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# *ANCESTORFUTURIST* EXPLORATIONS WITHIN A *DESIGN-TO-ROBOTIC-OPERATION* FRAMEWORK

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**ABSTACT**

The workshop on Cyber-physical Spaces at the HIPERORGÂNICO 8: Ancestorfuturism (H8A) Symposium identified linkages between Constant's vision from the 60-70s and its potential implementation with today's technology. It engaged in the investigation of utopian/dystopian visions about future habitats by reinterpreting Constant's New Babylon and introducing dynamic or interactive functional-ities to inhabitable space. Utopian/dystopian aspects were addressed by exploring on the one hand the potential of cyber-physical systems in architecture, on the other hand the challenges of overpop-ulation and urban densification, etc.

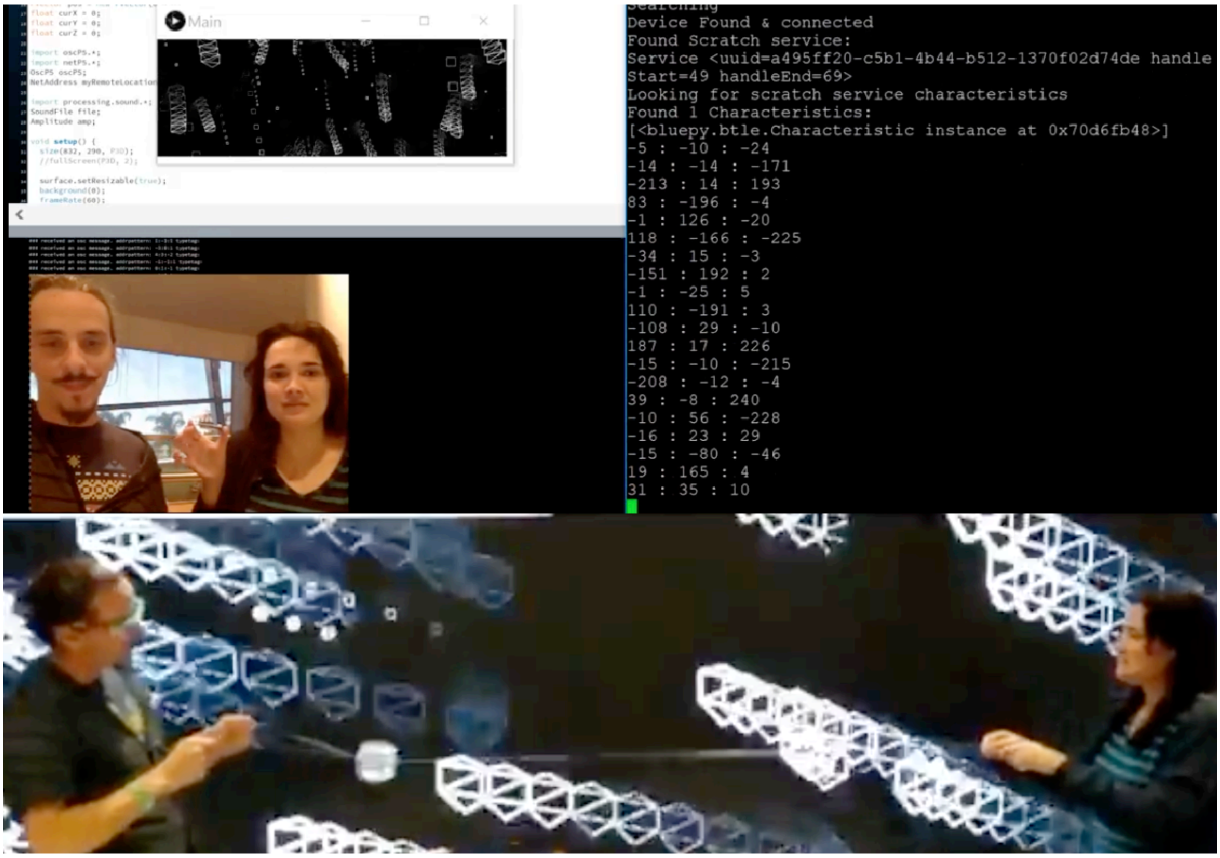

Fig. 1: Linking accelerometer with virtual representation (top). Accelerometer embedded in ball on two strings (bottom) is used to broadcast accelerometer data wirelessly to a listening node within an intelligent built-environment.

