Embedding Interactive Storytelling within Still and Video Panoramas for Cultural Heritage Sites

Karol Kwiatek
University of Plymouth
Faculty of Arts
Plymouth, United Kingdom
karol.kwiatek@plymouth.ac.uk

Martin Woolner
University of Plymouth
ICCI - Innovation for the Creative & Cultural Industries
Plymouth, United Kingdom
mwoolner@plymouth.ac.uk

***Abstract*— Still and video panoramas provide exciting opportunities for individual users to take virtual journeys through a wide range of environments. The opportunity they provide for the basis of interactive storytelling has not been substantially investigated. A combination of computer graphics and 3D modelling enriches the educational aspects of narratives created using a spherical video camera by illustrating objects that are hidden, not only physically but also due to the passage of time. Video panoramas created using a spherical video camera and within 3D modelling software are discussed in this paper employing the example of two heritage sites: Charles Church in Plymouth, UK and the town of Launceston, UK. Objects and artefacts created through the process of laser scanning and QTVR object movies can be placed within panoramic environments using XML and Flash based panoramic viewers enriching the experience of the audience by merging educational components with entertainment.**

Keywords- interactive storytelling; panorama; video panorama; virtual reconstruction; virtual tour; heritage; 3D modelling, interactivity; education

I. INTRODUCTION

This paper discusses new and compelling method for telling stories and narratives that are presented via the use of interactive still and video panoramas. The PhD researcher defines applications for enriching the visitor's experiences and learning methods through the exploration of interactive panoramic environments and the integration of interactive storytelling. New approaches for the provision of a high level of interactivity for the user within multimedia CD and DVD presentations is also introduced in this paper. In the examples discussed a number of still and video panoramas are linked together to enable the user to create their own narratives through the virtual handling of 3D artefacts, located in panoramic environments. The interpretation of objects in the visualisation of heritage sites enriches and develops an individual's interactive narrative experience and in this way they have a large educational purpose [1]. A combination of photorealistic panoramic environments and 3D modelling engages people's consciousness of a location by providing an explanation as an example about the history of the place. Interactive storytelling gives the audience the ability to discover and unveil the elements of a story while also and importantly entertaining them.

Robert Barker, who patented the principle of circular painting in 1787, found a method for immersing the audience in a new world, created via a unique painting format [2]. The word 'panorama' emerged from the Greek pan ('all') horama ('view') [3]. The concept of paintings without borders expanded rapidly with many people visiting panoramas that imitated the experience of travel to exotic locations or provided the opportunity to view historic significant scenes. During the same period the first successful balloon flights were taking place and people's awareness of the horizon was increasing.

The illusion created by panorama paintings was satisfactory at that time but the invention of photography brought new opportunities to the world of panoramic imaging. Nowadays the combination of photography and computer techniques facilitates the display of still panoramas in an interactive manner on a computer monitor. This paper discusses different approaches of generating interactive storytelling by using panoramic viewers employing both still and video panoramas.

II. STILL PANORAMAS AND PANORAMIC VIEWERS

Panoramas can be 'played' in panoramic viewers providing the user the ability to navigate a scene through the rotation and zoom functions [4]. Panoramic viewers based on Adobe Flash technology are actually the most popular programs as almost all computers have this plug-in already installed [5]. They provide panorama photographers with new functions that were not possible in QuickTime Player, these are for example: displaying transparency in images, adding video to panoramic environments and projecting multi-resolution panoramas. The users of panoramic viewers also have considerable flexibility to develop virtual tours individually by preparing XML (*Extensible Markup Language*) files where all actions and positions of *hotspots* (areas or graphics that enables additional interactive functions), pictures, videos and interactive elements can be defined. Virtual tours can also include music, sound, text and more recently video. All of these features can enrich the generation of interactive narrative within panoramic environments providing a broad scope of opportunity for historic architecture and cultural heritage sites. Moreover adding interactive maps to the virtual tour helps the user to navigate the environment (Fig. 1).

Figure 1. Example of a panoramic virtual tour with a map of St. Anne's church in Krakow, Poland [6].

