Journal of Virtual Worlds Research

Volume 2, Number 1.

Pedagogy, Education and Innovation in 3-D Virtual Worlds.

ISSN 1941-8477

Vol. 2. No.1
“Pedagogy, Education and Innovation in 3-D Virtual Worlds”
April 2009

This issue was sponsored, in part, by the Singapore Internet Research Centre,
the Department of Radio, TV & Film at the University of Texas at Austin,
and the Texas Digital Library Consortium.

The Journal of Virtual Worlds Research is owned and published by the
Virtual Worlds Research Consortium,
a Texas non-profit corporation.
(http://vwrc.org)

Journal of Virtual Worlds Research
jvwresearch.org ISSN: 1941-8477

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Use of a virtual world system in sports coach education for reproducing team handball movements

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Abstract

The continuous need for education and the significant changes in European policies and regulations overseeing sports coaching and training require the adjustment of teaching models and methods to the needs and potential of teachers, students, and technology.

In educational and training programmes for team sports coaching, it is common to use a group of athletes or video to demonstrate physical, technical, and tactical procedures. This requires significant human resources, both while developing the procedures and to reproduce them. Furthermore, both cases (live execution by athletes or video recording) are limited in visual perspective and detail. For this reason, specific software for demonstrating tactical procedures is sometimes used. But existing software presents significant limitations, for instance, when one cannot change procedures in real time nor can one interact with the audience.

This article focus on the development of a new resource: a software system combining tri-dimensional automated avatars in the Second Life world, an external control server, and an helper desktop application. Using this system, coaches enrolled in education/training programs can more easily be involved, even taking a player's role, and analyze movements from various points of view. This system aims to contribute to the improvement of the team handball coach education programs by supporting the understanding of the dynamics between defensive and offensive players in the organized phase of a handball game, using shared 3-D simulations with avatars.

Keywords: Second Life; handball team; simulation; coaching; coaches; bots.

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In Portugal, sports coaching education in team handball is held by its national sports federation in cooperation with a private enterprise exclusively devoted to handball coach education.

Recent changes took place at the national and European level in coaching education, regarding guidelines and foundations to the acknowledgment of a team handball coach career. These impacted the scientific and technical structure and mandatory hours in courses. Due the increase in programme hours, courses changed from local concentrated classes to a group of modular sports coaching education activities nationwide. As such, it was necessary to use distance learning approaches so that trainees could be involved in educational activities in different moments and while located in different parts of the country.

E-learning platforms have been used, such as Moodle and Stabos. However, they present some limitations regarding the availability of the specific sports-related learning objects used by educators/trainers for explanation, visualization, and interaction of students with sports techniques and tactics. Files and videos can be downloaded, but there is no provision for trainers and trainees to interact simultaneously with a specific tactics-oriented software. When lecturers approach these subjects, they usually use animations in presentation software or specific animation files; such efforts typically use a top-down view of placeholders (representing players), thus lacking three-dimensional details. For this reason, video files or streams are also commonly used, often lacking in quality for bandwidth reasons. Videos, however, are resource-intensive to produce, since a team of athletes must be trained to perform the various tactics flawlessly. Furthermore, videos can only be played by trainers and trainees: should they wish to change a specific detail of the recorded tactic, they would have no chance of doing so, for that would require a team of athletes to learn and rehearse that change and record a new video. We believe that virtual worlds present an opportunity to overcome several of these limitations.

First, by allowing a teacher/trainer to display on cue a prerecorded animation of a tactic, using automated avatars within a virtual world sports field, trainees/students can analyse that tactic from any angle and discuss it in real time with the trainer and other trainees. By pausing and unpausing the prerecorded animation of avatars, the trainer and the trainees can also place themselves alongside specific (automated) players and demonstrate a specific change to the recorded tactic. That is, while the automated player avatar plays its prescribed movement, the student will be doing something else, in effect saying "Ignore him, watch what I'll do instead."

Secondly, we propose that the trainer uses a software application to define the movements and actions of players in a tactic, store that tactic as a file in an e-learning platform, and to request its execution on-line, from within a virtual world training session. This not only simplifies the access to the learning object in education, but in effect, it allows the trainer to change a recorded tactic in response to the development of the educational process: if the discussion with students prompts the need for a change in a tactic, the trainer can readily edit the recorded file, save it, and replay to students the edited tactic. Depending on the complexity of the change, this can be done during the training session, in a break, or within a few hours.

