Journal of Computer Engineering, Electronics and Information Technology (COELITE)

Journal homepage: https://ejournal.upi.edu/index.php/COELITE

3D Large-Screen Immersive Video Mapping Installations & Interactive Light Game for Conference Seminars

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ABSTRACT

Technological improvements, especially in immersive technologies such as spatial augmented reality (SAR), commonly known as video mapping, have generated opportunities in the arts and performance industry, for example for exhibitions. This study examines the incorporation of interactive video mapping into conference seminars, emphasizing the design of large-screen 3D immersive installations and interactive light games in a college auditorium environment. The research employs a User-Centered Design (UCD) methodology, integrating user feedback during the design and prototyping phases to develop an engaging and immersive experience for conference participants. The project entails the development of two immersive themes: Forest and Underwater, utilizing 3D modeling and animation techniques. MediaPipe incorporates interactive features, enabling participants to participate in the exhibits via hand gestures, augmenting involvement and participation during conference panel sessions and breaks. The successful performance of these interactive zones and solutions for technical setup and optimization of high-quality, interactive 3D video mapping experiences in conference venues are examined.

ARTICLE INFO

Article History:
Submitted/Received 05 Aug 2024
First Revised 09 Sep 2024
Accepted 01 Oct 2024
First Available online 31 Oct 2024
Publication Date 31 Oct 2024

Keyword:
Video Mapping,
Conference Seminars,
Immersive,
Interactive,
Mediapipe.

1. INTRODUCTION

Technological advancements, particularly in immersive technology like spatial augmented reality (SAR), also referred to as video mapping, have created opportunities in the arts and performance sector. Viewers can directly experience reality through 2D or 3D animations, as well as light games and projected images on a surface, without the need for gadgets like head-mounted displays or mobile devices [1].

Video mapping can be projected onto flat surfaces like screens or walls, as well as irregular rooms or surfaces, including mock-ups, facades, buildings, or complicated 3D constructions [2]. PT. Daihatsu employs video mapping for the promotion of the All-New Sirion Car, projecting images, textures, themes, patterns, and animated films onto the car's facade [3]. Video mapping is utilized in cultural events, such as Wayang [4], and for tourism sites in Minahasa, projected onto a traditional building model [5]. A person's face can serve as a projection surface, like the technique employed by video editors when creating a music video for the band Kotak [6].

Video mapping is employed in formal settings within enclosed areas as an element of interior design for educational or recreational purposes [7]. Florencia et al. developed a video mapping project titled "Marine Life Experience," utilizing two projectors on a flat surface for the presentation. Furthermore, video project mapping is developed interactively using two scenarios: biota and atmosphere. The sea will react to the movements of visitors and alterations in things upon contact, although this study did not provide a technical explanation of the sensor utilization [8].

An interactive impression is often attainable when 3D animation projection can be modified in real-time in response to activities or events triggered by external variables, including sensors like cameras, mobile devices, or commands based on gestures, eye movements, or actions of visitors [9] [10]. Static movement in situ can be facilitated by motion detection software such as MediaPipe. MediaPipe has been applied in diverse domains including education [11] [12], health [13] [14], and performances or exhibitions [15] [16]. The visitor experience can be improved by technology, offering a more interactive and tailored performance guide.

Nevertheless, conventional conference environments frequently restrict audience participation and interaction. Static presentations restrict visual engagement, and passive learning settings might reduce retention and attendance pleasure [17] [18]. This project investigates the feasibility of incorporating interactive video mapping into conference seminars to overcome these limitations. This study specifically examines the design and implementation of immersive zones and interactive zones (light game) in a large-scene 3D video mapping installation within a college auditorium. The zones will enable participants to interact with the video mapping content during conference intermissions.

This research quantitatively examines the effectiveness of interactive zones within large-screen 3D video mapping installations for enhancing audience engagement and attention during conference seminars. The study will investigate the correlation between content creation techniques and user engagement, as well as analyze the technical setup and optimization strategies for delivering high-quality, interactive 3D video mapping experiences in conference venues.

