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Designing a Phygital Prosthesis for Urban Spaces

Merging Digital and Physical Realities

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KEYWORDS

Public Space
Phygital
Prosthesis
Internet of the things
Collab Music Production
Generative Algorithms

ABSTRACT

The "phygital" paradigm enables the creation of speculative narratives in contemporary human interaction, particularly in the context of the "new normal." The research explores the integration of physical and digital urban landscapes, aiming to create immersive experiences that could transform these environments. This effort results in the development of the Hyper-connector (prosthesis), an artifact that bridges the gap between physical and digital realms in public spaces. Acting as a facilitator, the Hyper-connector merges digital layers with physical spaces through human-computer interactions. This concept is made possible through advanced technologies, generative art, collaborative music, sound-reactive algorithms, and the Internet of Things. The article details the creation process of the Hyper-connector, addressing the potential of emerging technologies to overcome contemporary urbanism's limitations. Additionally, it explores how phygital prostheses could empower citizens to actively engage in the improvement of public spaces.

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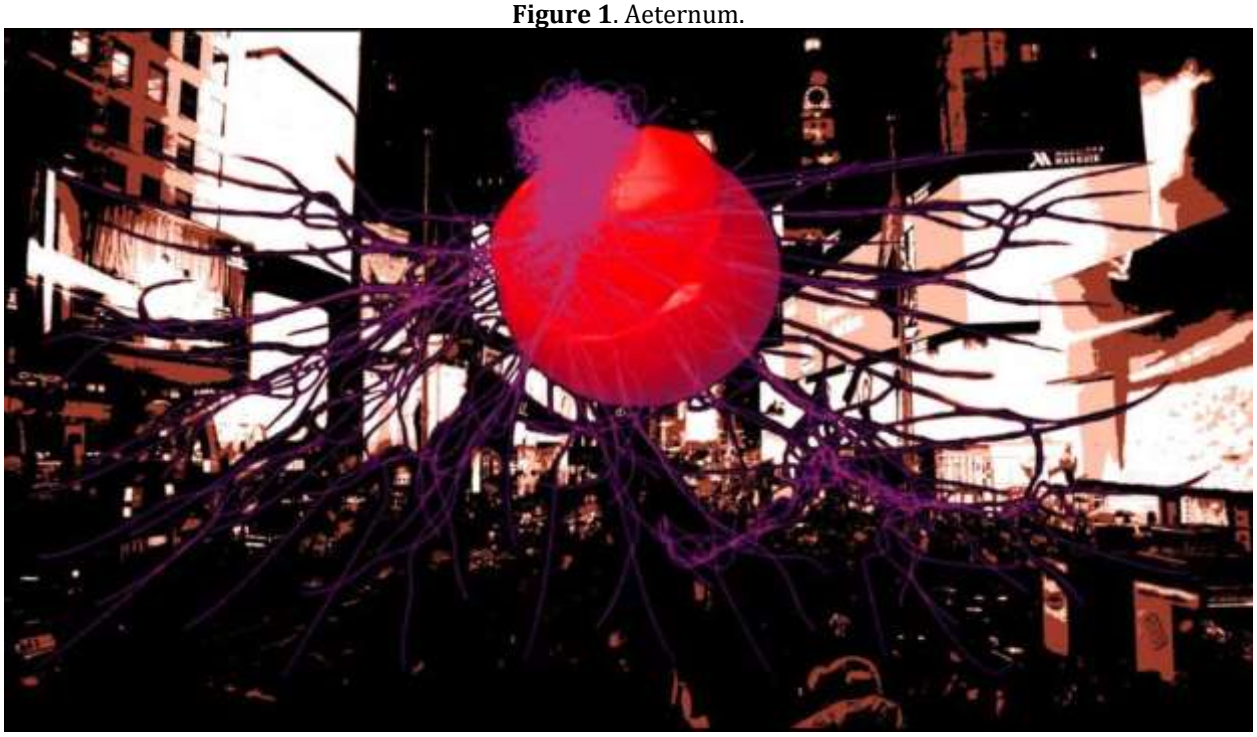
1. Introduction. MERGING WORLDS

Massive concerns about the destruction of reality over virtuality have been argued decades ago, the ideas of the proliferation of societies of the spectacle that Guy Deboard describes "Where the real world changes into simple images become real beings and effective motivation of Hypnotic behavior " (Debord G. , 2014, p. 6), people begin to fell in a wicked process of anesthetize all its time connected succumbed to the infinitive data updating, constantly flirting to the fluidity of Hyper-connectivity diving into an immersive virtual way of live, social networks such as Instagram, Tiktok are the cause of a considerably high percentage of human virtualization; in other words humans live more in virtual scenarios dazzling by the cultural shock as Paul Virilio describes "digital messages and images matter less than their instantaneous delivery; the shock effect always wins out over the considerations of the information content " (Virilio P. , 2005, p. 143), virtual societies live in the intersection of spectacle and the shock effect forgotten the natural world, actions as the government of Seoul took installing traffic lights on ground have help to face against the "smartphone zombies" (Yonhap, 2022) the increasing behavior obsession over virtuality alert that our current societies are more digital than physical, prosthesis as smartphones have kill some natural actions that humans naturally flowed on public spaces in the past.The second and subsequent paragraphs in sections must have 0.5 first line indentation. Text should be single spaced, and spaces should only exist between paragraphs when using block quotes.

