Digital Placemaking: Revitalize the Urban Outdoor Spaces through Interactive Media Architecture

Nayem Ahasan Srijon[1], Roufat Nahin Priota[2]

[1]Lecturer, Department of Architecture, BUET, Dhaka, Bangladesh

[2]Lecturer, Department of Architecture, Southeast University, Dhaka, Bangladesh

DOI: https://doi.org/10.51584/IJRIAS.2025.10060052

Received: 25 May 2025; Accepted: 31 May 2025; Published: 05 July 2025

ABSTRACT

The dependency on social media, and virtual communication has fostered sedentary lifestyles and a growing sense of social isolation in the digital age. This shift has significantly affected the vibrancy, inclusivity, and overall use of urban outdoor spaces—such as parks, plazas, and pedestrian zones—which traditionally play a vital role in fostering public engagement, social cohesion, and community well-being. In response, digital placemaking has emerged as a transformative strategy for revitalizing public spaces. Grounded in Human-Computer Interaction (HCI) principles, it fosters meaningful engagement and sociocultural connectivity within urban environments. This study explores how interactive media architecture can be utilized as an effective digital placemaking tool to enhance public interaction and revitalize underutilized urban outdoor spaces. Based on literature review, the study identifies the types of spatial layout of urban outdoor spaces, interface types and different modes of interactive media, and social interaction design patterns. The selected case studies are analyzed through comparative matrices, revealing the interconnections among spatial layouts, interface types, interaction modes, and design patterns, and highlighting recurring strategies used to engage the public. These relationships reveal a set of design strategies that shape the interfaces in ways that consistently foster similar patterns of user behavior. The paper further outlines the benefits and limitations of digital placemaking, identifies future directions such as AI integration and behavioral studies, and underscores the importance of sustainability and long-term considerations—including maintenance, cost, and adaptability. This knowledge supports architects and urban designers in crafting dynamic, inclusive, and participatory public spaces in contemporary cities.

Keywords: Digital placemaking, Interactive media architecture, Urban outdoor space, Human-Computer Interaction, Participatory public space.

INTRODUCTION

In recent years, the nature of public space and civic interaction has undergone a profound transformation. Accelerated by digitalization, urban life increasingly oscillates between physical environments and virtual platforms, reshaping how individuals connect, navigate, and engage with their surroundings. While digital technologies such as social media and online entertainment have expanded opportunities for virtual interaction, they have also contributed to a declining presence in shared public realms, leading to the gradual underutilization of urban outdoor spaces. Outdoor urban spaces refer to public areas such as parks, plazas, squares, nodes, and walkways, where people can gather, relax, socialize, exercise, and engage in various physical activities. These places have historically functioned as arenas for spontaneous interaction, communal activities, and democratic expression. Their diminishing vitality raises urgent questions for architects and urban designers seeking to foster inclusive, engaging, and responsive urban environments (Muller et al., 2006). Rooted in the foundational urban theories of Jane Jacobs (1961) and William H. Whyte (1980), the concept of placemaking has become a central theme in architectural discourse and urban research. Emphasizing human scale design, social cohesion, and a strong sense of place based identity, placemaking aims to foster meaningful connections between people and their built environment. In its contemporary evolution, placemaking now intersects with technological innovation, particularly through the integration of Human-

Computer Interaction (HCI), which has emerged as a transformative agent for reactivating urban spaces (Urbanowicz et al, 2016).

With the advent of Human-Computer Interaction (HCI) and cybernetics, placemaking has expanded into the realm of digital placemaking. This evolving field explores how digital technologies are reshaping traditional placemaking practices by moving beyond physical comfort to offer immersive and interactive urban experiences (Dalton et al., 2016). Technologies such as embedded sensors, augmented reality, artificial intelligence, and real-time data systems are being employed to transform static environments into adaptive, participatory, and socially engaging public spaces (Fredericks et al., 2016). Interactive media architecture, a central expression of digital placemaking, has gained popularity among both professionals and the general public for its visually compelling and intuitively designed interfaces, which encourage public interaction and engagement. This media driven approach empowers individuals to cocreate their spatial experiences, repositioning them as active participants rather than passive observers of public life (Fredericks et al., 2016). As technologies such as embedded computation, GPS tracking, AI, and immersive media become increasingly integrated into urban infrastructure, the built environment is evolving into a responsive interface—capable of sensing, adapting, and interacting with human behavior and environmental conditions (Ouda et al., 2022). By leveraging data from pedestrian movement, environmental patterns, and user input, these systems activate underutilized spaces, enhance spatial awareness, and contribute to improved safety and navigability within urban contexts (Suurenbroek et al., 2019).

This study investigates how interactive media architecture can be utilized as an effective digital placemaking tool to activate underused urban outdoor spaces and enhance public interaction. The literature review supports the development of a comparative framework to evaluate how Human-Computer Interaction (HCI) principles contribute to user participation and sociocultural connectivity. Adopting a qualitative research approach, the study analyses selected case studies to examine spatial configurations, interactive media components, and modes of user engagement. Grounded in HCI theory and the principles of interactive media architecture, the research positions digital technologies as integral elements in the design of inclusive, adaptive, and participatory public spaces.

LITERATURE REVIEW

The literature review has been conducted with a focus on interactive media architecture, interactive media components, and the key strategies necessary for fostering meaningful public engagements within urban outdoor environment.

Interactive media architecture

In the era of the Fourth Industrial Revolution, architects are presented with new opportunities to redefine the spatial relationship between humans and their built environments. Physical spaces are no longer perceived as static or unresponsive but are increasingly understood as dynamic, evolving systems capable of adapting to the complexities of contemporary life. In this context, interactive public space has emerged as a prominent field of academic research, offering innovative ways to reimagine human interaction in urban outdoor environments (Dalsgaard et al., 2010). According to Fong and Ching, media architecture refers to the integration of diverse digital technologies—including embedded computing, sensors, actuators, cameras, and GPS trackers—into architectural components to facilitate communication with the public. The growing affordability and accessibility of digital displays, mobile devices, and wireless networks have further accelerated the development and implementation of interactive installations in public spaces. Public spaces inherently present challenges related to crowd management and scalability, requiring intuitive strategies to maintain a smooth flow of experiences while respecting public behavioral norms and the transient nature of interactions. Intuitive interaction is more effective than a traditional HCI interface due to the participatory nature of the public spaces. It leverages familiar features to facilitate engagement with the potential people, and the media also clearly communicates any limitations, preventing overcrowding in the urban context. Intuitive mechanisms must correspond to the spatial configuration of the augmented environment, enabling participants to naturally engage with group dynamics and move fluidly between their personal space (micro-space) and the wider interactive context (macro-space). Furthermore, the content delivered by the digital interface must address the

needs of active participants operating within their micro-space while simultaneously engaging peripheral observers who perceive the larger macro-space. Designs of intuitive interactive media have traditionally resorted to two main processes: Tangible user interfaces (TUI) and Natural user interfaces (NUI). Tangible user interfaces are console, smartphone, tablet which mediate between users and the displaying media. They effectively foster interaction by reducing public visibility and the perceived risk of social embarrassment (Kray et al., 2008). Natural user interfaces are controlled via innate skills of using human body gestures. Figure 1 illustrates six distinct stages of a simplified interaction funnel based on natural user interfaces, outlining the progressive engagement process between individuals and interactive media installations (Michelis et al., 2011).