This article presents the ongoing development of such a resource to support and improve the expositive teaching method regarding concepts of interactional dynamics between defense and attack in the organized method of team handball game, using three-dimensional avatars in the Second Life virtual world. We intend to use this tool as much more than a "3-D shared video": we believe it will allow more participative learning methods, since trainees can involve themselves more easily in the players' role and discuss changes to recorded movements.

Although this work currently focuses only on team handball, the technical structure can be used for other individual and team sports.

This article is divided in three major parts:

- Technological support for training/education of handball coaches: here we focus on the different type of approaches used in team handball coaching education, and their supporting technologies;
- System architecture: here we present the overall technical architecture, its requirements, components, and goals; and
- Virtual world based handball coach education system: here we describe the current prototype implementation of the architecture, including the system components, the underlying technology and the functionality.

Technological support for training/education of handball coaches

The sports coach is one of the most import figures in sports because of all the roles the job demands: training athletes, guiding them, tutoring on performance, and socially representing the team, among others (European Network of Sport Science, Education & Employment [ENSSEE], 2007). The existence of qualified coaches is an essential measure to ensure qualitative and quantitative development of sport, respecting ethics, and sportsmanship. Therefore, coaching education is fundamental for the development of sports. Through training, sports coaches achieve the condition of access to their professional practice by receiving licenses that qualify and certify them. Currently, in Portugal, team handball coach degrees require the attendance of a considerable number of training hours, during which the candidate has to submit and fulfill skills in technical and scientific areas.

Although there is not an historical/scientific follow-up on means and methods used in the team handball coaching education programmes, it is believed that they followed the overall scientific and technological developments, adapting them to their needs: face-to-face classes, distance learning, and their associated technological innovations.

Regarding distance learning, trainers of team handball coaches have used various e-learning platforms, and both synchronous and asynchronous approaches are common. The e-learning objects in these platforms showed some limitations and resort to presentation files, animation files, and video, as mentioned in the introductory section.

In the sports software market, there is a wide range of team handball applications to support the training of technical and tactical components, observation, and game analysis, using video and two-dimensional animated diagrams. These applications produce files of simulated situations, typically non-integrated or impossible to use as learning objects in e-learning platforms. Besides being two-dimensional, these applications are not geared towards synchronous multi-user access, meaning that the only way for a trainer to use them in a synchronous learning session is to share his/her own screen. There is not an integrated system available to the trainers to allow them (during a learning session) to reproduce tri-dimensional sports movements, stop them, re-run them again as a 3-D movie, involve the trainees in that movie to perform analysis from various perspectives, and edit it.

There are also many well-known videogames dedicated to team sports, which can be used to act out a movement or record it, but these are not geared towards allowing the trainer to define the actions of each player. Furthermore, the recording of actions in such games can be done as a movie but not as an editable sequence of movements. There are also several avatar-controlled animation systems, but these do not contemplate sports.

In three-dimensional virtual worlds, where people can interact with each other and with virtual elements, team sports are also a reality, albeit limited in the same ways as those mentioned above for videogames – apart from the fact that it is easier for each player to be controlled by a different person. For instance, the already mentioned Second Life virtual world (SL) allows users, known as residents, to create personal content in a collaborative a way and share it with other users. Users are part of a social experience since they have available a variety of forms of communication such as instant messaging, private conversations, voice, streaming video, and animated gestures (Robbins, 2007). SL residents do not limit themselves to content creation: they author activities, events, and services, free or paid, using the SL currency – the linden dollar – and being involved in its economy.

We could have used a number of technological platforms for this virtual world based system. The choice of SL is due to its widespread use, its wide community of users developing content (including automated content), the growing body of educational research and use by educational & research institutions worldwide, and significant levels of satisfaction as a technological platform by post-secondary instructors (Bowers, Ragas, & Neely, 2009).

Regarding team handball sports coaching education, SL fulfils our basic technical requirements: it allows the scripting of movements and interactions, it has documented methods to allow automation of avatars, and it has on-line contact with internet servers besides its own. User-level requirements are also fulfilled: SL users can communicate live and share the same virtual space, they can watch together the same automated animations, and each user can control its own viewpoint and camera movement. Furthermore, other instructor technologies are also available, such as video streaming and slide projection.

