




2000 Eyes: Spherical View of La Fenice di Venezia

A Large-Format Equirectangular Drawing with a Gigapixel Resolution

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Abstract. “2000 eyes” is an artwork made for the Gran Teatro La Fenice di Venezia. It is a handmade spherical perspective drawn from observation in equirectangular projection, on the occasion of the special setup “Chiglia” (keel) designed during the Covid-19 Pandemic. This experimental project aims at testing practices and techniques to create gigapixel hand-drawn panoramic views of complex environments from observation and showing how the use of 360° drawings may enhance the perception of artworks and spaces, adding value to the visitor’s experience. The original panoramic drawing and its interactive 360° version are currently exhibited in one of the halls of the Theater. The permanent installation presents one possible way to experience an artwork focusing on the intersection of digital and physical worlds.

Keywords: spherical illustration · equirectangular drawing · VR illustration · artwork digitization · art installation

1 Introduction

Spherical perspectives, also called 360° drawings or 360° illustrations, are drawings that depict the whole visible environment into a single flat surface. These drawings can then be converted into immersive VR panoramas that can be viewed interactively.

Many artists are using spherical perspectives in their own works. There are many methods to obtain a 360° drawing, ranging from tracing from an equirectangular photograph or guesswork procedures [1], to applied descriptive geometry constructions [2–7]; from digital environments such as computer or tablet [8, 9] to paper or canvas [5, 7]. Nowadays the majority of 360° artworks are displayed only on a computer, smart device or VR headset, some artists paint and show their works only in an analogue way [10, 11].

Neither form of display shows the relation between the original drawing and the interactive version, and the general public often cannot decode that the unusual curvilinear perspective drawing is a fully immersive spherical perspective and vice versa. The

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juxtaposition of the original drawing and its interactive version, called Hybrid Immersive Model (HIM) [12–14], draws a straightforward connection between the two ways of representation, making the spherical perspective on paper more readable and enjoyable [15–17].

On the other hand, it is not simple to obtain significant results in terms of quality and details due to the technical limitations of the paper's size and pencil's stroke. To draw complex environments with proper details, artists need to sketch on large-format sheets and may have to adopt a different workflow. The special installation “Chiglia” (keel) made during the Covid-19 pandemic at the Gran Teatro La Fenice di Venezia was the occasion to develop and test different practices and techniques to draw a spherical perspective from observation in large-format paper and create a gigapixel VR version of a 360° drawing.

This essay focuses on the workflow used to make a handmade spherical perspective in equirectangular projection on paper combining key point measurements and intuitive drawing thanks to the author's experience, the digitization and the reprojection of a large format 360° artwork, the multiplicity of outputs and the exhibit as an art installation.

2 The Environment

The Gran Teatro La Fenice is the Opera House of Venice, Italy [18]. It is a significant landmark in Italian theaters and in the history of opera as whole [19, 20]. Its name (The Phoenix) symbolizes the revival of the opera company from its misfortunes. The building was damaged by several fires during the XIX century and was completely destroyed in the latest fire of 1996, which left only the perimeter walls.

The reconstruction of the present-day Theater (2004) was based on a design by architect Aldo Rossi [21], keeping to the motto “As it was, where it was”: the five tiers of boxes, stage and ceiling and intricate ornamentations in rococò style designed by Gian Battista and Tommaso Meduna [22] were meticulously reconstructed from historical documents, photographs and films.

2.1 The Installation “Chiglia”

During the first lockdown of the Covid-19 pandemic in 2020, the Fondazione Teatro la Fenice found a way to allow the artists to perform and the audience to attend events safely though a special setup: seats were removed from the stalls, making room for the orchestra, and placed on an installation consisting of a wooden slope that covered the orchestra pit and the stage. (Fig. 1).

“Chiglia” (keel), the installation designed by the set designer Massimo Checchetto [23] during the lockdown (Fig. 2) is the keel of a wooden ship under construction, or in the words of the CEO and Art Director Fortunato Ortombina of “an ark that will take us forward, into a new world” [24]. A special program was developed for the new setup and the Opera House was also open for tours [25].