## INTRODUCTION

According to Borges [1] the notion of *ancestorfuturism* addresses a potential reconciliation between archaism and futurism by challenging the assumed linearity between past and future and by identifying possible linkages between the two. The workshop on *Cyber-physical Spaces* (CS) at the *HIPERORGÂNICO 8: Ancestorfuturism* (H8A) Symposium identified linkages between Constant's vision from the 60-70s of a future city [2] and its potential implementation with today's technology. It engaged in the investigation of utopian/dystopian visions about future habitats by reinterpreting Constant's *New Babylon* and by introducing interactive functionalities. Utopian/dystopian aspects were addressed by exploring on the one hand the potential of cyber-physical systems in architecture, on the other hand the challenges of overpopulation and urban densification, etc.

## DESCRIPTION

Utopian/dystopian visions responding to societal challenges were investigated by introducing workshop participants to the *Design-to-Robotic-Operation* (D2RO) framework developed at the *Technical University Delft* (TU Delft). The task was to design and to integrate a fully functional *Wireless Sensor and Actuator Network* (WSAN) into a Cyber-physical Space. WSANs lie at the core of *Cyber-Physical Systems* (CPSs) [3], which represent *State-of-the-Art* enablers of both *Architectural* and *Computational Intelligence* in the built-environment. Strategies and methods pertaining to D2RO [4–13]—an emerging *computational intelligence in the built-environment* paradigm developed at TU Delft [12–14]—are used to develop this WSAN in an open, scalable, and decentralized manner.

In this context, D2RO subsumes capabilities and motivations typical expressed via *Ambient Intelligence* (AmI) [15] / *Ambient Assisted Living* (AAL) [16], which are research fields situated at the intersection of the Engineerings (viz., Electrical, Electronic, Mechatronic, and Information Systems), Architecture, and Medical Sciences. Accordingly, an inherited motivation behind D2RO is to develop built-environments where systems and services expressed in terms of *Information and Communication Technologies* (ICTs) promote and sustain the general well-being, qualitative spatial experience of the inhabited space, and the comfort of the occupant(s).

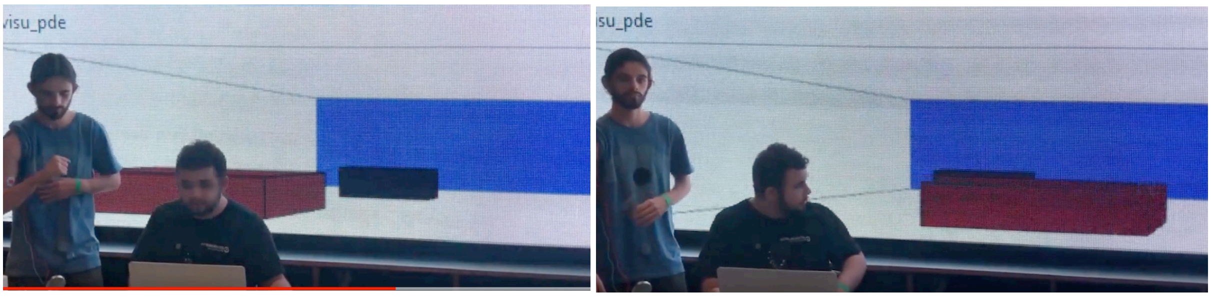


Fig. 2: Physical muscle contractions and arm orientations / motions are employed to select and move digital objects within a virtual space

Utopia/Dystopia

Utopias envision ideal communities or societies possessing perfect socio-politico-legal systems. The term is derived from More's book titled *Utopia* [17]. For instance, Constant envisioned the city of the future *New Babylon* inhabited by *homo ludens*[1] engaging in creative practice of daily life [18]. In *New Babylon,* land is owned collectively, work is automated and inhabitants engage in creative play. In contrast dystopias are communities or societies that are undesirable or even frightening as for instance described in Orwell's *1984* [19]. These are characterized by dehumanization, totalitarianism,

[1] Playing human (in Latin)

environmental disaster, or other characteristics associated with a cataclysmic decline in society. Both seem to have been and continue to be present in ancient and futurist contexts. *New Babylon* representing a past vision of utopian cities resulting from automation fits today's utopian and dystopian visions resulting from automation, overpopulation and urban densification.