2. METHODS

This study will adopt a User-Centered Design (UCD) methodology [19] [20]. The UCD process will be executed iteratively, involving cycles of prototype, user feedback, and refining. Drawing from [21], the application of the UCD is illustrated on **Figure 1**.

DOI: https://doi.org/10.17509/coelite.v3i2.73989
p- ISSN 2829-4157 e- ISSN 2829-4149

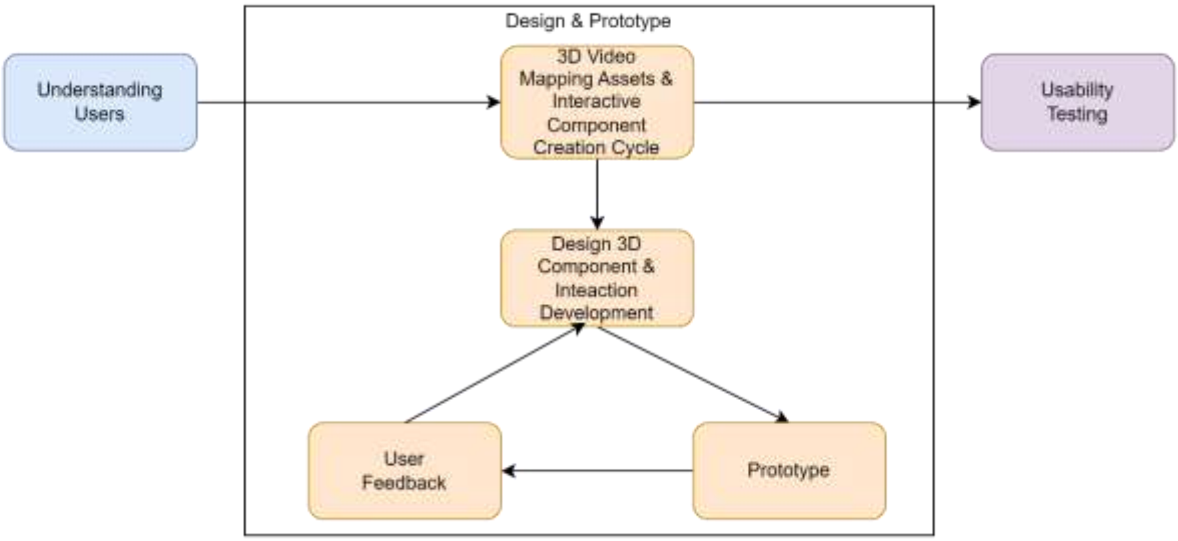

Figure 1. UCD for 3D Immersive Video Mapping and Interaction

2.1. Understanding Users

This study utilizes user research, comprising observations and interviews, to determine user needs and preferences for large-screen video mapping and interactive zones in conference seminars. This information will facilitate the development of user personas to direct design decisions and ensure the final product aligns with the requirements of the target audience.

2.2 Design & Prototyping

This Step includes the **Video Mapping & Interactive Component Creation Cycle,** the cycle consists of three steps loop namely Design of 3D Component and Interaction Development, Prototype, and User Feedback.

2.2.1 Design 3D Component & Interaction Development

- 3D Immersive Realistic Video Mapping Loop: Conduct user research to generate several animation scenarios for looping on a large 3D screen. There are two themes: Forest and Underwater.
    1. Forest Theme: Design visual content for the forest theme, considering elements such as tree species, vegetation, illumination, and ambiance.
    2. Underwater Theme: Design visual content for the underwater theme, encompassing the design of the shark, other marine organisms, coral reefs, and aquatic lighting effects.
    3. Design animations and transitions that are aesthetically pleasing for conference settings.
- 3D Immersive Interactivity for light game on normal-screen Video mapping with MediaPipe & Touch Designer
    1. Ideation: Conduct user research to generate several interaction ways via MediaPipe. Investigate diverse hand gestures for manipulating the 3D model's movements (e.g., direction, velocity) and evaluate the integration of these interactions with the comprehensive video mapping information.
    2. Low-Fidelity Prototype Development: Create a basic prototype to evaluate the fundamental concept of MediaPipe interaction with the 3D model, either utilizing a 2D representation or a simplified variant of the 3D model.