The installation reversed the environment giving the viewers a different perception, a kind of space within another space. It was a unique occasion to capture the beauty



Fig. 1. The Hall during a concert in July 2020. Left - view from the 1st order boxes. Right – view from the 4th order boxes (© Chiara Masiero Sgrinzatto)

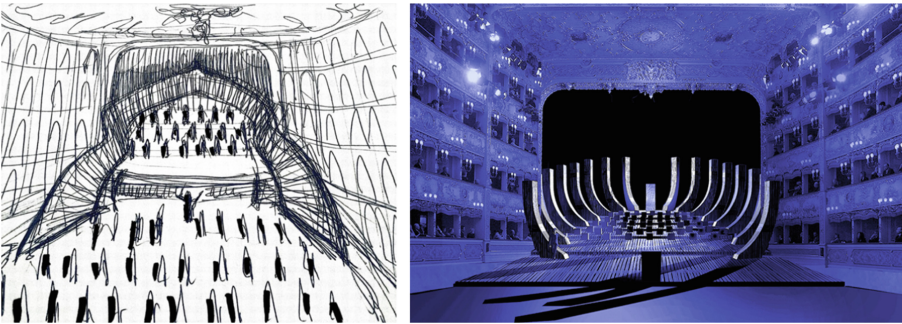


Fig. 2. “Chiglia”. Left – sketch by Massimo Cecchetto. Right - digital render (© Massimo Cecchetto, Fondazione Teatro La Fenice).

of the ornaments of the boxes and the ceiling and the complexity of the shape of the Theater.

In September 2020 the author could spend a whole day in the House drawing it from a privileged and unconventional viewpoint, that would have been impossible in a normal setup, unless by setting a scaffolding in a position just in front of the orchestra pit, usually occupied by stalls.

3 The Drawing Process

In the field of 360° drawing, this artwork is one of the few examples of spherical perspective on paper in such a complex space. In order to draw on large-format paper, she had to develop her own method, using tools to make the guesswork procedures more accurate in an “over-decorated theater” [26], using her intuition, matured from long experience, to guess how elements deform with distance between the measured key points. The workflow detailed below is the fruit of studies and definitions on spherical perspective drawing combined with her previous experiences [27].

3.1 Preliminary Operations

The author carefully planned the whole workflow before drawing in the Theater. She has made several sketches in her studio to become familiar with lines and curves on this large size and tested different kinds of paper. She opted for a 100 × 70 thick sheet of Canson Mi-Teintes ivory-color paper, It was previously prepared defining the 2:1 equirectangular area (100 × 50 cm), then tracing a simplified grid with a hard pencil (Fig. 3): the horizon, the eight vertical sections corresponding to the cardinal/ordinal directions and horizontal lines every 22,5°.

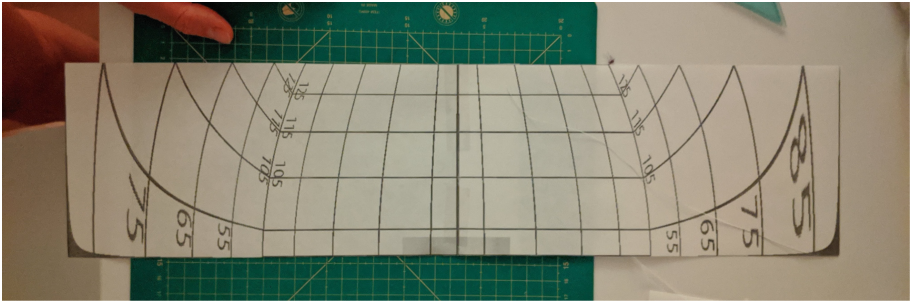


Fig. 3. The equirectangular grid used to trace the grid on paper (© Chiara Masiero Sgrinzatto)

3.2 Selection of the Viewpoint

Once you lose the language of framing, when everything is included in the image and no angle is left out, accurate positioning is key to communicate an environment.

The point of view of the 360° drawing was set considering the balance and beauty of the composition: the author chose a central position (Fig. 4 - left) to emphasize the geometric shape of the hall and to see the chandelier and the decorations of the ceiling, the 5 orders of boxes and the royal box.

The wooden installation provided a point of view that would have been inaccessible in the normal setup of the theater. Starting from the slope - the former stage - a runaway led to the center of the orchestra area - the former stalls - where opera singers and solo players could perform. The end of the runaway, similar to a diving board, was an ideal place to put the stand and sketch in total comfort.

3.3 Drawing on Location

To facilitate the drawing from observation on location, some paper tapes were placed on the floor (Fig. 4 middle/right) to indicate the viewpoint of the panorama and the cardinal/ordinal directions (0, 45°, 90°, 135°, 180°, 235°, 270°, 360°). The same directions were previously traced on the paper.