*Design-to-Robotic-Operation*

As part of a larger *Design-to-Robotic-Production- Assembly and -Operation* (D2RPA&O) framework *Design-to-Robotic-Operation* (D2RO) relies on the integration of robotic and/or cyber-physical and cloud-computing technologies of the 4th industrial revolution into architectural operation. It implies the use of cyber-physical and/or robotic systems and the Internet of things and services in order to monitor physical processes by creating virtual representations of the physical world that support decentralized decisions making [20]. Thus, D2RPA&O relies on (a) interoperability, which is the ability of robotic systems, humans, and factories/buildings to connect and communicate via the Internet of things and services, (b) virtual-physical coupling by linking sensor-actuator data (from monitoring physical processes) with virtual models and simulations, (c) decentralization, which is exploiting the ability of cyber-physical components to operate autonomously, and (d) real-time operation implying that data is exchanged in real-time [21, 22].

In the presented workshop the focus was on D2RO applied to Cyber-physical Spaces that extend human capabilities in the built environment by means of sensor-actuators.

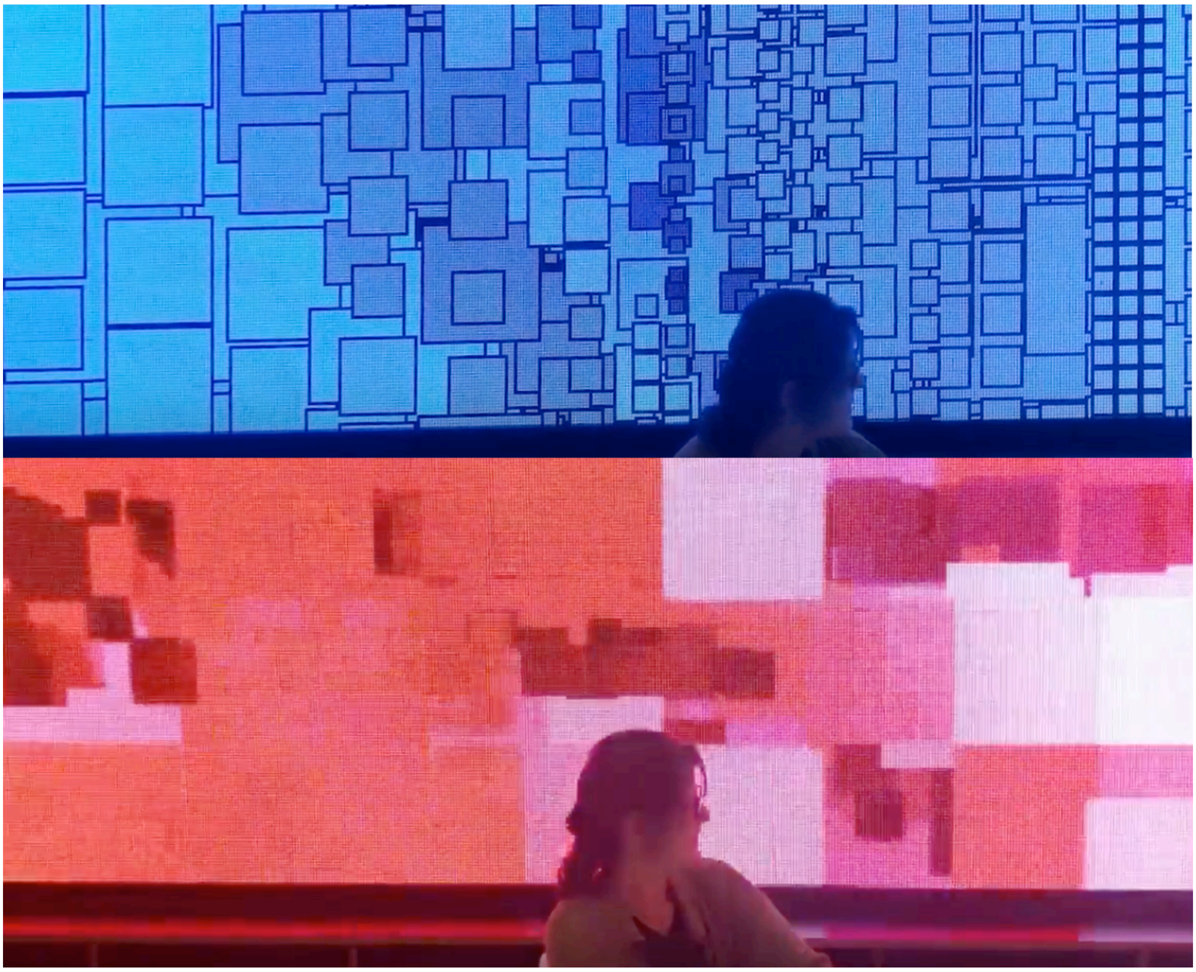

Fig. 3: Explorations with light-sensitive sensors that control pixelated pattern variations of a life-streamed video

