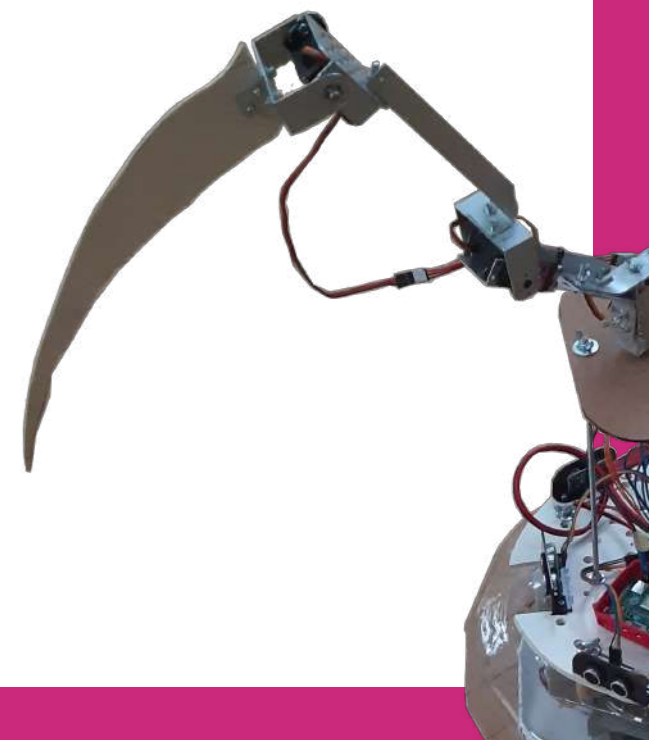




# AIRLAB

ARTIFICIAL INTELLIGENCE AND ROBOTICS LAB

## **THESIS PROJECT PROPOSALS**



**ONCE UPON A TIME IN A LAB..**

The following projects are kindly brought to you by



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# INTRODUCTION



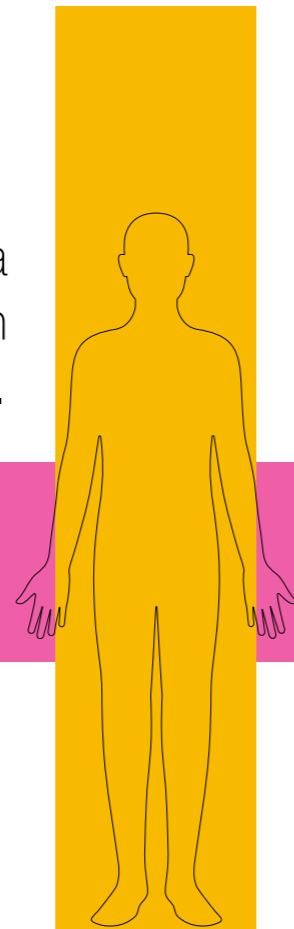
The following thesis proposals fall within the context of the research “**First Contact: Crafting Authentic Otherness to foster Social Interaction of Non-Humanoid Avatars**”.

The objective is to explore the minimal information required for humans to **understand and engage with *non-human entities***, social robots and virtual shapes, through **non-verbal communication**, focusing on creating authentic, believable, and **socially interactive characters**.

## THE SETUP *PHYSICAL METAVERSE*

Two humans will interact with each other through a “digital filter”. One is the Controller, and the other is the Visitor.

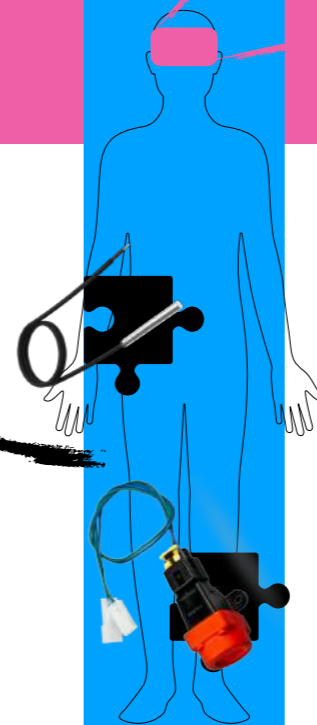
*The Visitor* is interacting with a robotic body, it is himself in relationship with the robot.



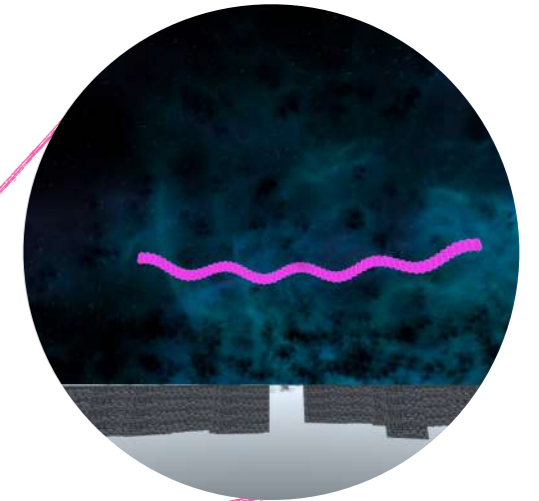
**VISITOR**



**CONTROLLER**



*The Controller*, in a different physical space altogether, **embodies the robot**, it controls it remotely, and perceives reality in an altered way: a translation of data received by the robot’s sensors in real-time. The representations it sees of the environment and of the Visitor are *abstract*, the human Visitor will *not be a recognisable* human to its eyes.

