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Adaptation of Museum Exhibits for Blind and Visually Impaired Visitors

ABSTRACT

Museum collections remain predominantly visual, which restricts access to cultural heritage for blind and visually impaired (BVI) visitors when original objects cannot be touched or visual information cannot be perceived directly. This practice-based study investigates how archival photographic material can be translated into tactile museum objects through digital reconstruction, three-dimensional (3D) modelling, additive manufacturing and multimodal interpretation. Two cases from the National Liberation Museum Maribor were examined: an architectural fragment of the Maribor court prison complex with an adjoining courtyard well, and an identification badge associated with Dachau. Because the available source material consisted of photographs rather than measured drawings or scans, the reconstructions required interpretation of relative proportions, repetition, graphic structure and tactile salience. The architectural model therefore preserves relational rather than absolute scale, while the well was enlarged and produced separately because its perspective did not permit reliable spatial placement. The badge was enlarged, its typography was redrawn in Glyphs, visual distinctions were translated into differentiated relief, and the prominent letter J was produced as a removable element. Models were prepared in Blender and OrcaSlicer and manufactured by fused deposition modelling (FDM) 3D printing using polylactic acid (PLA). 3D animations and audio descriptions were linked to the tactile objects through quick responsive (QR) codes. The results demonstrate a technically feasible workflow that can be implemented in a museum setting to transform incomplete two-dimensional (2D) records into tactile interpretations while making uncertainty explicit. As systematic testing with BVI participants was not completed before exhibition deployment, the findings concern design feasibility, manufacturability and interpretive potential rather than measured accessibility performance.

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3D modelling, 3D printing, tactile reproduction, museum accessibility, inclusive design, cultural heritage

1. Introduction

Museums increasingly seek to operate as visitor-centred and inclusive cultural environments, yet the interpretation of collections still depends heavily on vision. Objects are commonly protected behind showcases, architectural information is communicated through photographs and drawings, and labels frequently assume visual access. For BVI visitors, this can turn the conservation principle of “do not touch” into a barrier to understanding form, scale and spatial relationships. Museum studies have therefore argued for multisensory interpretation in which touch contributes directly to meaning-making rather than serving only as an auxiliary channel (Pye, 2007; Levent & Pascual-Leone, 2014). Studies involving blind and partially sighted museum users likewise show that access to 3D printed objects can support a more active and positive museum experience when tactile exploration is treated as a legitimate form of engagement (Karaduman, Alan & Yiğit, 2023; Bruns et al., 2023). Digital fabrication has expanded the practical possibilities for such access. Tactile maps, architectural models and replicas can be

produced by additive manufacturing, modified digitally and reproduced without subjecting fragile originals to repeated handling or transport (Urbas, Pivar & Stankovič Elesini, 2016; Montusiewicz, Barszcz & Korga, 2022; Kantaros, Soulis & Alysandratou, 2023). Recent work also emphasises the value of combining tangible models with audio or other digital information, particularly where the physical object alone cannot communicate context or complex spatial relations (Rossetti et al., 2018; Reinhardt et al., 2024; Avni et al., 2025). In this sense, a 3D printed reproduction is not only a copy: it can become an interpretative interface between the protected museum object, the exhibition narrative and the visitor.

Designing a tactile representation requires more than geometric fidelity. Tactile exploration is sequential and local, and recognition depends on clear boundaries, sufficient feature separation, manageable information density and stable elements that can withstand repeated handling (Millar, 1994; Wu et al., 2022). Features that are visually subtle may need to be enlarged or raised, while dense visual detail may need to be simplified. Research on tactile graphics and 3D printed cultural heritage models therefore stresses selective translation rather than indiscriminate reproduction (Wu et al., 2022; Montusiewicz, Barszcz & Korga, 2022). User-centred studies further show that material, scale, interaction method and the structure of audio information all influence the usefulness of tactile museum systems (Bruns et al., 2023; Avni et al., 2025).