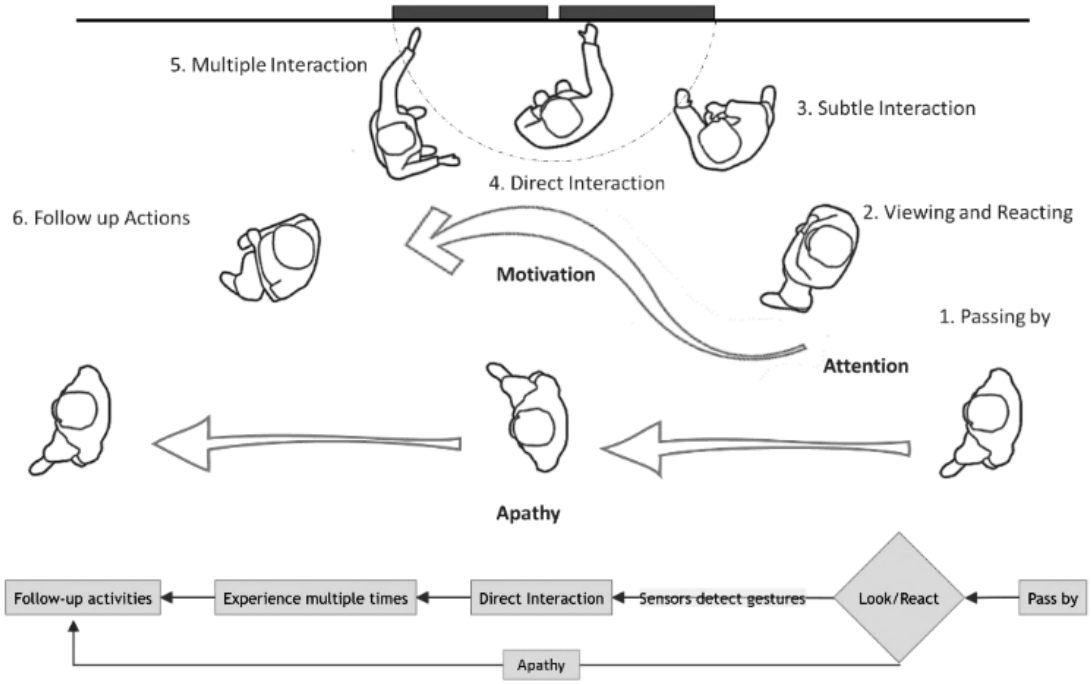

Fig 1: The audience funnel of gesture-based interface. Based on a diagram by Michelis and Müller (2011).

Each stage highlights different aspects of participant behavior. In the first stage, individuals were passing by the interactive installation without deliberate attention. In the second stage, they begin to notice the media. This is followed by subtle reactions or direct engagement, where users interact with the interface by positioning themselves intentionally in front of it. Some participants may return for multiple interactions, driven by increased curiosity after a brief pause. The final stages involve follow up activities, such as photographing the installation or walking away, marking the conclusion of the interaction process. Barriers can arise at each stage, preventing passersby from engaging fully with the media. Overcoming these barriers requires meaningful engagement and high-quality content that resonates with diverse audiences. In practice, many proposed gestures initially require user learning; however, once adopted, they often evolve into standard interaction design conventions within the emerging domain.

Interactive media components

To understand how interactive installations function within urban public spaces, it is essential to examine the key components that structure user engagement. These include the interactive interface, the spatial layout in which the installation is embedded, and the social interaction modes it facilitates. Together, these components determine the nature and scale of participation, the intensity of user involvement, and the overall impact of the media architecture on public behavior. The following subsections categorize and analyze these components to establish a comprehensive framework for evaluating interactive media as a digital placemaking tool.

Interactive interface

Interactive interface can be analyzed using the Intuitive Use of User Interfaces (IUUI) continuum. Figure 2 illustrates the stages of knowledge, such as innate, sensorimotor, cultural and individual expertise. Hespanhol

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VI June 2025

and Tomitsch identify three categories of interfaces: performative, allotted, and responsive ambient (Figure 3). The performative interface is defined by innate and sensorimotor knowledge to facilitate direct interaction by a few participants. The boundary zone is perceived, and the interface is clearly visible to the public. Most of the performative installations are based on a screen and are driven by a delimited interactive zone. The defined boundary results in a spontaneous division among the public into 'performers' (active participants) and 'spectators' (passive participants). The allotted interface draws inspiration from cultural and sensorimotor stages to support collective participation. The interface shares the same fundamental principles as performative ones; the interactive zone is spacious to accommodate a large population and stimulate spatial negotiation. Participants can operate the interface by themselves, and their interactions are distributed across the environment. The responsive ambient interface incorporates cultural and sensorimotor knowledge to provide subtle, seamless interactions that blend into the environment. The interfaces detect human presence and respond accordingly, but the feedback remains general and non-individualized.

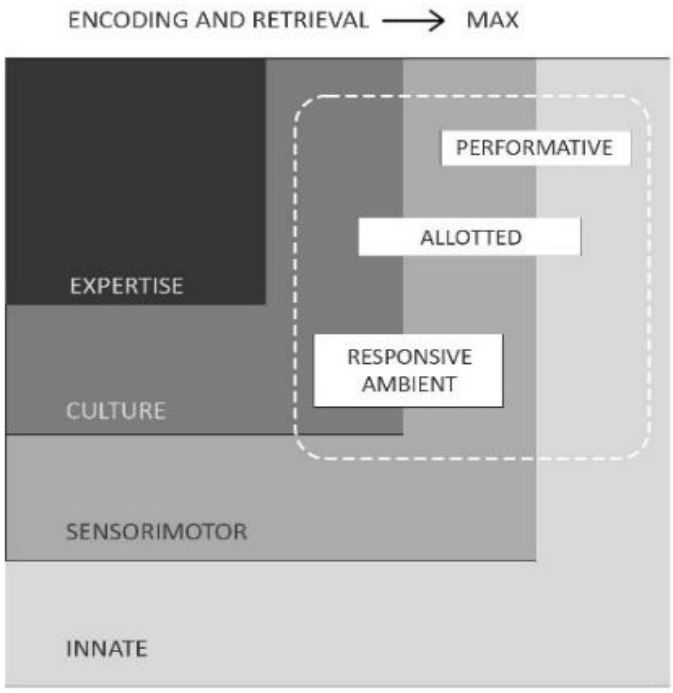

Fig 2: Interfaces in light of the IUUI continuum of intuitive interaction Based on a diagram by Hespanhol and Tomitsch (2015).

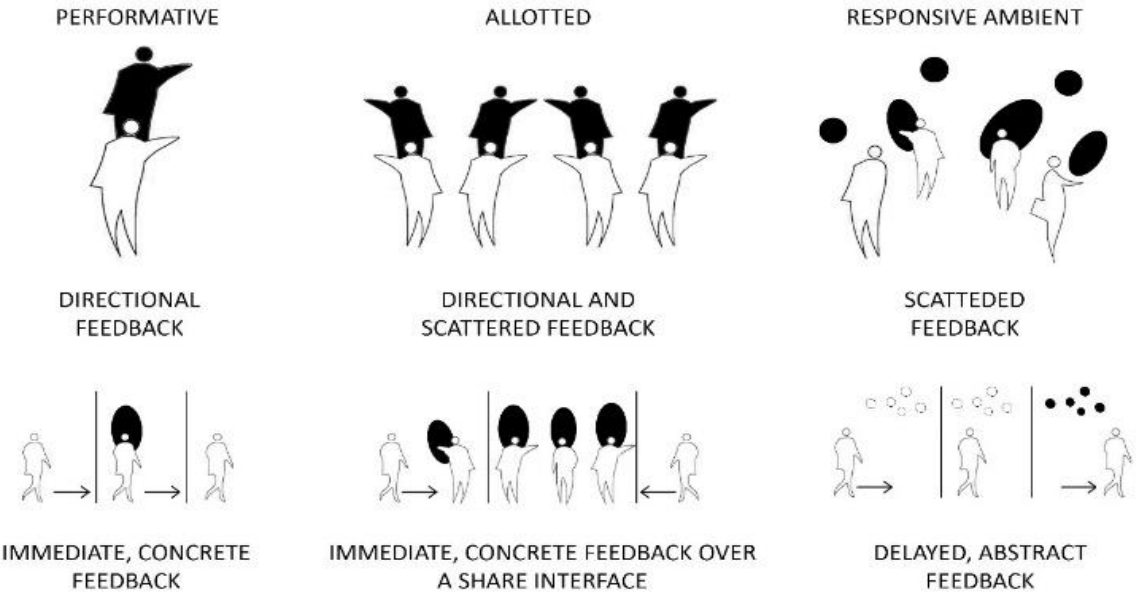

Fig 3: Interfaces and respective strategies with feedback patterns. Based on a diagram by Hespanhol and Dalsgaard (2015).