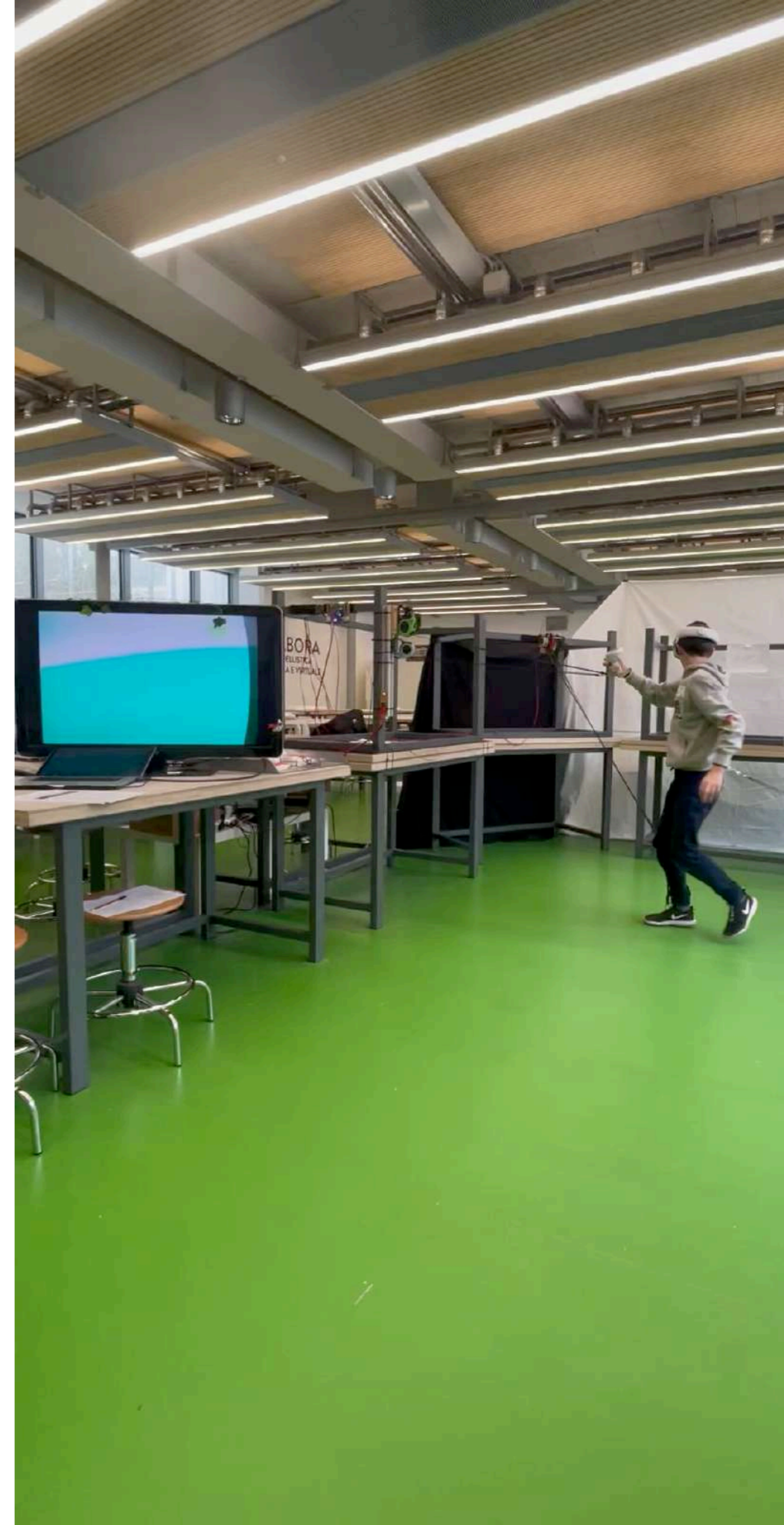


## THE RESEARCH *FIRST CONTACT*



The two humans are actually interacting, but through this “digital filter”. Neither is able to perceive a human directly: the Visitor perceives a robot, the Controller perceives an abstract shape. But in reality they are each the other human, “translated”. Crucially, the two can’t speak. They can only communicate through motion, of these new bodies.

Both instances can be considered **first contact** between two beings that don't know or understand each other at first, with non-anthropomorphic bodies, that need to find a way to learn how to communicate non-verbally to achieve some sort of objective.



project 1

# **MY ROBOT BODY**

## MY ROBOT BODY



How can we create a system that allows users to **naturally embody non-antropomoprhic avatars**?

This thesis proposal outlines a research project aimed at advancing our understanding of this critical aspect by exploring the role of individual robot **body components**, optimizing **embodied control**, and developing effective **proprioception mechanisms**.



## MY ROBOT BODY OBJECTIVES

The primary **objectives** of this thesis project are as follows:

*Component Analysis:* Investigate the key body components of existing robots, assessing their potential to convey agency, animacy, and social meaning during interactions with humans.

*Embodied Control:* Develop natural and intuitive control mechanisms for each robot body component, enabling users to manipulate them seamlessly.

*Proprioception Enhancement:* Design effective ways to provide users with real-time proprioceptive feedback, allowing them to perceive the state and actions of the robot's body components within a virtual reality (VR) environment.