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3. Integration with Touch Designer: Transfer the 3D models from Blender to TouchDesigner. Incorporate MediaPipe for hand gesture recognition and develop interactive components that enable users to manipulate elements of the 3D environments (e.g., relocating the shark, initiating animations).

2.2.2 Prototyping

- 3D Assets Creation for Large-Screen Video Mapping:
  1. 3D Modeling (Blender 3D) to create realistic 3D models for Large-Screen Video Mapping and develop the visual content for the forest theme and underwater theme.
  2. Develop animations and transitions that are aesthetically pleasing for conference settings.
- Interactive Zone Development:
  1. 3D Modeling (Blender 3D): Use Blender 3D to create realistic 3D models for the interactive zones (e.g., the shark in the underwater theme). Consider realism, scale, and optimization for real-time rendering.
  2. Prototyping Interactive Zones: Develop prototypes of the interactive zones within Touch Designer, combining the 3D models and MediaPipe interactions. Experiment with different visual effects, animations, and feedback mechanisms to enhance user engagement.
- **Technical Setup for Large-Screen Video Mapping:**
  1. Projection Mapping: Plan the projection mapping setup, including projector placement, lens selection, and edge blending techniques to ensure a seamless and immersive visual experience across the two facades of the auditorium.
  2. Content Layout and Sequencing: Design the layout and sequencing of the video mapping content on the large screens, considering factors such as visual flow, storytelling, and integration with the conference schedule.
  3. Synchronization and Control: Establish a system for synchronizing the video mapping content across multiple projectors and controlling the playback and transitions.

2.2.3 User Feedback

- Iterative Feedback and Design Reviews: Present the prototype to stakeholders at various stages of development. Gather their feedback on the design, functionality, and overall user experience. Incorporate their input into iterative design revisions, ensuring alignment with their needs and expectations.

2.3 Usability Testing

- **Observation and Field Studies:** Conduct observations of users interacting with the prototype in a realistic setting, simulating a conference environment as much as possible. Carefully document user behaviors, interactions, and any challenges they encounter.

3. RESULTS AND DISCUSSION

3.1 User Research Findings

The initial phase focused on understanding the users, specifically conference attendees and organizers, to identify their requirements and preferences for extensive video mapping and interactive areas within a conference seminar context. The 15th Industrial Research Workshop and National Seminar (IRWNS), which took place at Politeknik Negeri Bandung (POLBAN) from July 24 to 25, 2024, served as the basis for this study.

DOI: https://doi.org/10.17509/coelite.v3i2.73989
p- ISSN 2829-4157 e- ISSN 2829-4149

Firstly, there was a pronounced desire for increased engagement and interaction during conferences. Organizers expressed that traditional conference formats often lacked stimulating elements to maintain their attention. They highlighted that interactive and immersive experiences could significantly enhance their engagement, particularly during panel sessions and intermissions. Secondly, Layout The auditorium as illustrated in **Figure 2**, has two prominent facades—left and right—which will serve as the canvas for the large-scene video mapping projections (**Figure 3**). The interactive zones will be strategically positioned on the back within the left facades to encourage interaction and engagement during conference breaks and presentations.