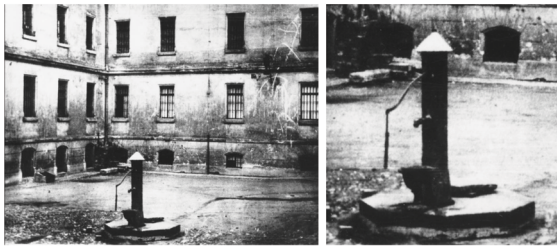
Many documented heritage workflows begin with a physical artefact that can be scanned, photographed from multiple viewpoints or otherwise captured as 3D data (Bruns et al., 2023; Kantaros, Soulis & Alysandratou, 2023; Reinhardt et al., 2024). The present study addresses a different and less straightforward condition: the source objects and architectural context had to be interpreted from archival photographs alone. A single photograph provides evidence of contour, repetition and relative position, but it does not justify hidden geometry, absolute dimensions or perspective-corrected placement. The research was therefore framed as a design-led translation from 2D documentary evidence into a 3D tactile representation, with an explicit distinction between what was visible in the source and what had to be inferred during modelling.

Three questions guided the work: which relationships should be preserved when historical scale cannot be established; how architectural rhythm, typography and colour-based distinctions can be translated into a clear tactile hierarchy; and how tactile objects can be complemented by digital information without making access dependent on vision. The resulting workflow combines 3D modelling, custom typographic reconstruction, FDM 3D printing, mechanical and colour finishing, and QR-linked animation with audio description. The study reports the design, fabrication and exhibition deployment of the resulting objects. It does not treat successful fabrication as equivalent to proven accessibility, because contemporary research consistently identifies the involvement of BVI users and structured evaluation as essential to reliable inclusive design (Avni et al., 2025; Avni, Danial-Saad & Kuflik, 2026).

2. Materials and methods

2.1. Source material and interpretive design strategy

The experimental work was carried out in cooperation with the National Liberation Museum Maribor and began with two archival photographs. The first was a black-and-white image of a courtyard bounded by two adjoining façades, later identified as part of the Maribor court prison complex, with a well visible in the foreground. The second photograph showed an identification badge associated with Dachau, bearing the inscription “Dachau”, the number “136919”, and a large calligraphic letter “J”. Figure 1 shows the architectural source and the well detail. The photographs were treated as documentary references rather than metric drawings. No architectural plans, dimensional data, calibrated scale reference or lens information were available; consequently, no defensible historical scale could be assigned to the reconstructed architecture. All dimensions reported below refer to the designed tactile objects.



» **Figure 1:** *Archival source material used for the architectural interpretation: the Maribor court-prison courtyard (left) and a detail of the courtyard well (right) (Source: National Liberation Museum Maribor)*

The design strategy therefore prioritised relational fidelity over unsupported metric precision. The façade was interpreted through recurring modules: the sequence of openings, storey organisation, window proportions and the distinction between upper rectangular openings and lower arched openings were preserved as a coherent rhythm. Repetition was used deliberately because a regular sequence can be followed progressively by touch and communicates the modular structure of the façade. At the same time, tactile salience was introduced through controlled recesses, projecting sills and simplified bars.

This approach is consistent with tactile-design research, which shows that recognisable structure depends on the selection and organisation of salient features rather than on reproducing every visual detail (Urbas, Pivar & Stankovič Elesini, 2016; Wu et al., 2022). When the photographic evidence did not support a reliable spatial conclusion, uncertainty was retained rather than concealed by speculative geometry. The main constraints of the source material and the corresponding tactile translation strategies are summarised in Table 1.

Table 1
Design logic applied to the tactile reproductions

Object	Constraint in the source material	Tactile translation	Production outcome
Architectural fragment	Single oblique black-and-white photograph; no plans, metric data or defensible absolute scale	Relative proportions; repeated window modules; differentiated recess depths; simplified bars and projecting sills	Large FDM model requiring supports; principal structure stable, but the finest bars proved mechanically vulnerable
Courtyard well	Perspective prevented reliable placement and scale within the courtyard	Detached from the architectural fragment, enlarged and presented as an independent tactile object	Independently manipulable model; supports required for the main print; improved stability and tactile access
Dachau identification badge	Small graphic artefact in which typography, geometric segmentation and colour carry most of the visual information	Enlargement; custom vectorised lettering; raised typography; differentiated relief; removable letter "J"; polychrome finish	Three support-free FDM components; sanding and painting improved surface finish and visual contrast

2.2. Reconstruction of the architectural fragment and courtyard well

The architectural fragment was modelled in Blender from basic polygonal geometry. Two adjoining walls and a floor plane formed the main structure. Rather than deriving a nominal scale from the image, repeated openings were constructed as modules and adjusted until their proportions matched the visible façade. In the final tactile model, the window openings measure approximately 19 × 40 mm and are recessed by 4 mm. Window sills project by approximately 1.5 mm, while the lower arched openings are recessed by approximately 8 mm so that the two opening types create clearly different tactile levels. A slightly raised pavement of approximately 1.6 mm introduces another perceptible transition across the courtyard plane. The bars were simplified into repeated vertical and horizontal members, balancing the visual rhythm of the reference with the mechanical limits of FDM printing.