*Convey Social Meaning:* Evaluate the effectiveness of the optimized robot components, control mechanisms, and proprioception techniques in conveying social meaning and enhancing non-verbal communication in human-robot interactions.



## MY ROBOT BODY PROJECT PHASES



### a. Component Identification

Identify and select specific robot *body components* for analysis, considering their relevance in conveying **social meaning**. These components could include limbs, manipulators, facial features, or other relevant structures.

### b. Embodied Control Design

Devise intuitive and *natural control mechanisms* for each selected robot body component. This will involve a combination of **sensor technologies**, haptic feedback, and gesture-based control interfaces to facilitate seamless manipulation.

### c. Proprioception Development

Create *VR-based proprioception* systems that offer real-time feedback on the state and actions of the robot's body components. This may include visual representations, or other sensory cues.

### d. Human-Robot Interaction Testing

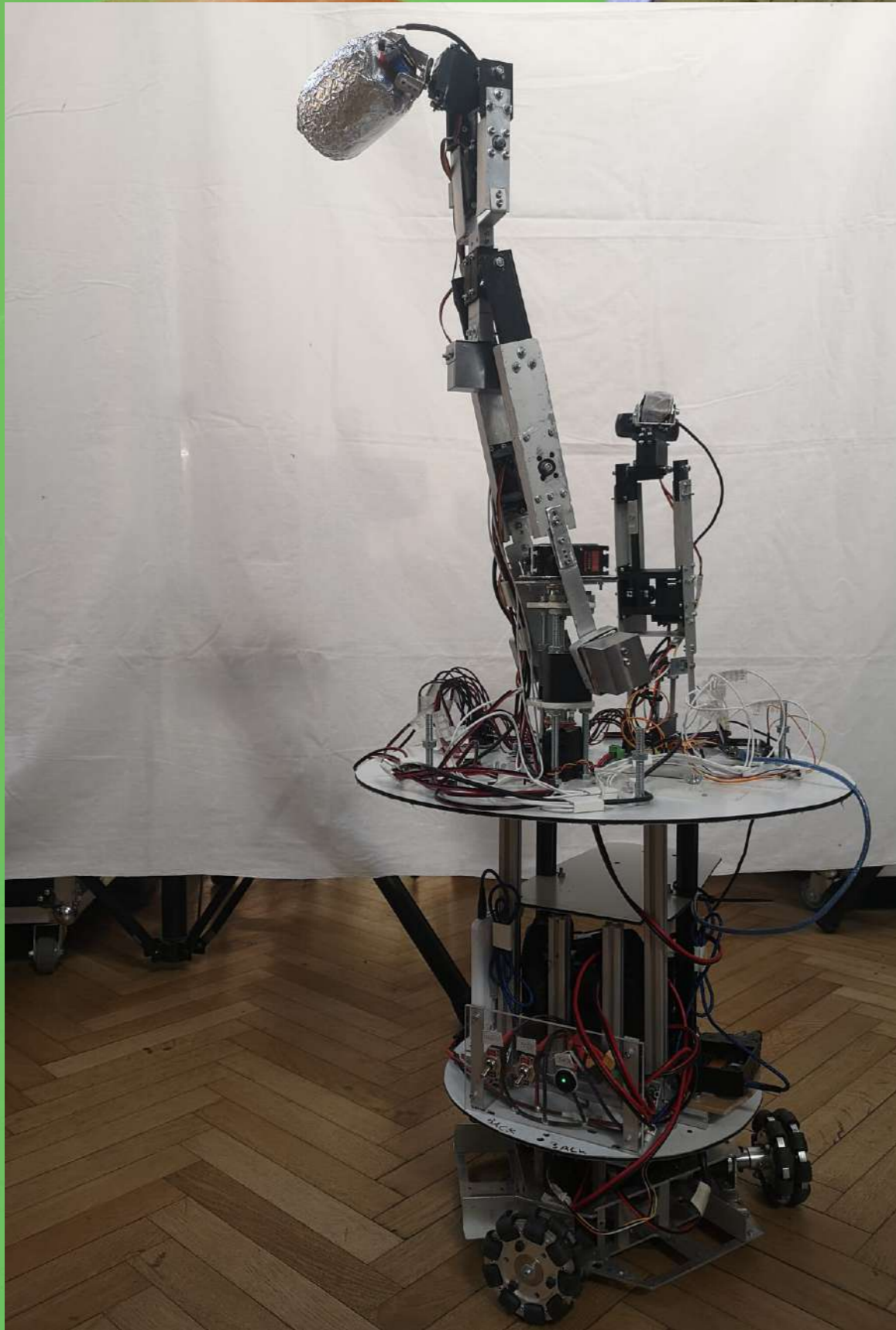
Conduct *extensive user testing* to evaluate the effectiveness of the optimized components, control mechanisms, and proprioception techniques in conveying social meaning during human-robot interactions. In the final scenario the user controls a robot playing in a *maze-like escape* room with another user in the **real world**.

### e. Data Analysis

Analyze the data collected during user testing to assess the success of the proposed components, control methods, and proprioception systems in achieving the project's objectives.



**MY ROBOT BODY** *THEM ROBOTS*



project 2

**THE ROOM**

# THE ROOM

Imagine you could step inside a room that is more than just a lifeless space.

A room that is designed to interact with you and communicate with you through movement and other non-verbal cues, an enclosed space that has come to life.