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VI June 2025

Spatial layout

The spatial layout is classified into two types—plaza and thoroughfare—based on the concepts of 'spatial nodes' and 'links' derived from urban planning literature, notably Hillier and Hanson's The Social Logic of Space (1984). A plaza refers to a spacious, open public area designed for social interaction and physical activity, whereas a thoroughfare serves as a connective route between plazas, characterized by a steady flow of pedestrians moving between various destinations.

Social interaction mode

According to Hespanhol and Dalsgaard, interactive public spaces facilitate diverse modes of social interaction, which can be categorized into six distinct types: appreciation, self-expression, playfulness, collective narratives, triangulation, and negotiation of space. These modes are further grouped under three broader categories—spectacle, creativity, and conversation (Figure 4). The terms define the dynamics of human engagement in interactive environments and how interactions unfold within the participants.

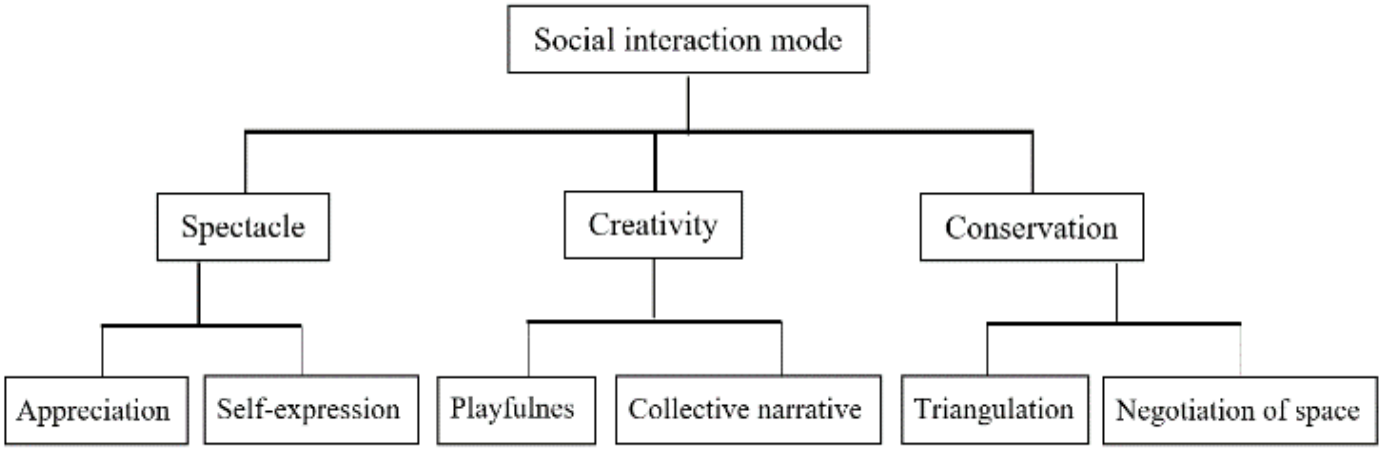

Fig 4: Different social interaction modes in public spaces.

Spectacle refers to visual and performative qualities of interactive installations that attract attention and invite participation. This category includes appreciation, where individuals passively observe the intervention, and self-expression, where users actively engage with the installation. To maximize participation, visibility, accessibility, and feedback mechanisms of interactive media are very crucial. Whether the feedback is immediate or delayed, the media must clearly communicate the response of the installation, enabling spectators to participate willingly.

Creativity involves playful engagement and the emergence of collective narratives. Playfulness allows participants to step outside everyday norms, fostering spontaneity and emotional uplift. When interfaces enable multiple users to interact simultaneously, collective narratives naturally unfold, supporting shared experiences and collaborative expression within the space.

Conversation encompasses triangulation, where shared interest in an unfamiliar interactive setting prompts dialogue among participants, and negotiation of space, which arises as individuals collectively define appropriate behaviours while remaining mutually aware within a shared environment. In this mode, participants often observe one another to interpret social cues and adjust their engagement accordingly. Each of the six interaction modes employs distinct strategies at varying scales to foster social interaction in urban outdoor spaces.

Strategies for Meaningful Engagement

Architects must seek to determine whether interactivity, as a medium, can produce a meaningful experience with public audiences (Muller et al., 2006). According to Surrenbroek, Nio, and Waal, a combination of five

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VI June 2025

strategies can create meaningful engagement, attract and encourage people, and address the complexities of a public setting. Strategies are sense of place, playful interaction, personalization, routing and legibility, and control. Sense of place aims to represent the collective identity and historical significance of a location by transforming individual experiences into shared narratives, often facilitated by technologies like sensors, digital storytelling, and crowdsourced content. Playful interaction enhances public engagement by activating overlooked spaces and encouraging spontaneous participation and social connection through media architecture. Personalization addresses how individuals adapt public spaces to their preferences, creating comfort and a sense of belonging within diverse social settings. Routing and legibility focus on navigability, drawing from Kevin Lynch's spatial principles, and utilize interactive elements such as digital signage and responsive lighting to guide movement and exploration. Lastly, control mechanisms help regulate behaviour and promote safety, efficiency, and social harmony through technologies like surveillance systems, access control, and behaviour shaping installations. Together, these strategies aim to connect people with their surroundings, promote active participation, enhance user experiences, improve navigation, and regulate behaviours.

Research Gap and Contribution

While existing literature offers a strong foundation on interactive media architecture, interface design, spatial configurations, and public engagement strategies, much of it remains descriptive, focusing primarily on typologies and technological capabilities rather than on evaluating the effectiveness of these interventions in varied urban contexts. For instance, although Hespanhol and Dalsgaard propose comprehensive classifications of interaction modes and interface types, limited research critically assesses how these frameworks perform across different spatial layouts, demographic settings, or cultural environments. Furthermore, Surrenbroek, Nio, and Waal, emphasized on five combined strategies to create meaningful engagement, but highlight a significant gap in the development of integrated design processes that effectively bridge interaction design with spatial planning. Similarly, Urbanowicz and Nyka advocate for integrating media interventions into city planning but highlight a need for more structured operational frameworks to align interactive installations with participatory urban renewal. This study addresses these gaps by combining theoretical frameworks with empirical case analysis to investigate how interactive media architecture can function as an effective digital placemaking tool. Through a comparative analysis of globally situated case studies, the study aims to validate and expand upon existing interaction typologies, spatial configurations, and interface classifications. This study presents a comprehensive evaluation framework that integrates HCI principles, spatial design, and behavioural responses. It further proposes actionable guidelines for designers and policymakers to assess the effectiveness and long-term sustainability of digital placemaking initiatives. Through this approach, the research contributes to a deeper understanding of how digital placemaking can cultivate inclusive, adaptive, and participatory urban environments.

METHODOLOGY

The methodology involves desk research, including an analysis of published online literature and case studies selected through random sampling. Ten interactive media installations were chosen, representing both plazas and thoroughfares, from small scale projects, such as furniture, installation to large scale projects, such as building facade, and parks. The study analyzes the cases based on a literature review to explore their reciprocal relationships. A comparative matrix evaluates the cases in terms of spatial layouts, interaction interfaces, input variables, display technologies, feedback mechanisms, social interaction modes, and interaction design patterns. This comparison provides a framework for understanding the recurring strategies of digital media and their corresponding social interaction design patterns.