The author could verify the polar coordinates of the key elements using a laser pointer. The Leica DISTO X4 has a built-in screen that shows the point that the laser is



Fig. 4. Left - This fisheye view shows the shape of the Hall from a Point of View very close to the drawing. Middle - The paper tape on the floor of the runaway (© Luca Vascon). Right - The paper tape on the floor, on the viewpoint (© Chiara Masiero Sgrinzatto)

measuring in live-view mode and displays beside the distance the vertical angle between the ground and the spot you are pointing to (Fig. 5). The intersection between the position on the horizontal axis (yaw) and the measured spot on the vertical axis (pitch) gives the exact point to draw on the paper. This enabled the author to connect the key points and fill the intermediate space guessing how measures are changing in an effective way.



Fig. 5. Left - Pointing a key point. Right - Checking with the laser pointer (© Luca Vascon)

Drawing the spherical panorama in the Theater Hall with a medium-hard pencil on 100×50 cm paper took about 4 h (Fig. 7 - left). The author started by tracing and checking the main lines, before going into the details (Fig. 6).

Sketching started from the Royal Box to the stage (installation), drawing gradually the five tiers of boxes. The decorations of the boxes, of the ceiling and of the proscenium have been carefully sketched little by little, once the corresponding part was roughly defined (Fig. 7 - right).

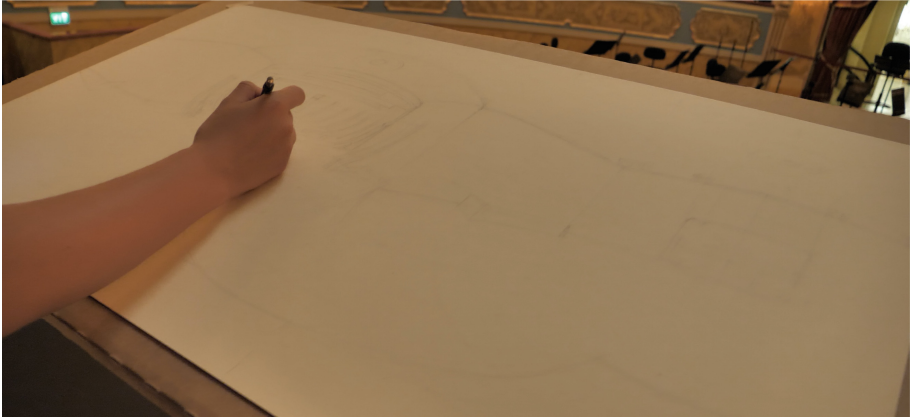


Fig. 6. Sketching the main lines of the drawing in the Theater (© Luca Vascon)



Fig. 7. Left - The 360° drawing process in the Hall (© Luca Vascon). Right - The 360° drawing and the installation "Chiglia" (© Chiara Masiero Sgrinzatto)

3.4 Completing the Artwork

The drawing sessions continued at the author's studio, refining the details in pencil (Fig. 8). In a second time the artwork was colored in Conté à Paris dry pastels and Bo-Reado colored chalks in short sessions of about 1 h a day (Fig. 9), taking about a couple of months in total.

Although this technique is unusual for this kind of drawing, being usually applied to rougher sketches, the author exploited the blending capacity of dry pastels to achieve a vibrant result, especially on the colorful ceiling and ornamentation of the boxes, as well as the reflecting covering of the installation' slope.

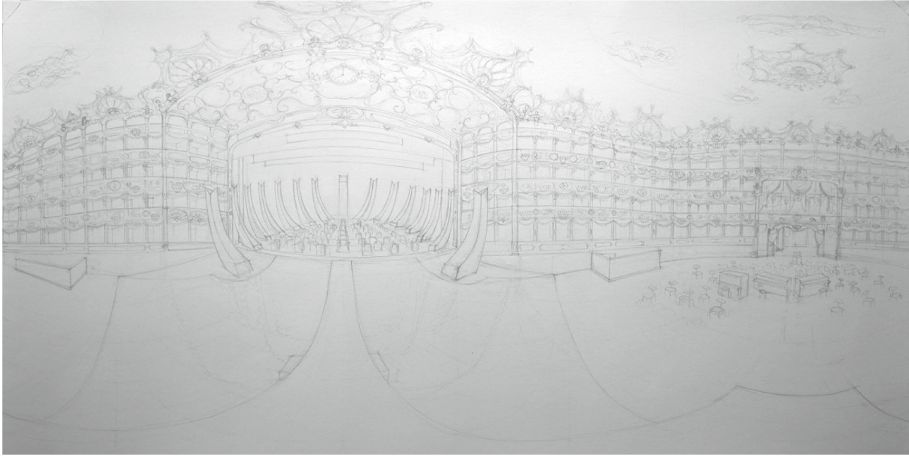


Fig. 8. The complete 360° drawing, pencil on paper (© Chiara Masiero Sgrinzatto)



Fig. 9. The coloring process with dry pastels (© Chiara Masiero Sgrinzatto)

To reveal the details, the outlines were inked over the colored surface with 0.20—0.50 points' rapidographs filled with black ink (Fig. 10 - left). To emphasize the shadows the dark parts were painted with brown, dark green, dark gray Royal Talens Ecoline liquid watercolor paint (Fig. 10 – right, 11, 12).