# THE ROOM

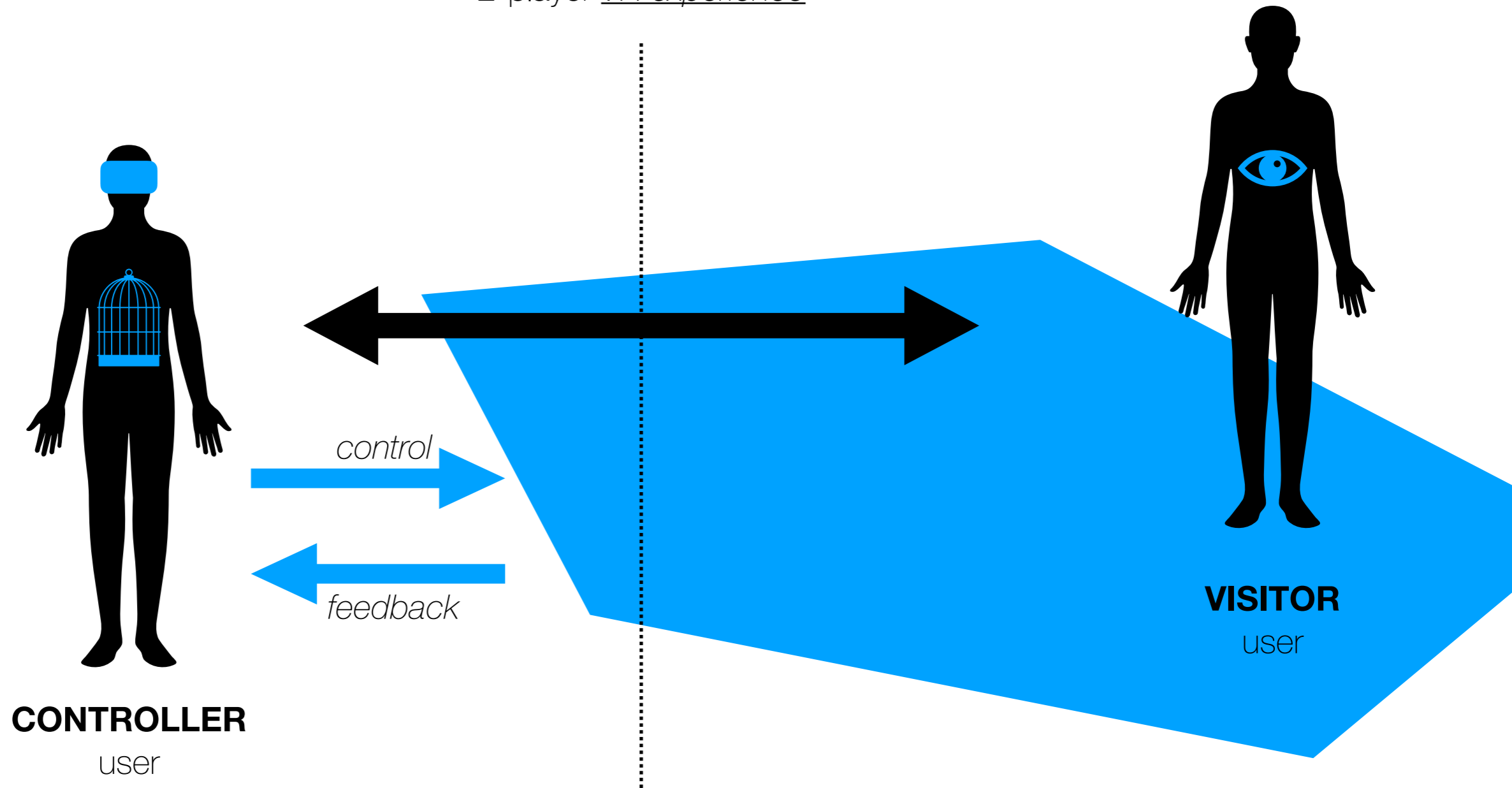


The project consists of the design and implementation of physical hardware and software modules of an entire mechatronic room, designed to be an interactive and engaging character that responds to your presence and actions. The Room is an “*avatar*”, controlled by a human user, and will engage in social interaction with the visitor of the Room. The project output will be a mixture of design, to imagine the modules, the experience they can lead to and explore the potential of different materials like cloth, and engineering work to complete the hardware and software.

# THE ROOM SETUP

## A "ROOM AVATAR"

Two users will be interacting non-verbally within a 2-player *VR experience*



The two users are **interacting through *the room***

The room is the ***non-anthropomorphic avatar*** of the controller user in this virtual metaverse

## THE ROOM OBJECTIVES

The primary **objectives** of this thesis project are as follows:

### *Design and Implementation of Mechatronic Room Modules:*

- Conceptualize and design hardware and software modules that enable the mechatronic room to perform a variety of actions and convey sensations.
- Explore materials such as cloth and their potential in enhancing the room's interactivity.

### *Engineering of the Mechatronic Room:*

- Execute the engineering work necessary to construct the physical mechatronic room, integrating the designed modules seamlessly.
- Ensure the room is fully functional, responsive, and capable of engaging in social interactions with visitors.

### *Real-World Testing and Contextual Evaluation:*

- Deploy the mechatronic room in real-world contexts to assess its performance and user engagement.
- Gather data and feedback from users to refine and improve the room's interactive capabilities.





