Возможности интерактивности в создании современных аудиовизуальных программ

В прошедшее десятилетие отмечено взрывным развитием области мультимедиа. Это развитие вызвало к жизни невиданный ранее уровень интерактивности пользователя в мультимедийных программах, вызвало исследование и развитие новых технологий, методов и устройств интерактивности. Область интерактивных Аудиовизуальных (AV) Программ, включающих интерактивные Кинофильмы, интерактивную Драму, интерактивное повествование и другие, стала одной из таких новых активных академических областей, так же как индустрия исследований и развития.

Ее изучают специалисты Драматического Искусства и при написании сценария, члены Компьютерной Графики, искусственного интеллекта и Технические сообщества так же как Индустрия развлечений [1-4].

Появление стандартов сжатия изображения и видео, типа MPEG-1 (1993) [5] и особенно MPEG-2 (1996) [6], позволили создателям контента обеспечить зрителей студийным качеством цифрового видео.

Развитие моделирования и рендеринга изображения, совершенствование компьютерных аппаратных средств позволили обеспечить взаимодействие с машинно-генерируемым визуальными программами типа видеоигры для домашних PC или игровых пультов.

Появление DVD в 1996 [7] с его высокой емкостью запоминающего устройства (теперь до 17.1 Gbytes данных), позволило передать кинематографическое качество интерактивного видео и аудио, удовлетворяющее домашнего пользователя, с помощью одной портативной среды.
Что еще более важно, DVD стал первой широко принятой технологией создания и передачи видео программ с высокой степенью интерактивности пользователя с рынком потребителя [8]. Кроме того, DVD теперь стал технологией, которая примиряет интерактивность на основе видео
(Видео DVD) и интерактивность на основе Интернета (Расширенный сетевой DVD [9]). Кроме того, учитывая новый курс промышленности к конвергенции игроков DVD и пультов видеоигр [10-12], будущие технологии перемещаются к интерактивным визуальным программам с комбинацией информации машинно-генерируемой и живого.
Для реализации необходимо, чтобы такая конвергенция между машинно-генерируемым и reallife видео - один из аспектов MPEG-4 (1999)-последнее усилие по стандартизации Кинофильма MPEG
Группа Экспертов (MPEG) Международной Стандартизации
Организация (Международная Организация по Стандартизации) [13, 14].
MPEG-4 - первый MPEG стандарт для зашифровывания на основе содержания мультимедийных данных, где сцена разделена на отдельные аудиовизуальные (AV) объекты и каждый объект AV закодирован независимо от другого AV возражает так же как независимо от сцены информация состава. Схемы зашифровывания единственных

Объекты AV могут измениться среди MPEG-2, базируемого, кодируя (реально-живой видео подход), 2-ое и трехмерное кодирование петли (подход компьютерной графики) так же как несколько другой зашифровывание методов. Представление на основе объекта аудиовизуальная информация делает диалоговые способности врожденный к MPEG-4 закодированное содержание, в то время как поддержка реально-живое видео вместе с машинно-генерируемым видео учитывает беспрецедентно широкие диалоговые способности.

В этой бумаге, мы сначала рассмотрим диалоговые способности как хорошо как различные пользовательские стили взаимодействия, используемые в диалоговом визуальное программирование сегодня. Тогда, мы проанализируем новое способности взаимодействия, которые MPEG-4 базировал визуальный
программирование принесет пользователям так же как который стили взаимодействия лучше всего удовлетворят этот новый тип программирование. Мы опишем наш осуществленный
опытные образцы нескольких из обсужденных диалоговых способности и стили взаимодействия, главным образом на основе объекта состав сцены, взаимодействие пункта-и-щелчка на основе объекта и диалоговый стиль взаимодействия. Наконец, мы будем проанализируйте результаты пользовательского взаимодействия с этими опытными образцами
и разговор об указаниях нашего будущего исследования относительно MPEG-4 базировал диалоговое визуальное программирование.

Сегодня существует два разных подхода в создании интерактивных аудиовизуальных программ:
Подход на основе видео или на основе клипа и подход с использованием Виртуального Мира или Компьютерной графики.

Диалоговые Способности в AV Программировании, созданного при использовании Подхода на основе ви деоклипа

Интерактивные AV программы, созданные на основе видеоклипов составлены из записанных заранее видео потоков и пользовательских навигационных команд, позволяющих по желанию пользователя процессе воспроизведения переходить от одного видео потока к другому.