The courtyard well required a different interpretative strategy. Its apparent dimensions and location are strongly affected by perspective because it is positioned much closer to the camera than the surrounding architecture. Embedding it in the courtyard at an assumed position and scale would therefore have turned photographic ambiguity into seemingly factual spatial information. Instead, the well was enlarged and reconstructed as an independent tactile object. This decision both avoided false precision and increased the opportunity for active manual exploration. The main cylindrical element is approximately 20 mm in diameter and 104 mm high, with a conical cap approximately 32 mm in diameter and 17.5 mm high. The object stands on an octagonal base of approximately 164 × 164 × 12 mm. Curved details, including the handle and spout, were constructed with Bézier curves, rotational modifiers and limited sculpting, while local geometry was simplified to avoid sharp, fragile or confusing transitions.

2.3. Enlarged tactile reconstruction of the Dachau identification badge

The badge presented a different translation problem because its identity is carried primarily by small-scale typography, geometric segmentation and colour. The tactile reproduction was therefore enlarged to an overall width of approximately 196 mm. The upper section was modelled as a shallow rectangular prism and the lower section as a triangular prism. The visual separation between the two fields was supported by differences in relief so that the basic structure could be understood through touch without relying solely on colour.

Typography was reconstructed separately because no existing typeface reproduced the irregular letterforms visible in the source photograph. The image was imported into Glyphs, where the word "Dachau", the number "136919", and the letter "J" were manually redrawn as vector outlines. The resulting OpenType font was imported into Blender and converted into 3D geometry. The inscription was raised by approximately 3.5 mm above the supporting surface, making the typographic information a spatial component of the object rather than

a purely printed graphic layer. The large letter "J" was designed as a removable insert. A recess approximately 5 mm deep was formed in the triangular component, while the separate letter was extruded to approximately 7 mm. It can therefore be removed, rotated, explored independently and returned to the corresponding recess. The original visual identity – dominated by white, red and black – was retained in the final polychrome treatment, but colour was not used as the only information carrier. Structural and graphic distinctions were also translated into level, shape, and raised typography. More general tactile colour vocabularies can use textures or raised pictograms (Cho et al., 2021); here, an object-specific solution was preferred because the goal was to preserve the internal organisation of a single historical artefact.

2.4. 3D printing and post-processing

Completed models were exported as STL files and checked in OrcaSlicer for manifold geometry, open edges, duplicated surfaces and required support structures. Errors that could not be resolved automatically were corrected in Blender. The architectural model and badge components were printed on a Creality K1 Max, while the well was printed on an Original Prusa i3 MK3S. Both printers used material-extrusion/FDM technology, a 0.4 mm nozzle and white PLA filament. Orientation was chosen to reduce supports where possible and to protect the main tactile surfaces. Support structures were required for the architectural fragment and the well, whereas the badge components could be printed without them.

Post-processing was treated as part of tactile design rather than as a purely cosmetic stage. Supports were removed manually, with particular care around projecting sills, bars and curved details. The badge was sanded with P100 and then P400 abrasive paper to reduce pronounced layer lines and local surface irregularities. The inscription and removable letter "J" were painted black and the triangular field red with acrylic paint, while the remaining field was left white. Mechanical smoothing and coating are established post-processing strategies for polymer prints, but they must be controlled so that the intended relief is not rounded off or lost (Dizon et al., 2021).

2.5. 3D animation, audio description and QR-linked interpretation

The same Blender models were reused for short 3D animations. Each object was placed in a virtual scene and animated with keyframes. The architectural fragment was rotated by about 45° because its most informative relationships are on the interior façades; the well was rotated through a full revolution, and the badge through about three revolutions. Studio-style lighting and material shading were used without additional textures, so the form and surface remained visually clear. Spoken descriptions were recorded in concise, easy-to-follow language, focusing on the objects' form, spatial relationships and key identifying features. The animations were edited in the free edition of DaVinci Resolve, together with the source photographs, narration and closing credits.