Panoramic viewers: Panorama Flash Player [7], KrPano [8] and Lucid Viewer [9] based on Adobe Flash Player are supported by many platforms: Windows, Mac and Linux. These viewers work with XML files.

Video panoramas provide the opportunity for the user to take a journey through a space without jumping from one place to another via hotspots; these can be a disorientating factor of still panoramas. The advantage that still and video panoramas have over 3D computer generated environments is the presentation of the world as it was registered with a digital camera and potentially enriches narratives and the educational aspects of many CD and DVD publications.

III. VIDEO PANORAMAS

Recent developments in camera technology and computer software make it possible to record not only 360-degree views of an entire scene but also to record 1 to 30 panoramas a second creating spherical panoramic video. The process of recording 360-degree video is achievable with a spherical video camera. Ladybug 2 (Fig. 2) manufactured by Point Grey Research is one of a few video cameras in the market that can "collect video from more than 75% of the full sphere" [10]. The output resolution of a video is in a format of 2:1, so it is the same as equirectangular still panoramas. The camera has six lenses and can record up to 30 frames per second. Recording a 360-degree video generates huge files of raw data that have to be converted for example to AVI video format. The size of files depends on the number of frames to be recorded per second (Tab. 1).

Figure 2. Ladybug 2 Spherical Digital Video Camera System from Point Grey Research [10]

TABLE I. SIZE OF FILES CREATED BY LADYBUG 2

Maximum resolution [pixels]	**1 minute of recording 360-video of a static scene**	
	Frames per second [fps]	***File size [GB]***
3500x1750	1	0.3
3500x1750	15	1.9
3500x1750	30	2.4

Ladybug 2 does not have a special button to start and stop recording. It must be operated from the powerful laptop with Firewire 800 output. The small camera can be also operated using a 10 metre long cable which makes the system of recording video panoramas more suitable for remote narratives (e.g. theatre performances). Virtual Surfers is a company [11] that has already recorded many examples of journeys that have been captured from the top of a car. The considerable opportunity that video provides as the basis for narrative has not been fully investigated.

Jason Villmer is the author of a Lucid Viewer [9]. This is a panoramic viewer that is specially designed for displaying spherical video. Lucid Viewer is a Flash based viewer that reads data from XML files. By coding in XML it is possible to extend panoramas by adding 3D objects or movies, this can lead to the generation of enriched interactive narratives, based on both still and video panoramas.

Still panoramas have no time limit for their performance, whereas video panoramas are time based. To create compelling material for a narrative there must be enough 360-degree video content to present, even if only as a background display. Still panoramas are used in many projects as backgrounds for environments in 3D modelling software. Ladybug 2 does not record audio, so the process of gathering ambient sound is also very important for the development of narratives.

Moreover, combining computer graphics, 3D modelling and video panoramas could lead to the creation of journeys through a defined space, but also journeys in time to show the past and the future of the chosen sites.

IV. 3D RECONSTRUCTION

A 3D reconstruction of Charles Church in Plymouth enables the viewer to experience a journey into the past by means of virtual video panoramas (not recorded by a spherical video camera, but generated in 3D modelling software).

Charles Church was bombed in 1941 and it was not rebuilt after World War II. The building will not be rebuilt as it is City's memorial to the civilians killed in the Blitz. The reconstruction process was initiated through the creation of five high resolution panoramas [12] representing the interior of the building (Fig. 3) these were imported into Autodesk ImageModeler. This software facilitates the creation of 3D models from images and panoramas. Five basic 3D models were exported from this software and then merged together in 3D Studio Max [13]. The reconstruction based on old photographs was applied to the merged 3D model not using photogrammetric solutions but rather artistic composition due to the lack of historical images of the entire interior.

Figure 3. Charles Church in Plymouth (UK) and a localisation of five panoramas [13].