Figure 1. Aeternum.



Source: MAB 2021 workshop. Short Presentations. Image of the author. 2021.

With The spread of the posthuman ideas arose the concept of prosthesis that Bernard Steigler defines as "the prosthesis is not a mere extension of the human body; it is the constitution of this body qua "human. "" (Steigler, 1998, p. 152), but prosthesis has revolved around a replacement of a missing part of the body with an artificial one (del Blanco, et al. 2024), but the conception has been modified by the time, "the idea of prosthetics is a tool. Most people's cell phones are prosthetics. If you leave your cell phone at home, you feel impacted by not having it. It's an important part of your daily function and what you can do in a day" (Mullins, 2010), "the prosthetic imagination" speculate to define the term "phygital urban prosthesis" as a "hyper-connector" capable to merge physical and digital realms supported with human-prosthesis interaction.

2. Objectives

The overarching scope of this research is to investigate the potential of phygital technologies within urban landscapes, specifically focusing on the integration of physical and digital realms to foster more interactive and co-creative public spaces. This aim is pursued through the following specific objectives:

2.1. To Develop Immersive and Interactive Experiences Capable of Transforming Urban Landscapes:

The first objective is to create new forms of urban engagement through the development of immersive, interactive experiences that blend digital and physical realities. These experiences are not only aesthetic, but also functional, designed to enhance the way citizens interact with and perceive their urban surroundings. By employing technologies such as generative art, sound-reactive algorithms, and real-time data-driven visualizations, the research explores how urban spaces can be reimagined as dynamic, responsive environments that engage citizens in novel ways adding a new digital layer over the static infrastructure, The intention is to move beyond passive consumption of public space, offering instead a framework in which the urban landscape itself becomes an interactive, evolving medium that fosters deeper engagement with its inhabitants.

2.2. To Explore the Empowerment of Citizens Through the Implementation of Phygital Prostheses:

The second objective examines how the implementation of phygital prostheses—exemplified by the Hyper-connector—can empower individuals and communities to actively participate in shaping and improving public spaces. Central to this objective is the democratization of urban development processes through citizen engagement. By providing citizens with intuitive tools to interact with and modify their surroundings in real-time, the Hyper-connector promotes a form of participatory urbanism. The research aims to evaluate how these prostheses can facilitate a more inclusive form of urban engagement, where decision-making and creative contributions are decentralized and accessible to a wider range of participants. This objective addresses not only the technical aspects of how phygital prostheses operate but also the broader societal implications, focusing on the potential to foster more equitable, responsive, and co-created urban spaces.

2.3. To Experiment the Role of Alternative Communication Modes in Urban Interaction:

A third objective is to assess how emerging technologies can enable alternative modes of communication that overcome the limitations of traditional urban interaction. The Hyper-connector operates at the intersection of physical presence and digital augmentation, offering new ways for individuals to express themselves and interact with their environment. The research seeks to analyze how these technologies can facilitate new forms of dialogue between citizens and urban space, potentially overcoming barriers related to accessibility, language, and socio-economic status. By utilizing non-verbal and technology-driven communication methods, the Hyper-connector encourages a more inclusive form of interaction, where diverse populations can contribute to and benefit from shared urban experiences

3. Methodology

The methodology for this research is structured around a multi-phase approach, combining design-based research, urban prototyping, and empirical analysis. This approach seeks to both conceptualize and evaluate the potential of phygital technologies, with a specific focus on the development of the

Hyper-connector as a tool for transforming public spaces and fostering citizen participation. The following steps outline the methodological framework:

3.1. Conceptual Design and Prototyping of the Hyper-connector:

The research begins with the conceptual design and development of the Hyper-connector, a phygital prosthesis aimed at merging physical and digital realities within urban environments. Drawing from interdisciplinary fields such as human-computer interaction (HCI), urban design, and digital art, this phase involves both the theoretical exploration of phygital frameworks and the practical design of the Hyper-connector prototype. Key technologies incorporated into the prototype include real-time data processing, generative art, and sound-reactive algorithms. These technologies enable the Hyper-connector to respond dynamically to environmental stimuli, creating a symbiotic relationship between urban space and its inhabitants. The design process is iterative, allowing for adjustments based on both technical performance and user feedback.

3.2. Pilot Implementation and Urban Integration:

Following the design phase, the Hyper-connector will be deployed in selected urban environments as part of a pilot implementation. This phase is essential for assessing the real-world applicability of the phygital prosthesis and its potential to reshape urban spaces. A series of field studies will be conducted in various urban locations, chosen based on criteria such as population density, diversity of public space use, and technological infrastructure. During this phase, the Hyper-connector will be installed in public spaces, allowing users to engage with its interactive features. Data collection methods will include observational studies, user interaction logs, and feedback surveys to assess both the functionality of the Hyper-connector and the extent to which it enhances public space engagement.

3.3. Citizen Engagement and Participatory Urbanism:

A key methodological focus is to examine the role of the Hyper-connector in promoting citizen participation and democratizing urban development. To achieve this, the research will involve direct interaction with citizens through workshops, focus groups, and public demonstrations. These activities will be aimed at educating participants about the potential of phygital technologies and empowering them to actively engage with the Hyper-connector. By providing citizens with intuitive, accessible tools to modify their urban surroundings in real-time, the project seeks to foster a co-creation model in which urban space is shaped collaboratively. Feedback from these participatory activities will be crucial in refining the prototype and assessing its capacity to democratize urban design processes.