Case studies

Ten different sample of outdoor spaces across different countries have been chosen for case studies, illustrating different technologies integrated to promote interactions in the urban environments.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VI June 2025

Heart of the city

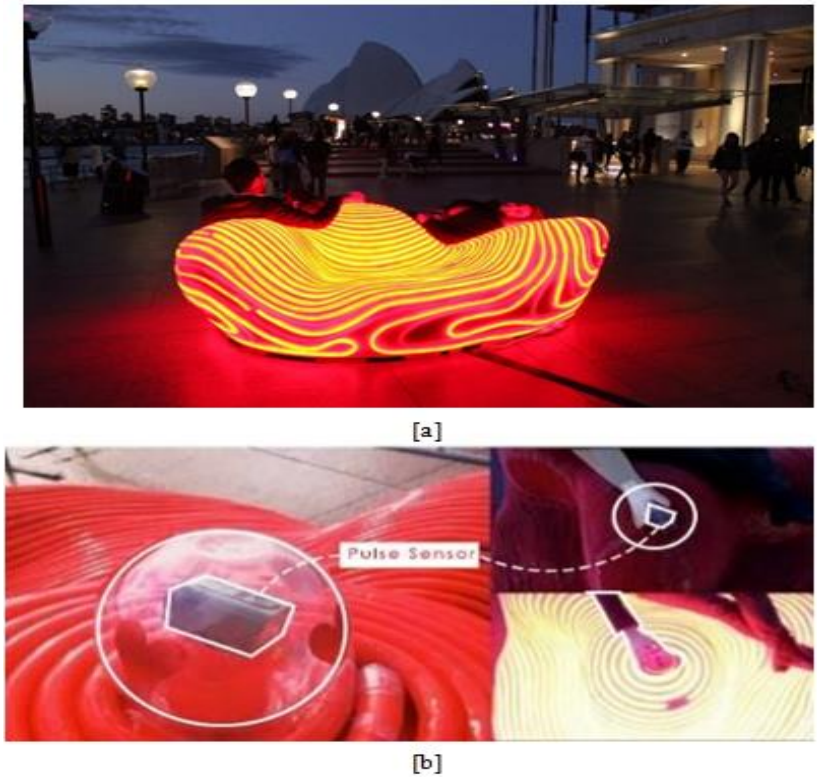

Fig 5: a) Heart of the city and b) Touch sensor at the middle portion [1].

Heart of the City is an interactive art designed by Aravinth Panchadcharam, Annie McKinnon, Antonia Franco in Sydney, Australia. The sculpture is inspired by the heart shape which pulses light according to the heartbeat of the people.

The furniture is composed of Styrofoam and Red LED neon flex cable where 5 people can comfortably sit and interact with each other. When a person places its finger on the pulse sensor, it starts light on and off according with the rhythm of the heartbeat of the user. Half of the cables pulses according to the right artery and the other half with the left artery. The sensor is located at the middle position of the sculpture. When the sculpture remains unused, it has its own rhythm of illumination. The sculpture attracts visitors, creates a closer attachment with the heartbeat of the citizens, and offers a place to gossip and experience the beautiful surroundings of Sydney Opera House.

Body moves

Body Movies is an interactive media designed by artist Rafael Lozano-Hemmer in Rotterdam, Netherlands.

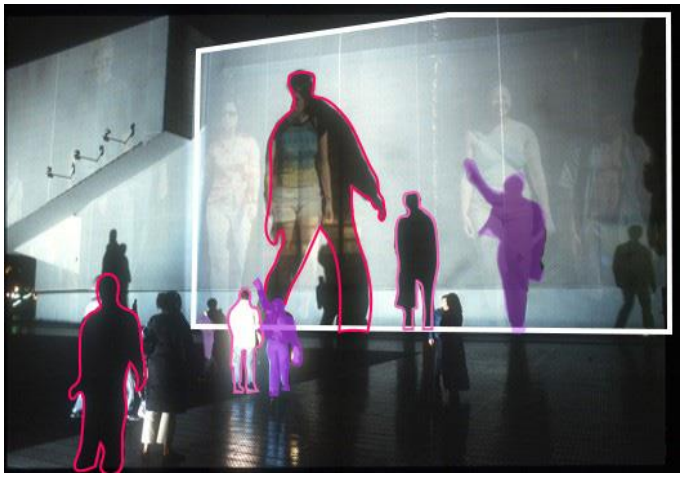

Fig 6: Body moves, projection of shadows [2].

The installation, inspired by seventeenth-century shadow plays, transforms the urban wall into dynamic social spaces. Massive portraits are projected onto a wall, illuminated by intense white lighting. Passersby use their shadows to reveal hidden photos on a wall in a playful choreography of light and movement. Shadow play, a simple and familiar gesture, often becomes the centerpiece of interaction, surpassing the original intent of revealing the portraits. This spontaneous interplay encourages playful self-expression among participants and fosters connections between strangers. Interaction primarily unfolds in front of the projections, where participants communicate via their shadows on the facade. Meanwhile, the periphery offers comfort zones for passive observation and social commentary. This dual dynamic exemplifies the installation's ability to blend active engagement with reflective appreciation, creating a multifaceted social environment.

ifly virgin wall

iFly Virgin Wonderwall is an installation in Tokyo, Japan, designed by Klein Dytham Architecture. The interactive wall is a 20-meter-long bright red acrylic wall featuring questions in LED ticker-tape display at each hour of the day for the passersby. People have to answer questions on their smart phones. The question serves as a prompt to engage people by encouraging them to answer. Once participants submit answers, they receive real-time feedback, which makes the interaction more engaging. Moreover, the installation includes leaderboards displaying the names and prizes who can score the highest correct answers. New questions appear each hour of the day, potentially encouraging the people to repeat visits to the installation. The initiative was intended for both educational and entertaining purposes. Participants share their participation and scores on social media, which further promotes social installation. The interactive technology enhances community engagement by fostering curiosity, surprise, and entertainment at the public space.

Fig 7: a) i Fly Virgin wall and b) Question in LED ticker-tape display [3].

Warde

Warde, an interactive public square in Jerusalem, was built by HQ Architects using motion and temperature sensors, lighting, fans, and woven nylon. They are in Vallero Square, which was previously run down and lacked appealing features. The flowers, four in total and each 30 feet high and wide were added to improve the square's urban environment. They are strategically placed to be visible from all angles in the square and the nearby market. Each flower inflates and opens when people approach, providing shade when needed and signaling the tram's arrival by inflating it all at once. This creative solution transforms the previously uninspiring urban space into one that interacts with and accommodates its users, enhancing the overall atmosphere.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VI June 2025

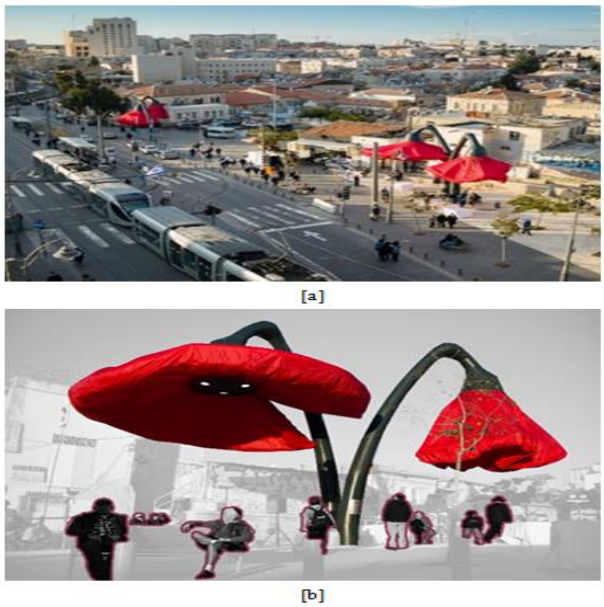

Fig 8: a) Warde Square and b) Peoples' engagement with interactive inflating flowers [4].

Back to front

Back to Front is an urban park project featuring a unique screen wall in the park's center. The interactive installation was designed by Jason Burges in Toronto's park walkways, using granite, LED lights, light sensors, glass lenses, steel structure, and bespoke control electronics. When people walk past the screen, they can see their abstract reflection on one side and the mirror image of someone on the other side.

