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Preserving Avatar Genuineness in Different Display Media

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Abstract Our research focuses on enabling users to interact with others using 3D avatars with the same appearance and personality in different media such as the Internet, SMS or television and using different devices such as PCs, MACs, PDAs, mobile phones and televisions. This work's main contribution is its use of a unique architecture, tested with a contact application, which is compatible with different media. The avatar appearance editor, the animation engine and the 3D models are the same for the different media: TV, SMS and Internet chat.

Keywords human interface · visualization and display · avatar · internet · mobile devices · television

1 Introduction

Nowadays, geographically dispersed people can choose between many different communication media and modalities: text (letter, SMS, chat), voice (phone, mobile, VoIP), video, etc. Video conferences are increasingly popular thanks to the Internet and even haptic communication is gaining momentum. However, for different reasons, simpler communication media are quite popular, SMS and virtual characters—avatars—amongst them.

Contact applications such as Second Life (http://secondlife.com, revised on February 2007) and Imvu (http://www.imvu.com/, revised on March 2007), are at their highest ever level of use. These virtual environments allow users to stay in touch with other people and be represented by a virtual character, also called avatar. In general, these applications are limited to web environments. However, Internet is not the only media used for entertainment, other devices such as mobile phones and televisions are often used in free time for entertainment purposes.

Proof of this is that the use of mobile devices increases every year. There are now more than 2.5 billion (http://www.inc.com/magazine/20070101/priority-outlook2007_pagen_2.html, revised February 2007) mobile phone subscribers in the world. The main functionality of mobile phones is communication between two (or more) people. Nevertheless, the demand for games and interactive applications is growing and current technologies make it possible to integrate these types of applications in different display devices.

From the television environment point of view, other changes are taking place. Regional and local TV channels are gaining ground and TV channels need to achieve a "loyal" TV audience. Because of this, more and more TV programmes receive SMSes from viewers expressing their opinions about the topics under discussion or about the programmes themselves. Talk-shows in which people try to find love or friendship are also more popular than ever all around the world. For example, the Dr. Keith Albow Show (http://drkeith.warnerbros.com, revised on March 2007) and the Oprah Winfrey Show (http://www2.oprah.com/tows/

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tows_landing.jhtml, revised on March 2007) in the US, "El diario de Patricia" (http://www.antena3.com/diariodepatricia/, revised on March 2007) in Spain or "C'est quoi l'amour?" (http://lachaine.tf1.fr/lachaine/magazines/0,3391549,00-est-quoi-amour-.html, revised on March 2007) in France.

Taking all of this into account, we believe that there are advantages to unifying the various entertainment environments to enable users to use a single virtual character representing him/her in the media where s/he desires to be virtually present at any particular time.

The approach we suggest to solve this general objective has been tested using three media: SMS, Internet chat rooms and television, and a contact application compatible with a multi-media virtual avatar. The objective of our research is to provide consumers with the possibility of using the same avatar in different media and display devices.

People who want to be represented by an avatar should have the possibility of configuring the physical appearance of their virtual character using any available hardware. The appearance and personality must be the same in all scenarios. Keeping the same avatar appearance and personality makes it possible to have a genuine presence in the different displays and media. But appearance is not the only important factor, users also want to have a realistic communication experience using the avatar, so it must have the ability to speak and to express realistic emotions.

The main challenge is to have a global architecture that is media-independent. In Section 2 we show currently available applications. In Section 3 we put forward a platform that allows us to solve the problem in a media-independent way. Section 4 validates the proposal using three different media. Finally, our conclusions are listed in Section 5.

2 Related work

Avatars are widely used and aim to provide a more natural interface for interaction between people and their devices. Numerous projects present virtual characters for their specific environment. Several applications for making communication more natural and more fun, including avatars, are increasingly available for mobile phones. For example, The SenseMS Application [3] allows you to send a MMS including text, audio, a photo and a 2D avatar expressing an emotion. ExMS [12] is another application for sending messages with 2D avatar animations that express emotions. LiveMail [11] presents a new way of communicating using 3D face models created from images taken by the phone camera. In [4], a scalable avatar for conversational user interfaces is available. Their function is to adapt the appearance of the avatar to the device; using, for example, a 2D avatar for small devices such as mobile phones. Y. Mochizui et al. [10] have developed a virtual TV phone application for conversation with a humanoid agent, and it is suitable for consumer communication equipment, especially mobile phones. The receiver of the call can select and display a humanoid agent instead of a caller.

