Interface Technologies

Milestone 4

Documentation of the developed product

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Concept

The concept for this project is centered around passive user interaction.

Like in Universal Everything's "AI: More Than Human", our project includes a digital artwork that interacts with people in a passive way. It doesn't need users to do anything on purpose, the piece reacts naturally to things like presence, movement or sounds.

Universal Everything, AI: More Than Human, London, 2019

Our initial inspiration for this was this type of military sonar display. Although we plan on using a sonar/lidar sensor, our display will be much more abstract, artistic and not necessarily used to extract information about the environment.

Universal Everything, AI: More Than Human, London, 2019

Our project is meant to be displayed on a big screen in a public space, with the sensor device hidden somewhere, capturing a radius of about 180 degrees in front of the screen. When the user walks within range of the sensors, their movement or the sounds they make will affect the art piece. This interaction is passive, the user doesn't need to intend to engage with it. If they notice the artwork is responding to them, they can choose to explore it further or simply move on.

The concept of our project is to create an artistic abstraction using this technology.
Our visual display will aim to explore not only the interactions between the users and the project but also to promote interactions between the users.

Steps of the Interaction Design Methodology

The development of the project followed an iterative approach, divided into three main phases: research, prototyping, and user testing. This structure allowed the team to explore the idea of passive interaction in a gradual and thoughtful way, always considering the public space context and the user's natural behavior.

Research

- A study of existing works in the field of interactive and sensor-based art was carried out, with a focus on projects that use passive interaction and subtle audience engagement.
- This research helped to understand how physical space and spontaneous user behavior can influence the perception of an artwork.
- It provided the conceptual and visual foundation needed to shape the direction of the project.

Prototyping

- Several prototypes were developed to experiment with different ways of translating sensor data (such as motion or sound) into visual or auditory responses.
- The process was hands-on and exploratory, relying on trial and error to find solutions that were both visually engaging and intuitively reactive.
- The main goal was to ensure that the interaction felt natural — subtle enough not to demand attention, but clear enough to spark curiosity.

User Testing

- The installation will be tested with users who were not involved in the creative process, in order to understand genuine, unprompted reactions.
- Observations will focus on how users perceive the interaction, how long they remain engaged, and whether the piece encourages social interaction between individuals in the space.
- Based on direct observation and collected feedback, adjustments will be made to both technical parameters and visual elements, as part of a continuous process of refinement aimed at enhancing the overall experience.

Implementation Strategy

Description of the plan

Research

- Create a concept for the theme of our project;
- Research the topic of our concept in order to understand how it will fit in our work;
- Explore how do we want it to interact with the public;
- Collect works directly related to the concept of our project;
- Research and collect visual references that can be used as inspiration for the visual display of our work.

Prototyping

- Start preliminary sketching to help us visualize what we want to design;
- Ideate and design an art style for our display;
- Create animations to study how we want the display to react;
- Design mockups to help visualize how the display will react with the users.

User Testing

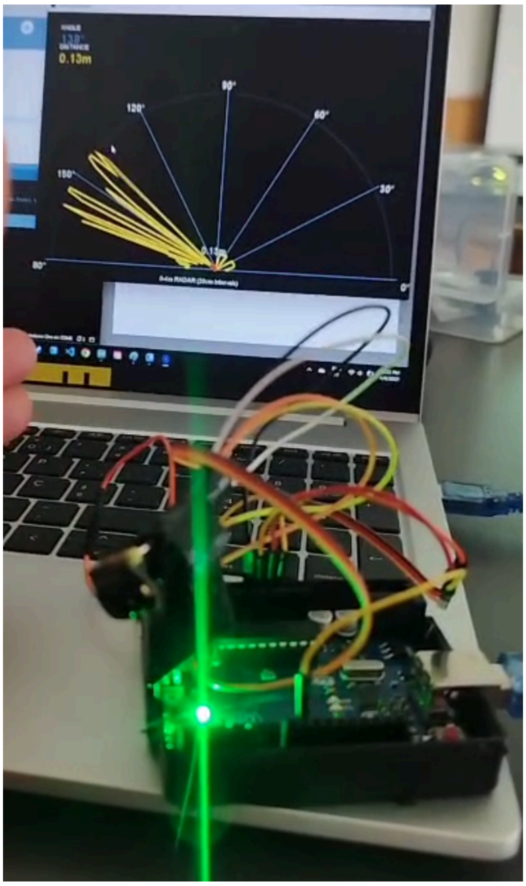
- Explore and make tests with processing.