The virtual reconstruction of Charles Church acts as a basis for storytelling that is associated to this environment. It is a story of a couple (now in their 80's) who had a wedding just one day after Charles Church was bombed. The time of the narrative was moved one day earlier to present the wedding in the church prior to its destruction. Video panoramas were used to illustrate the interior of the church in 1941 and now. The user can switch between panoramas to experience the differences between them (Fig. 4).

Figure 4. 360-degree images of the present interior of Charles Church (above) and of reconstructed 3D model of the church (bottom) [13].

Glassner [14] suggested 'bringing the outside world into the story environment' and the example of a story localised on an existing site calls on people's reflections and emotions about this place. This is also one of the main differences between games and interactive narratives where narratives 'engage largely through empathy with the characters whose emotions we identify' [15]. Interactive narrative that is aligned to a cultural heritage site enables people to understand the values and functions that were inherent to that space, in this particular example, a place of worship. It is also a good example of using *edutainment* (combination of education and entertainment) [16] with the system of reward and penalties in the application based on still and video panoramas.

Interactive storytelling can be enriched by using two layered video panoramas. The technique of presenting two still panoramas could be completed by employing Shockwave-based panoramic viewer (e.g. Spi-V viewer) [17], but the idea of linking two video panoramas and switching between them is quite interesting and could be applied in further stages of Charles Church project. One video panorama recorded with a spherical video camera (e.g. Ladybug camera) could present a journey from one point to another illustrating the world as it exists, whereas the second layer could be a video panorama rendered in 3D modelling software of approximately the same path but presenting the same environment in the past or in the future. Such a solution could be applied to visiting cultural heritage sites where visitors can be equipped with special VR glasses; they will be able to see video panoramas from the past (rendered in 3D modelling software).

Why video panoramas instead of a normal video? Video panoramas present the whole environment and only the user decides what part of the surrounding environment or action to watch or observe in more detail. This all encompassing moving space could be recorded as an example during a religious service in the past, with a similar service recorded in the present. This technique could potentially provide the opportunity to generate material and interactive views based upon the future.

Another way of enriching virtual tours and narratives based on 3D models of cultural heritage sites and 3D reconstructions would be the addition of video panoramas between high resolution still panoramas (Fig. 5). The user would click a hotspot located in an existing high resolution still panorama, by doing so, it would initiate a navigable video panorama that would run as the computer downloads the new location of the next high resolution still panorama, this would automatically open when the video image came to an end. This idea will help in the process of creating interactive narratives. The user will not feel lost in the space as sometimes happens with two separated still panoramas, where the connection between them is not visible. The great advantage of this solution is that the user can always stop the video panorama to admire places (in lower resolution) that are not visible from the first or second panorama. Unfortunately, this is very processor-demanding operation. It takes a lot of time to render high resolution panoramas in 3D modelling software and considerable time to generate video panorama presenting the journey from one place to another.

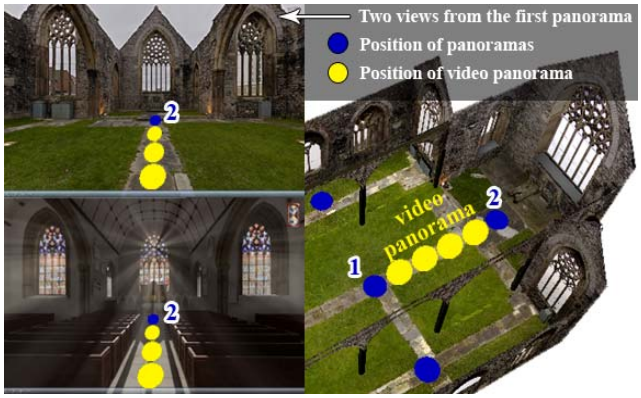

Figure 5. Applying video panoramas for the movement between panoramas.

Lucid Viewer, a panoramic viewer for spherical video appears to be an ideal tool to use for Charles Church project. It can load high resolution panoramas (up to 8000x4000 pixels), although it struggles with video panoramas in Flash Video format (FLV, F4V) where the resolution is higher than 2500x1250 pixels. This is due to the limitation of Adobe Flash Player. This panoramic viewer can also display video images of a person walking in the direction of the viewer by applying technique called *chroma keying* where one of the colours is removed from video (Fig. 6).