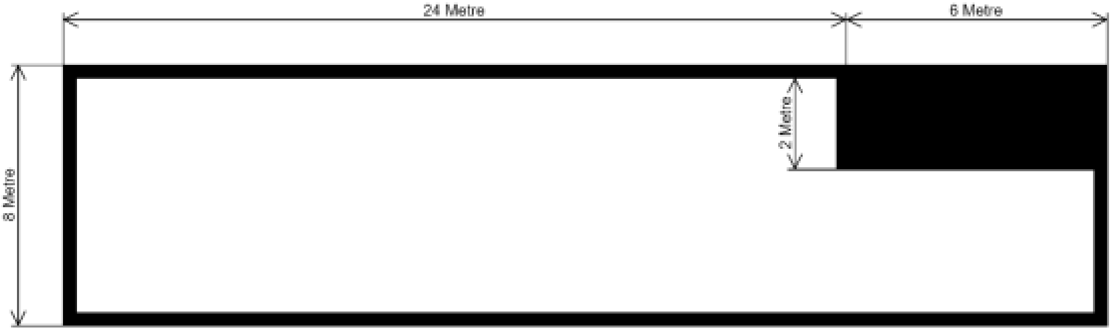

Figure 2. Auditorium Room Layout

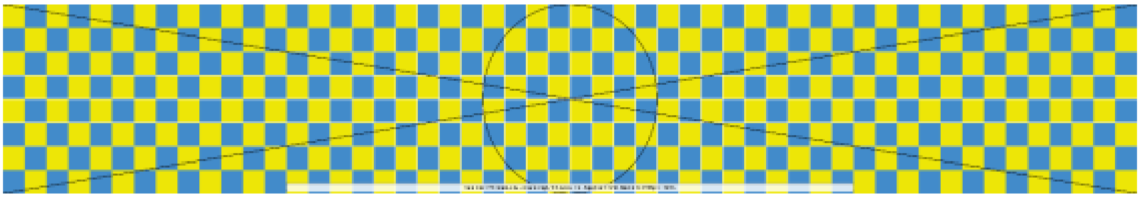

Figure 3. Left or Right Auditorium Video Mapping Target (24m width x 4 m height)

3.2 Design and Prototyping Outcomes

Based on the user research findings, the design and prototyping phase focused on developing two immersive themes: a **Forest Theme** and an **Underwater Theme**. This phase involved iterative cycles of creating immersive 3D environments and integrating interactive components using MediaPipe for gesture recognition.

3.2.1 Design 3D Component & Interaction Development

The key objectives in developing the immersive themes were realism and participation. The Forest Theme showcased immersive 3D representations of trees, flora, and fauna, establishing a verdant ecosystem. Dynamic lighting techniques replicated various times of day, transitioning from dawn to dusk, so enhancing the depth and diversity of the experience. Natural ambient sounds, including birdsong and the rustle of leaves, were integrated to augment immersion. The Underwater Theme showcased a dynamic marine ecosystem featuring lifelike representations of sea creatures such as sharks, fish, and coral reefs. Sophisticated lighting techniques replicated underwater caustics, establishing a genuine aquatic ambiance. Animations depicting sea life movements created a dynamic landscape that engaged users' attention.

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3.2.2 Prototyping

There are two phases of prototyping: the initial phase involves creating Full HD (1920x1080) 3D Forest Themes, followed by the development of Large-Screen (6656 x 1080) forest and underwater themes. **Figure 4**, **Figure 5**, and **Figure 6** present instances of developed Full HD 3D video mapping assets for Forest, featuring three primary quests: Hutan Bercerita I, Hutan Bercerita II, and Berjalan di Hutan.

Figure 4a. Hutan Bercerita I Scene A.

Gambar 4b. Hutan Bercerita I Scene B

Figure 5a. Hutan Bercerita II Scene A.

Gambar 5b. Hutan Bercerita II Scene B

Figure 6a. Berjalan di Hutan Scene A.

Gambar 6b. Berjalan di Hutan Scene B

The result of the second phase can be seen in **Figure 7**, **Figure 8, Figure 9, Figure 10**, **and Figure 11** Resulted Large-Screen 3D Assets for Forest and Underwater themes.

