Petit Godot*

Production of a mixed-media theatrical installation

Iain Mott†
Instituto de Investigação em Design, Media e Cultura
Universidade de Aveiro
Portugal
iainmott@unb.br

Paulo Bernadino Bastos
Instituto de Investigação em Design, Media e Cultura
Universidade de Aveiro
Portugal
pbernard@ua.pt

ABSTRACT

The production of a mixed-media installation is described, featuring miniature theatrical environments and pre-recorded performance and animation. The modules of the installation use the design of an 18th century French peepshow as a point of departure. The original viewing cabinets, made as amusements for parlours and salons, offered a primitive form of stereoscopy by way of a large bi-convex lens and gave individuals viewing two-dimensional coloured images the impression of depth and three-dimensionality, an effect often enhanced using prosceniums. In the current work, this basic form is hybridised with a contemporary expression of another archaic though persistent artistic technique, the 19th century theatrical illusion, the Pepper's ghost and in addition to two-dimensional scenography inside the peepshow, objects are included to better integrate the ghost image with its three-dimensional confines. LED lighting inside the cabinets is dynamically controlled and synchronised with the videotaped ghosts and further, *ambisonic* audio is delivered on headphones to promote a sense of immersion in the scene and an association of the viewer with focal characters.

CCS CONCEPTS

• Applied computing → Arts and humanities; Computers in otherdomains; • Human-centered computing → Visualization; Inter-action design

*This article includes material previously published by the author in the conference paper Haunting an 18th Century Peepshow: Design and function of the mixed-media theatrical installation Teatro Menor [9]. Teatro Menor was a working title for the installation Petit Godot.

†Sound artist, composer and lecturer in sound design at the Departamento de Artes Cênicas, UnB. Doctorate in arts from the University of Wollongong, Australia entitled Sound Installation and Self-listening and post-doctorate from the University of Aveiro. Website: https://escuta.org

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KEYWORDS

Design, Theatre, Set design, Installation art, Peepshow, Pepper's ghost, Embedded computing, Ambisonics, Binaural, Deepfake

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1 Introduction

This article describes the production of a mixed-media theatrical installation entitled *Petit Godot*, a collaborative work by Iain Mott with actress Simone Reis performing and adapting texts by the Romanian/French playwright Matéi Visniec. Now in its final stages of production, the research and development of the project was performed as part of complementary post-doctoral projects by Mott and Reis at the University of Aveiro, Portugal, under the supervision of Paulo Bernardino Bastos.

Petit Godot takes inspiration from a prior collaboration of Mott and Reis, entitled *O Espelho* (The Mirror), an installation that involved a synthesis of *ambisonics* (a form of surround sound) with the 19th century theatrical illusion, the *Pepper's ghost*. The Pepper's ghost illusion involves the projection of a two-dimensional stationary or moving image in a three-dimensional scene, for example, a projected character on a theatrical stage or in a diorama. It is a technique—often incorrectly referred to as holography—still in wide use and frequently employed in museum exhibits, corporate presentations and large budget live music events. Ambisonics involves acoustic rather than visual phantoms in three-dimensional space and the interaction between these two illusions was of prime importance in *O Espelho*.

Where *O Espelho* involved a full-scale diorama, the diminutive *Petit Godot* has interiors made to a scale of approximately 1:12 and enlists an earlier technology and viewing device to host the phantom image: the peepshow. The installation consists of five such devices, each with different interiors and videotaped performances based on five separate plays by Visniec, including *O Último Godot* (The Latest Godot) and from which the name of the installation is derived. The following text describes how the Pepper's Ghost and the peepshow are combined with the aid of current technology to provide a miniature and intimate setting for videotaped performance and animation.

2 The Boîte D'Optique

In his book *Peepshows: a visual history*, Richard Balzer cites a device made in 1447 by Italian architect Leone Battista Alberti as an early instance of a peepshow in which perspective views were seen through an aperture in a box. He also notes that other writers have placed an importance on the *camera obscura* in the development of the peepshow. Indeed, a French variant this diverse family of viewing devices, the *boîte d'optique* (optics box), is designed like a *camera obscura* in reverse. Instead of the outside world being focused by a lens and projected onto a viewing surface, often with the aid of a mirror, the viewer peers though a lens to view a reflection of an illuminated painted engraving often depicting landscapes or architecture. (BALZER, 1998, p. 18)