## WHY A ROOM?

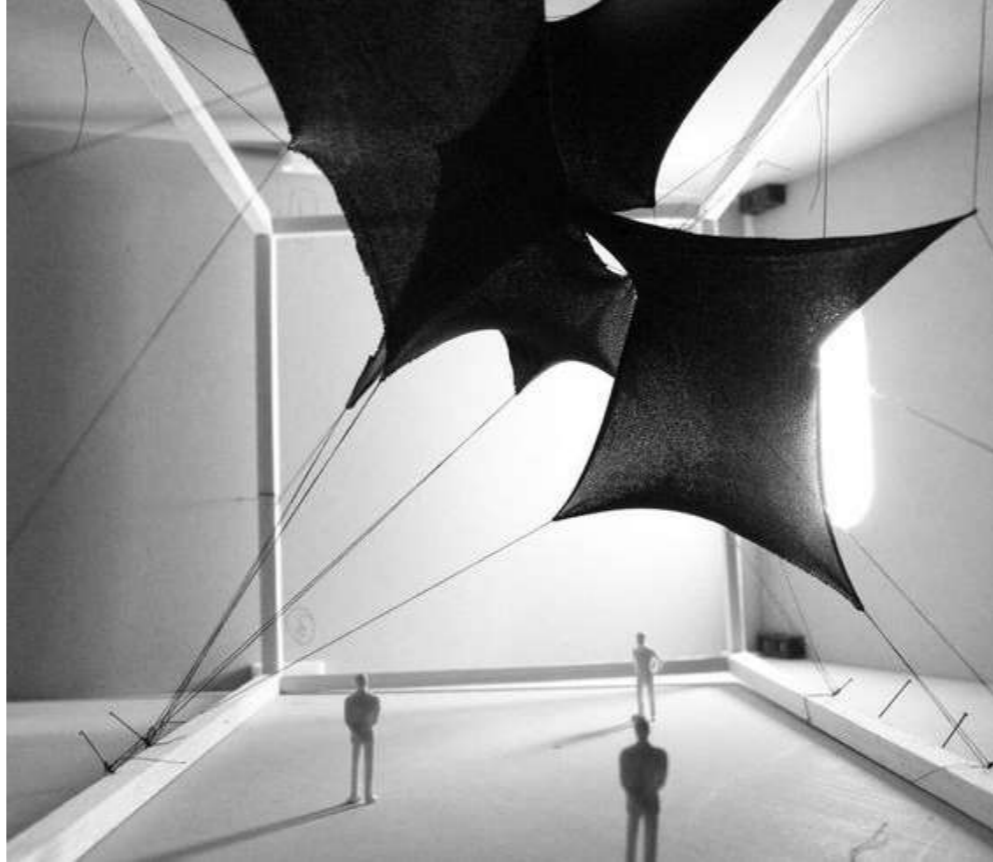
The room pushes *non-anthropomorphism to the limit*

Room-human interaction is radically different from what we are used to

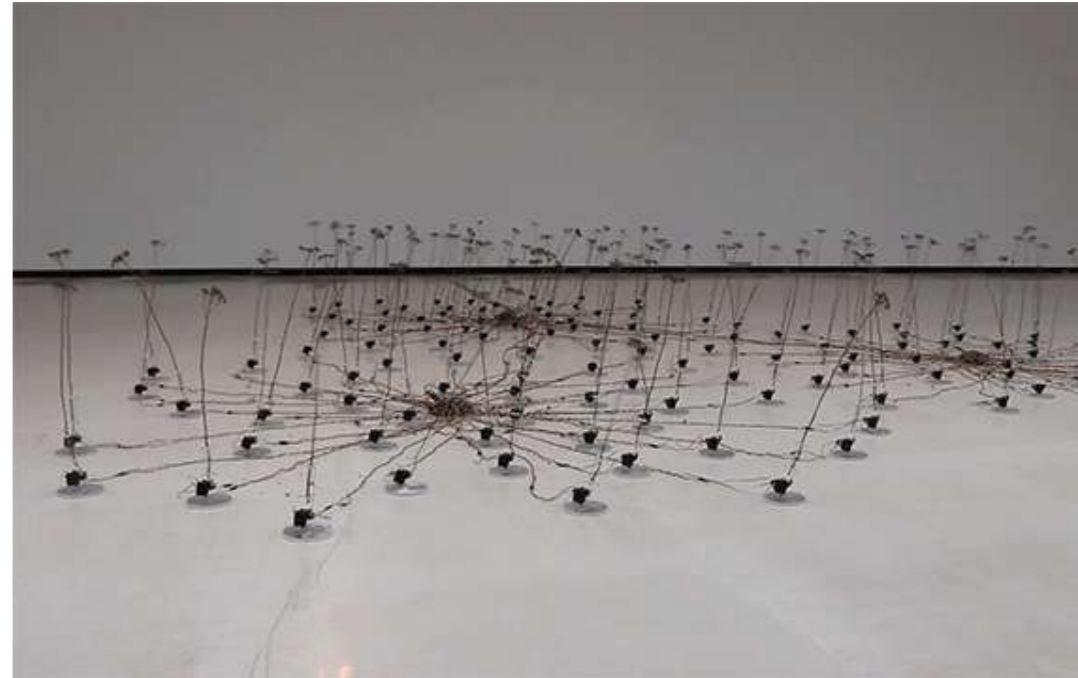
- No symmetry: one body is “within another”
- Personal space: what is the meaning of “distance” and personal space when a body is “within another”
- No focal point: the room avatar has no concept of “a face”, eyes, ears, .. it’s all distributed