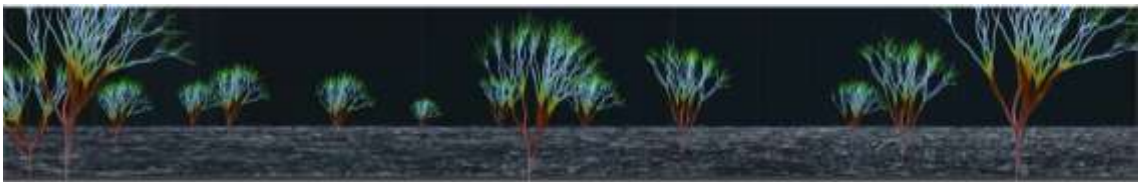

Figure 7. Large-Screen Fractal Forrest

DOI: https://doi.org/10.17509/coelite.v3i2.73989
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Figure 8. Large-Screen Forest I

Figure 9. Large-Screen Forest II

Figure 10. Large-Screen Underwater I

Figure 11. Large-Screen Underwater II

Interactive elements were crucial in converting passive visual presentations into immersive experiences. MediaPipe was employed to program unique hand motions for controlling objects within the scenes. In the Underwater Theme, users can manipulate the movement of a virtual shark through specific hand gestures. This intuitive control system enabled people to engage spontaneously without requiring additional guidance. The integration with Touch Designer facilitated real-time rendering and interactivity. The technology delivered prompt feedback to user inputs, so augmenting the sensation of action and immersion. Numerous iterations were performed to enhance the responsiveness and precision of interactions, guaranteeing a seamless user experience. **Figure 12**, **Figure 13, Figure 14, Figure 15, and Figure 16** are the process of creating interactive video mapping based on gesture recognition.

Figure 12. Interactive hand gesture video main projects

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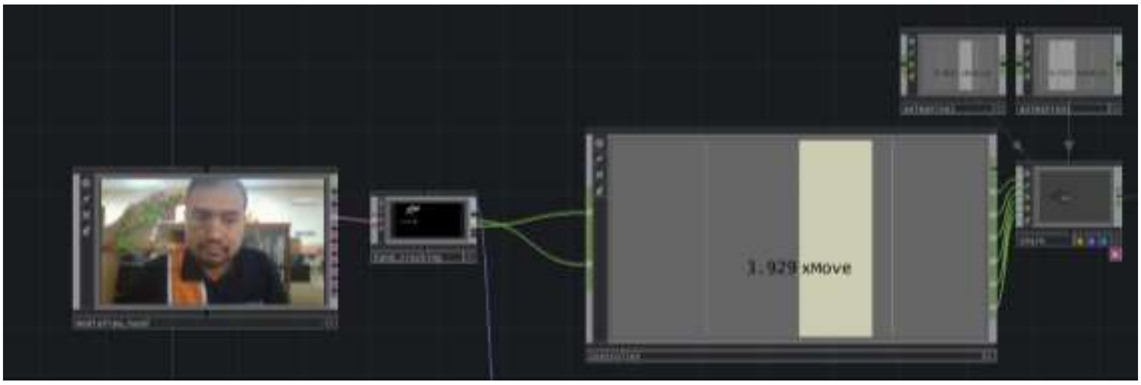

Figure 13. Medipipe integration with Touch Designer with media pipe-touch designer [22]