3.4. Real-time Data Analysis and Adaptive Interaction:

The methodology also includes the deployment of real-time data analytics to measure the effectiveness of the Hyper-connector in altering urban spaces and fostering public engagement. Data will be collected through the Hyper-connector's sensors and algorithms, which will monitor user interactions, soundscapes, and environmental changes within the public space. These data will be processed and analyzed using advanced computational techniques, allowing the system to adapt to user behavior and environmental conditions dynamically. This feedback loop is integral to the functionality of the Hyper-connector, enabling it to continuously evolve based on its interaction with users and the surrounding environment.

3.5. Evaluation of Long-term Impact and Scalability:

In the final phase, the research will focus on evaluating the long-term impact of the Hyper-connector on urban spaces and its potential for scalability. This phase will involve both qualitative and quantitative methods, including in-depth interviews with stakeholders, longitudinal studies of public space use, and analysis of urban data metrics. The aim is to assess how phygital prostheses can be sustainably integrated into public infrastructure and scaled to different urban contexts. Key considerations will include the technological feasibility of wide-scale deployment, the economic viability of maintaining such systems, and the social implications of phygital technologies in terms of accessibility, inclusivity, and urban equity.

3.6. Critical Reflection and Iterative Refinement:

Throughout the research, a process of critical reflection will be applied to both the design and implementation of the Hyper-connector. This reflective practice will allow for continuous refinement of the prototype based on user feedback, technical performance, and theoretical insights gained during the field studies. The iterative nature of this methodology ensures that the final version of the Hyper-connector is both functionally robust and aligned with the research objectives of empowering citizens and transforming urban landscapes.

4. Results

4.1. Hyper-connector-tool kit

The Greek root "hyper," meaning "beyond" or "over," and "connector" comes from the Greek word "konektōr" that means "to bind together" or "to fasten." It is often used in words related to joining or linking things together, such as "connect," "connection,". The hyper-connector, as a phygital urban prosthesis, is a technological innovation that enables a seamless integration of digital technology that be materialized in the physical realms, expanding the boundaries of urban design and public space, the combination of technologies such as collaborative music production, and sound reactive algorithms generated by creative code art make possible phygital experiences in public spaces, taking advantage of the “open-source technology might be used to aggregate skills, and ideas from a broad and heterogenous citizenry and actually make tangible changes” (Claudel & Ratti, 2018, p. 309).When experiences are a set of heterogeneous elements are tough to be replicated, but when experiences are homogeneous or evolve a limited action are easy to copy, it means that just a approximation of quantum-time-space ideas could help us to mitigate the pre-established linear conditions that Avant Garde public spaces allows, Last decades our linear way of life has developed “generations of human beings transformed into machines in the relentless pursuit of material wealth: We lived to work.” (Rifkin, 2011, p. 289), the danger of the material pursuit is the belonging that discard experiences converting us to a replaceable machine avoiding the speculative process trapping in a homogeneous reality. Currently digital realms have open new paradigmatic paths of livability when “all forms of creativity driven by digital technologies. In other words, digital creativity occurs when digital devices are used for various creative activities” (Lee & Cheng, 2015, p. 42), the present and future are quantum.

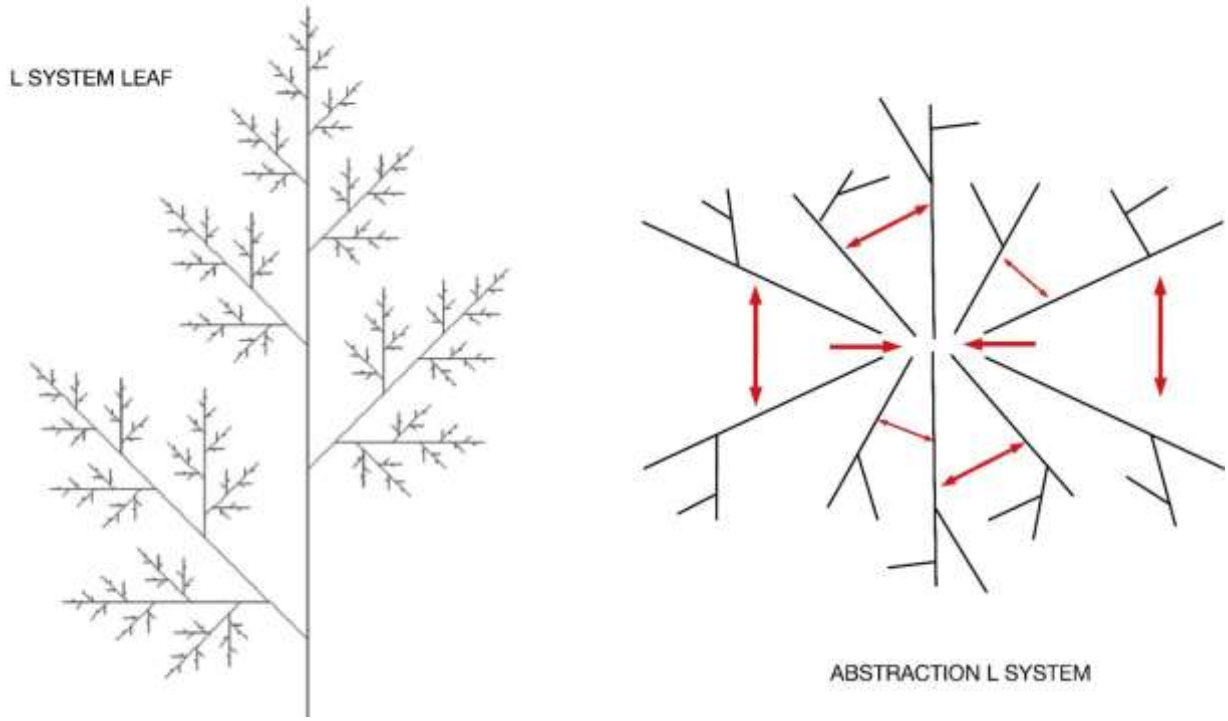
The Hyper-connector speculates with the idea of being the first phygital urban prosthesis developed as an urban prototype capable to be an extension of physical public spaces and humans-computer-interaction, addressing digital layers on physical public spaces, in “the late 1960s saw humanist disciplines contend with new human sciences that revealed ‘man’ to be a construct by exposing his technologies as supports and extensions.” (Harrison, 2013, p. 35), linking “as an extension or augmentation or enhancement of the human in investigations of the posthuman” (Morra, 2006, p. 11) ,the process of technification of human artifacts comes “from stone knives and axes that extended the capacity of the hand to the externalization of mental functions with the computer.” (Picon, 2004, pp. 114,121), digital transformation integrates a brunch of technologies such as IoT (Internet of the things),