Cyber-physical Spaces

The proposed Cyber-physical Space (CS) contains physical and software components that are deeply intertwined. Furthermore, the static and dynamic modalities of the space involve customization and reconfiguration, which are achieved by means of D2RO. In this context, three projects were developed at H8A with participating professionals and students. These projects aimed to interface the virtual and *physical* worlds via intuitive mechanisms, where instigated physical actions mirror actions or reactions in a virtual environment. The following is a short description of each project:

1. The first project used physical motion to define the position of digital objects within a virtual space (fig. 1). In this project, a wearable device (ball on two strings) was used to broadcast accelerometer data wirelessly to a listening node within an intelligent built-environment. This node, one of many in a larger System Architecture, relayed said data to a destination node that contained the program that generated the virtual environment. The incoming data informed the objects within said virtual environment to move in any perceived direction within a three-dimensional space, effectively echoing motions in the physical world within the virtual world.

2. The second project used physical muscle contractions and arm orientations / motions to select and move digital objects within a virtual space (fig. 2). In this project, an Electromyogram sensor attached to the forearm detected muscle contractions associated with the opening and closing of the fist. Moreover, an Accelerometer / Gyroscope / Magnetometer sensor attached to the same arm tracked its displacement and orientation. The resulting data was relayed wirelessly to a destination node that contained the program that generated the virtual environment. Unlike the virtual environment of the first project, the one in the second project represented objects such as windows, doors, lights, etc., within an intelligent built-environment. By pointing the arm towards a direction corresponding to one of these objects, the user could select it via muscle contraction and act on it via arm gestures. For example, the user could point towards a closed door, select it, and sway it open with a corresponding motion.

3. The third project used light-sensitive sensors to control the pixilation and fragmentation of a life-streaming camera (fig. 3). Several such sensors were used to determine the degree and origin of the distortion within said image. In a state where all sensors relayed readings within a predetermined range, the displayed image would be rendered as a normal reflection of a real location or space. But as soon as the readings exceeded said range, the resulting image would be rendered a fractal abstraction of said real location or space.

If utopian playful interaction is apparent in all three projects, a more dystopian scenario is considered in the second project, wherein by moving furniture in 3D space optimized use of space in high-density urban environments may be achieved. The purely mechanical spatial reconfiguration of such a scenario has been already implemented in Hong-Kong [23], where a small space of 32 square meters transforms by sliding walls across steel tracks into several subspaces accommodating functions such as kitchen, guest bedroom, library, dining room, laundry-room and spa. The H8A project enables this spatial reconfiguration to be implemented not only by adults but also by elderly, children, and special needs people.

**CONCLUSION**

These H8A projects identified opportunities to engage in futuristic cyber-physical explorations while promoting ancestor visions of *homo ludens*. Playfully interfacing virtual and physical worlds by mirroring physical actions or reactions in virtual environments, the projects seemingly disrupt the linear reading of time by emphasizing today’s virtual-physical continuum. These projects are indicative of tomorrow’s responsive environments, wherein humans interact with CSs endowed with some level of intelligence. Each proof-of-concept developed by the three teams instantiates a highly intuitive mode of interaction between the real (i.e., physical) and virtual, where the former affects the latter as if both belonged to one same domain. In this manner, the developed mechanisms represent distinct means to bridging the gap between the real and the virtual; and hint at the possibilities of how domain-heterogeneous services could be expressed as when deployed in a mixed-reality intelligent built-environment. To be sure, in their present state the interaction enabled by said mechanisms is demonstrated only unidirectionally, with physical states of affairs affect their virtual counterpart and not vice versa. However, the underlying System Architecture is structured and configured explicitly for bidirectional interaction, which is to be demonstrated in subsequent developments.

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