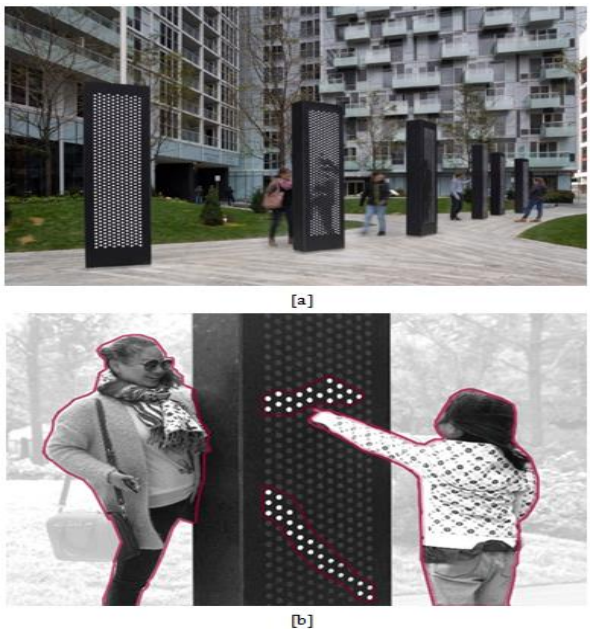

Fig 9: (a) Back to Front installation and (b) Peoples' engagement with the interactive LED screen [5]

The park has monolithic granite structures equipped with sensors that detect changes in light as people move through the park, trees shift, and the sun moves. These changes in light create dynamic shadows on the granite, which are then used to create animated silhouettes on the opposite side of the structure using LED lights and glass lenses embedded in the stone. The goal is to provide an enjoyable and ever-changing experience for park visitors, reflecting the shifting weather patterns in the city. Special electronic circuit boards control each LED or sensor node on the granite and the overall imagery results from these nodes' combined behavior. The installation can sense both static shadows from buildings and dynamic movements from people and trees, drawing inspiration from Toronto's characteristic "weather fronts" that influence the city's climate throughout the year.

Bubbles

'Bubbles' is an interactive neighborhood courtyard project designed by Architect Michel Fox in Los Angeles, USA. The open-air installation creates a sense of volumetric experience instead of a static surface on an urban courtyard. The installation is made of a tube containing a pair of translucent nylon bubbles, also used for fabricating parachutes. With a specialized sensor, the bubble pair can inflate or deflate with human contact. So, the reasoning behind these pneumatic volumes of bubble pairs is to respond based on the changing occupancy of the people at the open piazza. There are 12 bubble pairs, each 8 feet in diameter, connected by transparent ducting with a central structure for the ducts. The duct exchanges air between the bubble pairs caused by a fan inside it. At the center is a rigid 'seed' made of CNC-cut polyethylene containing bubbles. A person pushes a bubble to make a pathway to pass by or have a conversation with others; the bubble deflates to give them a space to communicate. More people generate more activity, which creates more spaces through the bubbles.

Fig 10: Concept of experiencing 2D to 3D volume of a courtyard

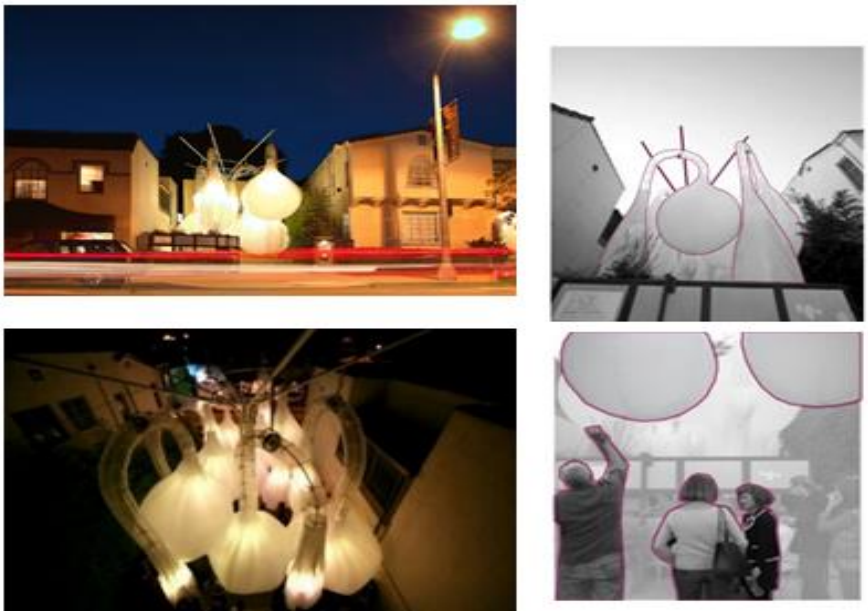

Fig 11: The interactive courtyard and interaction of people with the bubbles [6].

Enteractive

Cameron McNall designed the iconic landmark 'EnterActive' in Los Angeles, USA, which consists of an interactive media façade, pavement using LED panels AND tiles. The media architecture enlivens the streetscape with a beautiful rhythm of LED lights. It transforms a simple public entryway and facade into an immersive experience that portrays the essence of the vibrant life of the city. The public entrance features an interactive carpet of LED tiles. There are 176 tiles which respond to visitors' steps, illuminating patterns that mirror their movements. The building's facade also comes alive, echoing the dance in the foyer. The carpet is powered by advanced embedded computation technology, with weight sensors placed beneath each corner collecting data and registering movements 30 times per second. A master CPU interprets this data, activating the LEDs in response to visitors' actions. Custom software processes the weight data in real-time, determining where people stand and the direction of their movements. These data sources generate algorithms for dynamic light patterns, scaling the intensity based on activity on the carpet. Even when the carpet is unoccupied, echoes

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VI June 2025

of previous participants come to life, adding a sense of continuity to the ever-changing puzzles of light.

Fig 12: The interactive facade and interaction of people at the building entrance [6].

Another life

Fig 13: The mirror pool and peoples' engagement with interactive water fountains and laser beams are following footsteps of the visitors [8].

Another Life is a large interactive pool designed by Usman Haque. The mirror pool was built at Bradford city park in England. It was designed to connect various sensors, cameras, LED lights, fountains, and lasers. This project aims to bring Bradford Park to life, creating a sense of place with a unique dancing light and fountain as they move through the space in the real-time presence of the people. Sensors and cameras collect data on visitor movements, while LED lights and fountains provide dynamic responses. These technologies are part of the park's infrastructure and are controlled through Linguine OS software. The primary purpose is to entertain and engage urban visitors. People effectively become choreographers as their movements generate captivating LED light patterns that follow them around. The fountains interact with visitors by projecting water and changing light colors based on their movements. Therefore, the mirror pool encourages social interaction by creating a shared experience of movements among the visitors, a collective performance of the whole crowd.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VI June 2025

Public face

The Mood Gasometer, also known as Public Face, is a massive eight-meter-tall sculpture made of steel and neon tubes, installed on high, visible rooftops in Lindau and Vienna.

Fig 14: Installation of Public face in Vienna, Austria and Lindau, Berlin [9].

Because of monumental scale, the sculpture is a integrated part of city's skyline, with its shifting expressions visible from afar. The expression such as happiness, sadness, anger, or surprise is derived from the facial expressions of local pedestrians captured by surveillance cameras. The program utilizes an algorithm developed by Fraunhofer Institute to read the facial expressions of the local passersby. The machine analyzes the average emotions of the city inhabitants and the expression of the sculpture changes accordingly. The sculpture reveals the collective emotion of the people, visible to everyone in the city.

Fig 15: The public face changes its facial expression according to the average emotions of the public [9].

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VI June 2025

Swarm compass

Swarm Compass is a drone-based routing system is being developed by Japanese telecommunications giant NTT and the Ars Electronica Future lab. The swarm-based technology has been used to operate a group of drones which are capable of changing colors. The colors will be used as a means of communication to the public. The red-light signal is showing the temporary closures due to overcrowding, where the green lights will direct pedestrians the available paths through busy streets during large events. Aerial vehicles now serve purposes beyond navigation, contributing to the atmospheric enhancement of a space. The intelligent swarm drones are also assembled to form an air-borne screen that can also offer spectacular renderings of the events. The SPAXELS® department developed SwarmOS software to operate these drones autonomously from takeoff to landing. This advanced automated method produces collision-free flight trajectories for each drone in the swarm, while enabling seamless interaction among all flying units.

Table I Comparison Matrix of Ten Case Studies In Terms Of Interfaces, Location, Year, Spatial Layout, And Technologies.