sensors, boards, virtual reality, sound signals, sound reactive algorithms, and digital fabrication all of those technologies are components of the "Hyper-connector".

4.2. Shaping to plug in

This subchapter concerns to explain the speculative process of the shape creation of the "Hyper-connector", as a primary point in the design process was observing fundamental aspects of nature, one of the tools that helped to shape the Hyper-connector was forms found in nature on the L-systems parameters found in the branches of trees, the ramifications have features that fit with the aim of creating a collaborative, participative, and co-creative device employing social distancing parameters and enhance the user experience with human computer interaction, the "Hyper-connector" deploys wires as branches around its core, each branch-wire has a predeterminate number of sound-reactive patches that allows to stakeholders integrate and plug-in with the physical and digital realms while interact with the patches, allowing the Improvisation of immersive experiences as Charles Darwin argues " In the long history of humankind (and animal kind, too) those who learned to collaborate and improvise most effectively have prevailed" (Darwin, 2015, p. 23) , considering the speed growth of city dwellers, and the rampant rise proliferation of mental illnesses, public spaces need to be spaces of dynamism and co-creative and collective creativity.

Figure 2. L Systems abstraction



Source: Example and diagram of L-SYSTEMS. Figure of the author, 2023.

4.3 QUANTUMLAYERS, SOUND

Our environments have multiple layers that configurate our perception, most of them are visible as part of a physical network limiting our quotidian spaces, buildings, streets, squares, and parks use their geometrical shapes as boundaries of space, our cities define the limits of public and private, but what happens with the invisible layer that constantly dwell with us. "When, in due course, man invented words and music he altered the soundscape and the soundscape altered man. The epigenetic evolution interacting progressively between humanity and his soundscape has been profound" (Fuller, 1966, p.

52) , all objects in our world possess its particular sound that helps to difference and categorize them, cities produce an infinitive bunch of sounds that helps to grasp the dimensionality of space, proximity with objects that contribute to build a mental 3D scenario that helps to locate us inside a place:

> Regard the soundscape of the world as a huge musical composition, unfolding around us ceaselessly. We are simultaneously its performers, its audience, its composers. [...] Only a total appreciation of the acoustic environment can give us the resources for improving the orchestration of the soundscape. (Schafer, 1994, p. 205)

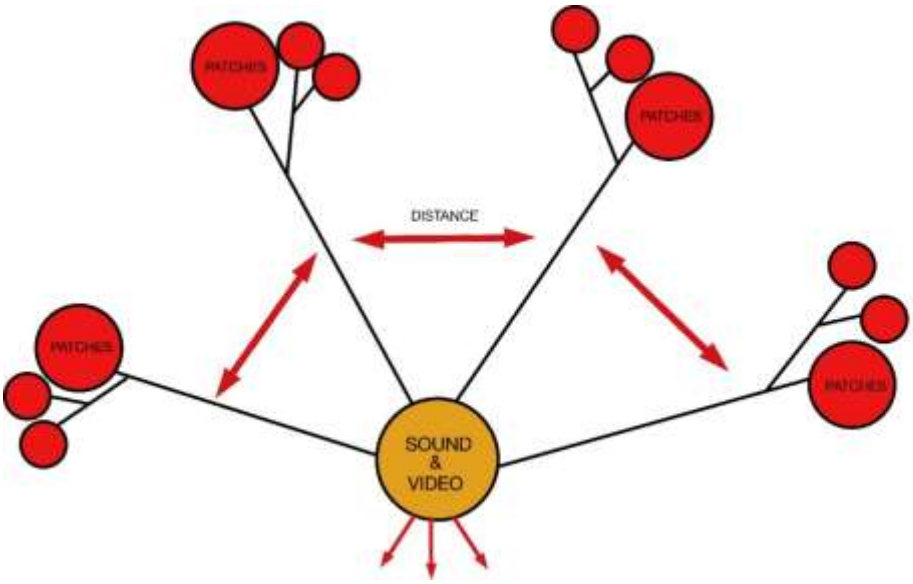
Sound is omnipresent, shaping our perception of space and influencing our emotional and cognitive responses to the world. It is an invisible layer yet powerful force that weaves through our daily lives, creating variations in our quotidian atmospheres, and identity within our environments. In the urban realm, sound is more than mere background noise—it is a fundamental layer of experience that connects people to places:

> The sonic city would not only enhance city life by helping to overcome the stress and anonymity of today's visual city, but would be one measure for developing the sensory awareness of city residents and would provide an environment more responsive to human action and purpose". (Southworth, 1969, p. 70)

But what are the main features of sound in public spaces, soundscape has the potential to alter the awareness of societies and help to perceive features of each environment, "sound provides the most forceful stimulus that human beings experience, and the most evanescent" (Smith, 2004, p. 389), contributing to create immersive experiences arise the idea of "Hyper-connector" as a giant "MIDI controller"(Musical Instrument Digital Interface) located on public spaces to address the speculation idea to create collaborative music, stakeholders that interact with the instrument experiment the potential to re-animate public places with immersive experiences that engage process to re-defining a co-creative and collaborative places as public spaces adding an additional layer as a sound as a tool for empowering the public participation and the art democratization in the creation and re-interpretation of spaces.

The creation of the "Hyper-connector" had some shape considerations, proximity and usability, to enhance the user experience we use L-System algorithm to shape it, the distribution of the patches considered the social distancing mandatory safety measures of COVID-19, and help to subdivide each branch that deploys from its core as an instrument, songs are composed by a set of instruments and people who plays within, but "MIDI controllers" have the capacity to provide fine-grained control over a wide range of musical parameters. They allow for nuanced and expressive manipulation of sound, providing musicians with a greater degree of control over their performance (Miranda, 2014, p. 153), additionally "MIDI" is a highly versatile and flexible protocol that enables the creation of complex musical systems and networks, allowing musicians to connect and control a wide range of instruments and devices from a single source (Collins, 2013, p. 78), the deconstruction of the "MIDI controller" as a "Hyper-connector" allows multiple people collaborate and interact in the process of creation of songs and melodies, bringing the capacity of each stakeholder to modify the tempo and frequency of each instrument of its preference, in the image below could see and exemplification of the physical interface of the "Hyper-connector".

Figure 3. Hyper-Connector Diagram.



Source: Explanation of formal distribution Hyper-connector. Figure of the author. 2023.

The advantages of the "Hyper-connector" developed as a giant "MIDI controller" are its scalability, and physical-digital adaptability, thanks to its shape and functionality the instruments that work in each patch can be modified and interchanged in a digital interface, one of the most useful music production is Ableton-live that works in a digital environment, addressing a long measure of digital instruments, sounds, VSTS(virtual instruments), effects, and PLUG-INs that help in the creation and performance of musical pieces. To set up the components and create the "Hyper-connector" need to follow the following steps

Table 1. Materials of Hyper-connector

Materials	Quantity
Touch Board	1
Arduino Uno	1
Protoboard	1
Shield cables (2.5m each)	12
Conductive paint	1
Paint can lid	12
Projector	1
Speaker	1
Micro USB cable	1
HDMI cable	1
Digital Audio Coaxial cable	2
CNC fabricated case	1
Tin solder	1
Solder station	1
PC	1

Source: Figure of the author. 2023.

4.4. Set up Arduino IDE and Add Files

Download Legacy Arduino IDE (1.8.X) from Arduino website

Save to Applications folder on macOS or run installer on Windows

Note: Touch Board doesn't work with Arduino web editor

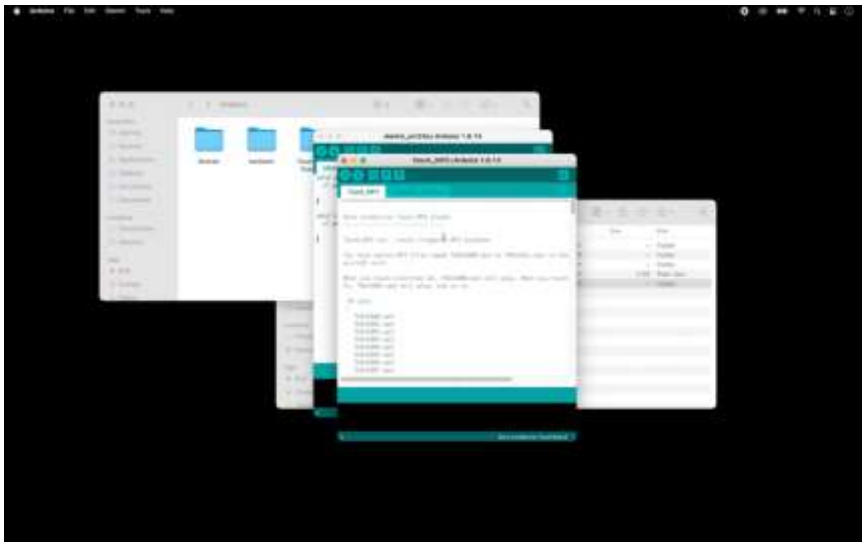
For Windows, install Arduino IDE from Arduino website, not Windows App Store

Open and close Arduino IDE to create necessary folders in Documents folder

Download manual installer

Follow included instructions to copy folders to correct locations

Figure 4. Set-up Arduino.