Using these messaging applications, users can send an expressive avatar to communicate with other people. However, the choice of appearances for the avatars is somewhat limited. The user can only choose from predefined avatars. Teenagers who tested the SenseMS Application said that "they would like the freedom to choose or make their own avatar".

As far as the configuration of the appearance of the avatar is concerned, in the Sims2 Mobile game (http://thesims2.ea.com/about/mobile/index.php, revised September 2007) users can define the appearance of their 3D characters. But this appearance is only for this game, users cannot use their avatars to communicate with other people.

The use of avatars on the Internet has also increased in the last few years. Several prototype applications have appeared with which people can chat or have a virtual interactions with other users. For example, BodyChat [15] uses embodied avatars to mimic human face-to-face communication. In [8], Ma et al. present a chat based on emotion estimation from the text that the user types. Moreover, an embodied avatar reproduces the text with the emotion estimation. Flat3D [13] is a 3D virtual world for the communication of creative activities throughout its own network. There are also some 3D virtual worlds on the web. For example, Second Life (http://secondlife.com, revised on February 2007) is a 3D virtual world with more than 4.5 million users. Outerworlds (http://www.outerworlds.com, revised February 2007) is a virtual reality 3D chat where people can talk with their friends, play interactive games, build a virtual house, etc. Worlds.com (http://www.worlds.net/, revised on October 2007) has a 3D chat where avatars move through virtual rooms and chat with other users.

With respect to television, several applications including avatars appear on television programmes. Marilyn [9] is a prototype for a virtual human avatar for intelligent interaction with digital TV for business television. An interactive TV show based in avatars is described in [7]. The show consists of a TV quiz that viewers can play from home, being represented by avatars which simulate the behaviour of the players. In [6] the authors show a meta-model aiming to specify agents' normative organizations from four points of view: structural, functional, contextual and normative. The model is explained with a TV game show in which avatars are based on agents. These avatars are directly controlled by their corresponding viewers. On AmigoTV [5] people can be connected with their friends

watching the same TV programme. Each user is represented by an avatar and s/he can change the emotion of the avatar depending on his/her mood. AmigoTV allows viewers to communicate via voice.

All of the above shows that the use of virtual characters to represent users in different environments is more popular than ever. Nevertheless, at present there is no application that allows the use of the same avatar in different environments. Therefore, we have based our research on multi-device avatars and focussed our work on contact applications.

3 Architecture

This section explains our platform's global architecture. Figure 1 applies the global concept to one particular case, which can be used for testing the concept. The main objective is to allow the user to interact with other people. This is achieved with the users' avatar. The avatar represents the user in remote places through different media. The platform we propose allows the avatar to keep its facial profile and emotional expression in these media.