Case studies	Type of interface	Location Year	Spatial layout	Displaying technology	Interactive technology	Interaction	Feedback
Heart of the city	Performative	Sydney 2015	Plaza	LED neon flex cable	Pulse sensor	Finger	Direct, Close-ended and predictable
Body moves	Performative/ Allotted	Rotterdam 2001	Plaza	Projection	Camera	Full body	Direct, Close-ended and predictable
i Fly virgin wall	Performative/ Allotted	Tokyo 2009	Thorough fare	LED ticker display	Smart phone	Tangible user interface	Direct, Close-ended and predictable
Warde	Allotted	Jerusalem 2014	Plaza	Nylon parachute	Motion sensor	Full body	Direct, Open-ended and predictable
Back to Front	Allotted	Toronto 2014	Thorough fare	LED light	Motion sensor	Full body	Direct, Open-ended and Unpredictable
Bubbles	Allotted	Los Angeles 2006	Plaza	Nylon parachute	Touch sensor	Hand	Direct, Open-ended and Unpredictable
Enter Active	Allotted	Los Angeles 2006	Plaza	LED panel and tiles	Weight sensor	Full body	Direct, Open-ended and Unpredictable
Another life	Allotted	Bradford 2012	Plaza	Fountain laser light	Camera	Full body	Direct, Open-ended and Unpredictable
Public face	Responsive ambient	Berlin 2010	Thorough fare	Neon tube steel frame	Camera	Full body	Delayed, Open-ended and Unpredictable
Swarm compass	Responsive ambient	Tokyo 2017	Thorough fare	Swarm drone	Camera	Full body	Delayed, Open-ended and Unpredictable

Fig 16: Swarm drones are guiding pedestrians like an interactive compass [10].

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VI June 2025

Analysis

A comparative matrix shown in Table 1, demonstrates comparison of the interfaces and key features of ten installations. Most of the cases used allotted interfaces such as Body moves, iFly virgin wall, Warde, Back to Front, Bubbles, EnterActive, Another life.

Allotted interfaces are used in plaza areas, with full-body gestures to interact with the media architecture. The interfaces prove to be highly effective in both deliberate and spontaneous interaction, mitigating social pressure and risk of embarrassment by enabling collective participation of the crowd. This method minimizes disruption to the social space's dynamics while enabling direct interaction among participants and indirect engagement with spectators through triangulation. Only a mediator smartphone (TUI) has been used i Fly Virgin Wall to interact with the crowd. Most performative interfaces provide direct feedback, closed-ended and predictable in nature. Public face and Swarm compass were identified as responsive ambient interfaces. Interfaces are mostly used to enrich the experience of thoroughfares of urban environment, offer subtle delayed, indirect and generic feedback rather than addressing individual users directly.

Another comparative matrix, shown in Table 2, describes all the case studies based on social interaction modes and design patterns. The mapping reveals that all the analyzed cases encourage public appreciation (passive spectatorship) as a social interaction mode, but self-expression is not found in all cases (active interaction), such as Public Face and Swarm Compass. These cases adopted a responsive ambient interface, where feedback delays and individuals are not often fully aware of their role, but participation occurs collectively, fostering a subtle sense of shared involvement.

Similarly, media architecture may evoke appreciation and enable individual self-expression, but not necessarily being playful in all cases. Installations like iFly Virgin Wall, designed to be primarily functional yet enjoyable, exemplify this approach. Such installations can serve as platforms for public voting, gathering opinions on issues, and expressing citizen preferences. The mapping also reveals that most of the cases encouraged collective narratives because the interface allows for simultaneous interaction by multiple people. The mapping of Table 2 also highlights triangulation as a recurring strategy across all the interactive installations. These installations encouraged conversations based on a shared interest in the contents presented by the media, while the interaction zone was negotiated naturally according to social norms during group interactions.

Social interaction modes, along with spatial layouts, reveal a set of recurring strategies characterized as social interaction design patterns. According to Hespanhol and Dalsgaard, these patterns are responsible for evoking some specific forms of crowd behavior in urban outdoor place. The patterns were derived by grouping several attributes. The left side of Table 2, the spatial layout, interaction, and feedback columns were grouped together and three interaction design patterns were identified in column 6: Shadow Playing, Remote Control, and Smooth Operator. On the other hand, right side of Table 2, recurring social interaction modes were grouped, and four additional design patterns were identified in column 13: Soapbox, Amusement Park, Swarm, and Automatic Gate. In Figure 17, each pattern is illustrated using metaphors aligned with the concepts, their operational characteristics, and the social interactions. Together, these interaction design patterns provide a framework for designing a successful interactive outdoor urban space.

Shadow playing pattern utilizes full-body interaction and provides immediate feedback to create a direct, one-to-one engagement among users and media architecture. It is commonly employed due to its effectiveness in engaging participants by giving them direct control over the media. Most of the performative and allotted interfaces adopted shadow playing pattern. The pattern fosters playfulness and can evolve into a collective narrative, especially when large groups interact with the installation. This design pattern is often used in plazas, offering participants the freedom to move while ensuring good visibility of the media architecture. Its emphasis on physical engagement and spatial openness makes it ideal for creating dynamic and participatory urban experiences.

Remote control employs a tangible user interface (TUI) to mediate interactions among the public and media architecture, commonly within plaza environments designed to support multi user engagement and immediate

feedback. For instance, the iFly Virgin Wall was designed following the remote-control pattern (smartphone). Two design approaches are common: centralized remote controls and distributed portable devices. Each approach has its tradeoffs. Distributed portable devices, such as smartphones enable simultaneous participation but may struggle with time negotiation and often rely on system-imposed rules rather than organic social agreements. Centralized remote controls, such as console addresses accessibility issues and provides a more focused interaction but limit opportunities for deeper social interactions, such as triangulation between participants and the media architecture.

Table II Comparison Matrix of Ten Case Studies of Interactive Media Architecture Installations.

						Spectacle		Creativity		Conversation		
Case studies	**Type of interface**	**Spatial layout**	**Interaction**	**Feed-back**	**Design pattern**	**Appreciation**	**Self-expression**	**Playfulness**	**Collective narratives**	**Triangulation**		**Design pattern**
Heart of the city	Performative	Plaza	Finger	Direct	Shadow playing	√	√	√		√	√	Amusement park
Body moves	Performative/ Allotted	Plaza	Full body	Direct	Shadow playing	√	√	√	√	√	√	Amusement park
i Fly virgin wall	Performative/ Allotted	Thoroughfare	Smart phone	Direct	Remote control	√	√		√	√		Soap box
Warde	Allotted	Plaza	Full body	Direct	Shadow playing	√	√	√	√	√	√	Amusement park
Back to Front	Allotted	Thoroughfare	Full body	Direct	Shadow playing	√	√	√	√	√	√	Amusement park
Bubbles	Allotted	Plaza	Hand	Direct	Shadow playing	√	√	√	√	√	√	Amusement park
Enter Active	Allotted	Plaza	Full body	Direct	Shadow playing	√	√	√	√	√	√	Amusement park
Another life	Allotted	Plaza	Full body	Direct	Shadow playing	√	√	√	√	√	√	Amusement park, Swarm
Public face	Responsive ambient	Thorough fare	Full body	Delay	Smooth operator	√		√		√		Automatic Gate
Swarm compass	Responsive ambient	Thoroughfare	Full body	Delay	Smooth operator	√		√		√		Automatic Gate

Smooth Operator operates with full-body tracking in high-traffic thoroughfares and responds with delayed feedback. For instance, among the case studies, Public Face and Swarm Compass exemplify the Smooth Operator pattern, showcasing its characteristics effectively. The pattern responds subtly to the movements of passersby, creating the impression of an independent entity not entirely controlled by the public. Smooth Operators are particularly suited for areas with intense pedestrian flow, seamlessly integrating into the environment while gently acknowledging the presence of the individuals.

This design approach maintains a balance between regular activities and subtle interaction. For example, Public Face and Swarm Compass adopts responsive ambient interface, both are identified as smooth operator design pattern.

Soapbox pattern is typically designed for quick and reliable individual expression, self-appreciation but with little playfulness or collective narratives, focusing on the core functionality. For instance, the iFly Virgin Wall was designed within this framework, to facilitate questions on local topics with minimal disruption to regular activities. This approach can be used in public consultation, providing valuable feedback to local governments without altering the social dynamics.

Amusement Park pattern in urban media architecture installations fosters all three social interaction modes: spectacle, creativity, and conversation. These installations integrate self-expression, collective play, and co-created narratives, facilitated through triangulation with the media architecture and often requiring spatial negotiation throughout the interaction. They act as disruptive urban interventions, turning passersby passer-by into performers or spectators while encouraging playful engagement, subverting social norms and establishing new ones through interaction.