Source: Figure of the author. 2023.

Title: Change Touch Board Code

Open Arduino IDE and select Touch_MP3 code from examples

Connect and turn on Touch Board

Driver installation may appear to fail on Windows, wait up to 2 minutes

In Arduino IDE, select board and port

Choose port with "CU" in name (Linux/Mac) or Bare Conductive Touch Board (Windows)

Click upload button and wait for confirmation

If driver installation fails on Windows, wait up to 2 minutes and try again.

Touch Board as a MIDI controller with Ableton Live.

Involves uploading the Touch and Proximity USB MIDI interface code to the Touch Board. Step Download the Generic MIDI Controller Ableton Live project and unzipping it to a convenient location.

The Touch Board is plugged in, and the Live project is opened, and the Touch Board is selected under Input in Live/Preferences/MIDI Sync.

Unplugging anything connected to the electrodes on the Touch Board and re-mapping the electrodes to different functions in the project.

Experiment adjusting the range and sensitivity of the sensors using the uploaded Arduino code.

Figure 5. Interface of Ableton live 11.

Source: Figure of the author. 2023.

Each column in the image belongs to an assigned digital instrument, each digital instrument can be digitally modified in Ableton live, mapped the characteristics of the digital instrument to a "MIDI controller", with the help of Arduino, Processing, Touch-board, jumper cables and the lids of the paint cans as recyclable conductive elements, materialize the “Hyper-connector” that subtracts the data generated through human interaction with the paint caps to convert in sound, parameters such as contact intensity, tempo variation and frequency could be modified by stakeholders each instrument convert physical actions to digital signals and reproduced in the physical environment; In this case, each branch that makes up the "Hyper-connector" is a different digital instrument, thanks to the use of technology such as IoT, we can deconstruct a scalable, adaptable MIDI device and take it to the public sphere, to use it in the process of creating experiences. co-creative collaboratives that are executable thanks to the use of phygital urban prosthesis “Hyper-connector”.

Figure 6. Testing patches of "Hyper-connector"

Source: Figure of the author. 2020

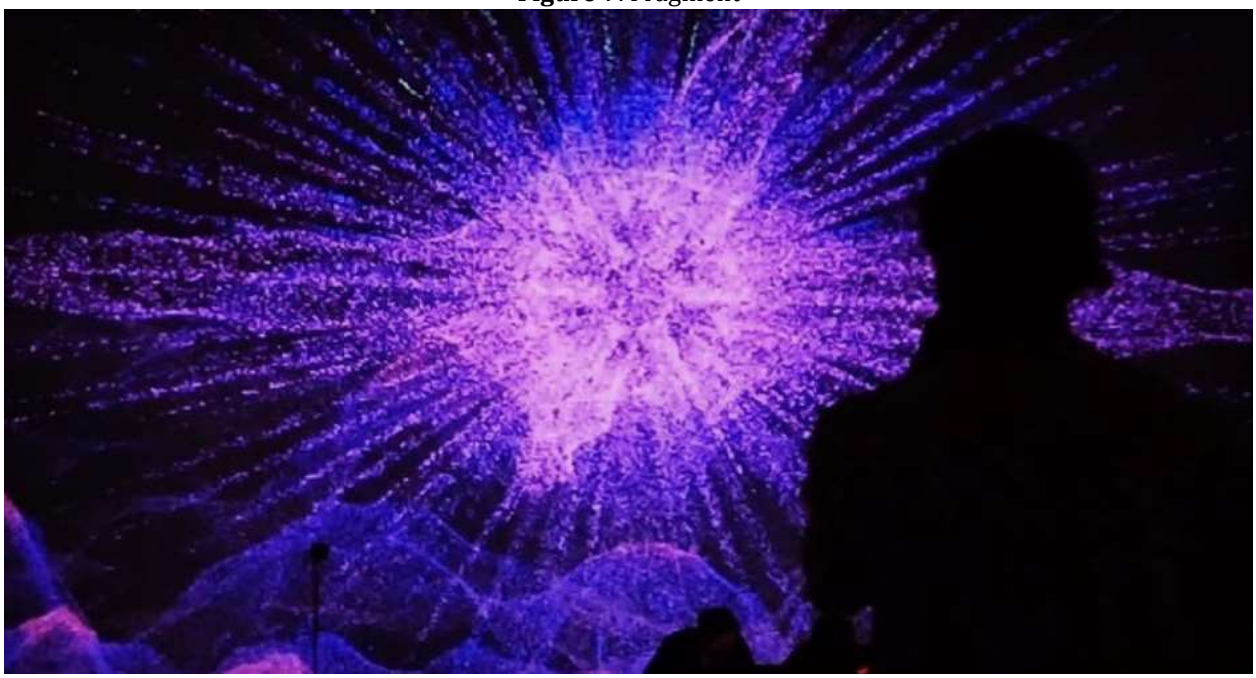
The development of artifacts that engage with the speculative process of creation that mold “a dynamic environment that actively shapes the spatiotemporal continuum of which we are part" (Kember, 2012, p. 158) could be more common enforcing the sense that “Human beings are social

creatures - not occasionally or by accident but always. Sociability is one of our lives as both cause and effect" (Shirky, 2009, p. 19)