Видео с гиперсвязью

Видео с гиперсвязью или просто **Гипервидео было первым воплощением интерактивных AV программ на основе видеоклипов.**

Само понятие появилось на основе, комбинирования двух слов видео и гипертекста и описывает видео, которое содержит связи с другим видео, а также изображением или текстом.

Гипервидео

Гипермедиа состоит из узлов (частей медиа) и связями между узлами, за которыми пользователи следуют, осуществляя навигацию по медиа. Это гипермедиа представляет собой интуитивный способ создавать, разделять и получать доступ к информации.

Пока понятие *гипертекста* весьма хорошо понято, идея относительно *гипервидео* все еще развивается и интерпретировалась различными способами.

If you know what hypertext is, it's easy to understand how hypervideo works. Without interrupting a video, a hypervideo's hot spots can link you to other sources of pertinent information. To obtain more information regarding any object, actor, or background in a video, you just click on it; you're then linked to text, photos, sound, video, or other content-delivering applications.

Один из первых проектов гипервидео было .HyperCafe. [1, 2], развитый в 1996 в Институте Джорджии Технологии. Система Гиперкафе была главным образом составлена из собрания видео скрепок со связями к другим видео скрепкам или тексту и разместит пользователя в действительный café и позволит пользователю .move. между различными столами и будет слушать беседы людей за теми столами.

Система Гиперкафе использовала четыре типа навигационных связей: **временные, пространственно-временные, пространственные и текстовые связи [2].**

A temporal link would give the user a certain time window to access a link in order to view a different video
stream. In the case of a spatio-temporal link, a specified spatial location in a video frame would trigger a jump to a different video sequence at a specific time window. Using spatial links, the user could alter the appearance of the currently playing video sequence. In the HyperCafe project, spatial links were implemented as dynamically available (transparent) objects present in video sequences, where these objects could be turned on and off. And finally, textual links would turn on and off text that appeared simultaneous to video, which is equivalent to subtitles in a regular movie.

1. HyperCafe project, <http://www.lcc.gatech.edu/gallery/hypercafe/>.
2. N Sawhney, D. Balcom, and I. Smith, .HyperCafe: Narrative and Aesthetic Properties of Hypervideo,. Proc. Hypertext 96, ACM, 1996, pp. 1-10.

Figure 1: As the camera continually pans across the cafe, many opportunities exist to select a single table of conversation and navigate to the related video narratives.

As one conversation is shown (video of man on the bottom left), two new temporal opportunities briefly appear (on the top and right) at different points in time. One of the new conversations can now be selected (within a time-frame) to view the related narrative, otherwise they will both disappear.

Figure 3: The main video narrative (on the left) shows a table with two men in the background.
A spatio-temporal opportunity in the filmic depth of the scene triggers another narrative.

Figure 4: A video collage or “simultaneity” of multiple colliding narratives, that produce other related narratives when two or more video scenes semantically intersect on the screen.

HyperCafe: Sawhney, Balcom, and Smith, at Georgia Tech

- Focus: literati vs. engineers
- Interested more in new form of literary discourse, i.e., hypervideo aesthetics for fictional narratives.
- Blends into work on interactive video, etc. (which so far has been of limited appeal)

HyperCafe Scenario

- Idea: Simulate a visit to a cafe.
  - by maintaining and exploiting (at least avant garde) film aesthetics
- Video sequences play continuously; can't be stopped.
- User navigates through videos and links presented.
  - Choices represent filmic decisions (normally left to the director).

Overview

- Entering: Overview shot of entire scene, viewing all participants.
  - Hear low hum of voices.
  - Instructions in the form of moving text appear on bottom on screen.
- Camera moves to each (of three) tables, offering opportunities to select from multiple conversations at table.
  - User is placed in a narrative sequence determined by the conversion.
- Plays continuously, forwards and backwards. (conversation played as constant hum until selection.)

Hierarchy of Video Scenes

- Main sequence: Provides access to all possible narratives.
- Second level: Conversational narratives for each table.
- Third level: Sequential stream of video scenes, representing the conversation
  - with links to other video conversations in the current table or other tables.