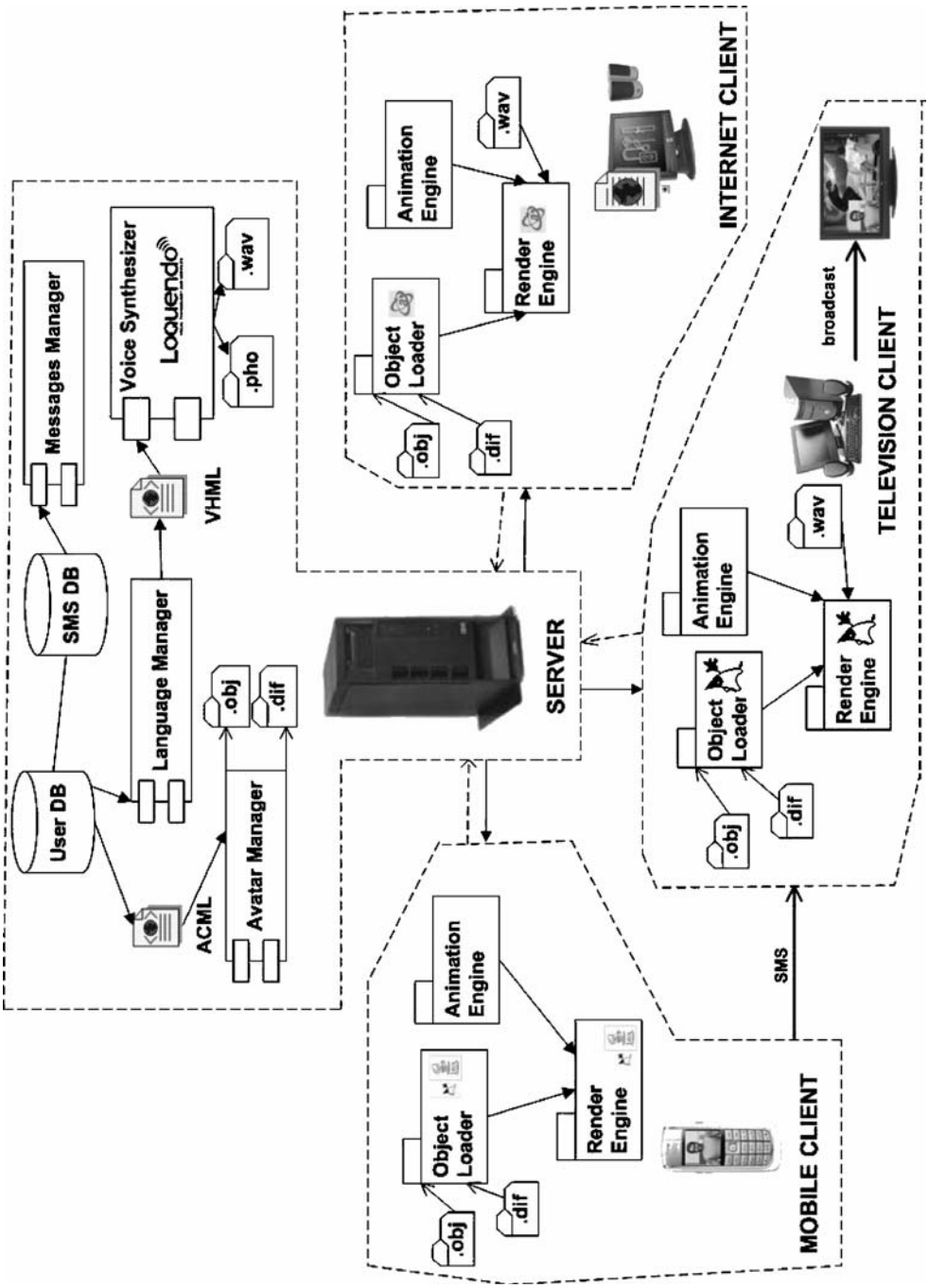

Figure 1 Platform architecture

The user has to license and download the application for his/her mobile phone or s/he can log into the webpage.

Section 3.1 deals with the architecture. Section 3.2 explains how the user can also edit his/her virtual character either from a computer or from a mobile phone. It also explains how we manage the virtual character's description. The platform can be accessed from different devices in order to edit the avatar, which we refer to as accessing the configuration tool. Section 3.3 deals with facial expressions (animation). The last section explains the architecture using an example.

Section 4 shows the examples used to validate the platform. They form a contact application which materializes the concepts presented in this section.

3.1 Platform architecture

The whole platform was developed using Java. The platform (see Fig. 1) is based on a central server with the following modules: language manager, avatar manager and messages manager.

The *language manager* module synthesizes the messages that the avatar must "tell" its remote partner. This module uses a VHML [14] file in which the text message incorporates the emotion that the avatar is going to express while "telling" the message. We have used a Loquendo Synthesizer to synthesize the text. The *avatar manager* module administers the avatar's appearance. This module will be explained later on. The *messages manager* module receives and distributes the messages to the platform users.

On the other hand each media connected to the platform has its own client. Each client must adapt to the specific requirements of its current hardware and display features. However, a common architecture based on three modules is used in for each client: the object loader, the animation engine (see Section 3.3) and the render engine. Figure 1 shows three media used to validate this architecture.

The *render engine* is built using the most convenient libraries for each interface device. Sometimes, Internet clients are reluctant to download and install additional plug-ins. Because of this, the Internet scenario uses Anfy3D. This library is integrated in the application. So the user does not need to download any additional plug-ins. This client is mainly oriented towards desktop browsing.

The mobile client uses the Mobile 3D Graphics API (M3G), which is the 3D graphics library used by J2ME, which is the adapted version of Java for mobile devices.