The artwork was framed in a Deco style frame that perfectly fit the drawing and was protected by a glass.



Fig. 10. Final touches with black ink and watercolor paint (© Chiara Masiero Sgrinzatto)



Fig. 11. The final 360° drawing (© Chiara Masiero Sgrinzatto)



Fig. 12. The 360° photograph of the Hall taken from the same point of view, reference picture to check the colors during the painting process (© Luca Vascon).

4 Digitization

To transform the spherical drawing on paper into an interactive 360° panorama, a digitization process is required. The drawing has enough details to justify a gigapixel resolution in the digital version. First, the artwork is photographed in several parts; second, these parts are assembled in the final picture and third, they are transformed into a fully spherical interactive image.

Usually, the author scans her artworks. In this case, due to technical problems, such as the size of the paper and the painting technique, a high-resolution scan of the paper could not be done without damaging the picture. Moreover, in past experiences the author notices that scans often have little distortions, hard to fix in post-production when matching the parts of big size artworks. The author opted for a photographic digitization process that is normally used in high-resolution reproductions of paintings [28], consisting in capturing the artwork in several parts, then combining them together to build the final image.

In a photographic studio, uniformly lit by a soft light, the drawing was photographed in more than 50 sections by the panoramic photographer Luca Vascon [29] with a Sony Alpha 7RIV camera mounting the Sony 100 mm f/2.8 Macro lens. This lens guarantees maximum image quality at close-focus distances and minimum aberrations. The camera was mounted on a custom tripod, the surface of the sheet was captured by moving it as many times as necessary to cover the whole artwork (Fig. 13), leaving an overlapping portion in each photograph to allow the stitching of the final image. The X-Rite Color Checker was used to make sure that the colors were accurate.



Fig. 13. Digitization of the drawing at the photographic studio (© Chiara Masiero Sgrinzatto)

4.1 Post-production and 360° Panorama

All photographs were digitally developed and tuned by the photographer in Adobe Camera Raw, then assembled and rendered as a flat panorama with PTGui Pro [30].

The drawing was already done in equirectangular projection, the right geometric projection to prepare the interactive version. Despite the overall accuracy of the drawing, some lines of the intermediate distances between points were not precise enough for the

computer reprojection, especially where the drawing was more distorted. Some minor errors at zenith and nadir were fixed in Adobe Photoshop, as well as the 0–360° line, in order to ensure a smooth and pleasant virtual experience. Adjustments on shadows and highlights were made to make the colors more vibrant.

The resolution of the output file is 47.072×23.536 pixels - 1,1 Gigapixels. The interactive 360° panorama was exported using KR pano [31], its tiling system allows a smooth transition between the different levels of zoom. It ensures a quick loading and an enjoyable navigation of a very large and detailed image.

5 Documentation

The whole process was fully documented by the author and her collaborators. Photos and videos were shot in the Theater during the drawing session as well as the digitization and framing. The coloring and inking sessions in the studio were documented with a timelapse. A screen capture shows the interactive navigation and some key details of the panorama. All the material collected was enclosed to the “making-of video” and published on YouTube [32].

6 Interaction

The artwork is exhibited and experienced a multiplicity of related modalities: it is available as a plane equirectangular map, as an interactive VR environment and as a paper sphere.

6.1 360° Panorama

The interactive VR panorama is available on a web page, fully accessible from any computer, smart device or VR headset connected to the internet [33]. Thanks to the 360° viewer the navigation is smooth and pleasant, despite the high resolution.

The drawing opens in stereographic projection, allowing the viewer to see the whole picture at a glance. A short animation brings it back to the rectilinear projection, allowing the exploration of the space. A clean and minimal custom-designed user interface controls the view and the zoom level. The illustration invites the viewer to an unconventional virtual visit that reminds some pictures of the Hall taken by *Vedutismo* painters and etchers [34], overcoming the limited field of view of the classical perspective.