Critical issues that might obstruct the development

Like briefly mentioned above in the prototyping topic, our microphone and super sonic sensors weren't working in this stage, so we proceeded with only the laser distance sensor and the servo.
This might be a hardware issue and we might have to purchase more units. In earlier stages, we tested these sensors only in the arduino IDE, without a display in processing, and they worked fine.
It's also possible that the arduino uno couldn't provide the power needed for all of the sensors, but we tested them individually without success.
This is a problem to tackle as soon as possible.

We are facing some issues with the capabilities of Processing to create natural and dynamic animations that we intend to create to give a more natural feeling to the visual display. We might need to adjust our plans to this situation.

Prototyping

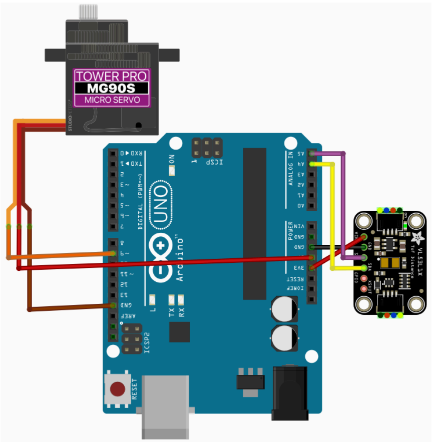


first physical prototype

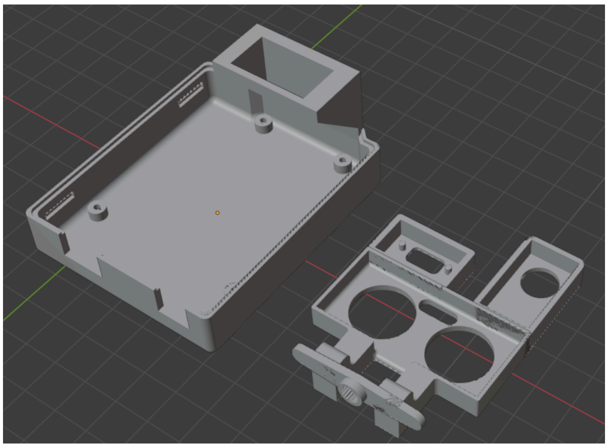
Our first prototype was very simple, as we mainly wanted to test the laser distance sensor (TOF400C VL53L1X) with our servo motor for 180° movement (MG90S 90-180). We 3D modeled a holder for the servo to be mounted on top of the arduino, and secured the distance sensor onto the servo blade with adhesive tape.

The purpose of this prototype was mainly testing the sensitivity of the laser distance sensor. It seems to be reliable up to 4m, with accuracy reducing on larger distances.

For this test we had a very simple display on processing, using serial for transfering data. The display simply displayed the current angle of the servo, creating a point according to the distance detected by the laser sensor, and connecting the points with a yellow line.



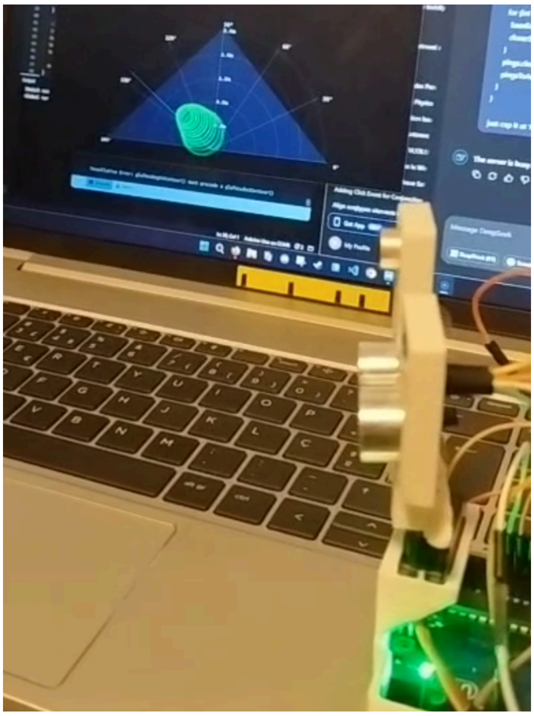
wiring for the servo and laser distance sensor



