

Integrating Virtual Environments with Multimedia contents in a Web Application.

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Abstract. In the present paper a system architecture for the combination, interaction and synchronization between different technologies is presented. Our system integrates 3D interactive virtual environments, 2D animations and games, avatars, form applications and documents, videos based in Chroma Key technology and other multimedia components. All of this inside a unique web application with a special objective, developing an interactive game for people who would like to become a self-employed worker. As the legal procedure (focused in the Spanish model) to start to be a sole trader is difficult and hard, we have developed a very intuitive, easy to use and enjoyable game to cover all information needed by these collective of people. The authors describe all the components of the architecture, the technologies used for developing each module and the combination and interaction between them to finally obtain this interactive game integrated inside a web application.

Keywords: Web 3d applications, Virtual Reality & Multimedia, e-learning,

1. Introduction.

Nowadays the use of technological resources becomes a common element in television, games, films or education and training applications. It is possible to see in live television a talent explaining some information in a virtual set, with a background completely different from the one that is really surrounding him, or educational web tools that use real videos of a person explaining concepts integrated directly in the web page. Also, the entertainment industry brings the user closer to these innovative tools and technologies, making possible, for example, the interaction with a virtual environment using our body (eye-toy games) or using simple tools that try to make the interface with the virtual game closer to real world interaction (wii games).

Taking into account all the possible technological resources available nowadays, the idea of an interactive web application

with a combination of different technologies could be possible. In this framework, we have developed an interactive game for people who want to receive information about the legal steps to become a self-employed worker. In Spain, the information available for this people is very limited. There are entities that try to help them in this difficult process, but in most of the cases, the future sole trader turns to an agency, to make the procedure easier and quicker. For that reason, our research group, with the ideas coming from the entity Forem Andalusia, has developed an easy to use tool, with complete information about the legal process to become a self-employed worker.

Giving the kind of application to be developed and the different content to be provided, we have identified the main characteristics and requirements to satisfy the necessities of the final users. Among these requirements we would like to highlight some of them. First of all, it is interesting to place the user inside different environments, simulating the official entities where the tasks have to be developed. Also, it is important to integrate in the application all the official documents not only to explain their different sections and method of submission, but also, to give the possibility to fill them up and test the user understanding. To give all the explanations of the procedure and documents, we should have a person, who guide the user along all the steps inside the game and clarify all the difficult concepts. Finally, to make the game more attractive and enjoyable, we should integrate 2D games to test the evolution of the user and reinforce their learning. So to provide all these contents inside this web application and achieve all these requirements, we should integrate 3D virtual environments to simulate the different entities, 2D interactive contents for games and application forms, PDF files for official documents, avatars for representing the user and also to teach and explain concepts, and sound to simulate the explanations provided. All combined inside a web application, completely interactive and personalized to each kind of future self-employed worker.

In the next sections we will review the related work in this area, describe the system architecture implemented to support the integration of all technologies used, analyze the different technologies integrated to develop the modules included in the system architecture, and the structure and functionality of the final game created which has been integrated inside a web application. After that, we give some conclusions and future work.

2. Related Work.

We have made a revision of the up-to date bibliography to find web-based applications that include virtual reality environments, avatars and other multimedia resources.

Firstly, we have look for tools what are meant for self-employed workers, which is the topic of our work. The only tool available is a web site that has all the information needed to guide people who would like to become a sale trader. In this web site there is a virtual agent (only a picture of a woman) that answers your questions and guides you through the web site to find the information requested [1]. But it is only a guide, with written information but without graphics or other interactive resources.

In the area of simulation of 3D scenes with characters we have found that Virtual Environments with agents has been widely used in pedagogical tools for learning and training. Some studies about the role of the media in learning has been developed, revealing that students scores higher using agent-based multimedia games than receiving text information [2]. Concerning the web-based virtual environments oriented to e-learning some authors use Virtual Reality Modelling Language (VRML) as a tool for developing collaborative learning environments including in some cases video and audio [3][4]. These kinds of applications consist of virtual environments with avatars representing people working collaboratively in a virtual world. Other contents (as documents, forms or 2D-games) are usually included by linking the application to external web-pages [5][6]. Thus, in our system we will need a 3D modeling language for developing 3D contents, but it cannot be the core of the application due to the necessity of integrating different contents.