Can we find ways to make meaningful nonverbal interaction with all these limitations and differences?  
If we can, we will have identified **something very general** about the mechanisms of interaction

# THE ROOM IDEAS



BRUCE NEUMAN

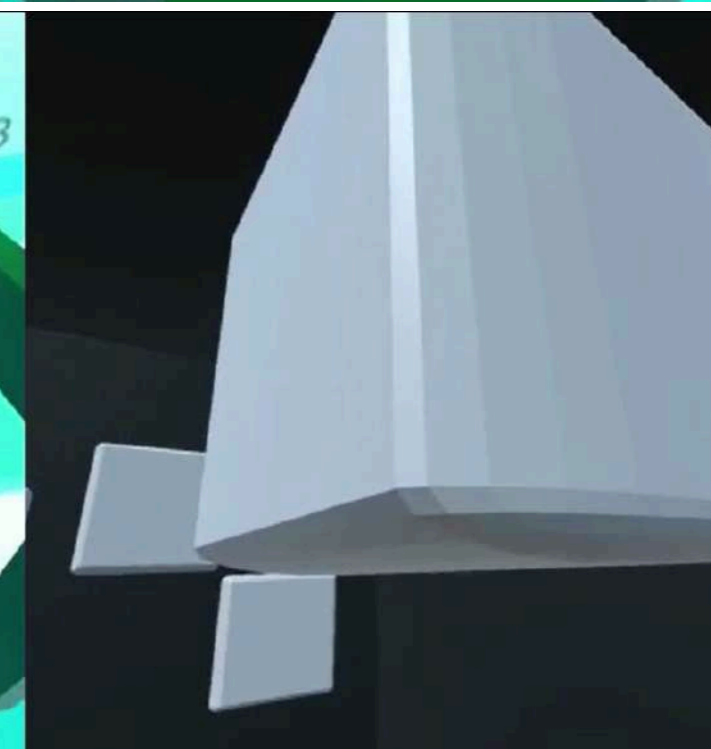
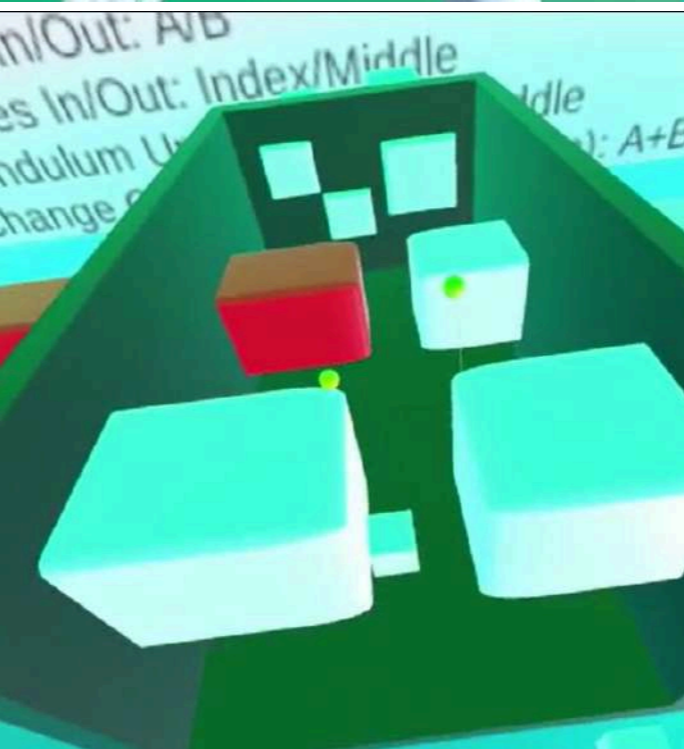
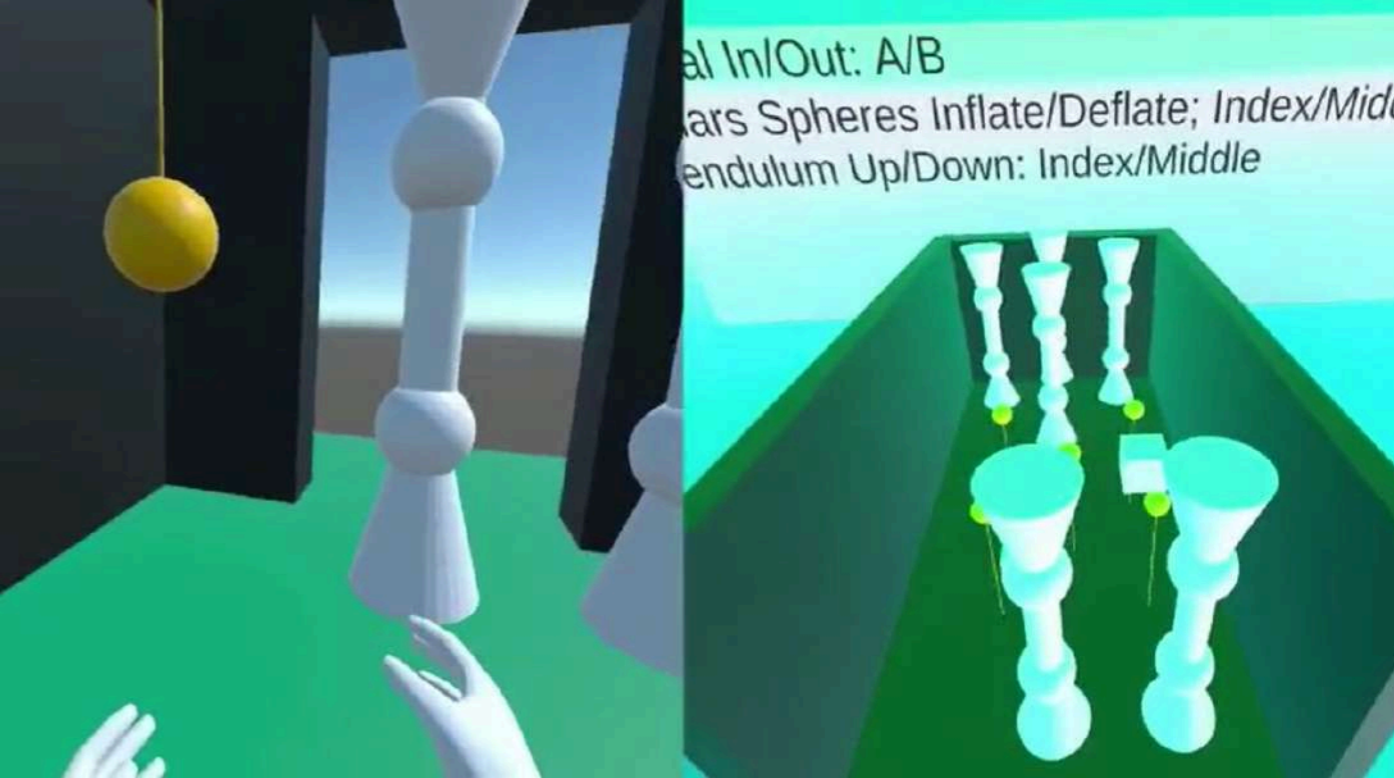
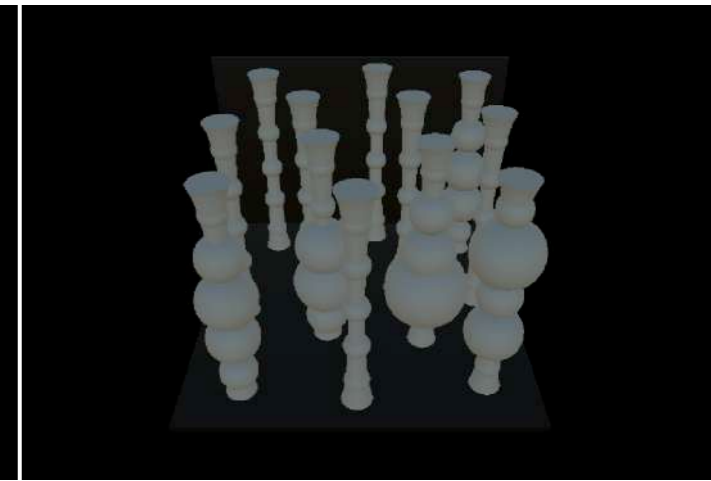
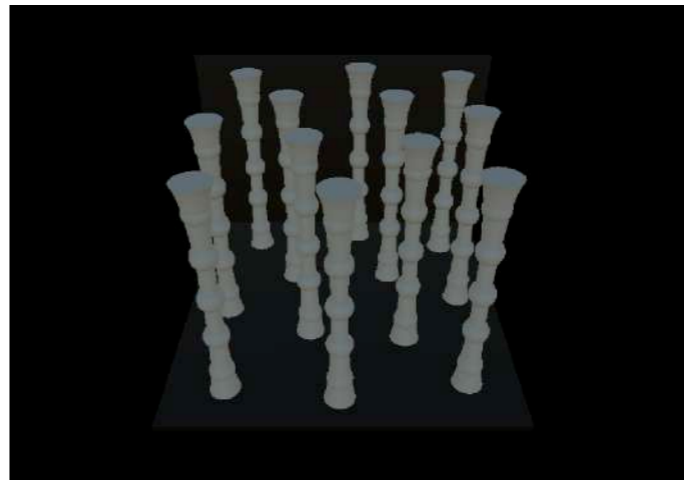