3D model support for other sensors

The wiring is the following:
Servo: gnd-gnd; power-5v; pwm-digital pin 9.
Laser distance sensor: gnd-gnd; power-3.3v; sda-analog4; slc-analog5.

After the initial prototype, we designed a more developed model, with support for more sensors, specifically a simple microphone (MAX9814) and a supersonic sensor (US-100).



The display for this round of prototyping was slightly more complex and artistic.
For unknown reasons, the ultra sonic sensor and microphone we purchased weren't working. It might be a hardware issue. Despite this, we continued only with the laser distance sensor for now.

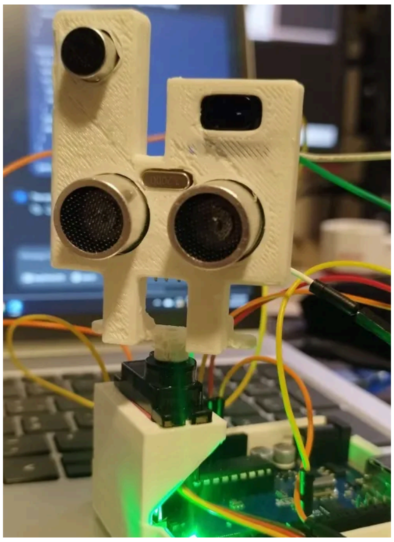
The arduino code to capture the distance at each angle remained relatively the same, while the processing code changed.

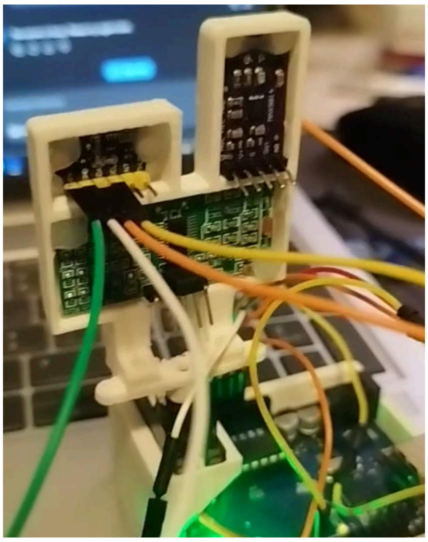
On the first 180° sweep, the code records the distance at each point without drawing anything, to establish the baseline for the empty environment.

support for other sensors

After this initial sweep, the display reacts only when an object's distance at each specific angle is less than the recorded baseline.

So, for example, if the baseline distance with an empty room at 90° is 2 meters, if the next sweep detects a distance of 1 meter at 90°, it will draw something at the appropriate point in that angle.In this case, the program is drawing animated green circles that grow outwards and reduce opacity with time. This is still a very technical display, in future stages we plan on turning this into a more abstract and artistic piece.