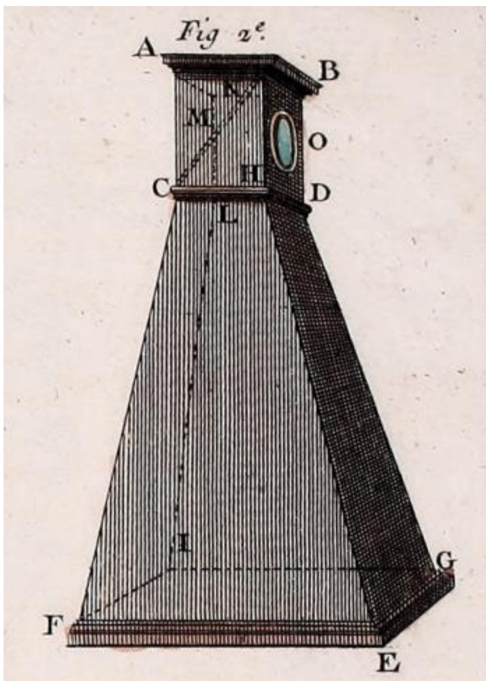

Figure 1: Boîte d'optique (1769)

One such *boîte d'optique* is used as a basic design model for the modules of *Petit Godot* and is shown in Figure **Erro! Fonte de referência não encontrada.**. It is from a volume entitled *Illusions de l'optique* by Edmé-Gilles Guyot (BALZER, 1998, p. 11; GUYOT, 1769, p. 61). In essence, an 18th century do-it-yourself manual, the book offers insight into how such peepshows and other optical devices were designed and constructed. As described in the book, this *boîte d'optique* employed a six-inch diameter convex lens at its viewport behind which was positioned a mirror angled at 45°, directing the viewer's gaze downwards towards the base of the pyramid where lightly painted engravings were placed. The insides of the box were painted black; however, one side of the pyramid was left open with gauze covering all but the very bottom. This gauze would be exposed to sun or candlelight to illuminate the interior. The remaining slot beneath the gauze was used to slide the engravings in and out. The sum of the distance between the engraving and the centre of the mirror and that of the distance between the mirror's centre and the viewport, were to be equal to the focal length of the lens. [4:56–58]

It is clear by the large diameter of the convex lens that the engravings were meant to be viewed with both eyes and the arrangement of the lens and mirror is identical to a simpler device from the period, sometimes known as the *zograscope*, which lacked the enclosures of the *boîte d'optique* [2:16–17,5]. The French name for the engravings used with both devices was *vue d'optiques* [2:32] and typically depicted views of landscapes, historical events and architecture. Optical properties of the simple bi-convex lens in both peepshows and zograscopes have the effect of disrupting the usual psychological visual cues that give the perception of flatness and proximity. So, in keeping with scenes extending to the horizon, the pictures viewed with both eyes through such lenses take on a distant appearance with a great deal of surface "plasticity" [5,6].

3. The Pepper's Ghost

Traditionally, the early Pepper's ghost illusion involved the positioning of a large pane of glass at an angle in front of a stage. An actor or sometimes an object, not directly visible by the audience and against a black background,[1] was illuminated with strong lights such that image of the individual or object was reflected off the glass. This phantom image appeared at a depth on the stage equal to the distance of the actor or object from the glass. The juxtaposition of a two-dimensional image in a three-dimensional set, created an illusion that the ghost image had three-dimensional form.

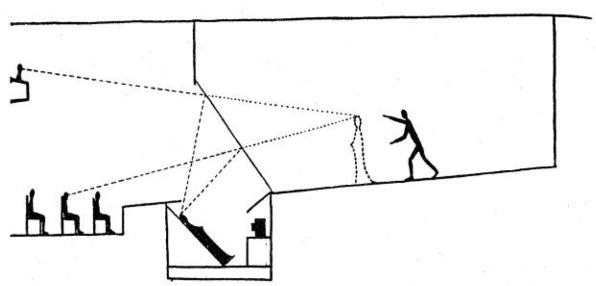

Figure 2: The 19th Century Pepper's Ghost

Depending on the lighting on the stage directly behind the ghost, it could appear solid, in the case of a dark background, or transparent, with an illuminated background. The effect was used in 19th century theatre in London and Paris to depict apparitions in plays and book readings such as, in the case of the Royal Polytechnic Institution in London, Shakespeare's Hamlet and A Christmas Carol by Dickens [15]. Figure **Erro! Fonte de referência não**

[1] When available, the orchestra pit was commonly used.

encontrada. illustrates the original Pepper's Ghost with an image reproduced from George Speaight's article on the subject, *Professor Pepper's Ghost* [15:16].