Taxonomy of hypervideo linking

- Temporal links: Time-based references between scenes.
  - Specific time in source triggers playback in destination.
  - used for "standard" narrative scene sequencing
- Spatial-temporal links
  - Specified location in source video triggers destination video at a specific point in time. (?)
- *Temporal link opportunities*: Previews of destination videos temporarily provide link.
- *Spatial link opportunities*: Spatial locations in source temporarily provide link

Prisoner of Life:
A *Short Cuts* Hypervideo

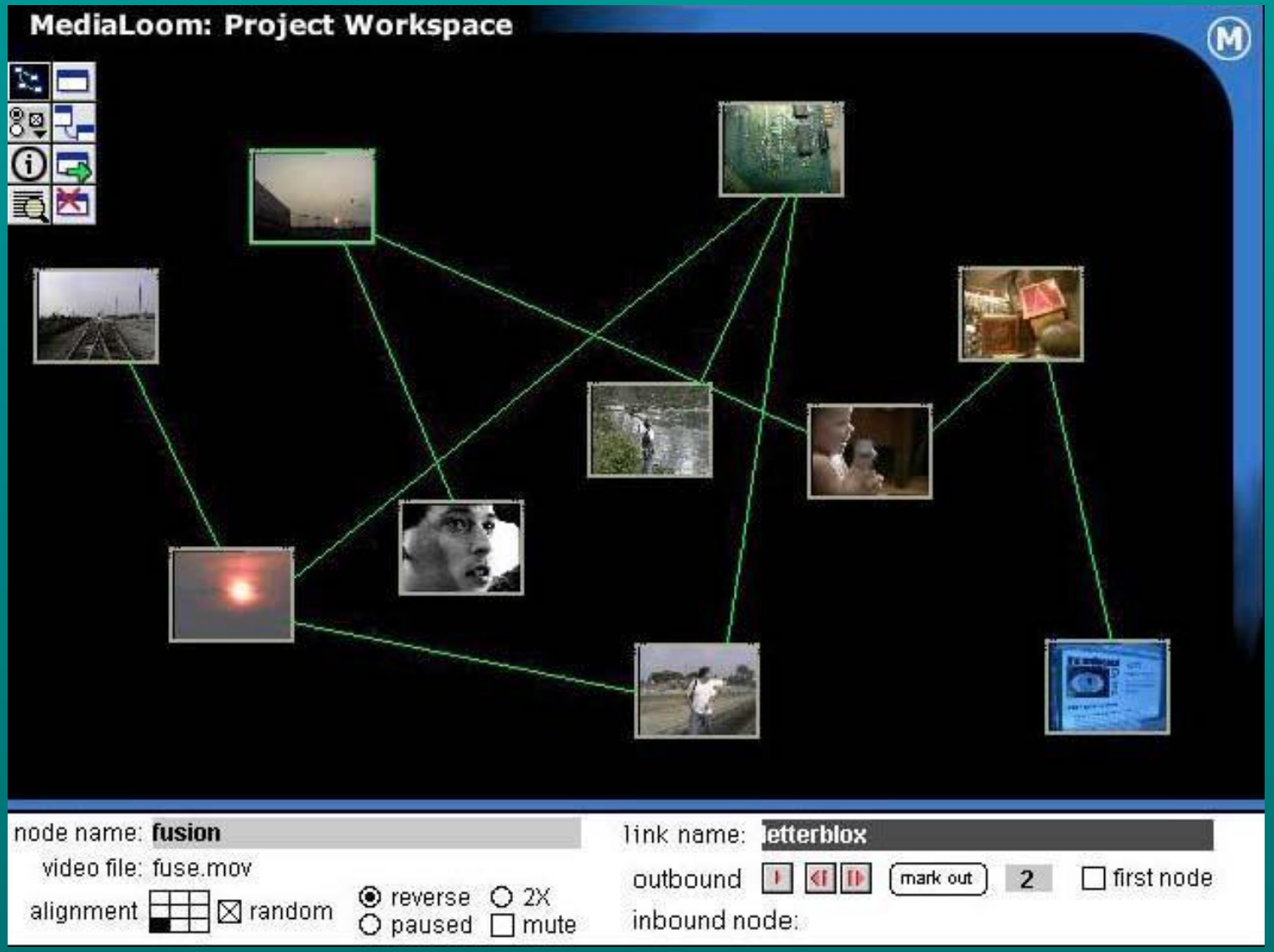
To demonstrate the functionality of MediaLoom I have created a short work called *Prisoner of Life*. This hypervideo is a reconfiguration of about thirty minutes of Robert Altman's film *Short Cuts*, a clear cinematic forerunner of hypervideo. Altman takes great care to interweave nine short stories by Raymond Carver so that the individual storylines all seem to be happening simultaneously. The camera swerves in and out of these narrative streams encountering characters who also are able to move from story to story. It is as though we are watching a computer monitor over the shoulder of Altman who is directing the flow of a hypervideo.