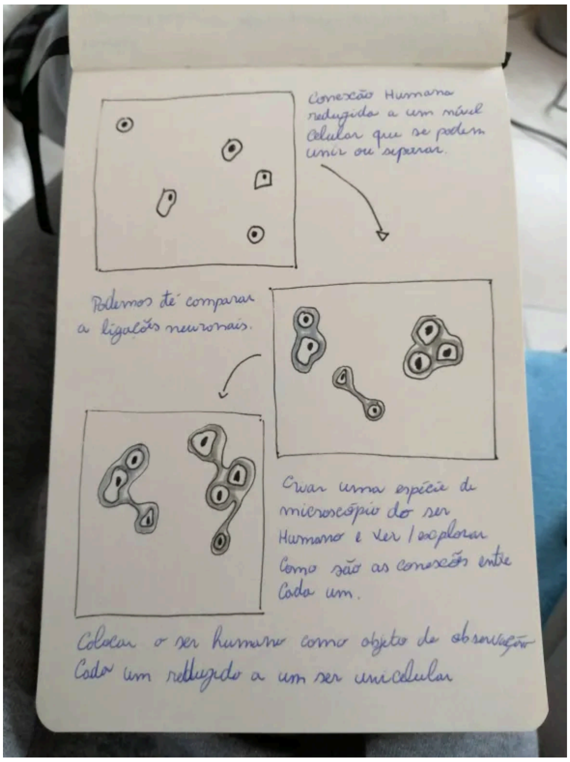




other images of the physical prototype

Designing

Conceptualization

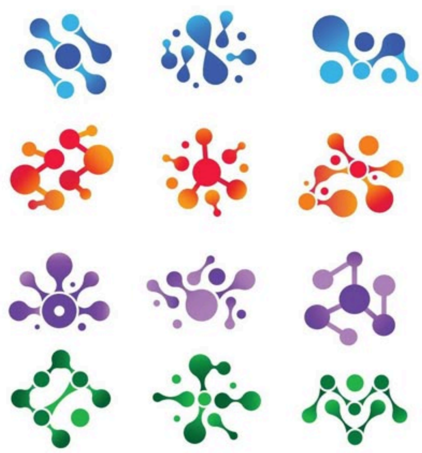


On the display side of our project, we are planning to make something inspired by living cells, aiming to explore the interactions between them that will be influenced by the users when they are in reach of our radar. The idea is to represent humans in the most basic form of life, creating something similar to a microscope view of the human being and explore the interactions between them.

Each human will be represented as a unique cell but once they get closer to another person, the cells interact with each other uniting and taking different forms.

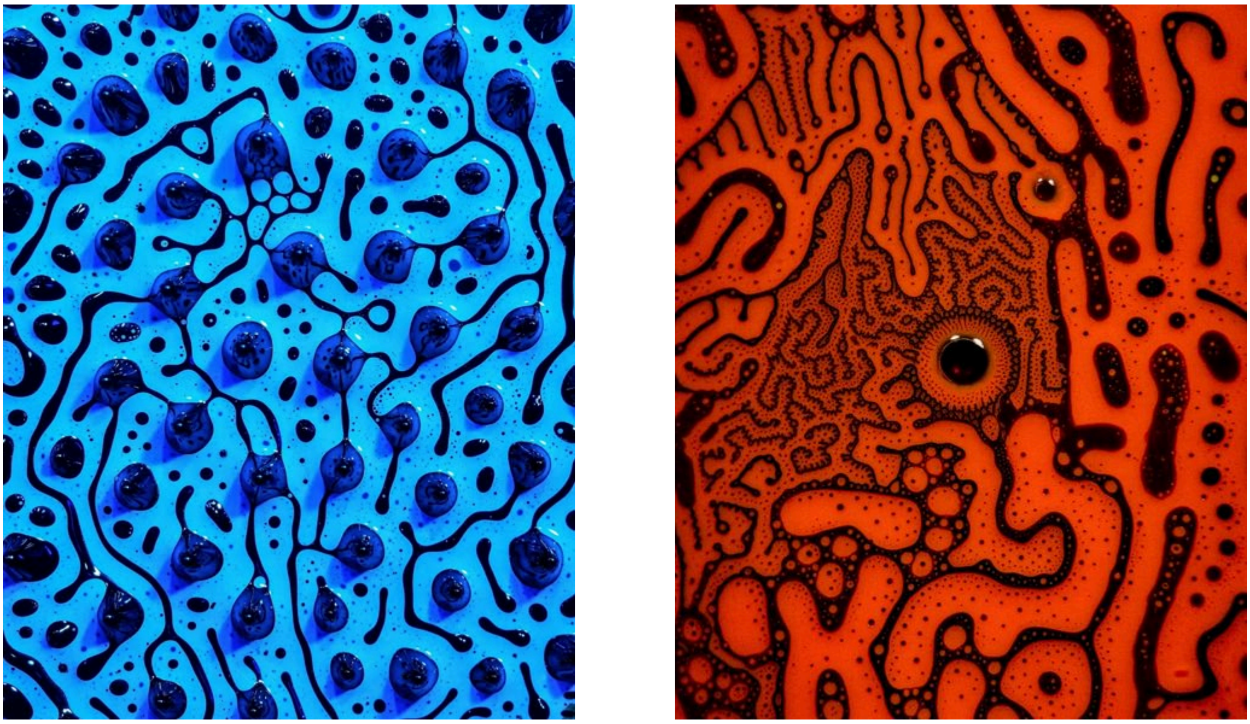
A primary sketch of the display to help us visualize the concept

Visual references



Our visual references are inspired by molecular art, cellular art, and ferrofluid under a microscope.