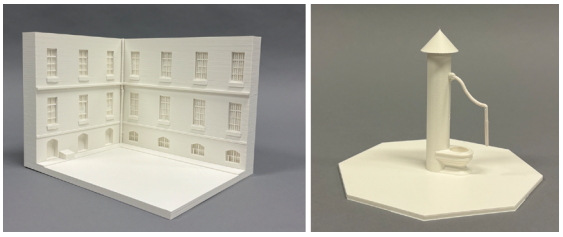
Two videos were produced: one combined the architectural fragment and the well, while the other presented the badge. The videos were hosted online as unlisted content and linked to QR codes positioned with the physical exhibits. The resulting layer did not replace the tactile object; it supplemented it with spoken explanation and moving visualisation. This multimodal logic is consistent with recent museum-accessibility research, which shows that tangible models can be strengthened by structured audio and complementary digital information, provided that interaction remains understandable and under the user's control (Cavazos Quero, Iranzo Bartolomé & Cho, 2021; Rossetti et al., 2018; Reinhardt et al., 2024; Avni et al., 2025).

3. Results

3.1. Architectural tactile reconstruction

The architectural workflow produced a tactile fragment of the Maribor court prison complex and a separate well. The architectural fragment required approximately 30 h 8 min of printing. Large planes and repeated window modules were reproduced consistently, and the differing recess depths created a clear geometric hierarchy between upper windows, lower openings and the courtyard plane. The main manufacturing weakness occurred in the finest bars: several members were vulnerable during support removal and could deform or break. The result indicates that literal miniature detail is not always compatible with the mechanical requirements of a tactile exhibit intended for repeated handling.

The well printed successfully as an independent element. The main print required approximately 3 h 33 min, while the handle and spout were produced separately. Detaching the well from the courtyard resolved two design problems at once: it prevented an uncertain perspective-derived position from becoming fixed in the architectural representation, and it allowed the object to be enlarged enough for independent exploration. The final architectural reproductions are shown in Figure 2. Their dimensions should therefore be read as interpretive design dimensions, not as measurements or scale-model data for the historical architecture.



» **Figure 2:** *Final FDM-printed tactile interpretations: an architectural fragment of the Maribor court prison complex (left) and an enlarged courtyard well (right)*

3.2. Tactile and typographic reconstruction of the badge

The enlarged badge was produced as three physical components: an upper rectangular part, a lower triangular part, and the removable letter "J". The components could be printed without support structures, which protected the raised lettering and reduced the risk of damaging the principal tactile surface during finishing. After sanding, the inscription remained clearly separated from the base, while the letter could be lifted, turned, and compared with its matching recess. The custom vectorisation retained the distinctive proportions and irregularities of the photographed lettering instead of replacing it with a generic typeface.

Polychrome finishing reintroduced the white, red, and black visual relationships of the source and increased contrast for visitors with residual vision. At the same time, geometry and relief allowed the main segmentation to be explored without colour. A design inconsistency became evident in the finished object: the lower triangular component contains two base relief heights where a single level would provide a clearer tactile field. A revised version should therefore regularise this surface before adding the raised auxiliary stroke and removable "J". Figure 3 shows the reconstructed lettering and the final polychrome tactile badge.



» **Figure 3:** *Development of the tactile identification badge: custom vectorised lettering reconstructed from the archival photograph (left), and final enlarged, polychrome 3D-printed object with removable letter "J" (right)*

3.3. Exhibition deployment and multimodal content

The physical models were installed in the exhibition environment and presented as handling objects alongside protected museum material, including within the exhibition *Z uporom iz teme*. The animations and audio descriptions were made available through QR codes at the display. During development, the initially selected QR service proved unreliable, as the generated link later ceased to function; the codes were therefore recreated using a service that ensured direct access to the hosted videos. This practical issue showed that the durability of an accessible exhibit depends not only on the physical model but also on the persistence and maintenance of its digital layer.

Figure 4 shows the architectural model and badge in the exhibition setting. Their installation confirms that the objects can be manufactured, handled and deployed in a real museum context. It should not, however, be interpreted as a formal usability result. Systematic testing with BVI participants was not completed before the exhibition timetable; consequently, tactile legibility, comprehension, preferred exploration sequence and the value of the removable component were not measured with the intended user group.



