Immersive Installation: "A Virtual St Kilda"

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Abstract. This paper discusses a Virtual Histories project, which developed a digital reconstruction of the St Kilda archipelago. St Kilda is the most western part of the United Kingdom. It is a world heritage site for both built and natural environment. The Virtual St Kilda acted as a focus for the collection and presentation of tangible and intangible cultural heritage. It was on show as an exhibition in the Taigh Chearsabah museum (Fig. 5) located in North Uist Scotland. The exhibition is built around the OpenSimulator Open Virtual World server, using commodity hardware. The simulation covers some 4 square km of virtual space, and models both tangible and intangible culture. It is integrated into the exhibition, which articulates an interpretation of the St Kilda legacy through the prism of contemporary North Uist life.

Keywords: Virtual worlds · Museum studies · Immersive technology · Cultural heritage · Reconstruction · Community involvement · Opensim

1 Introduction

This paper discusses the use of Open Virtual World Technology to create an immersive museum exhibit of the St Kilda world heritage site. The exhibit has been enjoyed by thousands of people at the Taigh Chearsabhagh Museum and Arts Centre. It includes a 3D interactive model of St Kilda as it was in the late 19th century. The model is based upon archaeological evidence (Emery 1996, Stell and Harman 1988, Harm 1996) and provides an accurate portrayal of both the geography and architecture of the Village Bay area of Hirta the largest island of the St Kilda archipelago.

St Kilda is an archipelago about 40 miles west of the outer Hebrides, in Scotland. It is both the most western and the remotest land in the British Isles. Evidence has shown that St Kilda's history goes back at least as far as the bronze age. St Kilda's remoteness makes it unique. The culture that developed there over the millennium during which it was inhabited is like no other culture in Britain. Similarly the natural life on the island is also a breed apart, literally in some cases. There are species of birds and mammals on St Kilda found nowhere else. St Kilda is a place of great, if rugged, beauty. It is sheer rock rising out of the Atlantic, the last bit of land before you hit America. All these factors make it a place of fascination for many. It has been designated a UNESCO world

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Fig. 1. Panoramic view of Virtual St Kilda main street

heritage site for both its natural and cultural value. It is one of only twenty four such dual sites in the world and the only one in Scotland. As St Kilda is such a remote site, requiring a four hour boat journey from the Outer Hebrides, few of the many who wish to visit will ever get to go there. The interest it generates and the difficulty of visiting it in person make it an interesting topic for a digital exploration.

The goal of this project was to make such an exhibit using open source software and commodity hardware. For this to work the exhibit had to be easy to use, reliable and capture the scale of the environment. The exhibit was to be unmanned, therefore visitors had to be able to walk up and use it without training. The exhibit also had to run reliably for months without intervention, save being turned on and off at night. A key aspect of St Kilda is the size of the cliffs and surrounding hills and the relationship between human habitation, agricultural architecture and natural environment. To capture this a model which represented several square km of real space was required. Further the exhibit was to integrate the many songs and stories which make up St Kilda's rich culture.

2 The St Kilda Archipelago

The archipelago consists of five islands (Soy, Boneray, Dun, Levenish and Hirte) and several sea stacks, including the highest stack on the British isles. Hirte, the only inhabitated island was evacuated in 1930. Villagers lived on the only street on the island (Fig. 1), located on Village Bay. This street, known simply as 'The Street' is lined with crofts, Blackhouses (traditionally Hebridean dwellings with thick walls and doors facing away from the sea) and Cleits (dry stone storage structures, unique to St Kilda, which cover the St Kildan landscape, more than 1100 in total). Village Bay is the closest thing Hirte has to a safe landing. Even in modern times poor weather makes it impossible for boats to offload cargo. When the island was still inhabited the islanders would sometimes go months, or whole winters, without receiving supplies from the mainland. All the factors that make St Kilda special also make it an excellent subject for a reconstruction. Its striking geography is something that can be hard to translate in still images or videos, but translates well into being explored virtually. Due to its remoteness

Fig. 2. Virtual and real views of St Kilda, across village bay, looking out towards Dun.

visitors are unlikely to be able to experience it themselves. The stories that are linked to it interesting strike a universal chord.