6.2 Phygital Installation

“2000 eyes” was presented at the Theater on December 20, 2021. It is currently shown as a permanent installation at the Sala Dante, one of the Sala Apollinee on the first floor of the Teatro La Fenice. It is on display daily, during the Theater’s tours and during the intervals of operas and concerts. The name evokes the key number: 2000 eyes of the 1000 spectators that the Hall can host; 2000 eyes looking at the center of the Hall, the point of view of the panorama; 2000 ways of experiencing the artwork itself.



Fig. 14. The installation “2000 eyes” at the Sala Dante (© Chiara Masiero Sgrinzatto)

The installation consists of the framed original drawing in equirectangular format on an easel on the center, a touchscreen monitor displaying the interactive version on the right and another monitor showing the making of video on the left (Fig. 14).

Visitors can see the complexity of the Hall that they have just experienced during the performances or the Theater’s tour on the equirectangular drawing and view a more recognizable environment in the interactive reprojection.

6.3 Paper Sphere

Another way to interact with the artwork is the paper sphere model. A limited edition of 100 paper craft sphere kits based on the same illustration, numbered and signed by the author, is available at the Theater’s bookshop (Fig. 15).



Fig. 15. Left – The author holding the sphere in front of the installation (© Fondazione Teatro La Fenice). Right - The paper sphere at the shop (© Chiara Masiero Sgrinzatto)

To make the kits a two-spirals (orange peels) origami template [35] was printed on A3 thick white paper in order to obtain spheres of about 10 cm in diameter. To facilitate the assembling of the spheres the sheets were laser-cut using the cutting path template.

7 Conclusions

This experience shows how spherical-perspective drawing can be used on large-format paper to obtain very detailed artworks and high-resolution VR versions. The technical challenges can be easily overcome by adopting the right workflow and using simple tools to facilitate the sketching.

The intuitive method can be adopted successfully by preparing the drawing paper with a simplified equirectangular grid and by checking the position of the key objects using a laser pointer with built-in display while sketching on location. The intermediate distance between points can be guessed in every row if the designer is familiar enough with the projection.

The digitization process, shooting many photographs assembled into a single file, preserves the original drawing from damage and geometric distortions that may occur using a scanner, obtaining VR outputs in gigapixel resolution.

The large-format paper allows one to display the original artwork in an art installation, more enjoyable and pleasant to the audience than small-format paper exhibits. It also gives the opportunity to experience the interactive version with a large-size touchscreen, emphasizing the relationship between the two modalities of representation for the general public.

The permanent installation of “2000 eyes” at the Theater gave the opportunity to build a narrative inside the space, to give the public a feeling of presence that can be different and more informative than the actual presence. It shows the Hall in a particular setup and documents the actions taken by the Fondazione Teatro La Fenice in a moment of difficulty for performing arts. Art can give an enhanced-reality effect.

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References

1. Sucurado, B.: Dibujos 360°. <https://brunosucurado.myportfolio.com/dibujos-3600>. Accessed 31 July 2022
2. Arno Hartmann · Grafik · Architektur · Lehre. <https://arnohartmann.de/panos.html>. Accessed 31 July 2022
3. TessaScape. <http://tessascape.com/>. Accessed 31 July 2022
4. Araújo, A.B.: Ruler, compass, and nail: constructing a total spherical perspective. *J. Math. Arts* **12**, 144–169 (2018). <https://doi.org/10.1080/17513472.2018.1469378>
5. Araújo, A.B.: Drawing equirectangular VR panoramas with ruler, compass, and protractor. *J. Sci. Technol. Arts* **10**, 2–15 (2018). <https://doi.org/10.7559/citarj.v10i1.471>