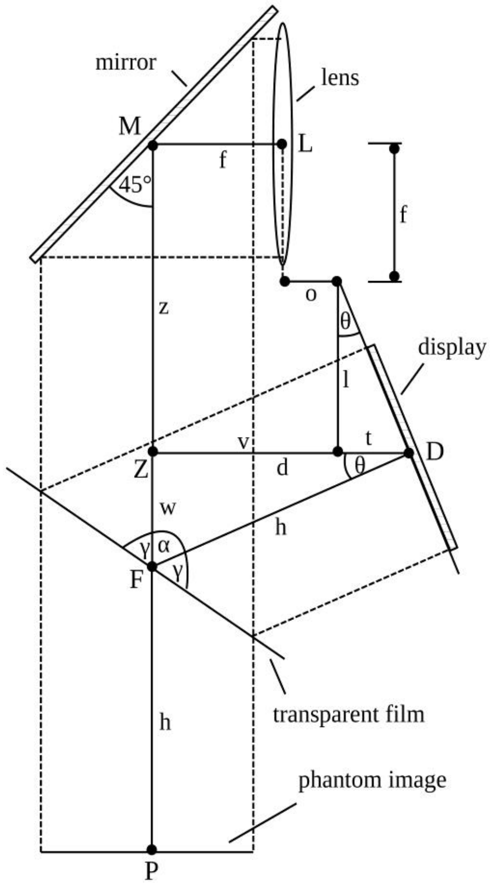

Figure 3: Geometry for a Pepper's Ghost `Peepshow

4 Peepshow Design

Contemporary Pepper's ghost illusions rarely involve live actors and often employ the use video displays, in the case of small-scale installations, or front- or rear-projection onto an adequate surface, in large installations. *Petit Godot*, as a compact example of the illusion uses a small flat-screen video display in each of the modules of the installation. To design the cabinet for each peepshow preserving the design characteristics of the *boîte d'optique* in Figure **Erro! Fonte de referência não encontrada.**, it was necessary understand the geometry involved and related formulas to establish the design constraints. These formulas would enable the correct positioning of the display and determine the scale and form of the cabinet for a given focal-length lens.

Figure **Erro! Fonte de referência não encontrada.** shows the geometry for a Pepper's ghost inside the turreted pyramidal form of the *boîte d'optique*. A bi-convex lens at point *L* is directed at a mirror angled at 45° at point *M*. The sloping sides of the box at the angle θ are distanced from the base of the implied turret with dimensions of $2f$ x $2f$ by an offset of o. The display is positioned on the front side of the pyramid with its centre at the elevation of point *Z*. Beneath the mirror, at a distance of w from point *Z* and centred on point *F* at an angle of γ, is a transparent film off which the ghost image is reflected. In this adaptation of the *boîte d'optique* the Pepper's ghost is at the focal point of the lens in the place of an engraving. Two dimensional images are included elsewhere in the cabinet and this will be discussed below.

$$l = z - f$$
$$v = f + o$$
$$t = \tan\theta \times l$$
$$d = v + t$$
$$w = \tan\theta \times d$$
$$h = \sqrt{d^2 + w^2}$$
$$\alpha = 90 - \theta$$
$$\gamma = \frac{\alpha}{2} - \theta$$
$$fl = h + w + z + f$$
$$mdh = \sqrt{l^2 + t^2}$$

The above formulas are derived from the geometry in Figure **Erro! Fonte de referência não encontrada.**, where *fl* is the focal length of the lens and *mdh* is the maximum display height. To experiment with the design, the formulas were entered into a Perl script with command line arguments for θ, o, f and z. The lens chosen for the project was a 127mm diameter bi-convex type with a focal length of 40cm. Another key factor in the design is the size and orientation of the display. Since the videos are of a solo performer, the display is mounted in portrait orientation; the maximum height of which, limited by the value *mdh*. The side panel offset value o was kept a zero where possible to agree with the model of the *boîte d'optique* and values for θ, f and z were tested and adjusted so that the resulting focal length approximated 40cm.

This approach gives a reasonable degree of flexibility in the design parameters with the main limiting factors being the display size and the focal length of the lens. A large display must not only fit inside the cabinet, it must also not be so large that part of its image becomes obscured or truncated by the size and arrangement of lens, mirror and transparent film. There is also the position of the phantom image to be considered and the pyramid must be sufficiently tall as to accommodate any scenographic elements to be positioned behind the ghost. The geometric values produced by the script were themselves tested, first as drawings made in the software *Sketchup*[2] and later in cardboard prototypes.

An initial design was made with the 40cm focal length lens and a display with the dimensions 21cm x 12.5cm. This produced a peepshow with a turret measuring 7.5cm x 7.5cm internally and with the sides of the pyramid sloping at an angle of 17°. It was quite similar in form to the *boîte d'optique* in Figure **Erro! Fonte de referência não encontrada.**. After prototyping and testing with a videotaped actor on a black background however, it was found that the character viewed through the lens was not of a sufficient size and it was decided to use a larger display. A second problem was identified with the display and that was that the black background in the videos was reproduced as a tone of dark grey rather than black and the square format of the display became apparent when reflected off the transparent film. The display used, like most displays, relies on a backlight to illuminate pixels and produces a dim but distracting glow. One solution is to use lighting to illuminate those parts of the set behind the regions where the edges of the display are visible on the film. This restricts the dynamic possibilities of the lighting, however. For example, the lights can never be fully dimmed to leave the ghost alone visible as the borders of the display will again be seen. Nor can complete darkness be attained in the scene.

