation trials (January 2015).

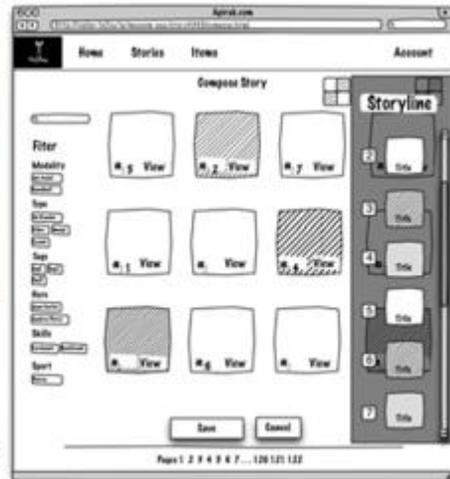
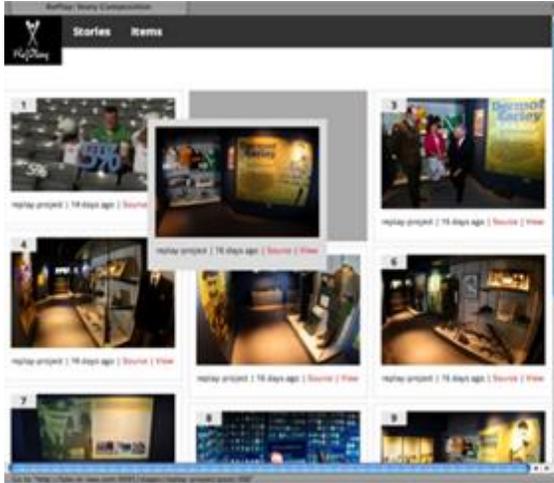


During the performed skill, the RGB+D (i.e. colour and depth) streams of the K4Wv2 devices are captured and stored. Using the calibration information, each set of multi-view recordings is used to reconstruct the captured athlete performing a skill fully in 3D. To do so, the four streams are merged, producing a common volume of the athlete, and the colour streams are processed to offer a weighted texture mapping to the volume.



### Authoring tool for museum curators

Curators manage all the multimedia resources available in a museum in order to offer complementary information to the visit. To do so, the RePlay platform includes a user-friendly authoring tool that can access and manage the available contents including those generated with the capturing system of the RePlay platform.



The authoring software for the INTERACT&PRESERVE scenario consists of two major parts: backend (server), and frontend (a responsive browser application). The backend on its own is split into two further parts, one that manages the data (creation of stories, adding new items, searching, etc), and another one that handles the heavy media processing tasks (image resizing, video/audio transcoding, document conversion, thumb extraction, etc).



Once the stories have been produced by the curators, visitors to the museum interact with the RePlay platform via a user-friendly multi-modal interface in order to discover and learn about the rich heritage of traditional TSG that is on display at the museum.

## Dissemination updates

### RePlay at ISB 2015

The RePlay platform was presented in a workshop organized by Vicon in the 33<sup>rd</sup> International Conference on Biomechanics and Sports (ISBS) which was held in Poitiers, France in July 2015. Dr. Amin Ahmadi (Dublin City University) presented the use of a Vicon system in conjunction with inexpensive sensor modalities (Kinect and wearable inertial sensors) to capture, digitize, preserve and promote Traditional Sports and Games in Europe. All the technical aspects of the RePlay platform were presented and discussed. Presentation was well-received at the conference and a large number of researchers from USA, Australia and Europe showed their interests in utilizing the RePlay platform for future studies.



### RePlay at ISB 2015

The RePlay project was presented within the Vicon User Group Meeting in Glasgow at the 25<sup>th</sup> Congress of the International Society of Biomechanics that was held at the Scottish Exhibition and Conference Centre (SECC) in Glasgow, United Kingdom, in July 2015.

The User Group Meeting was oriented to the presentation of the new Vicon Vantage cameras to an estimated audience of 200 users of the Vicon system. As the coordinator of the RePlay project, Dra. Maria Teresa Linaza explained the project briefly, including the current main achievements and further improvements.



The audience were mainly worldwide academics and industrial partners coming from the gait analysis and motion capturing industrial domain. The project was very attractive for health practitioners as a complement to current sensor-based technologies.

## Recent and upcoming events

### **Consortium meeting, Dublin, 1<sup>st</sup> – 3<sup>rd</sup> September 2015**

The sixth consortium meeting took place in Dublin after the review of the second year of the project. The meeting was devoted to the preparation of the Workplan for the development and integration of the final RePlay prototype, the technical discussion about the work done in WP4, WP5 and WP6, as well as the draft of the exploitation plan of the expected results.

### **Connect with us at booth i28 at ICT 2015, Lisbon, 20<sup>th</sup>-22<sup>nd</sup> Oct. 2015**

The RePLAY project will have the exhibition booth i28 at one of the European Commission's premier annual events – ICT 2015. The event will be held at the Centro de Congressos de Lisboa (CCL) in Lisbon. RePlay project partners will be present to discuss the project and provide demonstrations of the three scenarios of the project. So, please feel free to stop by and learn about the project in person!



The three scenarios of the RePlay platform will be shown in the booth. The improved version of the PLAY&LEARN scenario will be available for all the visitors to the booth, getting their feedback on the basis of the questionnaires once they have finished with the interaction. The COACH&TRAIN scenario will be demonstrated during several organized schedules so that one member of the consortium can wear the WIMUs. The reduced version (one Microsoft Kinect) will be available to test. Finally, the INTERACT&PRESERVE scenario will also be available in order to get the attention of potential customers.

### **Consortium meeting and Third End User Advisory Board Workshop, Dublin, January 2016**

The final consortium meeting in coordination with the Third End User Advisory Board Workshop will be held in Dublin in January 2016. The final RePlay prototype for the three scenarios will be built and further evaluated with the end users in order to gain their feedback for future exploitation activities.

## RePlay at the ACM Multimedia 2015

Since July, the stability and accuracy of the RePlay platform has been improved. The current version of the platform will be presented (oral presentation and live demonstration) at the ACM Multimedia 2015 Conference (ranked A+ Conference), the premier conference for multimedia experts and practitioners across academia and industry, which will be held in Brisbane, Australia from the 26<sup>th</sup> to the 30<sup>th</sup> October 2015.

Dr. Amin Ahmadi will demonstrate the COACH&TRAIN scenario utilizing nine inertial sensors and one Microsoft Kinect device. In addition, all the main components of the platform including motion capture, multimodal sensor fusion, real-time motion retargeting and motion comparison algorithms will be orally presented and discussed.



## RePlay at IEEE SENSORS 2015

RePlay will be presented (oral presentation) at the IEEE SENSORS 2015 Conference, that will be held in Busan (South Korea) on the 1<sup>st</sup>-4<sup>th</sup> November 2015. The IEEE SENSORS Conference is a premier forum for presentation, discussion and exchange of state-of-the art information including the latest research and development in sensors and their related fields. It brings together researchers, developers and practitioners from diverse fields including international scientists and engineers from academia, research institutes and companies to present and discuss the latest results in the general field of sensors.



The novel method using low-cost body-worn inertial sensors and kinematic modelling to accurately reconstruct lower limbs to monitor human movements in real-time in non-constrained and real-world environments will be presented by Dr. Amin Ahmadi.



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