Image of simple representations of molecules



Ferrofluid under a microscope by "*Cosmodernism*"

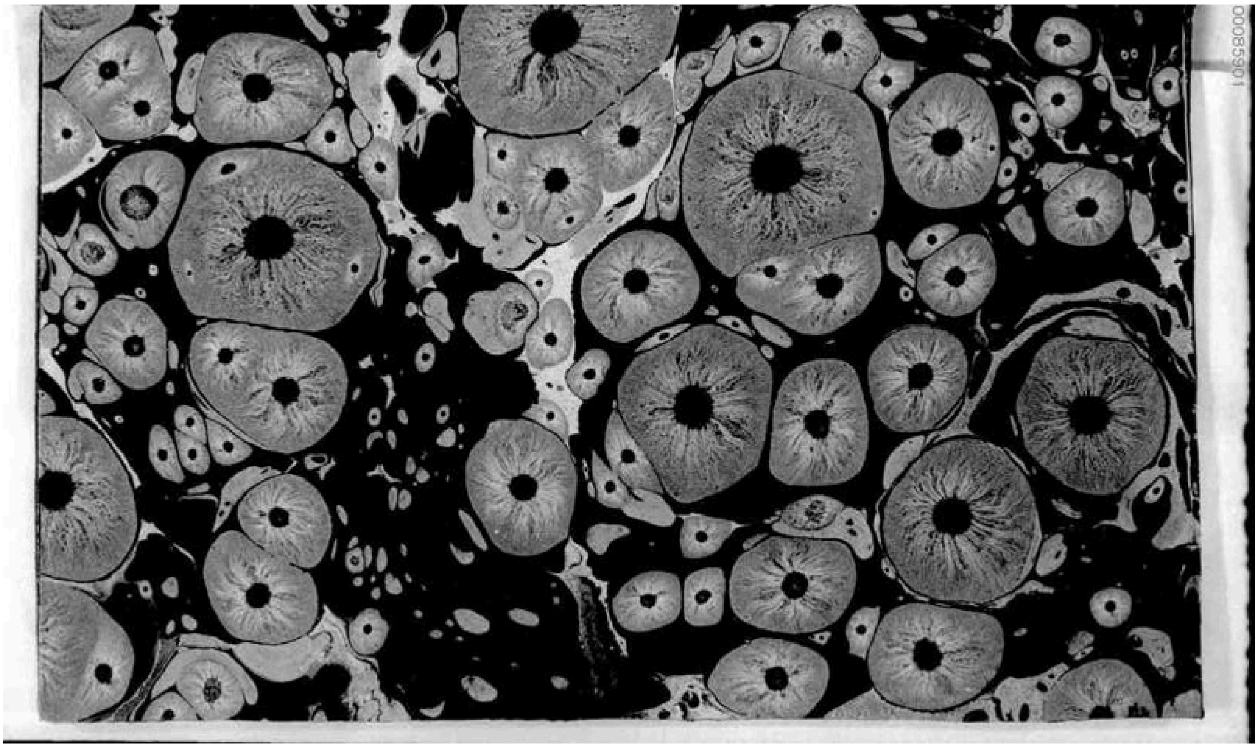


Image of molecules

Illustrations and animations

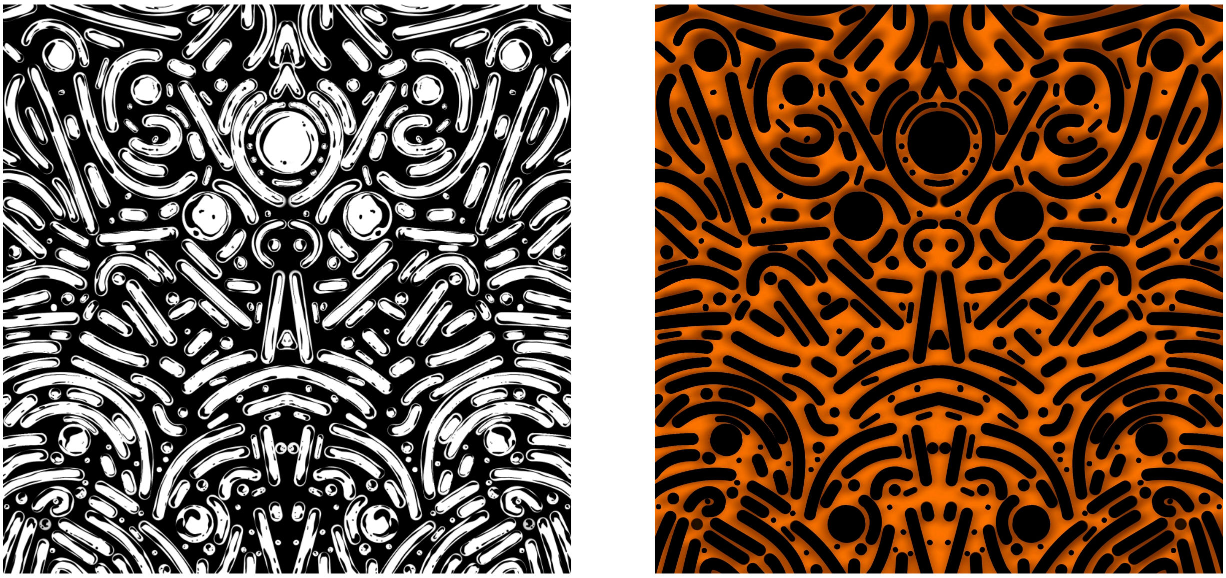


Illustration created to experiment some designs for our visual style

First animation sketch exploring the art style of the display

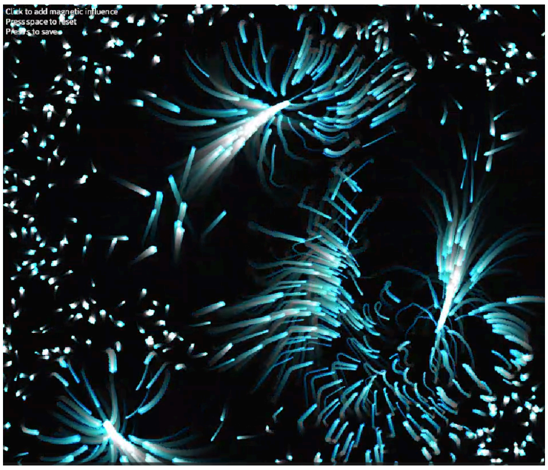
To examine the practicality and possibility of programming the molecular art form into the project, we recreated the molecular art form in photos. Next, a basic animation visually predicted the behavior of the system in terms of high density and sensor events. Subsequently, particle simulation was explored with a prior model of the potential configuration before the process evolved into the actual program. This process involved experimenting with different approaches in Processing to create the desired interaction, as well as developing programs with displays and interactions that could enrich our concept, visuals and interactions.

Processing

We began experimenting with Processing different approaches to create the described interaction. We wanted to understand if we could create something similar to our concept and also develop programs with displays and interactions that could serve as inspiration to enrich our concept, as well as our visuals and interactions.

Particles

We began testing with particle systems that interact with the cursor. The cursor would represent the users in this phase. They react with the cursor in similar ways but the particles react differently with each other.



Screenshots of two distinct particle systems.

The system on the left generates particles that move around the canvas in random linear directions, each one of them with an individual magnetic field that influences the way they interact with each other, by attracting the particles that are closer to them and creating clusters that, as time passes, create a comet-like shape that travels across the canvas. In this program when we move the cursor around, nothing happens, but when we press any button of the mouse the particles closer to the cursor change their course to the mouse's X and Y positions, creating clusters.