System Architecture

To assemble a set of requirements and goals for the system, we looked at our own experience: two of the authors of this paper have over twenty years of experience in handball coaching ("top handball coaches") and are sports researchers; one is in charge of coordinating handball coach education at the Portuguese Handball Federation and is, at the European Handball Federation (EHF), the Portuguese representative within the "Rinck" Convention on the mutual recognition of standards and certificates in the field of coaches' education in handball in Europe.

As put forward in the introductory section, the overall goal is to allow an educator of handball coaching trainees to define a team tactic, store it in an e-learning system so that it can be integrated within a global e-learning plan, and be able to replay it when requested within a multi-user virtual world. That tactic replay will be done by automated human-looking players (not geometric placeholders) during a training session. Furthermore, the educator/trainer must be able to pause/unpause the tactic replay to allow him/her or the coaching trainees to position themselves amidst the team of automated players. This serves two purposes: to get a particular perspective ("from the point of view of the referee," for instance) and to allow trainees and educator/trainer to demonstrate intended changes to the tactic that is being replayed by the automated avatars ("colleagues, when that player reaches me, ignore its subsequent movement; instead, look at what I'll do"). Finally, the educator/trainer should be able to edit a team tactic as quickly as possible, to the point of being able to replay the edited version in the same session.

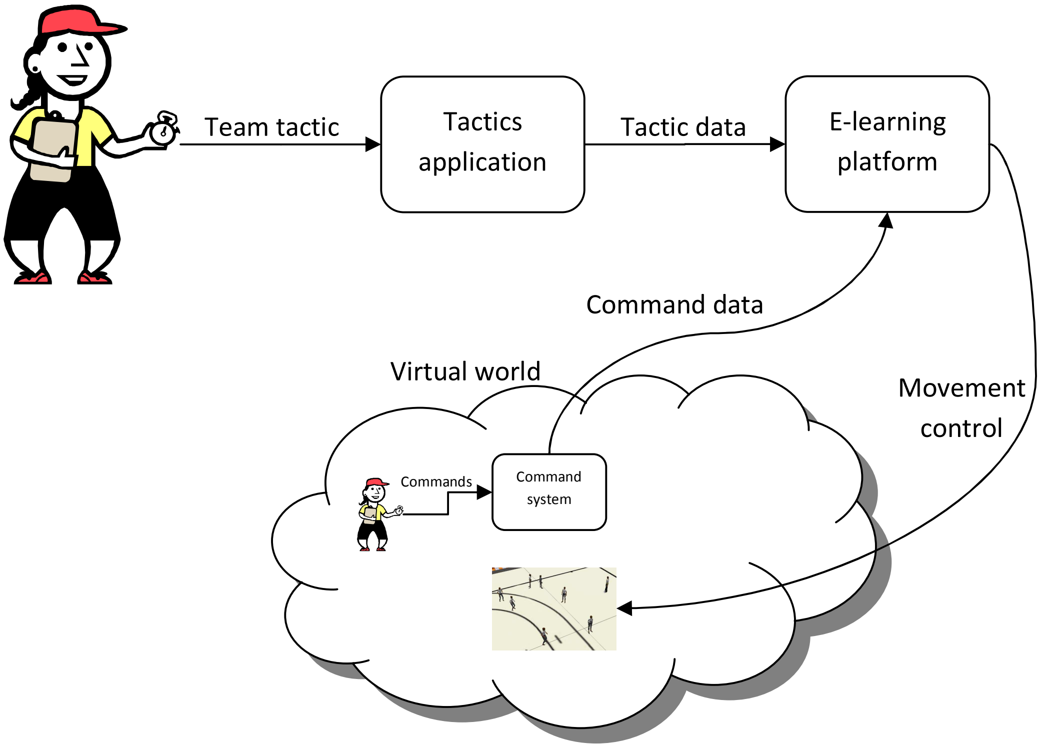

Figure 1. Data Flow Diagram.

From these overall goals, we devised an overall model for the system, presented in Figure 1. The trainer creates and edits team tactics (team movements) in a non-virtual world piece of software, the **tactics application**. This application stores and registers the tactics data as learning objects in an online **e-learning platform**. Then, from within a virtual world, the trainer will use a **command system** to issue the commands (to, for example, request the execution and pause/unpause of stored tactics). The command system sends the command data to the e-learning platform which then directly controls the execution of the tactic; that is, the movement of all automated players and ball.