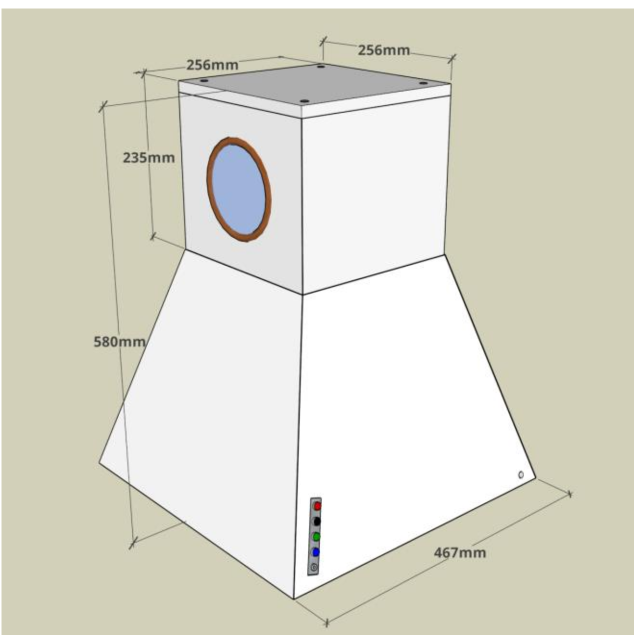

Figure 4: Peepshow dimensions

The solution has been to use a type of *OLED* display named *AMOLED*, used in certain mobile phones and tablets.[3] These displays do not use a backlight and from project's empirical testing, can reproduce a true a true black, that is, emit no light from darkened regions of the video. A Samsung Tab S2 9.7" tablet was chosen and has the dimensions of 237.3 x 169 x 5.6mm. While an expensive option to use in five separate modules, these devices may be hired at the time of exhibition and have the advantage of offering audio via a headphone jack. The provision of audio and video is discussed below.

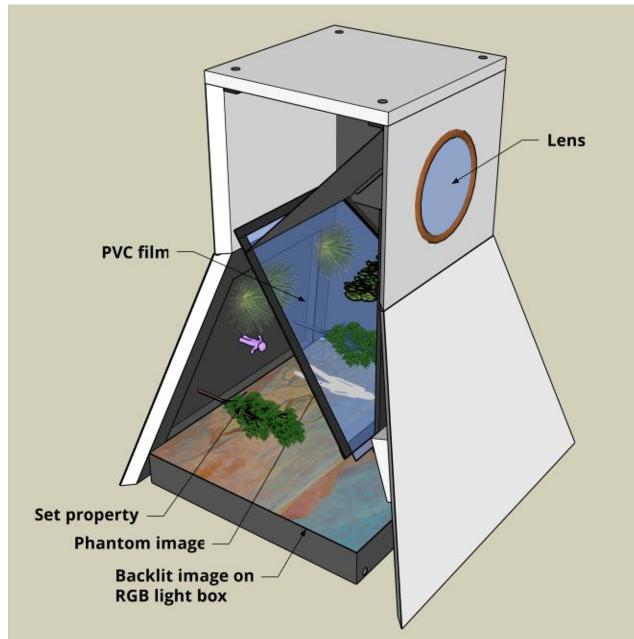

Figure 5: Peepshow interior

To accommodate the larger display and potentially other displays of a slightly greater size, the design needed to be modified. The sloping sides of the pyramidal base in the original prototype, not only permit viewing of images much larger than the dimensions of the turret, when a display is mounted to the side of the pyramid, the display itself is hidden. The extra width meant that the dimension *f* in the turret needed to increase to maintain an agreeable form. Because values of *h*, *w*, *z* and *f* need to sum to 40cm, the focal length of the lens, the change in *f* meant that the focal point of the lens was no longer situated at *D*, on the Pepper's ghost. The distance *z* could be reduced to compensate, but this, coupled with the increased height of the new display, would mean that the display would encroach into the turret. The angle θ was thus reduced to zero in respect of the display, while keeping the sides of the pyramid at an angle; set to 23° after tests using a second cardboard prototype. Since the screen is now vertical, its base becomes visible through the lens and it is necessary to mask it with a proscenium situated immediately above the display.

[2] www.sketchup.com

[3] OLED stands for *organic light emitting diode* and AMOLED for *active-matrix light emitting diode*. For a summary and references on these devices see: https://en.wikipedia.org/wiki/OLED

The resulting design made in Sketchup and first prototyped in dense cardboard, was constructed in MDF with a thickness of 15mm to give sufficient weight so as not to be shifted easily during exhibition. Its surface has been covered with white Formica with a brilliant finish. The 127mm lens is held in place at the front with a curved lip of wood.