4.5. Creative code

Our way of life acts as an algorithm deploying infinitive measure of data, that set of invisible information are part of our nature of being humans, all of the parameters associated with us build routines that integrate a set of data that re-write our code in real time, our presence constantly re-shape with the decisions that take and will take, code was created and wrote by humans, and humans are part of nature, so we are essentially nature of code. The intersection of code and data with human interaction in cities has led to the emergence of new forms of social and cultural interaction, enabling people to engage with their urban spaces in creative and meaningful ways (de Lange & de Waal, 2017), public spaces are beyond physical realms, the environment is now entangled, "supplanted by a more complex and non-linear pattern of urban development in response to the spread of new information technologies." (Allen, 2005).

Figure 7. Fragment



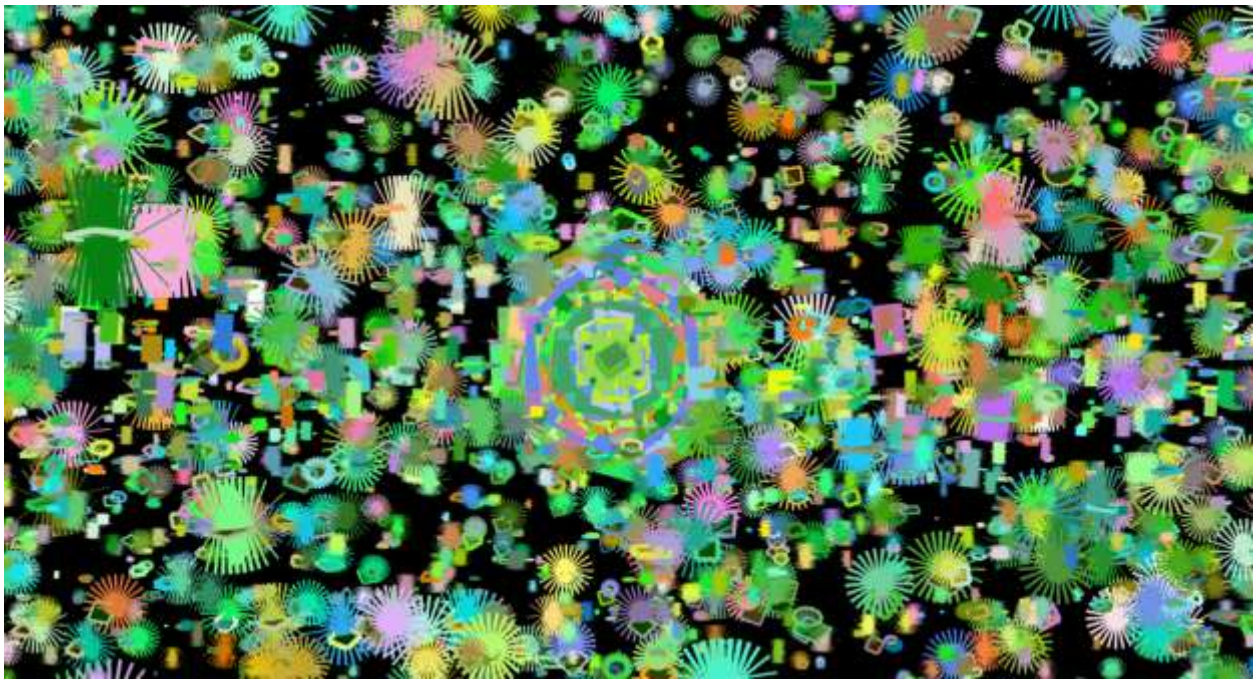
Source: Live Performance, ArsElectronica. New York . Figure of the author. 2021.

The implementation of Generative algorithms depict as sound reactive creative code help to enhance the user experience of the "Hyper-connector" adding a digital layer which is generated by the interaction between the scripted parameters of the code which could be updated and modified and the sound that produce the phygital urban prosthesis in real time, attaching variables as number of participants (stakeholders), the frequency, and the volume of each instrument executed, "For millennia architects have been concerned with the skin-bounded body and its immediate sensory environment . . . Now they must contemplate electronically augmented, reconfigurable, virtual bodies that can sense and act at a distance but that also remain partially anchored in their immediate surroundings." (William J. Mitchell, 1996, p. 43), in light of highlight the contribution to the expansion of such technologies was made by the democratization of mobile AR and VR devices (powerful smartphones, augmented reality glasses, virtual reality handhelds) and the adoption of many AR and VR games and apps in the mainstream (Wagstaff, 2018), as the democratization of public screens to showcase digital art exhibitions, and the increasing number of interactive experiences that use new media art as a language of communication and expression enforcing the idea that "the city is humanity's laboratory; where people flock to dream, create, build and rebuild" (Glaeser, 2012).

Hyper-connector address two invisible urban layers represented by the sound and the generative code, the merge of the two technologies blur the limits of traditional urbanism, speculating about a new space-time perception of stakeholders in public spaces, thanks to the use of the phygital urban prosthesis augmented the capabilities of the physical environment of public space, and the creative speculative actions of stakeholders, enforce:

> The democratization of [the right to the city], and the construction of a broad social movement to enforce its will, is imperative if the dispossessed are to take back the control which they have for so long been denied, and if they are to institute new modes of urbanization. Lefebvre was right to insist that the revolution has to be urban, in the broadest sense of that term, or nothing at all. (Swyngedouw, 2006, pp. 23-40)

Figure 8. Geometrical Flow.