Short Cuts lends itself quite well to hypervideation for two reasons: 1) the film anticipates many of the storytelling strategies intrinsic to the hypervideo form; 2) there are associations and tangents that are obscured by the linearity of the filmic medium which might be highlighted (or discovered new) in the medium of hypervideo.The idea of using *Short Cuts* as a demonstration of hypervideo was suggested as a possible future use of the Engine in a paper by David Balcom called "Hypervideo: Notes Toward a Rhetoric" and in "Short Cuts, Narrative Film, and Hypertext".

One might ask: why choose a film as the subject of a hypervideo artifact? I would echo the video critic Michael Nash who believes that interactive video authors can learn much from traditional modes of storytelling. Specifically he refers to Altman's filmmaking technique whose work "follows the trails of coincidence, tangent, and narrative association … in 'sequential parallel.'" Altman's work represents a kind of linearized multi-linearity enforced only by the material properties of the film footage. In particular Nash points to *Short Cuts* as "a model of how a technologically interactive narrative might work to take us beyond technofetishistic games with computers into a spiritual journey." It is my hope that the viewer of this hypervideo will previously have seen *Short Cuts* (or other films by Altman) so that the uniqueness of the connections allowed by the hypervideation is more apparent.

Though the video artist Grahame Weinbren is mostly critical of the computer as a medium for interactive video, the hypervideated Short Cuts seems a perfect illustration of some of his ideas in an influential essay called "Ocean of Streams of Story". Weinbren, taking a cue from Salman Rushdie's Haroun and the Sea of Stories, asks "Can we image the Ocean as a source primarily for readers rather than writers? Could there be a 'story space' (to use Michael Joyce's resonant expression) like the Ocean, in which the reader might take a dip, encountering stories and story-segments as he or she flipped and dived. . . . What a goal to create such an Ocean! And how suitable an ideal for an interactive fiction!" *Prisoner of Life* sets as its goal the creation of simultaneously flowing storylines that can be navigated by swerving between streams.

The image above shows the construction of one segment of *Prisoner of Life*. The viewer can negotiate the "streams" (represented here as vertically arranged clips) by moving between them laterally. Time in this configuration exists on the y axis moving from top to bottom. Notice that the television screens (each showing the same newscast) link the streams together thematically as a single moment in time.


MediaLoom: Project Workspace
node name: fusion
video file: fuse.mov
alignment
random
reverse
2X
paused
mute
link name: letterblox
outbound
mark out
2
first node
inbound node:

An early proposal for hypervideo considered it to be a new kind of cinematic experience and the researchers discussed its aesthetic properties [1,2]. In their system a filmmaker authors a set of possible narrative sequences in hypervideo material and the viewer chooses which sequences to watch. In [3] a generic data model for hypervideo represented semantic associations between video entities, i.e. regions in consecutive video frames, and other logical video abstractions. The focus was on semantic associations between entities, e.g. X is-a Y, rather than on story structures.

The use of hypervideo for interactive training has been demonstrated in [4]. Recently a system to support object-based hypervideo authoring has been proposed [5], and issues to do with hypervideo transmitted via interactive television have been discussed [6].

3. H.T. Jiang, and A.K. Elmagarmid, “Spatial and Temporal Content-Based Access to Hypervideo Databases”, *VLDB Journal* 7 (4), 1998, pp. 226-238.

4. J. Doherty, A. Girgensohn, J. Helfman, F. Shipman, and L. Wilcox, “Detail-on-Demand Hypervideo”, *Procs. ACM Multimedia 2003*, pp. 600-601.

5. H.-B. Chang, H.-H. Hsu, Y.-C. Liao, T.K. Shih, and C.-T. Tng, “An Object-Based Hypervideo Authoring System”, *Procs. IEEE Int. Conf. On Multimedia and Expo, ICME 2004*.