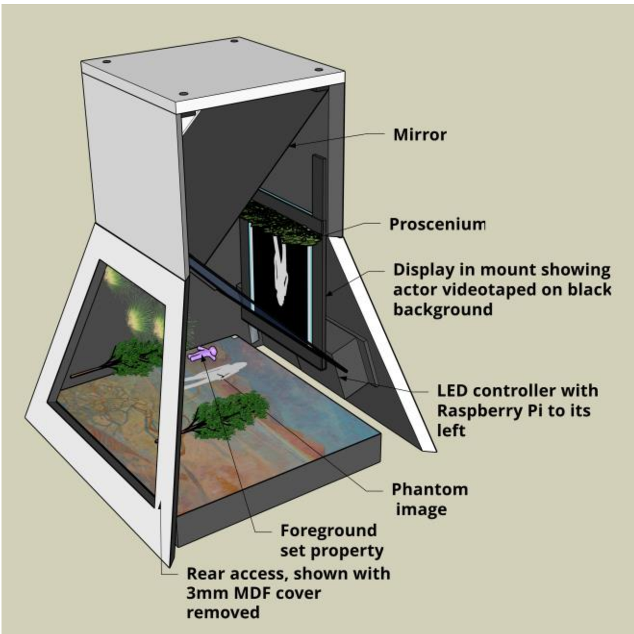

Figure 6: Peepshow interior

Where Figure 4 shows the external dimensions of the peepshow, Figures 5-7 show its interior from the side and from above. The scenography in these figures is merely illustrative, however shows that two main types of elements are present: two-dimensional images and solid objects which may be illuminated by either back or frontal lighting (see discussed below). As discussed above, the viewer peers through the lens and the mirror behind the lens directs the gaze downwards towards the angled PVC film and scenography below and above it. The PVC film, which reflects the phantom image of the Pepper's Ghost, is clear plastic food wrap stretched across an aluminium frame (Figure **Erro! Fonte de referência não encontrada.**). This can be removed and refitted, along with set properties, via an opening at the rear of the peep show covered by a 3mm panel of Formica clad MDF (Figure 6). The panel is secured by screws as it the second access point on the top of the turret, which allows for the removal of tablet by sliding it vertically out of its cradle.

At the base of the module is a free-standing light box. The inside of the box is lined with silvered insulation material and covered with dimmable RGB LED strips (see below). The lid of the box is a polystyrene diffusion panel and upon which is placed a photographic transparency or other translucent material such as textured cloth. LED spotlights are secured to the inner walls of the peepshow with screws and scenographic elements such as armchairs or trees are fixed to stalks attached to the polystyrene diffuser below.

Equipment, including a Raspberry Pi4 computer [4] and LED controller, is secured to the inner front wall behind the display and power adaptors for the display and the other devices, are located in the space in front of the light box (Figure 6). Figure 4 shows an array of buttons and a headphone socket on the right-hand side of the cabinet. The control mechanism is discussed below. Finally, Figure 7 shows a top internal view of the cabinet with the mirror and equipment hidden. It demonstrates the perspective seen by the viewer through lens and the two-dimensional animated phantom image is positioned with respect to foreground and background elements, as discussed above, to give it a sense of three-dimensionality. What cannot be shown in Figure **Erro! Fonte de referência não encontrada.** is the effect of the lens. The lens has by no means a narrow depth of field and it is still possible for the viewer to focus on other elements in the scene, however the eye naturally gravitates to the focal plane of the lens where the phantom image is situated.

Figure 7: Peepshow interior elevation

5 Performance and Video Production

The texts chosen for the five peepshows and interpreted and adapted by Simone Reis include the following short plays by Matei Visniec: *O Último Godot* (The Latest Godot), *Nina ou da Fragilidade das Gaivotas Empalhadas* (Nina or on the Fragility of

[4] www.raspberrypi.org

Stuffed Seagulls), *Ricardo III está Cancelada* (Richard III is Cancelled), *Olga, Macha, Irina, as Très Irmãs* (Olga, Macha, Irina, the Three Sisters) and *Tio Vânia* (Uncle Vania) [16,20,17–19].

Figure 8: Simone Reis as Macha in *As Três Irmãs*

Performances by Reis are videotaped with a Nikon D610 DSLR and Micro-Nikkor 55mm f2.8 Ais lens. Videotaping has involved full-body shots, head shots and assorted details. The lighting used includes three *soft-box* lights with two positioned either side of the performer and one overhead. As it is necessary to have a black background to produce a Pepper's Ghost (see above), a black drop cloth behind and below the performer and parts of the body not to be included in the phantom image are covered with black clothing. Further masking and contrast adjustments are made in video editing. Audio is captured with a small DPA lapel microphone and recorded both on a TASCAM DR-680 digital recorder and on the camera itself. Additionally, voice *offs* are recorded with a 797 Audio CR100 valve condenser microphone. All audio is mixed with the open-source Ardour 6 software as well as within the video editing environment itself. For this, DaVinci Resolve 17 software is being used on a Arch Linux desktop computer with a Geforce GTX 1650 Super graphics card and a Scarlett 18i20 audio interface.