To include interactivity in web pages with learning of teaching purposes we have found that Flash technologies are used in many works. On the one hand, in the University of Austria [7] there were projects oriented to develop Medical and Civil Engineering applications using Flash, which provided different Interactive Learning Objects, with the main objective of improving the learning of the students. These authors studied the interactivity and usability of Flash based tools in students with different backgrounds, analyzing the advantages and disadvantages of using this technology for learning purposes. Also, the use of Flash can help students in the school to learn some mathematical principles [8] or graphics concepts [9]. With this kind of animations and tools, teachers can explain difficult mathematical or geometrical concepts in a visual, animated and interactive way, fostering the learning and assimilation of knowledge. Nevertheless, none of these applications include virtual environments or 3D avatars.

Other authors use Chroma Key technology to enhance real scenes with virtual objects or integrate real humans in virtual environments [10][11][12]. Moreover, it is very frequent to

see virtual presenters included in web pages [13] (see Fig. 1a), or presenters in television giving the forecast weather with a virtual studio that helps to explain the information [14] (see Fig. 1b).



Fig. 1. Chroma Key use. a) Presenter in a web page. b) Presenter with a virtual background

Giving the widespread use of Chroma Key technology in films, television, games, etc, it is possible to develop applications and scenarios that facilitate this kind of impressive effects. In [15] the authors developed a Virtual Studio, where it is possible to use the Chroma Key technology for creating different kinds of application and in [13] we can find a company that sells Virtual 3D and 2D sets, with the Chroma Key prepared to be used in specific applications or programs.

After this review of the related work existing until these days, we have found that there are different solutions and languages for developing interaction, multimedia contents or virtual reality in web applications. According with the requirements describe in the previous section, we need to combine different technologies to obtain the main advantages of each one and solve our main problem, develop a web application with virtual environments, avatars, spoken explanations, 2D interactive contents, documents and games. Let's describe more in detail the architecture developed and used to create this interactive web application.

3. System Architecture.

3.1. System components.

As we have mentioned in the Introduction section, the requirements of our application establish the need to a combination of technologies to obtain a tool with different 3D virtual environments, 2D interactive contents, avatars and other multimedia components. For that reason, we have developed an architecture for giving support to all the different technologies needed and facilitate the combination and interaction between them in a unique application.

Giving the complexity associated with the interaction and interoperability between the different technologies, let's start organizing the different components needed for our

application, determining the technology to be used in each one.

Firstly, we have decided to use Flash and Flex technology as the base of all the components, because they are widely used in the development of web applications and allow the integration of 3D, 2D and other multimedia components. With this base in mind, we have created all the modules required for each component analyzing and testing its compatibility with Flash and Flex technology.

As we have developed a game for learning and training, we needed to create different environments to simulate the entities where the user has to carry out tasks to complete the legal procedure to become a self-employed worker (Treasury Department, Social Security, town council, etc). Therefore, we need a **module to control, simulate and give support for the navigation** inside each environment. For that, we decided to use Flash technology (using ActionScript) with the library Papervision to give support to the representation and control of the environment, and Collada as the format used to represent 3D models and store them in the data base (to be loaded by the application when they are needed). For our **3D Engine**, Papervision was chosen front X3D, Sandy3D or other 3D libraries for Flash because it is open source, has all the needed functionalities, it is easy to use and has different shaders and supports the creation of ad-hoc shader (useful in our case to integrate videos with Chroma Key in the scene). Also, this library supports Collada format and has all the functionality needed to load, control and integrate models in this format inside the application. Collada was chosen instead of VRML or X3D because its support not only for 3D models in web application, but also because it can store 3D virtual models based on skeleton internal structure (for character's animation) that we need to simulate virtual characters.