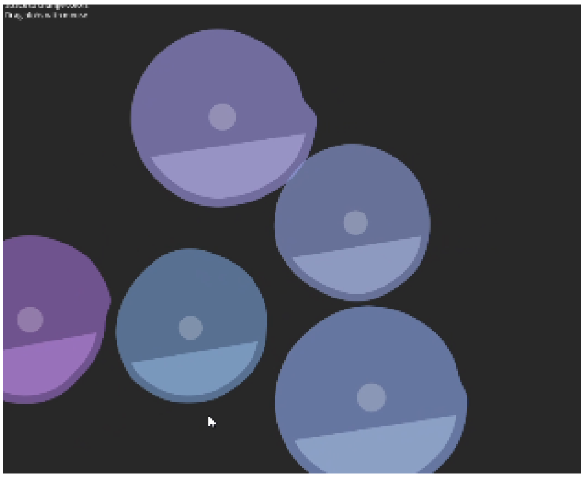
The system on the right generates particles that don't attract each other, they don't possess a magnetic field, and the way they move around, although it is still random, their movements create distinct patterns that are much more circular than the previous program due to the fact that they are always changing their direction and rotating. The interaction with the cursor is similar to the previous program, but in this situation there's no need to press any buttons to attract the particles, they are attracted automatically when they are in a specific range from the cursor, if we move the mouse around faster than the particles can keep up they will stop following the cursor around.

Cells

Our objective is to create animated forms that resemble living cells, to represent each individual, when they are closer to each other, they merge into a different and bigger shape, creating an interaction between the users.

To try and create this display we began experimenting. We still used a particle system, but this time the main focus was centered on making a particle with a liquid animation effect that interacted with the cursor to recreate this idea of a living cell. We came up with this shape that you can see in the image. It recreates the liquid effect and it can react with the cursor making the effect feel more organic.

Screenshot of the program that draws a single cell with a liquid animation effect

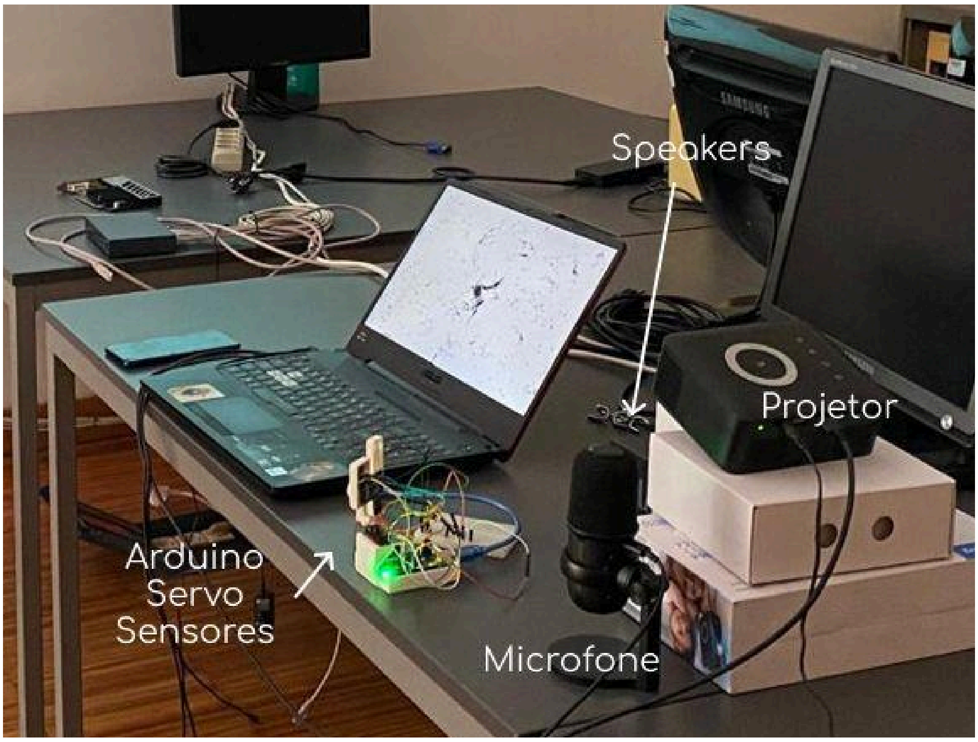


The next step was trying to make more particles. We recreated the program changing it to be able to create more particles, this time they could be added and removed by clicking with the left and right mouse buttons respectively, that collide with each other.