The soundtracks for the videos, which include synchronised voice, *offs*, music and sound effects, are heard by the viewer on headphones. The audio is processed using the extension class to sound synthesis language *SuperCollider* called *Mosca* [8,10]. On headphones, Mosca is used to produce a three-dimensional rendering of audio via ambisonic mechanisms, positioning sounds in three-dimensional space (Figure 9). It does so by using monophonic sound files or signals as source material or by using three-dimensional sound recordings made with a Core Sound Tetramic first-order ambisonic microphone [10:89]. Sound design produced in this way immerses the listener in a three-dimensional virtual acoustic space. The voice of the principal character in each peepshow, which generally looks directly at the viewer, is played in mono in the headphones such that it appears to come from within the head of the listener. This juxtaposition of the *internal* sound of the voice and the *external* sound of the ambisonic material, that is, the acoustic environment of the character, helps to immerse the listener in the *world* of the character and build a close association with the character herself, as if the viewer were looking into a type of mirror. An effect used in the precursor project *O Espelho* [7]. Mosca also provides the facility to recreate the ambience of different acoustic environments through convolution reverberation [10:90] and impulse responses (IRs) have been produced for this purpose using the software Aliki [1].[5]

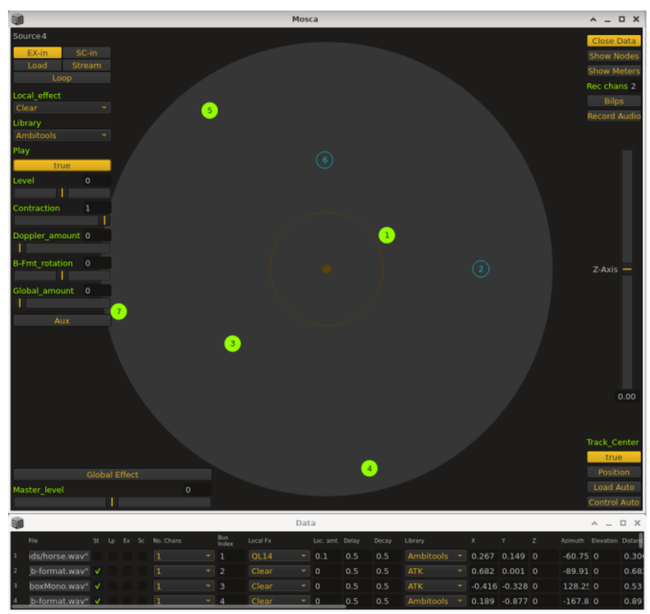

Figure 9: Mosca GUI

While Reis performs all roles in in the selected plays, some characters are presented as *a*nimated figures using machine

[5] For the specific technique used by Mott, see: https://tinyurl.com/ycjcx8gb

learning software in Python environments. Two of these characters involve the historical figures of Samuel Beckett and Vsevolod Emilevich Meyerhold. Initially, animations were were attempted using DeepFaceLab [11]. Like many so-called *deepfake* procedures, the software requires a *driving* video; generally a videotaped agent providing movements, voice and expressions as well as scenographic elements in the background. It also needs a face or head to act as a *source* in the resulting video. While photographs may be used as a source, many such photos of high and similar quality must be used and ideally, quality video recordings are needed to capture a wide range of expressions and head angles. Since there is scarce video material of Beckett available and in the case of Meyerhold, none, different techniques and software have been applied.

Figure 10: Animated photographs

One software used is called First-order-model and can animate a single source image with both bodily movements and speech [13,14].[6] The second is called Wav2Lip [12].[7] With Wav2Lip there is no driving video but instead an audio recording of a voice. The source may be either a single image or a video of an individual and the lips of the source are made to lip-sync to the audio. A third machine-learning software was used on the results of these processes to increase the resolution of the final videos as well as to correct colour rendition and to remove digital artefacts. This software is called Real-ESRGAN [21].[8] The top-left of Figure 10 shows an original photograph of Beckett by Henri Cartier-Bresson and to its right is a frame from the resulting video. The original image was first processed in Gimp 2.10 to remove the background and to colourise the portrait using palette mapping.[9] The image was then animated using First-order-model and driven by a video of Simone Reis playing his character. Finally, the individual frames of the video were processed with Real-ESRGAN. The bottom-left image in Figure 10 shows a portrait of Meyerhold and again to its right, a frame from the animated video is shown. To produce the video from this image, the second step was replaced with the Wav2Lip method. The resulting animation has the character in a fixed position but with far better articulation of mouth and chin.

Figure 11: Pepper's Ghost photographed through lens of peepshow

6 Audio, Video and Lighting Deployment

To replay the Pepper's Ghost and control light within each peepshow, a single embedded Raspberry Pi 4B computer with 4Gb of RAM and a non-GUI 64bit Arch Linux operating system[10] installed. Early in the development processes, the Pi 4B supplied audio and video to the tablet (see above) via an HDMI to USB adaptor. Additionally, a simple circuit was used to enable the tablet to receive the video signal and be charged at the same time through the single USB socket.[11] This however proved to be unreliable and caused damage to the tablet on one occasion. A wireless solution was found in Javascript coding and specifically, in libraries developed around P5.js.[12] All tablets and Raspberry Pi 4B computers are placed on a local network and each Pi 4B runs a simple web server. The tablets play video in a web browser with the content served by its associated Pi 4B on a specific local IP address.