The St Kilda model was developed in the first half of 2014. It is a technically challenging model, spanning 4 square km. This is orders of magnitude larger than is normal in OVW models. In order to support the larger size the client was modified to extend the far clipping plane of the view frustum. This enabled views that span from village bay out to the easily recognisable outline of Dun, to the south (Fig. 2). Extending the visible area to include this greatly increases the sense of presence and ensures that the iconic vistas of St Kilda can be recognised immediately. The terrain data is taken from Ordinance Survey GIS information. The reconstruction covers village bay with objective to represent enough of the space such that, when standing in the centre of the village visitors get an accurate impression of the geography in all directions. Modelling focussed on the village itself, here the crofts, Blackhouses and Cleits are all modelled. The models for the Blackhouses and Cleits were developed in external modelling software. This allowed the same models to be used to create high fidelity images and videos using special effect software and used again as imported meshes in the interactive reconstruction.

The model is dated to the 1880s. The reconstruction has been augmented with a number of NPCs. Records from St Kilda are relatively complete so each NPC is named after a real inhabitant of village bay and their appearance taken from contemporary photographs. The model also features embedded content displayed as web pages. Throughout the model there are items which contain further information, which glow when the avatar approaches. When clicked on the viewer’s inbuilt web browser displays a web page with text and images presenting information linked to the glowing object.

3 Development Process

The development of Virtual St Kilda was a collaborative process featuring an artist at the University of St Andrews (Sarah Kennedy), expert advice from the National Trust for Scotland (who manage St Kilda) and Access Archaeology, a

community archaeological group on North Uist. Once the model was developed supporting material was produced by collaborators, local and national.

The first stage was to use GIS data to create the landscape in which reconstructions would sit. In St Kilda this is particularly important as the shape of the land is one of the most recognisable aspects of the site. The GIS data used is the Ordinance Survey high resolution data.

Fig. 3. External view of Manse and Internal view of Blackhouse model.

For the site to feel authentic accurate reproduction is vital. With the GIS landscape loaded measurements from the site were used to map out the location of every structure to be modelled. These measurements include Google Satellite view data, contemporary accounts and photographs and archaeological surveys. The site as it stands today is relatively unchanged. Several of the crofts have lost their roofs and there is now a modern base, but otherwise the structures stand where they have stood since 1880. Having plotted the location of each structure surviving evidence of the site is surveyed as material to be integrated into the model. As part of this process areas of particular interest, recognisability or iconic status were identified. The date for the reconstruction is within the photographic era. Despite this there are still areas where no direct evidence is available showing precisely how it was in the past. In these instances more general evidence such as equivalent sites and written reports can be used to create an estimate at how that part of the model should look. As the model was developed there were meetings with experts from the National Trust for Scotland, and with members of the Access Archaeology group in Uist, to gather feedback. These meetings allowed expert interpretation to be incorporated into the development process. It is often the case that the ability to view an artefact, building or other element in its natural situation will allow theories to be tested and plausibility evaluated (Getchell et al., 2010). As changes are relatively simple to make multiple different versions of the same feature can be created and experts use these to make a decision about what is most likely to be correct. In this way the iterative design cycle of the Open Virtual World platform enables research into the heritage aspects of the projects. The outside of the manse church complex and the inside of the manse parlour are shown in Fig. 3. Views of NPCs inside a typical 1880 s house and crops growing are shown in Fig. 4. The

Fig. 4. View of cale growing in village bay and residents in past 1830 cottage.

system architecture used to support this development is dicussed in some detail in McCaffery et al., (2013) and an expansion of the reconstruction methodology can be found in Kennedy et al., (2013).

Once the model is created it is populated with content to help those who interact with it learn about the topic. This means adding multi media content and Non Player Characters. The model in turn is raw material that can be integrated into traditional media such as videos and still images, which can be distributed online or included in papers, newspaper articles and informational posters.

A set of videos was created as part of a program of community involvement. North Uist’s links to St Kilda mean there is a wealth of material about the archipelago in the community. Many of the islanders have travelled to St Kilda and the video and images they brought back were made available for the project. Images shot on St Kilda were used to make posters for the exhibit and as part of the embedded web pages. Two separate Uist organisations, Uist Film and Island Voices, had produced films about St Kilda. The footage in these films formed the majority of the live action footage which was integrated with virtual footage to produce short videos about St Kilda. The rest of the footage was filmed as part of the project. In order to do this the Kilda Cruises organised a voyage to Hirte. Once there Qinetiq, the contractors who run the base, made transport available so that footage could be shot all over the island in a short space of time. Local groups of musicians from North Uist, including the Gaelic singing teacher for the area, a ceilidh band group known as the Spring Chickens and children at local primaries, recorded pieces related to St Kilda, used in the videos. In the same primary schools pupils researched St Kilda and wrote narratives telling the stories they related to about their far flung neighbour. The childrens’ tellings of these stories were recorded and combined with virtual footage and the other material gathered to tell some personal tales with a distinct North Uist voice. Community produced content was combined with National Trust for Scotland archive footage to illustrate some of the more historical aspects of the site. Technology students at a local college produced posters which advertise the exhibit. The National Trust also provided access to a recording of an interview with one of the last inhabitants of village bay. This interview was combined

Fig. 5. Taigh Chearsabhagh Museum and Arts Centre and Virtual St Kilda Exhibition.

with virtual footage and footage supplied by local groups to create videos telling another form of story about life on St Kilda (https://vimeo.com/98057417).