Performative and allotted interfaces are ideal for creating such dynamic, engaging spaces. Most of the selected case studies' strategies were found to be aligned with amusement park design pattern.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VI June 2025

The swarm pattern represents interactive environments where individuals engage through triangulation with the media architecture while simultaneously negotiating physical space. Constructed as an allotted interface reliant on full-body interaction, this pattern is typically implemented in plazas to accommodate numerous simultaneous participants. Users interact with distinct sections of the interface and receive continuous feedback, maintaining awareness of both their own presence and that of others nearby. These dynamics foster a ripple effect, wherein local actions influence surrounding participants, mirroring the coordinated behavior of a swarm or school of fish. Installations such as After Life exemplify the swarm design pattern.

Automatic Gate pattern represents the installations in high-traffic pedestrian areas, offering varied level of playful feedback and appreciation but lacking self-expression or collective narratives. These media architecture designs seamlessly blend into the built environment, responding subtly to passers-by without disrupting their activities. Responsive ambient interfaces are ideal for this pattern, as seen in Public Face and Swarm Compass cases.

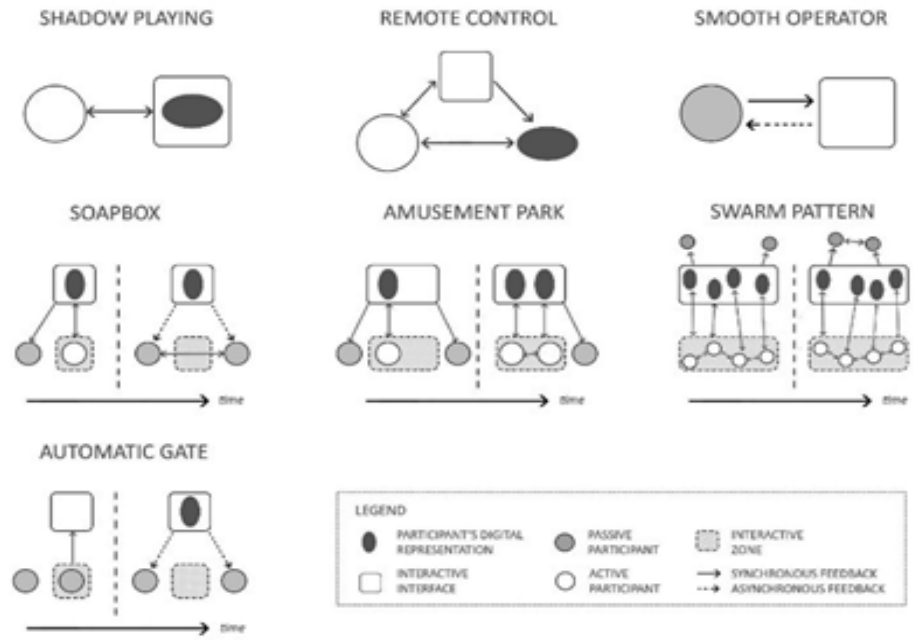

Fig 17. Social interaction design patterns. Based on a diagram by Hespanhol and Dalsgaard (2015).

DISCUSSION

Successful digital placemaking relies on the integration of technical, architectural, and social dimensions. Together, these elements shape how interactive installations facilitate diverse forms of human engagement within urban public spaces. This study examines ten diverse case studies—ranging from urban furniture and digital screens to facades, sculptures, fountains, and drone-based signage—to illustrate the potential of interactive media architecture in enabling public participation. These examples reveal that such technologies can support varied modes of engagement, including appreciation, playfulness, collective storytelling, and spatial negotiation, ultimately enriching the experiential quality of urban life. For instance, Bubbles exemplifies playful interaction in a plaza setting, while The Swarm Compass reflects a swarm pattern encouraging collective awareness within a thoroughfare. Such cases validate that interface type and spatial context co-construct the social experience, influencing whether users become passive spectators, active participants, or co-creators.

While the cases highlight the potential of interactive media for engagement and placemaking, they also expose several structural and operational limitations. Many interactive systems depend on high-tech components—motion sensors, facial recognition, and analyzing algorithms—that require ongoing maintenance, software updates, and responsive troubleshooting. Without institutional planning for these long-term operational needs, installations may deteriorate or fall into disuse, undermining their placemaking objectives. Cases like Public Face, while technologically advanced, also underscore ethical concerns, particularly around data privacy and

the surveillance of inhabitants. The emotion recognition technology used to animate public displays invites scrutiny into the consent and transparency of data usage—an issue largely unregulated in current public space design frameworks.

Moreover, digital placemaking initiatives often lack resilience planning. Environmental wear, vandalism, and fluctuating public interest pose significant challenges to their long-term sustainability. Outdoor interactive installations are inherently exposed to climatic conditions—such as rain, humidity, heat, and dust—that can degrade digital components and structural materials over time. Without durable construction and weather resistant design, these systems may quickly lose their functional integrity. Additionally, public spaces are vulnerable to vandalism and misuse, which can damage sensitive equipment and disrupt the intended user experience. Beyond physical threats, the long-term success of such installations also depends on their ability to retain public interest. What may initially attract enthusiasm can quickly fade if the interaction becomes repetitive, culturally disconnected, or technologically outdated. These challenges necessitate careful planning around material resilience, protective measures, and dynamic content strategies. Sustainable digital placemaking must therefore incorporate not only robust technical design but also mechanisms for ongoing maintenance, community stewardship, and adaptive user engagement.

A key insight from the analysis highlights the growing need to transition from conventional top-down urban planning toward more participatory, community engaged design approaches. Although many initiatives remain institutionally driven, there is increasing emphasis on embedding local voices and context aware interventions—often emerging from grassroots collaborations involving artists, NGOs, and cultural institutions. These approaches not only reshape physical environments but also act as catalysts for dialogue, shared authorship, and inclusive engagement. When supported by structured frameworks from planning authorities, they can foster more adaptive and locally resonant outcomes in digital placemaking.

Despite these promising models, urban planning institutions have yet to fully integrate digital placemaking into policy and infrastructure. Issues such as accessibility, regulatory oversight, and funding mechanisms remain underexplored. Without a coherent institutional framework, these efforts risk remaining isolated or temporary. Planning authorities must therefore adopt structured strategies that embed interactive technologies into broader urban systems—through zoning, public funding, community engagement processes, and legal protections for user data. To ensure long-term impact, future research should prioritize integrating adaptive AI systems, sustainability metrics, and maintenance strategies into interactive installations. Comparative cross-cultural analyses are also essential for understanding how digital placemaking functions within varied socioeconomic and geographic contexts. Ultimately, the challenge is to ensure that these technological interventions are not only engaging and inclusive but also sustainable, ethically regulated, and contextually appropriate within the evolving fabric of urban spaces.

CONCLUSION

This research contributes to the evolving discourse on digital placemaking by offering a multi-dimensional perspective on how interactive media architecture can enrich urban public spaces. Rather than treating technology as an isolated layer, the study frames it as a catalyst for rethinking civic experience, identity, and spatial engagement. Drawing from a range of case studies, the research underscores the transformative potential of interaction when grounded in cultural relevance, inclusivity, and localized interpretation. However, to sustain the impact of digital placemaking, interventions must be resilient, ethically governed, and contextually adaptive.

Emerging practices in digital placemaking highlight several guiding principles drawn from real-world implementations. A key strategy is to adapt existing urban infrastructure by embedding digital layers that enhance rather than disrupt core public functions. Designing at a human scale ensures that installations are approachable, emotionally resonant, and inclusive for users of all ages and abilities. Encouraging creative appropriation allows the public to shape interactions that reflect local identity and culture. Equally important is balancing solitary and collective experiences—systems should support both introspective engagement and shared social participation. To sustain interest, content must evolve gradually, blending familiarity with periodic novelty. Integrating diverse sensory modalities—visual, auditory, tactile, and bodily motion—

broadens accessibility, invites multisensory engagement, and deepens user immersion. Ultimately, successful digital placemaking should reflect community narratives and establish temporal continuity, linking past memories, present experiences, and future aspirations. These principles illustrate how digital placemaking can become more than a momentary attraction—it can serve as a tool for civic reflection and engagement. For architects and urban planners, this necessitates an expanded design vocabulary that incorporates robust technical systems with co-creative processes.