6. M. Finke, and D. Balfanz, “A Reference Architecture Supporting Hypervideo Content for ITV and the Internet Domain”, *Computers and Graphics* 28 (2), 2004, pp. 179-91

Interactive Storytelling

A significantly more sophisticated approach of interactive clip-based AV programming can be found in the area of Interactive Storytelling.

This approach uses a large collection of prerecorded and indexed video clips as a base for the interactive story. In order to maintain a sophisticated connection between the user input and a creative story line, interactive storytelling systems employ artificial intelligence (AI) concepts and techniques, such as Intelligent Agents. When the user interacts with the story, the storytelling engine makes decisions as to which clip to play next. An intelligent agent in such systems is the storytelling engine itself, with its primary responsibility being "intelligent" selection of the best clip from a collection of clips.

An example of a storytelling system can be a collection of video clips that show an actor talking and a storytelling engine that chooses a video clip of an actor giving the most appropriate answer to the user's questions [7]. Other examples of interactive storytelling systems using the clipbased approach can be found at the Interactive Cinema Group [8] and Media Lab [9-11] at MIT.

7. Synthetic Interviews project at Entertainment Technology Center at Carnegie Mellon University, <http://www.cmu.edu:80/acs/telab/Courseware/Stevens.html>.
8. Interactive Cinema group at MIT, <http://ic.www.media.mit.edu/groups/ic/>.
9. Object-Based Media at MIT, <http://www.media.mit.edu/~vmb/obmg.html>. Jonathan Dakss, Stefan Agamanolis, Edmond Chalom, and V. Michael Bove, Jr., ‘‘Hyperlinked Video,’’ Proc. SPIE Multimedia Systems and Applications, 3528, , 1998.
10. HyperSoap, <http://www.media.mit.edu/hypersoap/>.
11. An Interactive Dinner at Julia's,<http://www.media.mit.edu/~dakss/intdinner.html>.

DVD-Video

The most widely known and commercially successful application of the clip-based approach to interactive AV programming is DVD-Video.
DVD-Video titles are created using non-linear random access navigation amongst different MPEG-2 video streams and parts of video streams. The user interaction in DVD titles is mostly menu based and is achieved through the use of visible or non-visible (hidden) buttons that are put on top of still images or video and where each button has one or several navigation commands associated with it.
Most prevalent navigation commands in DVD are links that redirect playback from a current video/still-image stream to another video/still-image stream. These links are equivalent to the temporal, spatio-temporal, spatial and textual links that we have already discussed when talking about hypervideo.
In addition to interactive capabilities of hyperlinked video, DVD titles can supports, may it be to a limited extent, the storytelling approach to interactivity. DVD titles can support conditional navigation amongst video streams by taking advantage of internal DVD variables (System Parameters and General Parameters [12]) that the DVD player can read from and write to its registers. By creating sophisticated storytelling scripts with multiple conditional branching nodes, DVD titles can for example create a story that will take different turns and appear to do it seamlessly to the user.

Furthermore, DVD supports one additional type of links – a web link [13], where by activating a link the user can connect to a web site and display some or all of its contents via a web browser. The web links can also be transparent to the user, whereas some content will be seamlessly downloaded from the Internet and presented to the viewer as a part of the movie itself.

12. DVD Specifications for Read-Only Disc, Part 3, Video Specification, Version 1.0, August 1996.
13. Interactual Technologies Inc., <http://www.interactual.com/>.

Interactive Capabilities of AV programming created using the Virtual-World Approach

In the virtual world approach to interactive AV programming, instead of using prerecorded video clips, the visual information of the story is generated real-time. This is most often achieved by using computer-generated interactive characters, also called believable agents - characters that seem to be able to reason and generally seem lifelike in their actions and behaviors (but not in their appearance). The part of the storytelling system that controls the behavior of characters can be somewhat similar to the storytelling engine used in the clip-based approach to storytelling with the output of the storytelling engine being the choice of the most appropriate behavior for a certain character.

Examples of some of the virtual-world storytelling systems are the OZ project at CMU [14, 15] as well as multiple projects and Media Lab [16] at MIT.

14. OZ Project homepage at Carnegie Mellon University, School of Computer Science, <http://www.cs.cmu.edu/afs/cs.cmu.edu/project/oz/we b/ >.
15. An Oz-Centric Review of Interactive Drama and Believable Agents, Michael Mateas. Technical Report CMU-CS-97-156, School of Computer Science,Carnegie Mellon University, Pittsburgh, PA, June 1997, <http://www.cs.cmu.edu/afs/cs.cmu.edu/project/oz/we b/papers.html >.
16. Media Lab at MIT, <http://www.media.mit.edu/>.