The model in Figure 1 does not account for specific features of the virtual world platform. Specifically, it does not address the method for movement synchronization amongst automated players and ball, nor does it specify whether the movement control by the e-learning platform is for every detail or only for higher-level aspects. This is merely the overall dataflow model, conceivably applicable to a wide range of virtual world platforms. Details on how these and other issues were addressed are presented in the following section which describes the current prototype.

Virtual World Based Handball Coach Education System

We are developing a prototype implementation in the SL world of the model presented in the previous section. To test it, we built a handball field so that team tactics can be understood in context, seen in Figure 2.

The trainees can use the seats on either side and use SL built-in camera control features to watch the team tactic from any desired perspective without having to position their own avatars. Trainees can, however, move their avatars onto the playing area, in order to better demonstrate a proposed movement to other trainees or the trainer. For this purpose, the field was built on 1:1 scale. It can be visited at the Utopia Portugal VI server in SL, at coordinates 120 X, 208 Y, 606 Z; the url for this is http://slurl.com/secondlife/Utopia%20Portugal%20VI/120/208/606. A video of the system in action is available in YouTube at http://www.youtube.com/watch?v=tlVQ4hfbcW4.

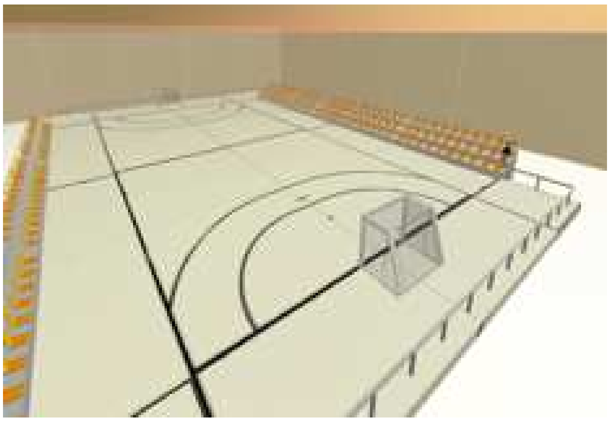

Figure 2. Handball Field in Second Life.

In the current prototype, the tactics application was implemented as Windows desktop application. The e-learning platform for this first prototype was implemented as a simple web service on a web server, for prototype development and testing purposes; we are now integrating it into an actual e-learning platform. In this prototype, the command system within the SL virtual world is a combination of virtual world clickable objects and text commands that are issued by the trainer as instant messages to an automated avatar (a "bot" in SL terms). We are still evaluating the effectiveness and adequacy of these specific prototype implementations, but they have sufficed to render the system usable and operational.

The tactics application records the tactics data in a proprietary XML format which we developed arbitrarily, just for the purpose of testing the overall model and data flow approach; a later phase of this research will study the data requirements and establish whether a specific data format needs to be devised or if existing languages and ontologies can be leveraged for this purpose.

For communication with SL, rather than implement a full client of the SLGOGP protocol used to communicate with SL servers, we employed a freely-available open source library written in the C# programming language that provides SL login, communication, and control features ready called "libopenmv" but formerly known as libsecondlife, which can be used in Linux, OSX or Windows environments (Lentczner, 2008 and libsecondlife, 2009).

Figure 3 shows the various layers of the platform, allowing a better understanding of the system and how the various components are connected with each other.

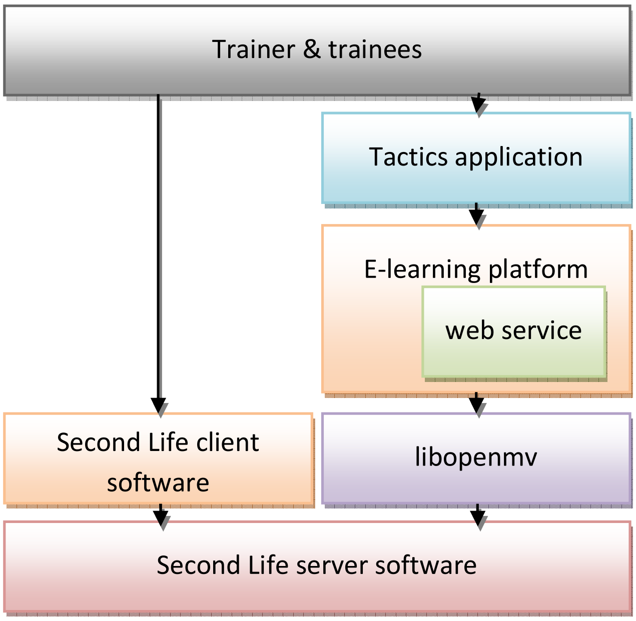

Figure 3. Multi-layer System Components.