Figure 14. 3D Shark Render and Movement

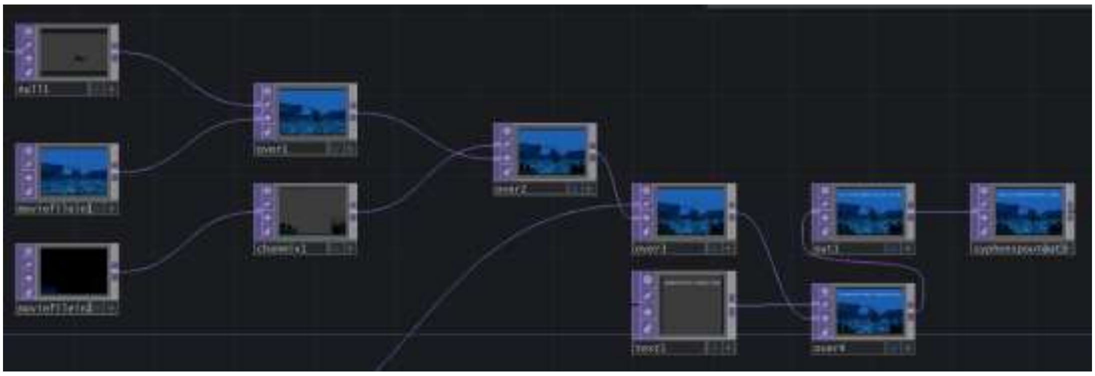
Figure 15. Underwater video background

DOI: https://doi.org/10.17509/coelite.v3i2.73989
p- ISSN 2829-4157 e- ISSN 2829-4149

Figure 16. Final Light Game Interactive Hand Gesture Video

3.2.3 Usability Testing

Executing large-screen projection mapping needed careful preparation. A triple-projector configuration was implemented for showing each side of the auditorium's facades, as depicted in **Figure 17**. The positioning of the projector was chosen to reduce shadows and distortions, while the lens selection guaranteed suitable throw lengths and image dimensions.

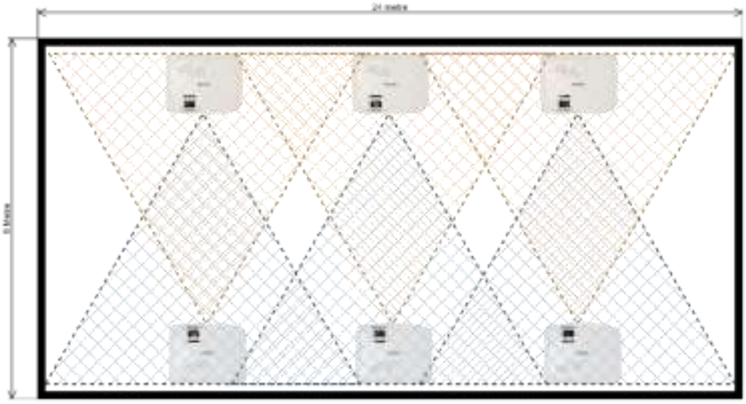

Figure 17a. Triple-projector setup placing

Gambar 17b. Light Game setup

Edge blending techniques were utilized to attain seamless transitions between projections. This entailed calibrating overlapping regions to harmonize brightness and hue, resulting in a cohesive image across both facades. Synchronization protocols were established to coordinate animations and interactions among the many projectors, maintaining uniformity in the user experience. **Figure 19** and **Figure 20** illustrate the application of video mapping for the opening day of the IRWNS sessions.

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p- ISSN 2829-4157 e- ISSN 2829-4149

Figure 19a. Left Forest Theme Facade **Gambar 19b.** Right Forest Theme Facade

Figure 20a. Planning Light Game Facade **Gambar 20b.** Light Game Facade

3.3 Discussion

The immersive themes and gesture-based interactivity provided a novel method for participants to connect with the event beyond conventional formats. Occasional misreading of gestures resulted in undesired actions within the interactive settings. The problem became more evident when numerous users engaged concurrently, resulting in the system misattributing gestures.

Integration of numerous projectors via edge blending and synchronization facilitated seamless real-time rendering for 3D assets, essential for preserving immersion throughout interactions. These technical solutions may serve as a benchmark for analogous future initiatives. The incorporation of interactive zones signifies a transition towards more engaging and participatory conference designs. Such installations can distinguish events, offering distinctive experiences that differentiate conferences in a competitive environment.