Figure 6. Lucid Viewer can display a movement of a person in a panoramic environment, that was recorded using *chroma keying* technique.

Reverse video panoramas could be used for the journey from the second to the first panorama (Fig. 5). This is only acceptable if no movement is surrounding the panoramic camera in the 3D modelling software.

In the next project of applying poetry to interactive storytelling this process can be applied on the example not of a 3D model but a real town, where two video panoramas in both directions must be recorded using a spherical video camera between two still panoramas.

V. POETRY IN INTERACTIVE STORYTELLING

This project presents a method for combining poetry into an interactive narrative based on still and video panoramas. Poems were applied to this new narrative to enable each individual to find their own journey through the interactive storytelling and by providing the sense of a story unfolding.

Charles Causley was a famous English poet who lived in Launceston, Cornwall and died in 2003. He was famous for his children poetry and spent most of his life in Launceston, Cornwall in the United Kingdom. There are many references in his poetry to locations in his town and also many links between his poems and artefacts in his house. For this project the placement of virtual 3D objects, created through the process of 3D laser scanning were placed within panoramic environments. Panoramas were also used for the visual interpretation of the house and as a tool to archive and reconstruct the site after its renovation. Almost every object in the house has its own narrative in relation to the poet and his poetry. The user can visit his house virtually using panoramic imagery and learn more about his life and his relationship with Launceston by interactively touching objects that still remain in his house after his death. Those objects were scanned using Konica Minolta 3D scanner. To move from the first room (one panoramic environment) to another, the user has to find an artefact that is hidden in the first room. The clues to findings these objects are hidden in a few verses of a poem that is played and displayed while exploring an interactive panorama. To exit the house the user has to solve all of the puzzles in the house and find the key to the main door. Outside the house the user is instructed how to navigate video panoramas, these present the town from different perspectives. The experience of the user is considerably different when controlling video panoramas, because of the increased interactivity that is available with this format. The narrative is experienced interactively and includes oral storytelling and in some instances 3D reconstruction of sites in the town (former town wall or castle).

In this project Causley's poetry will provide the clues that instigate further investigation. For instance, in one of Causley's poems there is a reference to the wall of the church in Launceston.

Mary, Mary Magdalene
Lying on the wall
I throw a pebble on your back.
Will it lie or fall?[18]

"This relief is to be found on the south wall of St Mary Magdalene church. It is said that a stone lodged on her back will bring good luck" [19].

Such objects and puzzles are gateways (Fig. 7) for further interactive narratives with additional clues and quizzes.