Another important part of the system is the **avatar's manager**. We need to integrate virtual characters to represent the user inside the environment. These characters should have different animations to simulate their movement and behavior inside the virtual scene. As we have mentioned before, we used Collada for this kind of components, because it is the most interesting technology to give support to this kind of elements.

In the **avatar module**, we identified a special case. The application must have a virtual teacher who would explain all the contents, steps in the procedure, legal documents, forms, etc. This avatar needs to be as closed and clear as possible to foster the user understanding and learning. We decided to separate this special avatar in another module, representing it with a real person through **video sequences**, because of the realism possibilities given to the character. As we explain in the Related Work section, one of the most commonly used technology to integrate a real person in a virtual environment or web page is the Chroma Key technology. Given the support that Flash technology gives to video integration in web pages, and the possibilities that Papervision gives to integrate video

inside a virtual scene using a special shader to eliminate the background, we decided to use Chroma Key technology for the teacher representation. With this, we can simulate a real person inside a virtual scene, with all the real movements needed to explain the concepts, point at the important information and other actions.

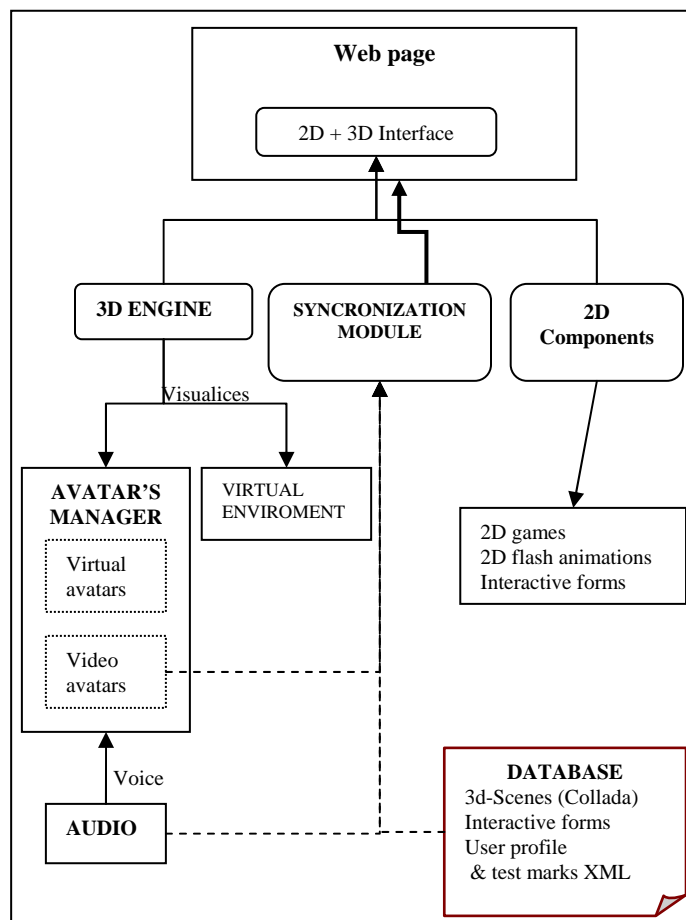


Fig. 2. Sytem architecture diagram.

Another important component was the **audio** one. This represents the spoken explanations that the teacher gives along all the game. These explanations were synthesized from text to mp3 files, and integrated and synchronized with the teacher movement inside the application using Flash and ActionScript.

Along the game, the teacher should explain each form application and legal document that a user requires in each step in the procedure to become a self-employed worker. We necessitate another module to integrate this interactive forms, explain them (synchronizing spoken explanations, the teacher movement and the automatic fill up of the document to clarify the explanations), and finally evaluate a user allowing him to complete the form and test their answers. For that, we used Flex technology because it makes possible the easy creation of interactive forms, and evaluation of them after user interaction. Also, it is possible to establish a communication between each Flex form and the **Flash animation** of the teacher while is explaining the document. This gives a big

realism because the avatar is explaining the document while it is filling up.