» **Figure 4:** *Tactile reconstructions in the exhibition environment: architectural fragment and well (left), and enlarged identification badge displayed alongside protected museum objects (right)*

4. Discussion

The combined cases show that converting a historical photograph into a tactile museum object is better described as interpretive translation than as geometric reconstruction. This distinction is crucial when source data are sparse. A single photograph can support statements about visible contour, repetition, relative position and graphic structure, but it cannot justify hidden geometry, absolute dimensions or a perspective-corrected 3D layout. In the architectural model, relational fidelity was therefore prioritised: façade rhythm, storey organisation, recess hierarchy and the relationship between adjoining walls were preserved, while historical scale was deliberately left undefined. This is consistent with

research showing that tactile recognition depends on the careful selection and organisation of salient features rather than on an unfiltered transfer of visual detail (Wu et al., 2022; Montusiewicz, Barszcz & Korga, 2022).

The separate well is a particularly clear example of a design approach that explicitly acknowledges uncertainty. Because the photograph did not permit reliable placement of the well within the courtyard, an apparently complete reconstruction would have required an arbitrary spatial decision. Presenting the well as an enlarged associated object made that uncertainty visible in the design logic instead of hiding it.

At the same time, the decision improved stability and tactile readability. In heritage interpretation, such explicit treatment of uncertainty is preferable to false precision, especially when a tactile user cannot independently inspect or geometrically interpret the source photograph.

The badge required an inverse strategy: rather than reducing a large spatial environment, the design enlarged a small graphic artefact whose meaning is concentrated in typography, geometry and colour. Enlargement alone, however, would not have made the graphic hierarchy tactile. The custom Glyphs workflow retained the characteristic inscription, while raised lettering, differences in base level and the removable "J" converted visual organisation into spatial organisation. Colour was retained as an additional visual layer for partially sighted and sighted visitors but was not allowed to carry meaning independently.

Research on tactile colour coding similarly shows that information conventionally conveyed by colour can be translated into raised patterns and other tactile distinctions (Cho et al., 2021).

The removable "J" adds a simple form of tangible interaction. Typography is no longer just a relief to be traced on a surface; the character becomes an object that can be removed, explored and reinserted. This principle relates to broader work on smart and multimodal museum exhibits, where tactile replicas are combined with user-controlled channels for additional information (Pistofidis et al., 2021; Pistofidis et al., 2023; Avni et al., 2025). The present solution is intentionally kept low-tech and easily replaceable. Its advantages are simplicity and direct manipulation; its limitations are the risk of losing the separate component and the current lack of evidence that removal improves recognition for blind users.

The physical-digital relationship is equally important. Audio can explain spatial relationships that may be difficult to infer from an unfamiliar object without guidance, while animation can support partially sighted and sighted visitors and provide a shared interpretive layer around the same model. Previous studies of cultural-heritage models have shown the value of pairing tactile objects with structured audio and multimodal information (Rossetti et al., 2018; Reinhardt et al., 2024). In the present project, QR-linked content provided a low-cost, updateable solution, but it also introduced a dependency on a compatible smartphone, an accessible scanning workflow and stable online hosting. User studies of interactive tangible museum interfaces show that autonomy, discoverability and control over audio playback are significant design considerations (Avni et al., 2025). Future versions should therefore consider a directly discoverable tactile trigger in addition to the QR link.

Digital models also have value beyond the immediate exhibition. Once an interpretation has been developed, replicas can be produced for handling sessions, travelling exhibitions or partner institutions without repeatedly transporting or exposing fragile originals. Cultural heritage research has identified this capacity for reproducibility as beneficial for both access and conservation (Montusiewicz, Barszcz & Korga, 2022; Kantaros, Soulis & Alysandratou, 2023; Reinhardt et al., 2024). Nevertheless, reproducibility increases the responsibility to identify the output accurately. Where the source record does not support metric reconstruction, the object should be described as a tactile interpretation or a reconstruction from photographic evidence rather than as an exact replica.

The fabrication process revealed a related technical lesson: tactile design and manufacturing design cannot be separated. FDM is well suited to relatively large and robust forms, but fine bars, overhangs, support scars and layer lines can undermine both mechanical durability and perceptual clarity. The damaged window bars demonstrate that critical details should be adapted to the printing process before fabrication, for example by reducing their number and increasing their section. Post-processing can improve comfort and surface quality, yet excessive sanding can soften the intended relief (Dizon et al., 2021). Trial prints of representative details, alternative orientations and systematic comparison of layer height, infill, nozzle diameter and filament would therefore strengthen a subsequent iteration.