Television clients do not face the usability restrictions that appear in the other two clients have. As it is managed by professionals, Java3D is installed for the render engine. This solution is more powerful than Anfy3D. The broadcaster creates the avatar animation using a regular PC with a Java3D-based application. The avatar is then combined with the rest of the images. The resulting image is broadcast.

Nowadays, desktop computers are able to render wonderful 3D scenes, so Internet or TV clients' avatars can be very realistic. However, this realism will improve in the future thanks, amongst other things, to new hair modelling and face animation techniques.

The same is true for current mobile phone technologies. At present it is possible to load and render satisfactory 3D models, but animation is rather slow. For example, we tested a 3D avatar defined by 3,740 faces. It was converted to m3g format with 70 kB and 14 kB textures for the Sony Ericsson K750, Z520, S700 or W600 mobile phone emulator achieving about one or two frames per second. Note that animated faces require more polygons than expressionless ones because they must render realistic gestures.

In the next few years mobile phones will probably have computing power similar to that of current desktop systems, but desktop systems will also improve performance and services, and so there may still be a functional gap between the two.

The *object loader* functions are specific for each media and hardware combination. They import from the server the avatar description using the libraries or functions that are most appropriate for each specific render engine. As we will explain later on, the avatar description is received in XML format. For each given user, all the media make use of the same avatar model. The model is stored and managed on the platform (*avatar manager*). Section 3.2 explains the modelling aspects which we call avatar configuration. This approach guarantees that the avatar's appearance is the same in the different media because all the media use the same 3D models and avatar appearance configuration.

Finally, the animation technique module generates the virtual character's facial expression. As Section 3.3 explains, the same module is replicated in all the devices which meet the computing power requirements.

3.2 Configuration tool for 3D avatars

The avatars' descriptions are stored in the server. They are managed by the Avatar Manager on the server side and by the Object Loader on the client side. The configuration tool consists of these two modules.

Users edit their own avatars using the tools that are provided by the object loader installed in the client they are interfacing with at any given time. This section describes two different implementations, one for each client: the mobile client and the Internet client (desktop browser).

When hardware compatible with a specific media receives an avatar with a message, its object loader gets the model that must be rendered from the avatar manager.

Avatar descriptions are stored and transmitted using XML format (see Fig. 2). We have called the XML avatar appearance ACML (Avatar Configuration Markup Language).

```
<?xml version="1.0" ?>
<!DOCTYPE ACML (View Source for full doctype...)>
- <acml>
  - <person age="32" category="adult" gender="female"
      name="Elena" variant="Elena:1" disposition="happy"
      language="spanish" photo="c:/photos/elena.jpg">
    - <appearance>
      - <head name="Elena" facial_estructure="0.5"
          lips_thickness="0.5" nose_thickness="0.5"
          weigh="default">
          <object situtation="./models/avas.txt" />
          <color texture="./textures/texture.jpg" />
        </head>
      - <body name="Elena" weigh="default">
          <object situtation="./models/avas.txt" />
          <color texture="./textures/texture.jpg" />
        </body>
      - <complement name="dress">
          <object situtation="./models/camisa.obj" />
          <color texture="./textures/camisa.jpg" />
        </complement>
      </appearance>
      <facial_animation technique="morphing"
        model="polygons" />
      <corporal_animation technique="mocap"
        model="polygons" />
    </person>
</acml>
```

Figure 2 ACML for avatar appearance

As mentioned above, the avatar appearance must be the same in all scenarios, and because of this the mobile and the Internet clients' configuration tool makes it possible to configure the same kind of 3D avatar.

Both the configuration tools for 3D virtual characters are integrated into a contact application (see Section 4). First, the user licenses via SMS and then s/he can edit the avatar using the MIDLet that has been downloaded to his/her mobile phone client. S/he can also use the Internet client. The customer can use either of the two environments whenever s/he wishes.

The user has to configure his/her personal data such as name, age, gender, personal preferences, etc., but also edit the appearance of a 3D avatar which will represent him/her in three different environments: mobile phone, Internet and television. S/he can choose the gender of the avatar and then edit its physical appearance, choosing between different options with an intuitive menu on which s/he can select the hair, eyes and skin colour; the width of the face, nose or lips; the hairstyle, etc. The user avatar's appearance can be easily changed.