As the synchronization between the different parts of the game results very important we developed an **activation stack** for the correct combination of the different parts. One of the components that need synchronization is the explanation of each legal document, because we have to combine the audio, the teacher's video and the automatic fill up of the form. Each form contains a big quantity of sections, so it is necessary to develop a method to show an example of filling the document while the teacher explains that field of information. In this activation stack, we could indicate in each step of the simulation, the field to be filled up, the MP3 audio to be reproduced and the Chroma Key video of the teacher to be used. At the same time we can specify in this stack other actions to be performed, like showing pictures to make more visual the information explained, activate information notes that help the understanding, animations and other different elements. At the same time, we can control what is the next step in the general process, and which is the next component to be activated in the game.

Finally, we should integrate a **2D animation module**, with support for games, animations and interaction. To each step in the procedure, we required to incorporate 2D games (like a crossword, relation game, question with several answers, etc) from the information given in each step to reinforce the user learning and assimilation of the concepts. For this module we used a combination of Flash animations and Flex integration and control.

All these modules were integrated and controlled using Flex technology, which allows the interaction with Flash components, animations, forms, and other elements. The final application uses **XML technology** to store the important configuration information and also, to store in the data base the profile of each user connected to the web page, who registers into the application and starts to play the game. This information will provide important results about the global understanding of users, the most conflictive points in the game and other characteristics of the future sole trader.

3.2. Technology used.

From the different modules described in the previous section, we can highlight the technology used for each one, and the integration of all of them in the same application. Let's review each kind of technology in great detail.

First of all, the base of all the content of the game has been created using Flash. This trendy technology is one of the premiere tools to create Rich Internet Applications (RIA) with several advantages: scalability, consistence, independence from a specific operating system, consistency, MP3 sound, small files (to make easier download of the different parts), high quality graphics and integration of video and other

effects [2]. The programming of user-dependent interactivity is possible by using the programming language "ActionScript", in our case, ActionScript 3.0 based in JavaScript.

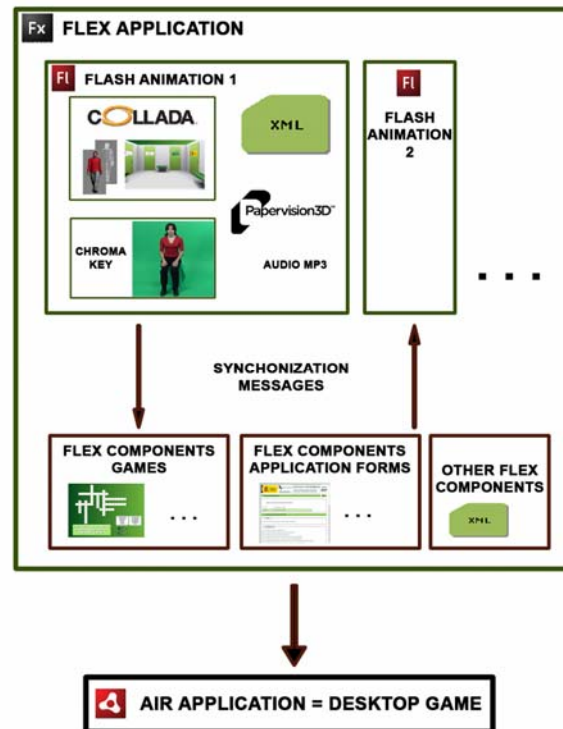


Fig. 3: A diagram of the connection and communication between the different components.

In the last years, new frameworks based on flash technology have appeared, making the development of web applications easier. Within the family of Adobe products we could find a working environment called Flex. Adobe Flex is a collection of technologies released by Adobe Systems for the development and deployment of cross-platform RIA. Flex provides a workflow and programming model using MXML, an XML-based markup language. Interactivity is achieved through the use of ActionScript, the core language of Flash Player. One of Flex main advantage is its flexibility, making possible to integrate Flash movies, images, sounds, PDF files, HTML, Papervision, etc., in the same project. For all this advantages we decided to integrate all the component using Flex technology, allowing as the control over all the elements and the interaction and synchronization between them.