6. Araújo, A.B., Olivero, L.F., Rossi, A.: A descriptive geometry construction of VR panoramas in cubical spherical perspective. *Diségno* 35–46 (2020). <https://doi.org/10.26375/disegno.6.2020.06>
7. Olivero, L.F., Sucurado, B.: Analogical immersion: discovering spherical sketches between subjectivity and objectivity. *Estoa. Revista de la Facultad de Arquitectura y Urbanismo de la Universidad de Cuenca* 8, 80–109 (2019). <https://doi.org/10.18537/est.v008.n016.a04>
8. Araújo, A.B.: Eq a sketch 360, a serious toy for drawing equirectangular spherical perspectives. In: *Proceedings of the 9th International Conference on Digital and Interactive Arts*. pp. 1–8. ACM, Braga (2019). <https://doi.org/10.1145/3359852.3359893>
9. PanoPainter. <https://panopainter.com/>. Accessed 31 July 2022
10. Mr. Kim Van Do, Artist, b. 1954 New York, NY. <http://thekimdo.jimdofree.com/artwork/>. Accessed 31 July 2022
11. Termesphere Online Gallery. <https://termespheres.com/gallery/>
12. Araújo, A.B., Olivero, L.F., Antinozzi, S.: HIMmaterial: exploring new hybrid media for immersive drawing and collage. In: *Proceedings of the 9th International Conference on Digital and Interactive Arts*, pp. 1–4. ACM, Braga (2019). <https://doi.org/10.1145/3359852.3359950>
13. Olivero, L.F., Rossi, A., Barba, S.: A codification of the cubic projection to generate immersive models. *Diségno* 53–63 (2019). <https://doi.org/10.26375/disegno.4.2019.07>
14. Olivero, L.F.: *Hybrid Immersive Models from Cubical Perspective Drawings – Modelli Ibridi Immersivi da Disegni in Prospettiva Cubica* (2021)
15. Lechner, T.: *Brawl Mars First Thursday*. <https://www.flickr.com/photos/tomlechner/3084463611/>. Accessed 31 July 2022
16. Masiero Sgrinzatto, C.: *Venice original: a spherical illustration of an imaginary environment*. In: *10th International Conference on Digital and Interactive Arts*, pp. 1–4. Association for Computing Machinery, New York (2021). <https://doi.org/10.1145/3483529.3483754>
17. Olivero, L.F., Araújo, A.: I'm watching you/me: live drawing and VR visualization of spherical perspectives using touch designer. In: *10th International Conference on Digital and Interactive Arts*, pp. 1–4. ACM, Aveiro (2021). <https://doi.org/10.1145/3483529.3483778>
18. Teatro La Fenice. <https://www.teatrolafenice.it/>. Accessed 31 July 2022
19. Brusatin, M., Pavanello, G.: *Il Teatro La Fenice. I progetti, l'architettura, i decori*. Alberizzi, Venezia (1987)
20. Mancini, P., Muraro, M.T., Povoledo, E.: *I Teatri del Veneto, Venezia e il suo Territorio*. Corbo e Fiore Editori, Venezia (1996)
21. Barbati, V., Cecchi, R.: *I progetti per la ricostruzione del Teatro La Fenice*. Marsilio Editori, Venezia (1997)
22. Teatro La Fenice. *Archivio Storico: Meduna*. <http://archiviostoricolafenice.org/ricerca.php?q=meduna&Tipo=documenti/>. Accessed 31 July 2022
23. Massimo Checchetto *Scenografia*. <https://www.operabase.com/artists/massimo-checchetto-24206/it>. Accessed 31 July 2022
24. *Comunicato Stampa, Teatro La Fenice*. <https://www.teatrolafenice.it/wp-content/uploads/2020/06/Luglio-riapertura-della-Fenice.pdf>. Accessed 31 July 2022
25. *Ottone in Villa*. <https://www.operabase.com/productions/ottone-in-villa-121677/it>. Accessed 31 July 2022
26. Romanelli, G.: *Gran Teatro La Fenice*. Biblos, Cittadella (1996)
27. Chiara Masiero Sgrinzatto. *Handmade illustrated 360° panoramas*. <https://www.chiaramasiero.sgrinzatto.com>. Accessed 31 July 2022
28. Factum Arte. *Panoramic Composite Photography*. <https://www.factum-arte.com/pag/1343/panoramic-composite-photography>. Accessed 31 July 2022
29. Luca Vascon. *VR Photography*. <https://www.lucavascon.net>
30. PTGui *Stitching Software*. https://ptgui.com/support.html#6_5. Accessed 31 July 2022

31. KRPano. Gigapixel/Multiresolution. <https://krpano.com/examples/?multires>. Accessed 31 July 2022
32. 2000EYES the Making of. <https://youtu.be/bVRC AO2d9Js>. Accessed 31 July 2022
33. Veduta sferica del Teatro La Fenice di Venezia, settembre 2020. <https://www.chiaramasierosgrinzatto.com/2000eyes/>. Accessed 31 July 2022
34. Teatro La Fenice Archivio Storico: Giovanni Pividor. <http://archivistoricolafenice.org/ricerca.php?q=Giovanni%20pividor&Tipo=>. Accessed 31 July 2022
35. 360craft. <https://360craft.pythonanywhere.com/en/>. Accessed 31 July 2022