Skin colours are predefined in a realistic colour list. For example, the user cannot select blue or green skin. An example of avatar configuration on the Internet client (desktop browser) is shown in Fig. 3 and an example for mobile phones can be seen in Fig. 4.

For a more realistic character appearance, the face is textured; the eyebrows and lip colours are brought out. When a piece of clothing for the body is selected, the avatar appears smaller on the screen to show the body. The user can move the avatar and zoom it to see the details of the virtual character.

As can be seen in the previous images, with these configuration tools users will be able to create and edit their avatar's physical appearance. The idea behind both tools is the same: the user has the same options to edit the avatar. However, mobile phone and Internet technologies are different. Because of this the configuration menu is different for each tool.

The Internet tool menu is more visual and intuitive. The user can see an image that represents the clothes that can be chosen, or see the colours defined for the skin, eyes or hair, etc.

The menu for the mobile phone is different. The MIDLet interfaces are simpler, so users can only see the options that they can change and then, once they have selected an option, try it with the mobile phone's left and right-hand keys. These keys change selected option's appearance.

3.3 Facial expression: the animation engine

In a real, face-to-face communication between people, the person who is talking expresses emotions, makes gestures, etc. The listener also makes gestures and expresses emotions to agree or disagree with the speaker. Because of this, it is important to have a 3D animated and expressive avatar and give the user the feeling that s/he is interacting with a real person.

The same facial expression technique is applied in all the scenarios. We have implemented an animation engine that runs on mobile phones and on user's computers in the same way. The animation is created in real time using morphing. This technique consists of combining different predefined models to generate the animated expressions' key frames. As mentioned in [2], for the generation of each key frame we have to calculate a new geometry in which the coordinates of each vertex are the function of the corresponding vertices of the *morph targets*. So, if we want to view the animation between two morph targets, for example a face with closed eyes and another with a happy face, we apply the algorithm shown in Eq. 1 for each vertex:

$$V(i) = p(1) * EyesClosed(i) + p(2) * Happy(i) \quad (1)$$

where $V(i)$ is the vertex; $p(1)$ and $p(2)$ are the respective target weights and EyesClosed(i) and Happy(i) are these facial expressions' vertices.

However, this technique has a very high computational cost. In general, the differences between the predefined targets are only significant in a few vertices. For example, a default face without emotion and a face with a blinking eye are only different in the eyes' vertices. Because of this, we

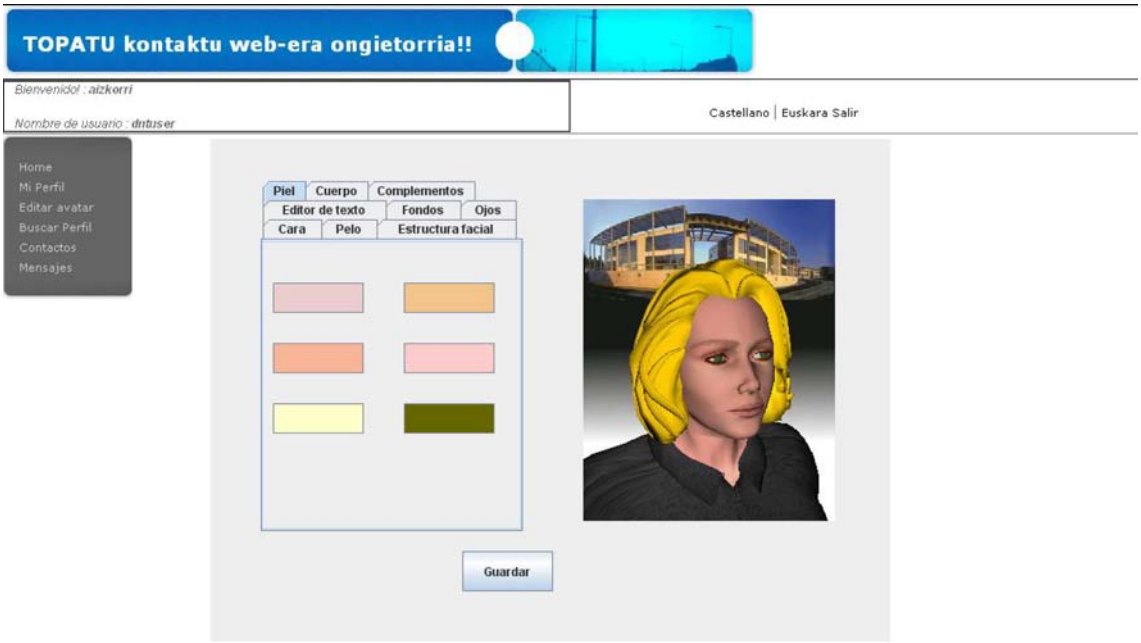

Figure 3 Configuring the face of a female avatar on the web

have applied an adaptation of the morphing technique described in [1] only using each target's modified vertices:

$$V(i) = \sum_{j=1}^{n} p(j) * \left(V_j(i) - V_{def}(i)\right) \quad (2)$$

where $V(i)$ is the vertex i of the new key frame, $p(j)$ is the weight of target j, $Vj(i)$ is the vertex i of target j and $V_{\text{def}}(i)$ is the vertex i of the neutral target. So the algorithm is only applied in the vertices that are different and in this way the computational cost is reduced.

3.4 Architecture example

The following example explains how the architecture works and which data are transferred. Ana has licensed with her username and password. She can edit her avatar on the webpage or using the MIDlet installed in her mobile phone. When she wants save the avatar, the ACML is sent to the server and saved in the user database.

When she enters the contact application, her avatar's ACML is sent to the client she is currently using and the *object loader* displays her avatar. When Ana wants to *chat* with Daniel (another licensed user) Ana's avatar's ACML is sent to Daniel (and the same is done with Daniel's avatar) and the avatar's appearance is loaded.

If Ana sends a SMS to Daniel using the contact application, Daniel will receive an MMS with the picture of Ana's avatar. In the prototype with the avatar animation, Ana's avatar's ACML will be sent with the message.

If Ana wants to express her opinion on a TV show, she has to send a SMS using the contact application's MIDlet to the TV show phone number. The producer decides if the SMS is displayed as text or if the avatar tells the message. If her message is shown as a text, the television client asks the server for a picture of Ana's avatar. On the other hand, if her message is told by the avatar, the television client asks for the ACML file.

4 Concept and architecture validation

As mentioned above, the main objective of our research is to create a multi-media virtual character which can be used in the most popular entertainment environments. The avatar

Figure 4 Different configurations of a male avatar on the mobile phone

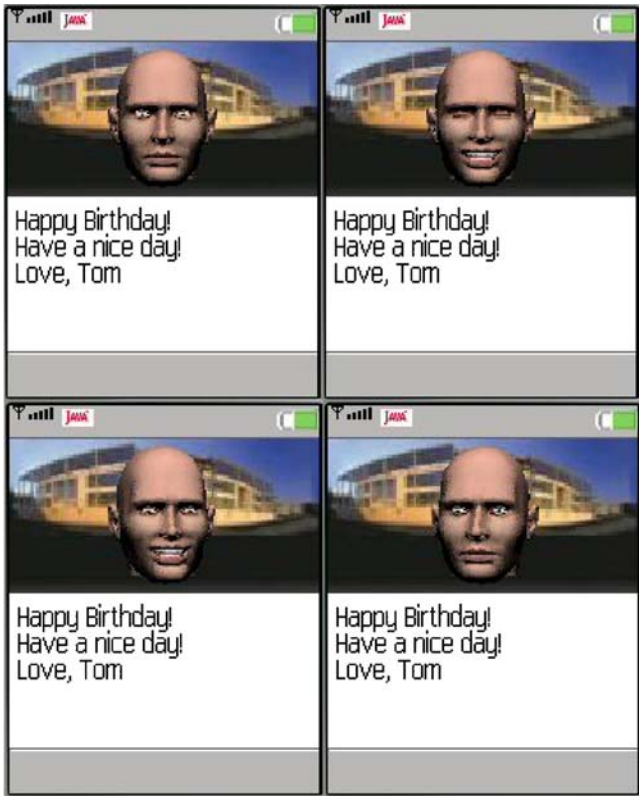

Figure 5 Message with an animated 3D avatar

will be a virtual representation of the human user who wants to be present in remote places using his/her desired media. Our prototype has been validated in three media: Internet (desktop browser), SMS (mobile phones) and television.