Figure 4 presents the overall look of the tactics application. It follows a common placeholder approach to represent the player position on the field, with a timeline to help define movements and actions. Following a common software methodology of iterative and incremental development, several interface features have been developed and refined. For instance, the figure shows that the trainer can start the process of creating a new tactic by selecting from a set of predefined initial player layouts, organized into defensive ("Defensivas"), offensive ("Ataque"), or general ("Geral") groups. Several such features have been implemented, but their description and listing is beyond the scope of this article.

Using the timeline at the bottom of the application window, the trainer can specify the position of each player at each specific moment; he/she positions the timeline at the desired moment and drags the players to their position at that time. Using buttons and options in the interface, the trainer can specify whether a player should execute the movement by walking or running and whether displacement should be done together with some other motion (for instance, moving arms in a defensive stance). Movements done without displacement can also be defined in a similar manner (for instance, shooting, catching a ball, and others).

While creating or editing a tactic, the trainer can employ the play/stop/record button at the bottom of the screen to preview the tactic execution within this application. Whenever desired, the tactic can be saved as a file and placed in the folder structure of the web server where the web service is running (in the final system, this would be the process of publishing the tactic as a learning object in the e-learning platform). Currently, the file names and folder are used as part of the commands issued by the trainer from within the SL world, but this notation will be adapted once we implement the prototype in an e-learning platform.

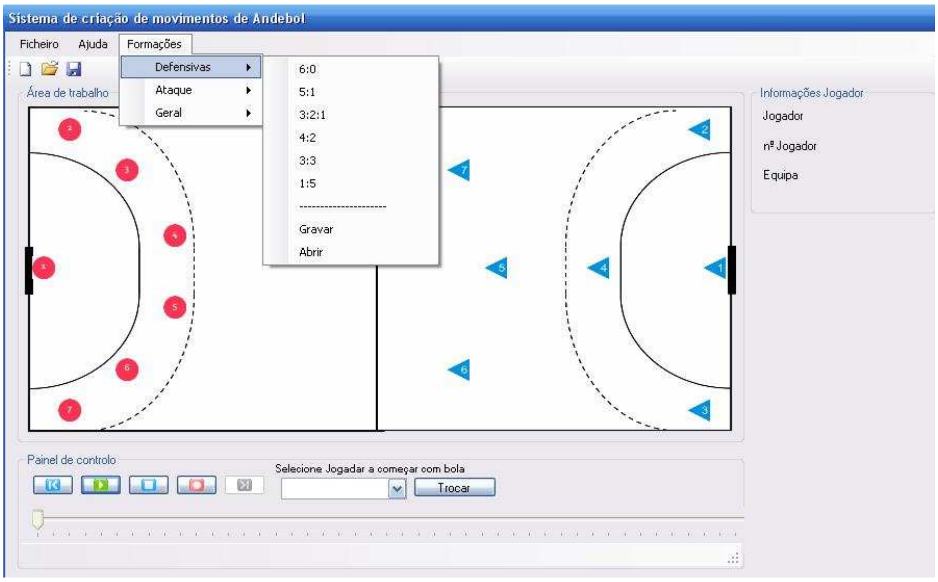

Figure 4. Tactics Application Prototype.

Within the SL virtual world, we realized that the avatar login process can be slow. Therefore, we provided to the trainer the option of requesting the “creation” of all automated players at the beginning of the virtual learning session (that is, request that the web server of the e-learning platform logs on all “bots” immediately, instead of having to do that process when a tactic execution is requested). The trainer can then request the “destruction” of the players (i.e., log them out) at the end of the session or whenever desired. This is currently done by clicking (in SL terms “touching”) two button on a virtual control panel, as seen in Figure 5. These buttons are scripts in SL’s LSL language to perform a security validation (used to verify whether the avatar clicking on them is the trainer or not) and send the login request command to the web service/e-learning platform, through an HTTP request message. The web service logs on each bot as a separate processing thread for better performance and responsiveness.

Figure 5. In-world Control Panel for Logging On and Off Automated Players.

Once the bots logon process has been completed, the handball field and system are prepared for a synchronous learning/training session, with all automated players ready to execute tactics, shown in Figure 6.