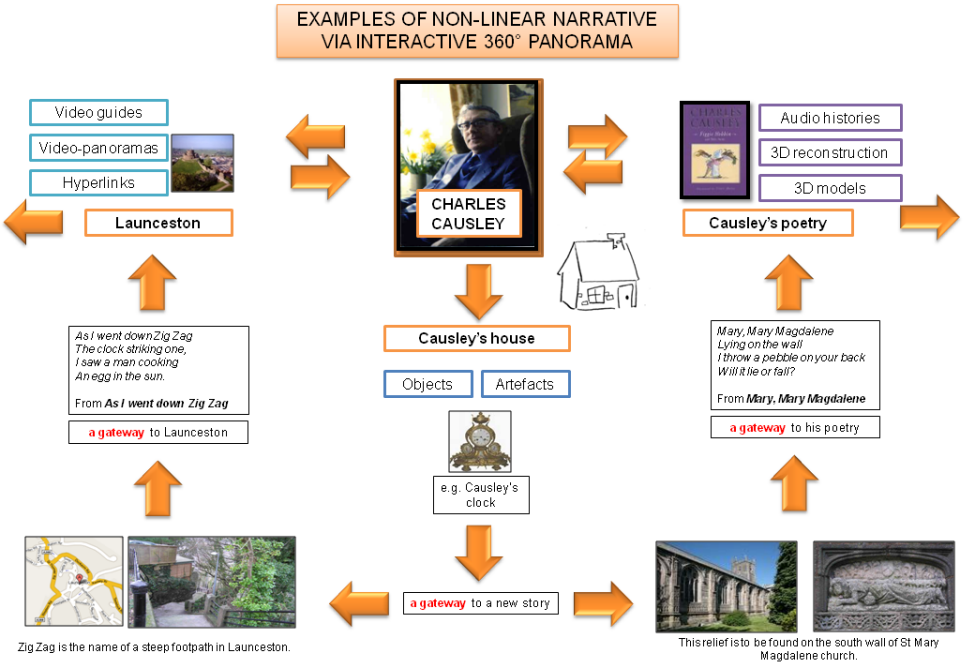

Figure 7. Example of non-linear narrative based on Charles Causley's poetry and the references to the town.

To record the content for interactive storytelling a special helmet (Fig. 8) was built to mount the camera making this setup more portable. GPS data was also collected using Bluetooth GPS to merge the video panoramas recorded with Ladybug 2 with a map of the location.

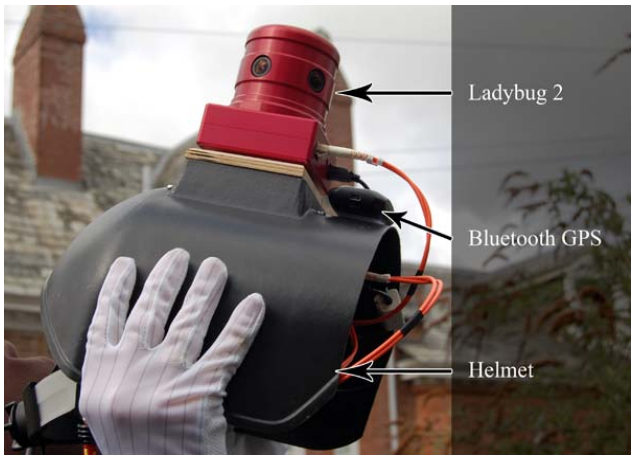

Figure 8. The helmet with Ladybug 2 with Bluetooth GPS.

The use of a motorised wheelchair (Fig. 9) was helpful in the creation of video panoramas of the town. Video panoramas were recorded using Ladybug 2 placed on the helmet. They were then converted to AVI files using LadybugCapPro software (Fig. 10) which were then converted to FLV (Flash Video). The later files are accepted by Flash panoramic viewers and enable the generation of interactive narratives by writing XML code files. FLV is suitable for presenting streaming data on the Internet. This non-linear interactive narrative presented on the internet about Causley's references to the town and his poetry should help promote Launceston and his work.

Figure 9. A motorised wheelchair was applied for recording video panoramas in Launceston.

VI. CONCLUSION

The combination of still and video panoramas is a considerable visualisation tool, representing a significant method for developing narratives that are appropriate for cultural heritage sites. The extensive educational and entertainment function of non-linear narratives enriches the experience of the audience. The user could initiate and develop their interest in a new subject by undertaking a journey that

employs still and video panoramas. Experimentation continues to improve the method of recording video panoramas and the recording an ambient sound.

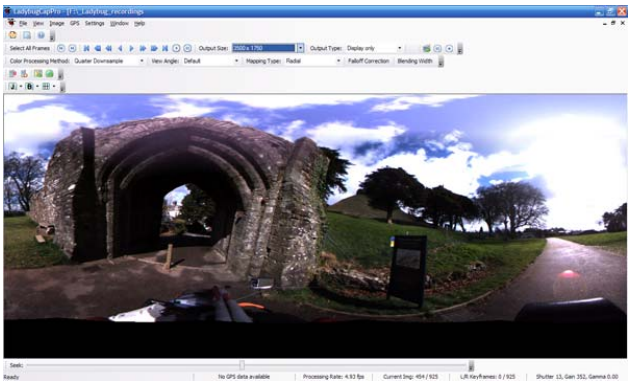

Figure 10. LadybugCapPro – software for capturing and converting video panoramas recorded with Ladybug 2.

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