The spectator initiates the video and associated lighting events (see below) by pressing one of several buttons on the base of the peepshow; The buttons are coloured red, black, green and blue and respectively perform the functions of initiating the video and lighting sequence, stopping the sequence, adding Portuguese subtitles and adding English subtitles. The buttons are connected to

[6] Source code: https://github.com/AliaksandrSiarohin/first-order-model
[7] Source code: https://github.com/Rudrabha/Wav2Lip
[8] Source code: https://github.com/xinntao/Real-ESRGAN
[9] For a tutorial, see: https://www.youtube.com/watch?v=JW_siMWqnr4

[10] The AArch64 disk image was installed from: https://olegtown.pw/Public/ArchLinuxArm/RPi4/rootfs
[11] https://is.gd/govTuk
[12] https://p5js.org

four of the Pi 4B's GPIO[13] pins. Button presses are detected by a shell script[14] which sends OSC (Open Sound Control)[15] messages, via the *oscsend* utility of the OSC implementation *liblo*[16], to control the interactive multimedia sequencing software OSSIA Score [3][17]. Once activated this software in turn sends further OSC messages to control video playback in the tablet's browser and associated lighting events. A default *device* within the software named *score* is configured to act upon the incoming messages to control the transport of a timeline and branching structures and triggers, etc., therein. In this way, video may be selected and replayed with or without subtitles.

Figure 12: Pair of peepshows in MDF, Formica, Glass, Plastics and Electronics

The code for both the control of video and OSC messaging was adapted from the *video canvas*[18] capability of P5.js and the OSC messaging of p5js-osc[19] respectively.

The GUI timeline of OSSIA Score is populated with control events and editing, in this project, is monitored on a Linux desktop computer during development using X-forwarding. The timeline is used to sequence control data, both of a continuous and discrete type. An excellent tool in OSSIA Score is *color automation*. The multimedia designer may define RGB colour gradients where one colour merges into the next in synchrony with other media events and this technique is being used to adjust colour and brightness in the LED strips.

Figure 13: Detail showing headphones and buttons to control playback and captions

As with the video, the chosen protocol for the lighting control data is OSC. In order for the OSC messages to modulate the LEDs, a second utility from *liblo*,[20] named *oscdump*, has been modified to control the GPIO pins of the Raspberry Pi. The utility listens for OSC messages sent from OSSIA Score on a specified port, parses the data and makes system calls to another utility called *pigs*, part of the *pigpio* library[21]. The parsing process involves *gamma correction*[22] on incoming RGB data for the values to produce the desired colour on the corresponding LED strip. Circuitry under GPIO control and used to adjust the LEDs, modulates the 12V power supply with MOSFET transistors[23] to perform intensity and colour adjustments on the connected LEDs. The Raspberry Pi 4B has 28 GPIO pins available to the user and excluding any pins used for data input (for example, the three pins used for button interaction, described above), this means that individual control can be made on up to 28 single colour LEDs or 9 RGB LEDs and 1 single colour LED and other combinations besides.

The LED strips are of the readily available *5050* type[24] and the intensity of the red, green and blue LED elements are independently controllable via three wires on each strip. A fourth wire is for DC power. No specific type was given for the monochromatic LED spotlights sourced. They are however 12V, consuming up to 1.5 watts, dimmable, with a colour temperature between 3000 and 4000K and produce a concentrate light beam of 30°.[25] On testing, they were found to work perfectly well with the same circuitry used for the LED strips. Where the LEDs produce too much light within the peepshows, neutral density gels are used to reduce the intensity.

[13] General Purpose Input/Output.
[14] http://www.faqs.org/docs/air/tsshell.html
[15] http://opensoundcontrol.org/
[16] liblo.sourceforge.net
[17] https://ossia.io
[18] https://p5js.org/examples/dom-video-canvas.html
[19] https://github.com/genekogan/p5js-osc
[20] liblo.sourceforge.net
[21] abyz.me.uk/rpi/pigpio/
[22] For e brief description of gamma correction and for the look up table used to parse the RGB data, see: https://learn.adafruit.com/led-tricks-gamma-correction
[23] Implemented using an online tutorial: https://dordnung.de/raspberrypi-ledstrip
[24] https://tinyurl.com/j8jlkt3
[25] tinyurl.com/yey53wmv

7 Conclusion

The development of the theatrical installation *Petit Godot* has involved a synthesis of disparate techniques and artistic approaches, engaging with text, performance, video production and editing, animation, ambisonic sound design, embedded computing, design, mixed media sequencing and optical illusion. It has traversed 300 years of artistic tradition, connecting innovations of the 18th and 19th centuries with those of the contemporary era, albeit on a miniature scale. By employing the peepshow, solo performance and ambisonic binaural sound in particular, and in the context of a public installation, it does so in an intimate and social setting. It is hoped that a sense of wonderment, so important to the peepshows and theatrical illusions of the past, is encouraged and experienced in the reception of the work.