4.1 The internet scenario

Once the user licenses the contact application, s/he can use the web browser to configure the avatar's physical appearance which is going to represent him/her, as we have explained in Section 3.

The avatar defined by each user can be materialized in an avatar chat integrated on the contact application webpage. In this chat, the user writes the text, as in other chats rooms, but the difference is that the reader can also see his/her friend's avatar reproducing this text, which has been synthesized. The users of this chat have the feeling they are talking with a "real" person. Besides, the users of this scenario can decide if the avatar is to reproduce the text with a realistic emotion such as happy, sad, angry, etc. Users select the emotion before they send each message.

To be in contact with other people using this chat, both users have to be connected. But if someone wants to contact a user who is not on line, s/he can send an email in which his/her avatar will appear.

4.2 The mobile phone scenario

As in the Internet scenario, the user can edit the physical appearance of his/her virtual character. S/he can then send messages to other users including the avatar that s/he has defined.

We have developed two ways of sending personalized messages. The first method sends a message that appears together with an animation of the sender's avatar expressing an emotion selected by the sender. Different message captions with an animated 3D avatar are shown in Fig. 5. The second method consists of sending an MMS with the text and one caption of the user's avatar. These messages have to be sent using the corresponding option in the MIDlet.

Current technologies make it possible to run the animation engine on mobile phones. However, the animation is a bit slow due to current mobile phone capability. In the near future, new technologies will make it possible to run animation engines smoothly. The most recent mobile phones integrate graphic chips for accelerated graphics, which allow integration of the animation engine. This will allow this kind of application to run smoothly.

So the alternative to the first method is to send a MMS that contains the text and the avatar's caption, as in Fig. 6.

4.3 The TV scenario

The idea behind the TV scenario is that the avatar represents users who send a SMS to television programmes using the contact application's MIDlet. At present, the messages that people send to TV programmes show the text that the user sends. Using this application, an avatar can reproduce the message. It could be done using two different methods: either an static avatar (photo) and the text appear on the screen, or the avatar animates and tells the text.

The first method is appropriate to prevent the avatar from interrupting the TV host and guests. In this way, the image of the avatar and the text can appear on the screen

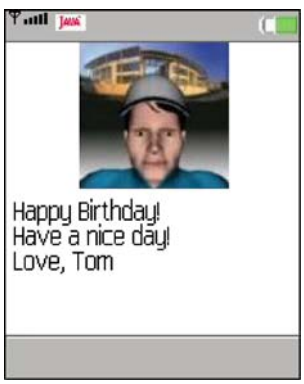

Figure 6 MMS with the avatar's caption

combined with the programme's images and viewers at home can read the messages and watch the picture of the sender's avatar.

Some messages can be reproduced by the avatar if the TV producers think it appropriate. The TV host will pause and give way to the avatar. It will have the appearance that the user sending the message has configured. At home, the viewers watch the sender's avatar telling the SMS text.

One issue with SMSes is that senders often shorten words. Current text-voice synthesizers cannot understand abbreviated messages. As a preliminary solution, we have implemented a tool that TV employees can use to edit SMS contents.

5 Conclusions

We have defined a multi-media virtual character management architecture. This has been validated using a contact application and different display systems. Using this new architecture, the application has the following features that do not appear in related work.

The virtual character can be used in different media, three in the validation system SMSes, the Internet and TV. Furthermore, the avatar's appearance is the same in three media. This means that the proposed platform keeps the avatar's facial profile and expression.

Users can edit their avatars' appearance using their mobile phone or Internet configuration tools. The avatar is able to express realistic emotions decided by the user in all the media thanks to the animation engine. This avatar represents the user in three media that make use of devices with different capabilities. The avatar description is stored and transmitted using ACML (Avatar Configuration Markup Language), a proposal that is currently being developed.

In the Internet scenario (desktop browser), users can chat with other people using their avatar reproducing the written text to the interlocutor. Another possibility is to send a caption of the avatar in an email. If an SMS is received on a TV programme, this message can be reproduced by the incoming avatar.

To sum up, we can configure the physical appearance of our own 3D virtual characters, which will represent us in different media such as SMS, the Internet, or television, and different devices such as computers, mobile phones and televisions.

The evaluation of this proposal was monitored by a content creation company. Once the research and validation applications have provided satisfactory results, this company will take charge of the deployment of these ideas and systems.

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