Flash and Flex work with vector graphics so if we want to introduce 3D scenes we need to use specific libraries that can be integrated inside this platforms. One of these possible libraries, and the one used in this project, is Papervision. Papervision is a graphic library written in ActionScript 3.0 which gives support for loading, rendering, interaction and treating graphic models inside a Flash animation. This library has specific support for the Collada format, an XML schema for graphic models used in web applications and other software applications [16].

Finally, Chroma key techniques removes the need of real scenography creation and also enables the use of various effects hitherto available only in professional postproduction studios, such as special effects, environment animations, live or prerecorded material compositing, and many other things. This technology allows to record videos with a uniform colored background to, subsequently, extracting that setting and changing it for another completely different one. This environment can be for example a virtual scenario in 3D (see Fig. 9a and b).



Fig. 4: a) An stage for Chroma Key technology. b) The video integrated in a virtual scene.

4. Integrating contents on the web-site.

Once we have decided the architecture and technologies suitable for our purpose, we have developed a web site using them. Our web site is addressed to people who want to become a self-employed worker (in our case focused on the Spanish process). We have developed the web as an interactive game for making easier and enjoyable the learning and training process needed to understand the complicated legal steps.

This game integrates virtual environments with avatars that guide user through the process, with traditional web pages including forms, images and flash animations.

In this section we will describe the contents and games developed to illustrate how the technologies are integrated.

4.1. Web contents.

As we mentioned before, our future users will be people with an idea of setting up a business and who need detailed information about the procedure that they have to follow to start to work as a sole trader. With this game we would like to answer their three main questions: what, how and where.

In Spain, the procedure can be divided into three main steps:

1. **Legal Procedure:** This is the most complicated and long part of the process. It includes all the legal documents which have to be presented in the different Spanish ministries. There are four important steps inside this:
 - Procedure for foreigners.
 - Fiscal Procedure.
 - Labor Procedure.
 - Local Procedure.

2. **Business Plan:** it is an official document which describes and analyses the business opportunity, studies its technical and economical viability and helps with the conversion of the business project or idea in a real business.
3. **Financing Methods:** in this part of the procedure, future self-employed workers receive information about the possible ways of obtaining the money they require for setting up their business.

Giving this long and complicated process, it is necessary to offer to these future sole traders the possibility of understanding all the steps in an easy and enjoyable way. In the game we have developed, they can know what applications form have to be submitted each time, where they have to present them and how they need to fill them up, to indicate all the information needed. Also, they can select the specific steps they will need to take depending on the conditions of their future business (for example, there are different steps if the self-employed workers will have employees or not).

After this general overview of the Spanish process to become a self-employed worker, let's describe in detail the web-page objective of this paper.

4.2. Web description.

First of all, the process starts asking for a user and password that will help to store the user's profile and his/her progress in the game. Each profile is associated with a user, a password and a business idea (see Fig. 5).



Fig. 5: a) Start of the game. b) Identification process to start

After that, a virtual character is presented and he will be our avatar inside the tool and will represent us in all the process (see Fig. 6a). Finally, we can choose between two possibilities for playing: one with instructions and explanations given by a virtual teacher about all the process (guided mode) or another one without help in any of the steps, where the user is alone to analyze and follow all the procedure (not guided mode) (see Fig. 6b).



Fig. 6. a) Presentation of the avatar. b) Selection of the playing modes.