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REFERENCES

[1] Fons Adriaensen. 2006. Acoustical Impulse Response Measurement with ALIKI. In *4th International Linux Audio Conference*, ZKM Karlsruhe, Germany.
[2] Richard Balzer. 1998. *Peepshows : A Visual History*. Harry N. Abrams, Inc., New York.
[3] J.-M. Celerier. 2018. Authoring interactive media: a logical & temporal approach. PhD thesis. University of Bordeaux, France.
[4] Edmé-Gilles Guyot. 1769. *Illusions de L'Optique, Nouvelles récréations physiques et mathematiques*. Gueffier, Paris. Retrieved from t.ly/illusionsdeloptique
[5] Kees Kaldenbach. 1985. Perspective Views. *Print Quarterly*. Retrieved April 12, 2021 from https://kalden.home.xs4all.nl/auth/perspectiveviews.htm
[6] Jan Koenderink, Maarten Wijntjes, and Andrea van Doorn. 2013. Zograscopic viewing. *Iperception* 4, 3 (May 2013), 192–206. DOI:https://doi.org/10.1068/i0585
[7] Iain Mott. 2016. O Fantasma Acústico. In *Práticas e Poéticas Vocais*. EDUFU, Uberlândia.
[8] Iain Mott. 2017. Botanica: navigable, immersive sound art. In *16º Encontro Internacional de Arte e Tecnologia*, Lisboa, Portugal. Retrieved from tinyurl.com/vb9tbr8
[9] Iain Mott. 2021. Haunting an 18th Century Peepshow: Design and function of the mixed-media theatrical installation Teatro Menor. Aveiro, Portugal. DOI:https://doi.org/10.1145/3483529.3483707
[10] Iain Mott and Thibaud Keller. 2019. Three-dimensional sound design with Mosca. In *18º Encontro Internacional de Arte e Tecnologia*, Faculdade de Belas Artes da Universidade de Lisboa, 85–96. Retrieved from https://tinyurl.com/uwkr8nz
[11] Ivan Perov, Daiheng Gao, Nikolay Chervoniy, Kunlin Liu, Sugasa Marangonda, Chris Umé, Mr. Dpfks, Carl Shift Facenheim, Luis RP, Jian Jiang, Sheng Zhang, Pingyu Wu, Bo Zhou, and Weiming Zhang. 2021. DeepFaceLab: Integrated, flexible and extensible face-swapping framework. *arXiv:2005.05535*. Retrieved from https://arxiv.org/pdf/2005.05535.pdf
[12] K. R. Prajwal, Rudrabha Mukhopadhyay, Vinay Namboodiri, and C. V. Jawahar. 2020. A Lip Sync Expert Is All You Need for Speech to Lip Generation In The Wild. *Proceedings of the 28th ACM International Conference on Multimedia* (October 2020), 484–492. DOI:https://doi.org/10.1145/3394171.3413532
[13] Aliaksandr Siarohin, Oliver J. Woodford, Jian Ren, Menglei Chai, and Sergey Tulyakov. 2019. First Order Motion Model for Image Animation.
[14] Aliaksandr Siarohin, Oliver J. Woodford, Jian Ren, Menglei Chai, and Sergey Tulyakov. 2021. Motion Representations for Articulated Animation. *arXiv:2104.11280 [cs]* (April 2021). Retrieved March 16, 2022 from http://arxiv.org/abs/2104.11280
[15] George Speaight. 1989. Professor Pepper's Ghost. *Theatre Notebook* 43, 1 (1989), 16–24.
[16] Matéi Visniec. 2012. *O Último Godot*. É Realizações Editora.
[17] Matéi Visniec. 2012. *Ricardo III está Cancelada*. É Realizações Editora, São Paulo.
[18] Matéi Visniec. 2012. Olga, Macha, Irina, as Três Irmãs. In *A Máquina Tchékhov*. É Realizações Editora, São Paulo, 63–74.
[19] Matéi Visniec. 2012. Tio Vânia. In *A Máquina Tchékhov*. É Realizações Editora, São Paulo, 85–93.
[20] Matéi Visniec. 2018. *Nina ou da Fragilidade das Gaivotas Empalhadas*. É Realizações Editora, São Paulo.
[21] Xintao Wang, Liangbin Xie, Chao Dong, and Ying Shan. 2021. Real-ESRGAN: Training Real-World Blind Super-Resolution with Pure Synthetic Data. *arXiv:2107.10833 [cs, eess]* (August 2021). Retrieved March 16, 2022 from http://arxiv.org/abs/2107.10833