INTERACTIVE CAPABILITIES IN MPEG-4 BASED VISUAL PROGRAMMING

Examining the above two approaches to creating interactive AV titles we can see that each approach has its own pluses and minuses. With the clip-based approach, the AV title uses videos with real actors, and thus can take advantage of their artistic performances. Also, there is no concern of making the actors' appearance look life-like. The drawback of the clip-based approach is a coarser granularity of interaction then it is possible to achieve with the computer graphics approach, i.e., there is a limited set of video clips available to choose from and also each clip has to be reasonably long. In the virtual world based approach, the range of behaviors for the AV data can be much greater (thought still limited). Also the interaction itself can occur at much shorter intervals as well as impact many, if not all, aspects of the audio-visual appearance of the story. On the downside, at present is not possible to make the appearance of computer-generated video completely believable and also the story does not benefit from artistic performances of real people.

The new MPEG-4 standard for encoding of AV information allows us to incorporate and take advantage of both the clip-based and the computer-graphics based approach to interactivity in the same MPEG-4 AV stream.

Object-based Interactivity

With MPEG-4 based interactive programs, the focus of user interactivity shifts from stream level navigation to the object level navigation.

Instead of only switching playback from one video stream to another as it is done in the clip-based approach, the viewer of an MPEG-4 title can also modify the appearance of the AV contents derived from a single MPEG-4 stream.

With MPEG-4, the user can modify the composition of a scene as well as the properties of individual AV objects within a scene. Specifically, the user can [24] perform the following:

1) insert or delete an object in a scene,
2) change the transparency on a object,
3) change the location of an object and the size/scale of an object,
4) change other properties on an AV object, such as texture, color appearance, viewing angle, etc.

The specific object properties that the user can and can not modify depend on the encoding scheme used for that object. MPEG-4 supports two general types of video objects: natural and synthetic, which for better understanding can be referred to as naturally encoded and synthetically encoded objects. Natural video objects are objects that contain 2D video information, the objects can be of any shape, are encoded using an encoding scheme similar to MPEG-2 and usually contain video information that has been acquired through the use of a video camera. Synthetic video objects can contain either 2D or 3D visual information and are encoding using 2D or 3D mesh coding. In case of 2D coding, the object's visual information can be either acquired from the real life or can be computer generated. In the case of 3D mesh coding, the object's visual information is computer generated and may or may not use real-live textures.

At present, for naturally encoded video objects it is possible to manipulate the object's transparency, scale as well as the location of an object within a scene (see Figure 1).

For synthetically encoded video objects the interactive capabilities are more advanced. The user can move, scale, rotate synthetic objects, change the viewing direction in a scene as well as change the object.s color and texture properties.

Scripting Object Behaviors

In addition to the direct manipulation of the scene composition and AV object's properties by the user, an MPEG-4 based interactive title can include scripted object behaviors. Such behaviors would change the same types of object properties that the user can change through direct manipulation, but do it in a seamless way. For synthetically encoded video objects, the range of possible object behaviors can be the same as it is in the virtual world approach to storytelling. For natural video objects the range of behaviors would be more limited, as we have discussed in the previous section. By including a engine responsible for the selection of object behaviors, the MPEG-4 based interactive title can achieve the same level of interactivity as it can be done with the virtual world approach projects (see Section 2). Furthermore, an MPEG-4 based title can create interaction between computer generated and real-live video objects (characters for example), which has previously been only possible in high-cost Hollywood productions.

4 INTERACTION STYLES IN MPEG-4 BASED VISUAL PROGRAMMING

With the increase in interactive capabilities associated with content-based encoded AV titles, it has become especially important to use interaction styles and interaction devices that would allow for efficient, non-ambiguous as well as intuitive interaction which is important to create for a truly emerging viewing experience.

Variations on the Point-And-Click Interaction style

The most typical interaction style that has been used in PC video application as well as DVD and hyperlinked video programs is point-and-click interaction. This type of interaction can be found in the present-day DVD remote control that allows the user to move from one button to the next using the directional keys. Other such devices can be, for example, a keyboard and a joystick, or a laser pen, which is equivalent to a point-and-click mouse interaction on a computer.