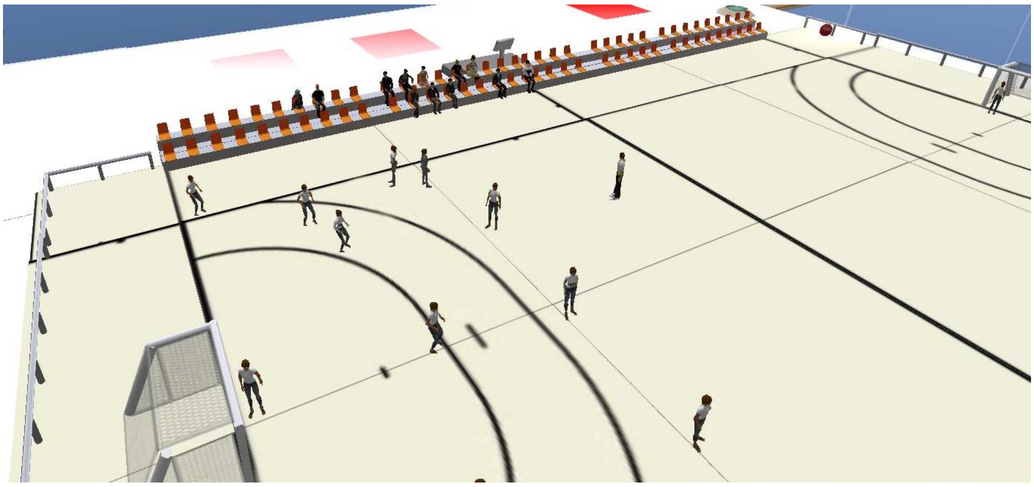

Figure 6. Overview of Handball Field with Bots Logged in; Trainees are Seated.

From this point on, the trainer can issue commands to the web service/e-learning platform as a private textual conversation with one of the automated players, whom we call the “master” bot (in the current prototype, the goalkeeper) – that is, by sending instant messages (IM) through the internal SL IM system. While other interfacing options where considered, such as the visual buttons of Figure 5, we chose the IM approach due to its higher response rate: visual solutions require some scripted programs to be executed before commands are sent to the web service, but IMs are sent to the recipient directly by the underlying SL system, which in comparison with scripting solutions, is almost instantaneous. This is not relevant for initiating a tactic, but it is critical for pausing it at a precise moment. The trainer's command system is therefore a combination of the visual elements of Figure 5 and the textual commands that he/she issues to the master bot.

The tactics execution process thus takes place in the following manner: when the trainer issues the command to execute a stored tactic, the master bot receives the trainer's IM, and that event is detected by the web service controlling the bots, which processes the IM, loads the appropriate tactics-definition file, and initiates its execution by commanding the actions of each player and ball. During this process, the trainer can send an IM command to the master bot requesting that movement pauses or unpauses, as the educational situation progresses. A further development stage will include commands for backtracking the current movement and other options that trainers may find necessary.

Discussion and Conclusions

Coaches play an important role in introducing people to sports and in helping players and athletes to improve and achieve success. Coach education programs aim to provide coaches with the competences for this job.

The format of Portuguese team handball coaching education programs includes theoretical and practical sessions. Due to the amount of hours that the candidates need to attend these as part of their educational framework, these sessions are divided into a set of seminars over one year of supervised practice. Our proposed system aims to improve the quality of the educational content by allowing trainee coaches to visualize tactics in three-dimensions in a shared environment, where they can analyze them from different perspectives and cooperate by demonstrating changes to the stored tactics using their own avatars alongside automated avatar players ("bots").

This article presented the software architecture of the system and the current state of the prototype under development, as well as the technical approach and details used in its development.

It is expected to improve the reproduction of movement and tactics, by incorporating in the animation process SL avatar "gestures" to better convey the fine elements of the tactic. The ball movement itself is still under study; while different worlds may require different solutions, for SL we are experimenting with a combination of a ball-shaped automated avatar and ball-shaped virtual world objects that can be attached to the hands of automated players and thus follow their motions accurately. Once the full technical process is complete and operational, we will have to focus on the data language, as previously mentioned in the body of this article.

Although this work is focused on team handball, we believe the overall structure can be used as a starting point for developing systems for coaching education on other individual and group sports and physical activities in general. We hypothesize that it may also be an adequate starting point for other areas, such as business training, wherever there is the need to resort to predefined three-dimensional manifestations of human actions that need to be analyzed from different perspectives by a group of people wishing to control their reproduction for cooperative analysis and discussion purposes.

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