Products of the community engagement include videos available online, streamed into the model and part of the St Kilda exhibit. These videos, as well as the posters that were produced and also the many events that were used to gather the material and share it with the community, help extend the reach of the project in directions that complement the model itself and ensure value in multiple contexts.

Records exist of who lived in what house during the time period. Linked with these names are historical documents photographs. Using this data NPCs were created to represent real inhabitants. These NPCs are scripted to walked through the town, performing the activities that would have filled the islanders days. These NPCs can interact with the user, they can speak, both in audio clips and through text. The research for the NPCs was helped by local knowledge, and by the National Trust for Scotland.

4 The Exhibition Space and Exhibit

The room in which the exhibit is installed is a large, barn like space within the museum. The room is a cuboid space approximately 5 m across, 15 m deep and 6 m high. There is no ceiling, just the beams which support the roof. The door is situated on the front wall, opposite the mezzanine balcony. The installation consists of a 3×1 m poster along one wall, a projection covering the width of the front wall, coming down low enough to cover some of the door, a table with a 25" monitor and an XBox controller. The table is overlooked by a Kinect. Everything is controlled by a computer on the mezzanine level. This connects to a projector creating the projection and a wireless received for the XBox controller. The monitor receives its signal through a wireless HDMI kit. A powered USB cable runs from the mezzanine down to the Kinect.

The exhibit itself is made up of a series of short videos, ranging from two to ten minutes long, and a free exploration mode where the visitor uses the XBox controller to explore the model. The videos are intended as short, stand-alone pieces. They are designed with reference to the youtube format, where information is presented in small sections but linked with more information so

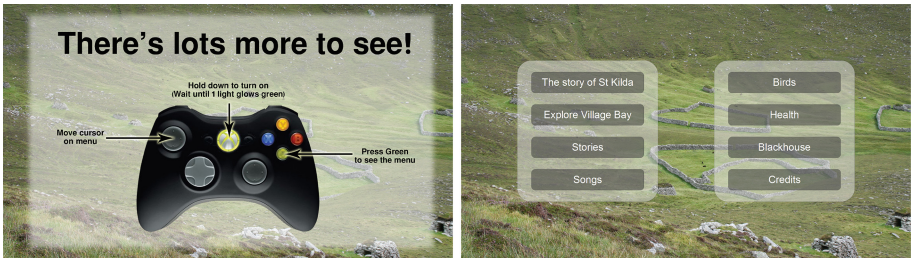

Fig. 6. Instructions and main menu of the exhibit.

interested users can explore further if they wish. The videos are discussed above and cover subjects such as health on the islands (https://vimeo.com/100323053), what Blackhouses and Cleits are and recordings of music with known links to St Kilda. There are also two longer videos. The first, ‘Impressions of St Kilda (https://vimeo.com/94653938) is a seven minute piece composed of a mix of real world footage and virtual footage introducing St Kilda and the different aspects that make it special and some information about the exhibit. The video has a voiceover narration. Each paragraph of information is narrated first in Gaelic and then English. The second long video is a ten minute long mood piece of the sights and sounds of St Kilda. This is designed to run when visitors have not started interacting with the system at all.

The Blackhouse (https://vimeo.com/94504484) and Cleit (https://vimeo.com/99984295) videos combine renders, done using special effects software, with real world footage, shots from the main model and recordings of local residents performing St Kildan songs. The special effects shots integrate animated text and effects, such as smoke, into a high polygon mesh of the structure (Fig. 5). The high poly meshes were then simplified and imported into the model. The modelling of the Cleits and Blackhouses was done by Alice Watterson and the animation by Alice Watterson and Keiran Baxter. The videos which tell general stories of St Kilda combine virtual footage and real footage. In these videos a static backdrop shot was filmed in the virtual world. Pupils from the local Cairnish primary school were recorded, twice, telling stories they had researched and written out about St Kilda. The first recording was audio only to get a clear recording. In the second a projector was used to cast shadows of the pupils over a white backdrop. This shadow footage was later manipulated in Blender to produce a pure black and white mask of their shadow. The final composite features the children’s audio and their shadow projected over the virtual background. A frame from one of these stories is shown in Fig. 7.