4. CONCLUSION

This study effectively incorporated interactive 3D video mapping installations into conference seminars, improving audience engagement and happiness through immersive Forest and Underwater themes with gesture-based interactions. The installations successfully converted inactive conference areas into vibrant settings, promoting greater engagement and maybe improving information retention and networking prospects. The technological viability of executing large-screen projection mapping in conference venues was validated, showcasing the practicality and efficacy of these new solutions.

Future research should concentrate on improving gesture recognition algorithms, investigating multimodal interaction techniques, and broadening thematic content to augment the significance and influence of interactive 3D video mapping installations in conference seminars. By maintaining a focus on user-centered design principles and resolving technical problems, such installations can revolutionize conference and event design within the realm of multimedia technology.

5. ACKNOWLEDGMENT

The Research Program is financed by DIPA funds from the Bandung State Polytechnic, as indicated in the contract document of Applied Research funding No. 235.4/PL1.R7/PG.00.03/2024. The authors would like to express their sincere gratitude to the conference committee of the 15th Industrial Research Workshop and National Seminar (IRWNS) for their invaluable support and for providing the opportunity to conduct this research within the context of their event. In addition, thanks to the talented students who dedicated their time and skills to developing the 3D assets and interactive light games that were essential to this research.

6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

7. REFERENCES

[1] L. T. De Paolis, S. Liaci, G. Sumerano, and V. De Luca, "A Video Mapping Performance as an Innovative Tool to Bring to Life and Narrate a Pictorial Cycle," *Inf.*, vol. 13, no. 3, pp. 1–11, 2022, doi: 10.3390/info13030122

[2] I. P. Sari, A. Juhana, and N. Nurhidayatulloh, "Global Trends in The Study of Projection Mapping Technology Using Bibliometric Analysis," *J. Print Media Technol. Res.*, vol. 12, no. 4, pp. 219–229, 2023, doi: 10.14622/JPMTR-2309

[3] R. Yulianto and Rudianto, "Pemanfaatan Video Mapping dalam Kegiatan Bisnis," *Bisnis Teknol. Politek. NSC Surabaya*, vol. 1, pp. 42–46, 2014.

[4] A. Pahrulroji and Z. S. Soeteja, "A Case Study on Behavior of Performing Art Appreciators in Public Space: Indonesian Puppet (Wayang) Performance Arts and Video Mapping," *J. Ind. Prod. Des. Res. Stud.*, vol. 1, no. 2, pp. 65–78, 2023, doi: 10.17509/jipdrs.v1i2.53657

[5] J. Heybert Rompas, S. RUA Sompie, S. D. E Paturusi, T. Elektro Universitas Sam Ratulangi Manado, and J. Kampus Bahu-Unsrat Manado, "Penerapan Video Mapping Multi Proyektor Untuk Mempromosikan Kabupaten Minahasa Selatan," *J. Tek. Inform.*, vol. 14, no. 04, p. 4, 2019.

[6] I. H. B. Wicaksana, "Application of Video Mapping Technique in Kotak Band Video Music," *Bus. Econ. Commun. Soc. Sci. J.*, vol. 4, no. 2, pp. 89–96, 2022, doi: 10.21512/becossjournal.v4i2.7963

[7] De Paolis, Lucio Tommaso, Silvia Liaci, Giada Sumerano, and Valerio De Luca. "A Video Mapping Performance as an Innovative Tool to Bring to Life and Narrate a Pictorial Cycle." Information 13, no. 3, 2022. doi: https://doi.org/10.3390/info13030122

[8] F. I. Wijaya, S. P. Ramadina, and A. Simarmata, "Video Mapping Application in Sea Life Experience Interior Design as Education and Recreation Facilities," *Lect. Notes Electr. Eng.*, vol. 1029 LNEE, pp. 779–789, 2023, doi: 10.1007/978-3-031-29078-7_68

[9] Young, Millie. "Drawn to 360°: How can the aesthetics and qualities of traditional 2D animation storytelling add to the immersive VR projection paradigm?." *Animation Practice*, Process & Production 7, no. 1, pp. 11-40, 2018.