In an MPEG-4 program, where multiple video objects are present on the screen at the same time, it becomes especially important and challenging to make the viewer aware of the possibilities for interactions. The user may have to be made aware of the presence and the spatial

Possible solutions to the "link-awareness" problem can include semitransparent or flashing shapes/outlines within the video, changes in the cursor, playback of an audio-only preview of the destination video when the mouse is moved over a linked space and others. In addition to being aware of a link, the user has to also be made aware of a type of a link. Some of the solutions for that include visualization by convention (for example convention by color or shape) and the use of icons, which can be derived from the video itself, such as a screen shot, or can be an abstract representation the video. The obvious drawback of all such solutions is that they interrupt the flow of the presentation and require the user to continuously pay attention to the extra shapes/colors on the screen. We think that preserving the aesthetic integrity of a video program should be always of the outmost importance in a video title. Consequently, we believe that none of the above suggestions should be used for interactive titles with an artistic value, such as movie titles (thought some of them can be used for video games).

The best approach to informing the user of the available navigation choices would be to agree on some industry conventions such as, for example, that a certain button on the remote control accesses information about the object and another button moves the object, etc. Also an appropriate solution would be to either have a mode switch or a navigation ticker stream. In case of a mode switch, the viewer would be able to turn on and off a navigation map that would show on top of the complete video area. With a navigation ticker, which could be turned on and off as well, symbolic representations of navigation commands that are available at that time would appear at the bottom or on the side of the video frame similarly to subtitles.

A significant benefit that MPEG-4 encoding brings to point-and-click interaction with video is the ease of creating the object-based hyperlinked navigation. In order to create hyperlinked video interactivity we always have to specify .hot-spots. that follow specific changing location from one frame to the next as well as changing in shape areas in a video stream. In MPEG-4 based titles the creating of hot-spots for the video objects can be easily accomplished by using the information about the shape and location of an object that is included within the MPEG-4 stream syntax (see Figure 2).

Virtual Reality Device Interaction

Because MPEG-4 based programs can allow for high degrees of manipulation of visual information (especially 3D synthetic objects), the use of virtual reality input devices may be advantageous for some applications. These types of devices can be for example sensing gloves, sensing floor pad, body suites, as well as magnetic or optical sensors that can be attached to a user [25]. However at this point these devices are expensive, complex to set up and use and at the present state of technology can not be adopted in the mass market

Voice Command Interaction Style

Trying to go away from specific hardware devices for interaction, some interactive storytelling systems have been using voice commands to navigate video programs [26]. Using voice commands to navigate video instead of pointing can be highly efficient and intuitive (given the robust speech recognition / speech interpretation systems and an appropriate social environment). Voice-based interaction can be especially important in programs with many interactive options available, such as MPEG-4 based programs. However the use of voice to simply give commands to the video program does not solve the linkawareness problem, which is important to overcome in order to achieve a truly emerging viewing experience.

Conversational Interaction

One style of user interaction stands apart from all others as being the most intuitive and easy to use. This is conversational interaction. In this type of interaction the video program itself uses voice to invite the viewer to interact with the program, where as the user may or may not uses his voice to navigate the video. Based on the responses or commands of the viewer the interactive video unfolds.

Conversational interaction is native to the interactive storytelling systems. It has been used in such works as the OZ project [22, 23], where the user could talk with animated characters, and in a clip-based storytelling project Synthetic Interviews [17], where the user could have conversations with prerecorded videos of an actor playing Einstein.

Conversational interaction is especially important in the context of MPEG-4 since it is highly appropriate to use with MPEG-4 Face and Body Animation (FBA) objects. FBA objects are a subset of MPEG-4 synthetic objects and use either 2D or 3D mesh encoding as well as specific facial and body models to facilitate animation.

With their embedded support for Text-to-Speech interface

Advanced Technologies Glossary

Hypervideo is where embedded in the video stream are clickable hyperlinks to the Internet. *(Source: The ITV Dictionary)*

MPEG-4 builds on MPEG-2 by allowing for greater use of multimedia/graphics within the video stream and for better compression. Its standards are for use in digital television, interactive graphics and interactive multimedia (which includes video.) MPEG-4 is expected to be a major standard in the ITV realm. MPEG-4 delivers video quality as good as MPEG-2 at about one-third less the bit rate. *(Source: The ITV Dictionary)*