Shots of the interactive model used in the Blackhouse and Cleit videos, as well as in the ‘Guided Tour’, are more dynamic than the static backgrounds of the stories. Camera movements are programmed and then played back using the sofware which powers the exhibit (McCaffery et al., 2014). As they are played back the video stream from the computer is routed through an external device that can capture the stream to an SSD drive and simultaneously patch it

Fig. 7. A frame from the lady grange story. Students explore in stereoscopic 3D.

forward to an output device. When camera movement is introduced lower framerate become readily apparent. The video is recorded at 30FPS so if the client is rendering fewer frames than this output smoothness is jeopardised. Another problem encountered in moving shots is tearing as the camera pans. To solve these challenges the camera moves at 10 % or 1 % of the intended speed of the final movement. This results in many frames of recorded material covering a single frame of intended output. When the footage is sped up again samples across these multiple frames produce a much smoother final image than recording at full speed. This process produces smooth shots without the necessity of reducing graphical options to achieve an optimal framerate. To work all dynamic movement in the scene had to be slowed. This meant adapting scripts which make waves crash, birds circle and smoke sputter to operate at a reduced frequency and not appear hyperactive on the sped up footage.

The exhibit is designed to run without the presence of a member of staff. When the first visitor of the day enters the room the exhibit is playing the mood piece on a loop. This remains until the visitor either moves to the back of the room or starts to press buttons on the XBox controller. When presence is detected in the room by a Microsof Kinect the Guided Tour is played. Once this has completed a notification appears telling the visitor that if they wish to explore further they can pick up the XBox controller and go to the menu. If they do not do this the Blackhouse video plays, followed by one of the recorded songs set to real world footage of St Kilda. Once this has completed the visitor is again prompted to engage with the XBox controller. If they do not more content is presented automatically. After a third prompt the exhibit will go back to playing the mood piece. If at any point the user does engage with the XBox controller they can press a button to go to the main menu. From the main menu, shown in Fig. 6, they access all of the content in the model. To do so they use the joysticks on the XBox controller to move a cursor. When the cursor is hovered over a menu item for a couple of seconds that menu item is selected. Most menu items are made up of several videos, played back to back. Special cases are the option to explore the world directly and the credits. As well as prompts on the screen the exhibit also features laminated signs, instructing the visitor how to control it with the XBox controller. While the exhibit is generally designed not

Fig. 8. A frame from the Cleit animation and render of the inside of a blackhouse

to require staff intervention members of staff will occasionally go into the exhibit and give tours of the content. In these tours they can highlight areas of interest to specific visitors and tailor the experience to the group. This format also means that visitors who might be put off by having to engage with technology can have a more directed experience than simply watching the automated content play (Fig. 8).

A core design principle is community involvement. North Uist is a remote island with a relatively small population. Many people on the island have direct connections to St Kilda. Some have links to the people who once lived there, others work, or have worked there. In order for the exhibit to be received well and integrate into the environment where it was intended to be installed it was very important the local population took ownership of the project. The footage shot by local groups, recordings of local musicians and videos of local primary school students telling stories of St Kilda features centrally in the videos. Taken together this means that the exhibit is a combination of documentary and interpretation. Local, historical, academic and virtual all combine together to create something which is multi-faceted and tells the story of a unique place in a unique way all through a strong local voice. The end result is something that the community is happy to publicise to the world as their perspective on a site of international interest.

5 St Kilda in Schools

As well as installing the St Kilda scene as museum exhibit it was used as the basis for workshops across North and South Uist and Benbecula, known collectively as the ‘Long Island’. These islands are three of Scotland’s outer Hebrides. Workshops were done in three primary schools and in an adult learning centre. Two of the schools (Lochmaddy and Cairnish, both on North Uist, Fig. 9) were primary schools with only a few dozen students across the 7 primary classes. The third was a larger primary school on Benbecula where students were streamed into Gaelic and English classes. In all schools a computer was set up with a projector and an XBox controller that pupils could gather round and watch content on.

Fig. 9. Pupils in Lochmaddy and Cairnish engage with the content.