[10] Hinterwaldner, Inge. *The systemic image: A new theory of interactive real-time simulations*. MIT Press, 2023.

[11] V. Kriznar, M. Leskovsek, and B. Batagelj, "Use of Computer Vision-Based Hand Tracking in Educational Environments," *2021 44th Int. Conv. Information, Commun. Electron. Technol. MIPRO 2021 - Proc.*, pp. 804–809, 2021, doi: 10.23919/MIPRO52101.2021.9596976

[12] K. Naganandhini, B. Sowmya, S. Pavish, J. Nitesh, R. Karthika, and E. Prabhu, "Hand Tracking Based Human-Computer Interaction Teaching System," *2022 3rd Int. Conf. Issues Challenges Intell. Comput. Tech. ICICT 2022*, pp. 1–5, 2022, doi: 10.1109/ICICT55121.2022.10064617

[13] C. H. Yeh, W. C. Shen, C. W. Ma, Q. T. Yeh, C. W. Kuo, and J. S. Chen, "Real-time Human Movement Recognition and Interaction in Virtual Fitness using Image

Recognition and Motion Analysis," *Proc. 2023 12th Int. Conf. Aware. Sci. Technol. iCAST 2023*, pp. 242–246, 2023, doi: 10.1109/iCAST57874.2023.10359266

[14] Q. Huang *et al.*, "A Finger Motion Monitoring Glove for Hand Rehabilitation Training and Assessment Based on Gesture Recognition," *IEEE Sens. J.*, vol. 23, no. 12, pp. 13789–13796, 2023, doi: 10.1109/JSEN.2023.3264620

[15] N. Zerrouki *et al.*, "Deep Learning for Hand Gesture Recognition in Virtual Museum Using Wearable Vision Sensors," *IEEE Sens. J.*, vol. 24, no. 6, pp. 8857–8869, 2024, doi: 10.1109/JSEN.2024.3354784

[16] T. Kuflik *et al.*, "A visitor's guide in an active museum: Presentations, communications, and reflection," *J. Comput. Cult. Herit.*, vol. 3, no. 3, 2011, doi: 10.1145/1921614.1921618

[17] P. J. Fahy, *Media characteristics and online learning technology.* Athabasca University Press, 2004.

[18] Mulders, Miriam, J. Buchner, and M. Kerres. "A framework for the use of immersive virtual reality in learning environments." *International Journal of Emerging Technologies in Learning (iJET)* 15, no. 24, pp. 208-224, 2020. doi: 10.1109/ACCESS.2021.3058735

[19] T. Keinonen, "User-centered design and fundamental need," *ACM Int. Conf. Proceeding Ser.*, vol. 358, pp. 211–220, 2008, doi: 10.1145/1463160.1463183

[20] E. Duque, G. Fonseca, H. Vieira, G. Gontijo, and L. Ishitani, "A systematic literature review on user centered design and participatory design with older people," *IHC 2019 - Proc. 18th Brazilian Symp. Hum. Factors Comput. Syst.*, 2019, doi: 10.1145/3357155.3358471

[21] F. Zhang, A. Doroudian, D. Kaufman, S. Hausknecht, J. Jeremic, and H. Owens, "Employing a user-centered design process to create a multiplayer online escape game for older adults," *Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics)*, vol. 10298, pp. 296–307, 2017, doi: 10.1007/978-3-319-58536-9_24

[22] Torin Blankensmith, "MediaPipe TouchDesigner Plugin." 2023. Available: https://github.com/torinmb/mediapipe-touchdesigner

DOI: https://doi.org/10.17509/coelite.v3i2.73989
p- ISSN 2829-4157 e- ISSN 2829-4149