ERNESTO NETO



Horror vacui  
2015

# THE ROOM PROTOTYPES



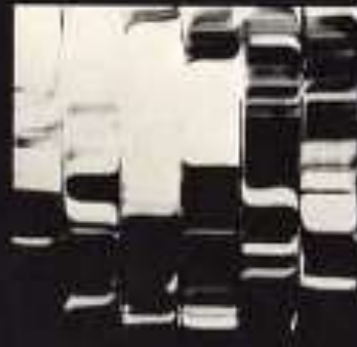
project 3  
**ECHOES**

# ECHOES



auto-vision, serie no. 2

auto-vision, serie no. 3



auto-vision, serie no. 4

auto-vision, serie no. 5

What is **the role of sound** within the Physical Metaverse? A fundamental aspect of this interaction is the exchange of information between the two humans. While **visual cues** have played a pivotal role in this context, the integration of **multisensory** modalities, including **sound**, holds immense potential to enrich the quality of human-robot communication.

This thesis proposal outlines a comprehensive research project aimed at **exploring the role of sound** in expressive actions, *sensory translation*, and as a universal medium for **data exchange** within human-robot interactions.

The primary **objectives** of this thesis project are as follows:

*Investigate Expressive Sound in Robot Actions:*

- Explore the integration of sound as an expressive tool to convey emotions, intentions, and social cues effectively.
- Analyze the impact of expressive sound on the human perception

*Develop Sound-Based Sensory Translation:*

- Develop novel techniques to translate sensory information from the robot's environment into expressive sound representations.
- Assess the effectiveness of sound-based sensory translation in providing users with a comprehensive understanding of the robot's surroundings and actions.

*Sound as a Universal Data Translation Medium:*

- Explore how sound can be employed to convey diverse types of data, including visual, tactile, and environmental information, enabling seamless communication between users and robots.

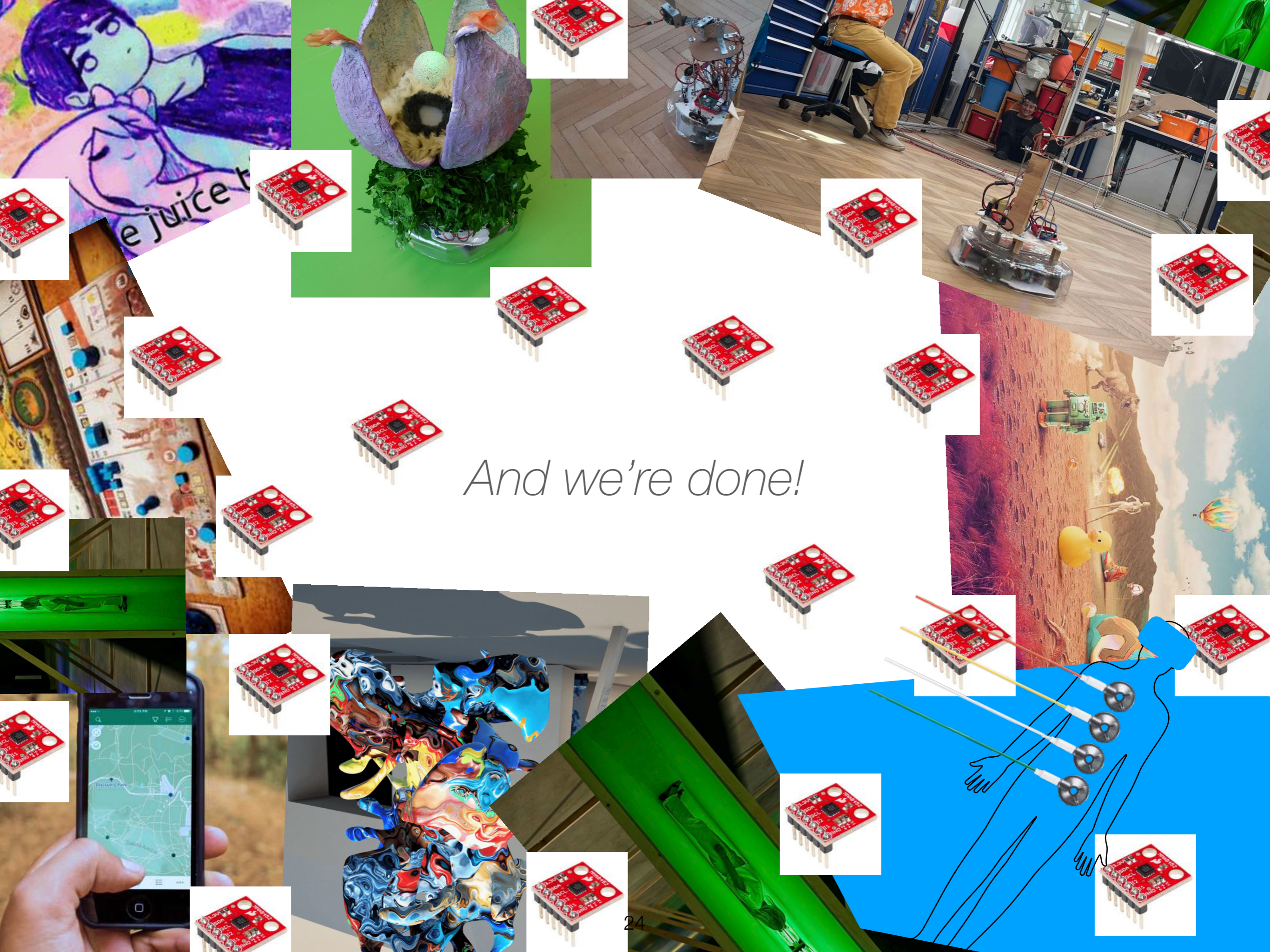


## MOTIVATIONS

The incorporation of sound as a vital component within the *Physical Metaverse's* interactions is motivated by several factors:

- **Enhanced Expressiveness:** Sound can serve as a powerful means for robots to express emotions and intentions, making interactions more engaging and intuitive for users.
- **Multisensory Perception:** By integrating sound, we aim to create a multisensory experience, providing users with a more immersive and comprehensive understanding of the avatar's actions and environment.
- **Universal Data Translation:** Sound's unique properties make it a potential medium for translating various types of data, simplifying the exchange of information within the human-human interaction system.

Can we find ways to turn sound into the **primary** tool in nonverbal interaction?  
If we can, we will have *dethroned* the visual channel from its hegemonic role and created **new**  
**immersive** experiences



*And we're done!*