Source: PCD Coimbra conference. Figure of the author. 2022.

Thanks to the use of sound reactive algorithms the interactive immersive experience provoked by the "Hyper-connector" could be ephemeral, adaptative, speculative, and overall temporal, without affect the physical space, open new paradigms where simulations could fling a infinitive number of possible modifications, all the algorithms used by the "hyper-connector" were scripted from scratch in processing, and P5JS, both softwares are free and open source,

4.6 LET THE ART PLAYS YOU

Art improvisations can be seen as the process of continue creation, "Life is the art of drawing without an eraser" (Radmanesh, 2006, p. 269). Therefore, speculative process affirms the importance of the its application, allowing the exploration of new ideas. "For the first time perhaps, architecture itself with a deeply non-tectonic reality. Given these premises, how can the designer be in deep accordance with the invisible flows of information that constitute the bones and flesh of the digital world" (Picon, 2009, p. 49). New media art should be a fundamental part of monumental static architecture, addressing its dynamic, networked, and fluidity, allowing alternative ways of thinking of public spaces.

Highlighting that some innovative and creative processes arose from the ideas of Hulzinga. "All play transcends the immediate need of life and imparts meaning to the action. All play means something."

(Huizinga, 1995), play makes worlds through metaphor, accounts for worlds through myth and cares for worlds through ritual (Sutton-Smith, 1997) , the paradigm of new media art allows this new typology of tools emphasizes individuals and individual minds. In fact, it is exactly the emergence and growth of digital technologies that contributed to new, systemic ways of thinking and talking about creativity (Glaveanu, 3028). Incorporating concepts of the quantum physics such as superposition and entanglement.

Figure 9. Hyper-connector- phygital urban prosthesis

Source: Video Fragment. Temporary Atmospheres.2023. Figure of the author.

Improvise could engage quantum process of creation involving the use of non-deterministic, non-linear, complexity, and uncertainty, merging digital layers with intuitive process of co-creation, the results of the actions finally translate as a complex uncertainly collaborative process of improvisation, where electrons and bits intersect and interact in random parameters to communicate abstract geometrical elements.

Figure 10. Hyper-connector- phygital urban prosthesis

Source: Video Fragment. Figure of the author. 2023

5. Conclusion

The creation and introduction of phygital urban prosthesis in public places address numerous benefits to the society, the creation of immersive co-creative and collaborative art experiences that help to face the accelerated increasing of mental illness in current societies, more interactive and dynamic public spaces that address new features that architects and designer could create new opportunities of model business, the empowering process of citizenship that collaborative and co-creative experiences add to the public space enforce democratization of knowledge exchange and art. The prosthesis is designed to produce collaborative music and sound reactive algorithms that generate new media art, and it is equipped with sensors that acts as a MIDI controller that help to react to the artistic code scripted in Processing, creating an audio-visual immersive atmosphere, citizens could modify the code-form-sound in real-time in public spaces. According to Büsser and Löwgren, "media art can be a powerful tool for creating social change, making artistic statements, and empowering communities" (Büsser, 2011, p. 5) Therefore, the implementation of the “Hyper-connector” in public spaces can encourage collaboration and creativity, and provide an avenue for stakeholders that want to express themselves and showcase their talents in a way that use art as a language of communication in public realms.

Moreover, the democratization of new media arts with the implementation of phygital urban prosthesis in public ephemeral installations help to the citizen dwellers to exhibit their works and share knowledge is a highlight aspect that can contribute to the enrichment and dynamism of public spaces. As stated by Fleischmann and Strauss, "a key challenge in the development of new media art is the democratization of access to the means of production and exhibition" (Fleischmann & Strauss, 2001, p. 173) The use of the phygital urban prosthesis “Hyper-connector” can contribute to spread the new paradigm of phygital public spaces.

However, it is important to acknowledge that the implementation of such prosthesis also comes with some drawbacks. One of the main challenges is the elevated cost of this kind of prosthesis, as well as the complexity in electronics and the maintenance of each one. Additionally, variable weather conditions could affect the functionality and damage the prosthesis, which requires constant monitoring and maintenance. Despite these challenges, the potential benefits of the phygital urban prosthesis “Hyper-connector”, considering that the prototype is still in its early speculative phases, it is necessary to optimize it to adequately define the limitations, cost and resistance to extreme weather conditions, outweigh the drawbacks, and the “hyper-connector” can be scaled up for other uses as well, such as a

simulator of physical changes, interactivity gamification experiences, and to help in the creation of quantum experiences.

In conclusion, the phygital urban prosthesis presented in this project can bring numerous benefits to society, including mental illness recovery, more interactive and dynamic public spaces, and an empowering process of citizenship. Additionally, it can contribute to the democratization of new media arts and enable people to create, exhibit, and share their works with others. However, the implementation of this prototype also comes with some challenges, including cost, complexity in electronics, and maintenance. Nonetheless, the potential of the phygital urban prosthesis for creating quantum experiences and other uses shows its scalability and promising future, speculating with the idea of a future where quantum artistic experiences could showcase in public space.

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