In Lochmaddy one group, consisting of the older classes at the school, attended the exhibit. In Cairnish the pupils were split into two groups, younger and older. In both schools the pupils had been involved in the creation of the content and where excited to see themselves projected on the screen. Sessions in Lochmaddy and Cairnish started by showing the 'Guided Tour' video, to introduce the material, and then showing the footage that the children had been involved in the creation of. Having seen the linear material the projector was switched to showing the virtual world and the children were given the opportunity to use the XBox controller to explore St Kilda. When exploring the children were prompted to take turns with the XBox controller, with all children not currently in control able to watch the projection and talk amongst themselves and to the child in control. This process was allowed to be relatively free, pupils were not forced to stay quiet and watch passively, they were encouraged to talk amongst themselves and to commentate on their experience. This lead to very enthusiastic sessions with much laughter and interaction. Pupils enjoyed being able to fly, especially when the ability to cease flying and watch the avatar fall from a height down to the ground was discovered. One of the consistent things that pupils enjoyed was attempting to find unexpected parts of the scene. Exploring underwater or trying to get inside houses which they were not supposed to enter.

In Benbecula primary 6 students visited the workshop, split between the Gaelic and the English streams. Where the settings in Lochmaddy and Cairnish were relatively informal in Benbecula larger class sizes and older students required more structure. In Benbecula each class sat down and watched the 'Guided Tour' video. Having watched the video they were split into two groups, with each group given access to a computer running the scene. In the groups pupils were encouraged to explore and think about questions such as 'How many people do you think lived in the village?' and 'What do you think it might have been living in such a remote place?'. Pupils were encouraged to share control such that everyone had a turn in charge of the avatar. After approximately twenty minutes the groups were relaxed and pupils had the opportunity to try out the Oculus rift. When pupils were initially given control there was some hesitance

as to what they should be doing. All groups did explore the scene thoroughly. When the groups were relaxed and some pupils went to try the rift the noted tendency was for those to remain to focus more closely on the scene. Smaller groups lead to those with particular interests getting longer to investigate and familiarise themselves with the content.

Mairi Morrison from Comann Eachdraidh Uibhist a Tuath (North Uist Cultural Society) offered the following reflections: To begin with I had only a vague idea of what we were expected to do. Something about St. Kilda? so when the team arrived they could film some drama and song. With little time to plan, we embarked on our journey of exploration. We had half a morning for five weeks to research and prepare. We decided we would show the DVD of the St. Kilda Story (1980), with footage from 1906 to 1930, and the Wildlife of St Kilda, filmed over 27 years from 1957.

The filming itself, though nerve wracking for some, worked really well, in spite of the scanty preparation. The crew were highly sensitive to the needs of individual children and worked in an enabling way. The ability the process allowed for multiple takes was a distinct advantage, since the children could pause to recollect their words or be prompted. In addition, filming the soundtrack separately in a better acoustic space helped them to relax more and focus on conveying the words and narratives more clearly.

When the children had the opportunity to see the virtual St Kilda and try out the handsets and the 3D goggles for themselves the following day, the effects were startling. They seemed to master the technology, on the whole, swiftly and competently and were mesmerised and enchanted by the opportunities it gave them for movement, visualisation and imagination as they travelled through an unfamiliar terrain and yet a tangible world. Their feedback was instantaneous and heartfelt. Awesome, Its the best thing ever, It feels like youre really there. Educationally it was utterly uplifting. Some pedagogical observations:

1. The medium of media is arresting and exciting- a valuable learning incentive
2. Where the children have ownership of their contributions, they tend to develop personal and group confidence
3. Challenging them with original primary, adult resources helps them to raise their game
4. Careful scaffolding of the learning helps individuals to progress to their next proximal zone (Vygotsky)
5. Working towards a real outcome helps the learning to be more purposeful and relevant
6. Assuming a role reduces the pressure of performing as oneself

The Education Scotland Report, Inspection of the learning community surrounding Sgoil Lionacleit Eilean Siar Council comments: *The Virtual St Kilda Exhibition, codeveloped with children from a local primary school and adult volunteers from the North Uist Historical Society provides very good outcomes related to the four capacities*[1] *in Curriculum for Excellence.*

[1] succesful learners, confident individuals, responsible citizens, effective contributors.

6 Conclusion

This paper has described the creation of the Virtual St Kilda Exhibition. The exhibition provides insight into the lives of people who lived there in the 1880s. It enables appreciation of the relationship between the natural environment and human habitation, In doing so it enables visitors to make use of existing digital literacies to explore the past. Through using commodity hardware and open-source software it has been possible to create an exhibit which captures both intangible culture the stories, songs and lives of the inhabitants and material culture the buildings and artefacts. In addition to the positive outcomes of the development process, the exhibition itself has been well received. When the Virtual St Kilda exhibit opened visitor numbers are up by 28 % compared to the previous year. Feedback from visitors to the exhibit has been positive.

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