The main limitation of the present work is the lack of systematic evaluation with BVI participants. The objects were designed according to established tactile principles, successfully manufactured and installed in an exhibition, but these achievements do not show how efficiently intended users identify the forms, understand the spatial relationships or interpret the removable component. Studies in which blind users directly evaluate 3D printed cultural assets show that user preference can depend on material, print process, scale and interaction design (Karaduman, Alan & Yiğit, 2023; Bruns et al., 2023; Avni et al., 2025). A recent systematic review similarly identifies structured stakeholder involvement and rigorous, mixed-method evaluation as

central requirements for advancing museum accessibility (Avni, Danial-Saad & Kuflik, 2026). Future work should therefore involve BVI participants in co-design and iterative testing, record tactile exploration strategies and comprehension, and compare alternative relief heights, feature spacing, textures, scales and audio structures.

5. Conclusions

This study presents a reproducible workflow for translating sparse 2D museum records into physical tactile interpretations through 3D modelling, typographic reconstruction, FDM 3D printing, post-processing and multimodal digital content. Its main contribution lies not in a particular software package or printer, but in the design decisions required when the source itself is incomplete: preserving documented relationships rather than inventing absolute scale, using repetition and relief to establish tactile hierarchy, enlarging features when their original size would prevent meaningful exploration, and separating elements when photographic perspective makes their original spatial position uncertain.

The two case studies required complementary translation strategies. In the architectural fragment, repeated window modules and differentiated recesses communicated façade rhythm, while the well was detached and enlarged to avoid implying unsupported spatial precision. In the badge, graphic organisation was translated into spatial organisation through enlargement, custom raised typography, differentiated base levels and a removable typographic component, with colour retained as an additional visual layer. These choices align with the wider literature showing that successful tactile representations depend on selective simplification, perceptually clear feature separation and iterative refinement, rather than on visual fidelity alone (Wu et al., 2022; Montusiewicz, Barszcz & Korga, 2022).

The project also demonstrates the practical museum value of digital replicas. Tactile reproductions can expand opportunities for handling and multisensory interpretation while reducing direct contact with protected originals, and they also allow the same digital model to be reproduced in other institutional contexts (Kantaros, Soulis & Alysandratou, 2023; Reinhardt et al., 2024). At the same time, technical success must not be equated with proven accessibility. The next research stage should systematically involve BVI users in testing and redesign, in line with current evidence emphasising user participation, autonomy and contextual evaluation (Avni et al., 2025; Avni, Danial-Saad & Kuflik, 2026). Such work is necessary if tactile reconstructions are to function not only as technically successful objects but as genuinely understandable and inclusive museum interfaces.

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7. References

Avni, Y., Danial-Saad, A., Sheidin, J. and Kuflik, T. (2025) 'Enhancing museum accessibility for blind and low vision visitors through interactive multimodal tangible interfaces', *International Journal of Human-Computer Studies*, 198, 103469. DOI: 10.1016/j.ijhcs.2025.103469

Avni, Y., Danial-Saad, A. and Kuflik, T. (2026) 'Design for inclusion: a systematic review of technologies and frameworks for enhancing the museum experience of blind and low-vision visitors', *International Journal of Human-Computer Interaction*, 42(20), pp. 16861–16891. DOI: 10.1080/10447318.2026.2623227

Bruns, A., Spiesberger, A.A., Triantafyllopoulos, A., Müller, P. and Schuller, B.W. (2023) ''Do touch!' – 3D scanning and printing technologies for the haptic representation of cultural assets: a study with blind target users'. In: *Proceedings of the 5th Workshop on analySis, Understanding and proMotion of heritAge Contents, SUMAC '23, 2 November 2023, Ottawa, Canada*. New York: Association for Computing Machinery, pp. 21–28. DOI: 10.1145/3607542.3617351

Cavazos Quero, L., Iranzo Bartolomé, J. and Cho, J. (2021) 'Accessible visual artworks for blind and visually impaired people: comparing a multimodal approach with tactile graphics', *Electronics*, 10(3), 297. DOI: 10.3390/electronics10030297