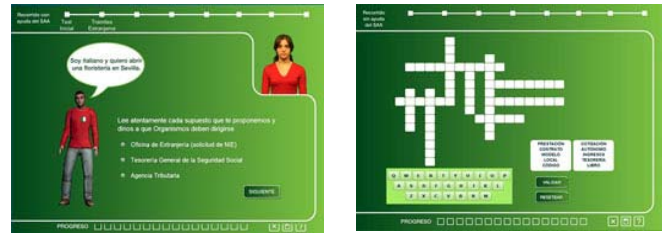


Fig. 9. Two different games to understand the process.

In the guided mode, you can start directly in a specific part of the game or initiate it from the beginning, depending on your interests. This gives a lot of flexibility to the user and covers all possible interests of them. In both cases, the user will have a virtual teacher who gives all the explanation needed to understand each step of the game and complete it correctly (see Fig. 7).



Fig. 7. Teacher explaining concepts in a virtual scene.

This virtual teacher is a video of a real person, making all the movements (mouth, body, hands, etc) required to accompany the oral explanations given (see Fig. 8). This video was captured using the Chroma Key technology and processed to extract the green background, replacing it with a virtual environment created for simulating the different institutions where the user has to carry out each step. Thus, four virtual environments (a virtual office and a hall representation of the Treasury Department, Social Security and town council) have been developed, and depending on the web page visited, the avatar is integrated in one of them.



Fig. 8. Image of the real teacher in a virtual scene and an application form explanation.

In each part of the process, the future self-employed workers will receive detailed instructions to fill up the form, and after that the user (represented by an avatar) has to do an easy game related with all the information provided (see Fig. 9) and finally has to fill up the application form with his real data.

When the game arrives to the Business Plan (third step in the official procedure), besides the explanations given by the teacher, a PDF corresponding to the official document with all the information added will be shown to explain each section with more detail. The document can be filled and printed or stored to use it whenever necessary. Finally, the user can know all the information related with the financing methods available for a self-employed worker, which could help to select the most appropriated one.

In the not guided mode, the correct order of institutions where the user has to present each application form and the order of presentation of each legal document has to be selected, to complete the procedure in a correct way. In this mode, there is no interactive help, no games and no prizes along the process.

At the end of both modes of the game, the user has to fill a final questionnaire. With it, we can analyze the degree of understanding of all the stages of the game (explanations, order of the steps in the procedure, forms, etc). With the answers given in this form, the virtual teacher gives a conclusion of the whole game, making suggestions depending on the punctuation obtained in the questionnaire.

5. Conclusions and Future Work.

We have presented in this paper an architecture to integrate different technologies for developing an interactive game to help people in the complicated procedure to become a self-employed worker. The combination of technologies allows us to obtain a scalable, interactive and platform independent game, with all the information and elements important to obtain an easy-to-use and intuitive application. All design to be accessible by a web page.

The combination of Flash animations, with 3D environment and characters created in Collada format, mp3 sounds synthesized from text, and real videos created using the Chroma Key technology make possible the creation of each necessary module to finally obtain a complete interactive game meant to foster the understanding and learning of a special collective of users inside an enjoyable environment. All these animations, together with games, official interactive application forms and prizes for each stage that a user

finishes, are integrated in a Flex application and controlled using messages and activation stacks. At the end, the user has a web application which can be used for getting all the information needed before undertaking the process to become a self-employed worker.

This game was initially tested over a small collective of users, to check its usability, degree of interaction, navigability and general understanding of the global game, over a group of common users not familiarized with this legal procedure. The results obtained gave us the first improvements we have included in this first version. As future work, we would like to evaluate this application over experts in the legal procedure to become a self-employer worker, and over possible future users of different ages and backgrounds. Another interesting test would be to evaluate the tool with current sole traders who have undertaken this legal procedure alone or with some help, because this would give us information about as helpful could be this tool.

6. Acknowledgements.

This project was developed thanks to the ideas provided by the entity Forem Andalucia and their special interest in providing to the specific sector of self-employed workers an easy-to-use, interactive and enjoyable game to facilitate them the understanding of the legal procedure before undertaking it. Also, it is important the work done by the Artec Group of the University of Valencia, to understand and show all the process in this innovative game.

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