While many interventions are still led by institutions, the success of grassroots and community-led efforts underscores the value of bottom-up approaches. When supported by enabling policies, these localized, culturally sensitive micro-interventions can produce more inclusive and responsive outcomes. To institutionalize these practices, urban governance must create pathways for structured implementation—through zoning codes, funding models, maintenance planning, and ethical regulation. Public-private partnerships, community collaborations, and civic tech initiatives all have a role to play. By embedding these strategies into planning systems, cities can ensure that digital placemaking becomes an integral part of equitable, adaptive, and socially responsive urban development. When grounded in local context and sustained through collaborative governance, interactive technologies have the potential to enrich everyday urban life and strengthen the relationship between people and place.

ACKNOWLEDGEMENT

The author acknowledges Dr. Asma Naz, associate professor from the Department of Architecture, BUET, for guidance and use of materials from the MSc. Arch Course ‘Interactive Technologies in Architecture’ (Arch-6502).

Ethical approval

All real-world images included in this study were sourced from publicly available internet resources.

Conflict of interest

The authors declare no conflict of interest, and no external funding was received or utilized for conducting this study

REFERENCES

1. Franco, A. (n.d.). Anaisa Franco : The Heart of the City. Anaisa Franco. https://www.anaisafranco.com/heartofthecity
2. Rafael Lozano-Hemmer - Body Movies. (n.d.). Www.lozano-Hemmer.com. https://www.lozano-hemmer.com/body_movies.php
3. Klein Dytham architecture. i-fly Virgin Wonderwall. [online] Available at: https://www.klein-dytham.com/i-fly-virgin-wonderwall/1h1id5d124ce9m8hr1dsln60m8eil7
4. Archello, Warde | HQ ARCHITECTS. [online] Available at: https://archello.com/project/warde.
5. Jason Bruges (n.d.). Back to Front. [online] Jason Bruges Studio. Available at: https://www.jasonbruges.com/back-to-front.
6. LIN, F. FOX LIN. [online] FoxLin Architects. Available at: https://foxlin.com/portfolio_item/bubbles/.
7. Datadreamer.com. (2023b). datadreamer - Enteractive. [online] Available at: https://www.datadreamer.com/item/enteractive
8. haque.co.uk. Another Life (2012). [online] Available at: https://haque.co.uk/work/another-life
9. Maus, B. (2024). Public Face II — allesblinkt. Allesblinkt.com. https://www.allesblinkt.com/projects/public-face
10. Kinshita, S. (2018, July 21). Swarm Compass. Ars Electronica Futurelab. https://ars.electronica.art/futurelab/en/projects-swarm-compass
11. Michelis, D., & Müller, J. (2011). The Audience Funnel: Observations of Gesture Based Interaction With Multiple Large Displays in a City Center. International Journal of Human-Computer Interaction, 27(6), 562–579. https://doi.org/10.1080/10447318.2011.555299

12. Hespanhol, L., & Tomitsch, M. (2015). Strategies for Intuitive Interaction in Public Urban Spaces. Interacting with Computers, 27(3), 311–326. https://doi.org/10.1093/iwc/iwu051
13. Hespanhol, L., & Dalsgaard, P. (2015). Social Interaction Design Patterns for Urban Media Architecture. Human-Computer Interaction – INTERACT 2015, 596–613. https://doi.org/10.1007/978-3-319-22698-9_41
14. Ouda, M., & Noha. (2022). The International Hybrid Conference on Contingency Planning and Adaptive Urbanism (CPAU). Contingency Planning and Adaptive Urbanism International Hybrid Conference, 2022. https://doi.org/10.21608/furp2022.2022.1811
15. Kurniawaty, G., Horlanso, V., Aditama, M. Y., & Larasati, D. (2022). Digital Placemaking and Its Effect to The Architectural Development (Case Study: City of Dreams, Macau). IOP Conference Series: Earth and Environmental Science, 1058(1), 012021. https://doi.org/10.1088/1755-1315/1058/1/012021
16. Birks, F. and Arup (2014). Drivers of Change, AAAS Annual meeting for global challenges, https://aaas.confex.com/aaas/2014/webprogram/Paper13276.html.
17. Dalton, N.S., Holger Schnädelbach, Mikael Wiberg and Tasos Varoudis (2016). Architecture and Interaction Human Computer Interaction in Space and Place. Cham Springer International Publishing.
18. Kindberg, T., Chalmers, M. and Paulos, E. (2007). Guest Editors' Introduction: Urban Computing. IEEE Pervasive Computing, 6(3), pp.18–20. doi:https://doi.org/10.1109/mprv.2007.57.
19. Tieben, R., Sturm, J., Bekker, T. and Schouten, B. (2014). Playful persuasion: Designing for ambient playful interactions in public spaces. Journal of Ambient Intelligence and Smart Environments, 6(4), pp.341–357. doi:https://doi.org/10.3233/ais-140265.
20. Müller, J., Alt, F., Michelis, D. and Schmidt, A. (2010). Requirements and design space for interactive public displays. Proceedings of the international conference on Multimedia - MM '10. doi:https://doi.org/10.1145/1873951.1874203.
21. Fong & Chan Architects. (n.d.). Media Architecture: Past, Present, and Future. [online] Available at: http://www.fca-arch.com/insights/2019/1/23/media-architecture-in-2019
22. Her, J.-J. and Hamlyn, J. (2010). Meaningful Engagement: Computer-Based Interactive Media Art in Public Space. Springer eBooks, pp.17–24. doi:https://doi.org/10.1007/978-3-642-11577-6_3.
23. Muller, L., Edmonds, E. and Connell, M. (2006). Living laboratories for interactive art. CoDesign, 2(4), pp.195–207. doi:https://doi.org/10.1080/15710880601008109.
24. Hespanhol, L. and Tomitsch, M. (2015). Strategies for Intuitive Interaction in Public Urban Spaces. Interacting with Computers, 27(3), pp.311–326. doi:https://doi.org/10.1093/iwc/iwu051.
25. Dalsgaard, P., Dindler, C. and Halskov, K. (2011). Understanding the Dynamics of Engaging Interaction in Public Spaces. pp.212–229. doi:https://doi.org/10.1007/978-3-642-23771-3_17.
26. Suurenbroek, F., Nilo, I. and Waal, M. (2019). Responsive Public Spaces: Exploring the use of Interactive technology in the design of public spaces. Singapore: Springer Singapore.
27. juliusvonbismarck.com. (n.d.). Public Face: juliusvonbismarck.com. [online] Available at: https://juliusvonbismarck.com/bank/index.php/projects/public-face-ii/ [Accessed 17 Sep. 2023].
28. Architizer. (2015). WARDE by HQ Architects. [online] Available at: https://architizer.com/projects/warde/#:~:text=%E2%80%9CWarde%E2%80%9D%20is%20an%20urban%20installation
29. ArchDaily. (2015). HQ's Blooming Flowers React to the Presence of Pedestrians. [online] Available at: https://www.archdaily.com/776260/hqs-blooming-flowers-shade-pedestrians-standing-beneath-them.
30. SEGD - The Society for Experiential Graphic Design. Enteractive at 11th and Flower. [online] Available at: https://segd.org/projects/enteractive-11th-and-flower
31. Urbanowicz, K., & Nyka, L. (2016). Interactive and media architecture – from social encounters to city planning strategies. Procedia Engineering, 161, 1330–1337. https://doi.org/10.1016/j.proeng.2016.08.597
32. Fredericks, J., Tomitsch, M., & Stewart, L. (2017). Design Patterns for Integrating Digitally Augmented Pop-ups with Community Engagement. International Journal of E-Planning Research, 6(3), 19–41. https://doi.org/10.4018/ijepr.2017070102
33. Dalsgaard, P., & Halskov, K. (2010). Designing urban media façades. In Proceedings of the 28th International Conference on Human Factors in Computing Systems (pp. 2277–2286). ACM. https://doi.org/10.1145/1753326.1753670