Cho, J.D., Cavazos Quero, L., Iranzo Bartolomé, J., Lee, D.W., Oh, U. and Lee, I. (2021) 'Tactile colour pictogram to improve artwork appreciation of people with visual impairments', *Color Research & Application*, 46(1), pp. 103–116. DOI: 10.1002/col.22567

Dizon, J.R.C., Gache, C.C.L., Cascolan, H.M.S., Cancino, L.T. and Advincula, R.C. (2021) 'Post-processing of 3D-printed polymers', *Technologies*, 9(3), 61. DOI: 10.3390/technologies9030061

Kantaros, A., Soulis, E. and Alysandratou, E. (2023) 'Digitization of ancient artefacts and fabrication of sustainable 3D-printed replicas for intended use by visitors with disabilities: the case of Piraeus Archaeological Museum', *Sustainability*, 15(17), 12689. DOI: 10.3390/su151712689

Karaduman, H., Alan, Ü. and Yiğit, E.Ö. (2023) 'Beyond ''do not touch'': the experience of a three-dimensional printed artifacts museum as an alternative to traditional museums for visitors who are blind and partially sighted', *Universal Access in the Information Society*, 22(3), pp. 811–824. DOI: 10.1007/s10209-022-00880-0

Levent, N. and Pascual-Leone, A. (eds.) (2014) *The Multisensory Museum: Cross-Disciplinary Perspectives on Touch, Sound, Smell, Memory, and Space*. Lanham: Rowman & Littlefield.

Millar, S. (1994) *Understanding and Representing Space: Theory and Evidence from Studies with Blind and Sighted Children*. Oxford: Clarendon Press.

Montusiewicz, J., Barszcz, M. and Korga, S. (2022) 'Preparation of 3D models of cultural heritage objects to be recognised by touch by the blind – case studies', *Applied Sciences*, 12(23), 11910. DOI: 10.3390/app122311910

Pistofidis, P., Ioannakis, G., Arnaoutoglou, F., Michailidou, N., Karta, M., Kiourt, C., Pavlidis, G., Mouroutsos, S.G., Tsiafaki, D. and Koutsoudis, A. (2021) 'Composing smart museum exhibit specifications for the visually impaired', *Journal of Cultural Heritage*, 52, pp. 1–10. DOI: 10.1016/j.culher.2021.08.013

Pistofidis, P., Arnaoutoglou, F., Ioannakis, G., Michailidou, N., Karta, M., Kiourt, C., Pavlidis, G., Mouroutsos, S.G., Tsiafaki, D. and Koutsoudis, A. (2023) 'Design and evaluation of smart-exhibit systems that enrich cultural heritage experiences for the visually impaired', *Journal of Cultural Heritage*, 60, pp. 1–11. DOI: 10.1016/j.culher.2023.01.004

Pye, E. (ed.) (2007) *The Power of Touch: Handling Objects in Museum and Heritage Contexts*. Walnut Creek: Left Coast Press.

Reinhardt, D., Holloway, L., Thogersen, J., Guerry, E., Corvalan Diaz, C.A., Havellas, W. and Poronnik, P. (2024) 'The Museum of Touch: tangible models for blind and low vision audiences in museums'. In: Lee, J.H., Ostwald, M.J. and Kim, M.J. (eds.) *Multimodality in Architecture: Collaboration, Technology and Education*. Cham: Springer, pp. 135–155. DOI: 10.1007/978-3-031-49511-3_8

Rossetti, V., Furfari, F., Leporini, B., Pelagatti, S. and Quarta, A. (2018) 'Enabling access to cultural heritage for the visually impaired: an interactive 3D model of a cultural site', *Procedia Computer Science*, 130, pp. 383–391. DOI: 10.1016/j.procs.2018.04.057

Urbas, R., Pivar, M. and Stankovič Elesini, U. (2016) 'Development of tactile floor plan for the blind and the visually impaired by 3D printing technique', *Journal of Graphic Engineering and Design*, 7(1), pp. 19–26. DOI: 10.24867/JGED-2016-1-019

Wu, C.-F., Wu, H.-P., Tu, Y.-H., Yeh, I.-T. and Chang, C.-T. (2022) 'A study on the design procedure of three-dimensional printable tactile graphics for individuals with visual impairments', *Journal of Visual Impairment & Blindness*, 116(4), pp. 507–516. DOI: 10.1177/0145482X221122754

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