Screenshot of the program that draws up to 5 cells with a liquid animation effect and collisions

Interactive Abstract Art

Setup



Arduino
1. Arduino Uno

Servo and sensors:
1. Laser distance sensor TOF VL53L1X
2. Ultrasonic distance sensor HC-SR04
3. Servo 180º MG90S

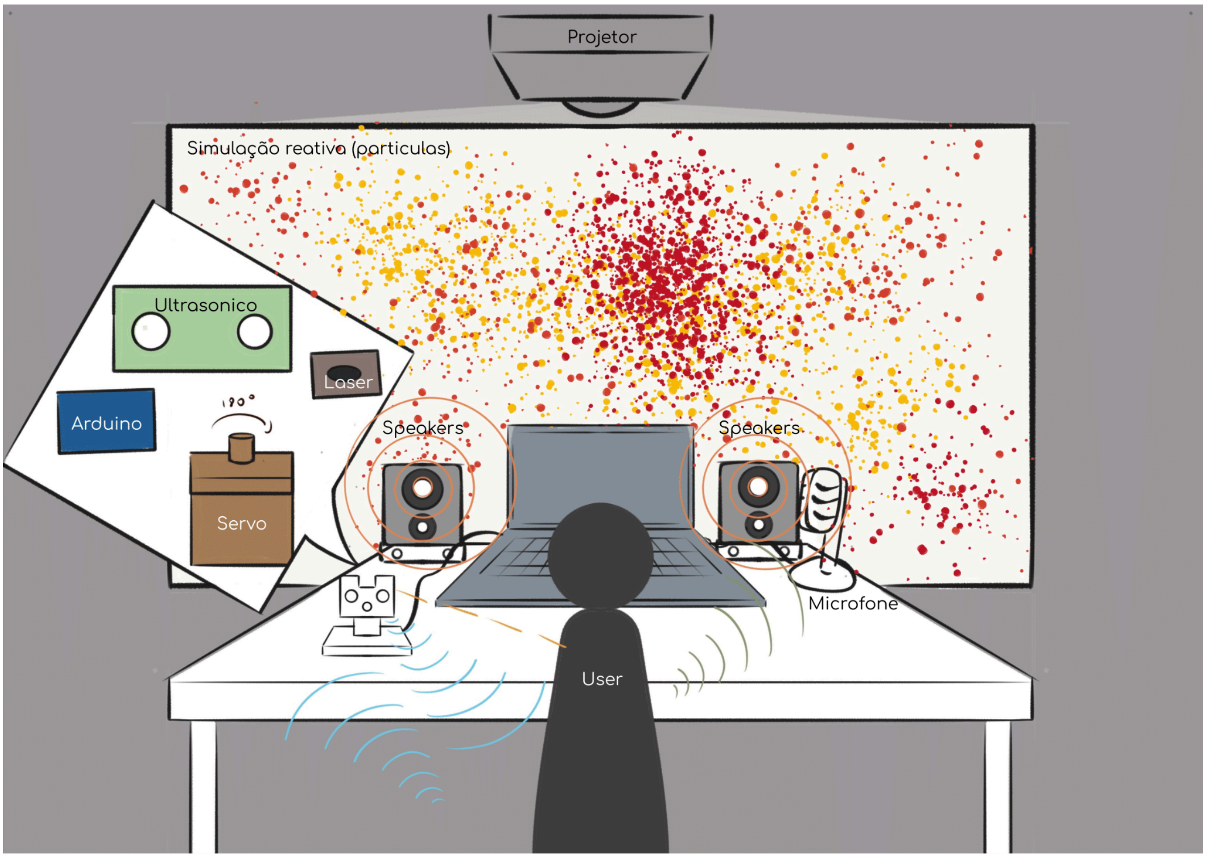
Microphone:
1. HyperX SoloCast USB Microphone

PC

Speakers

Projector

Diagram



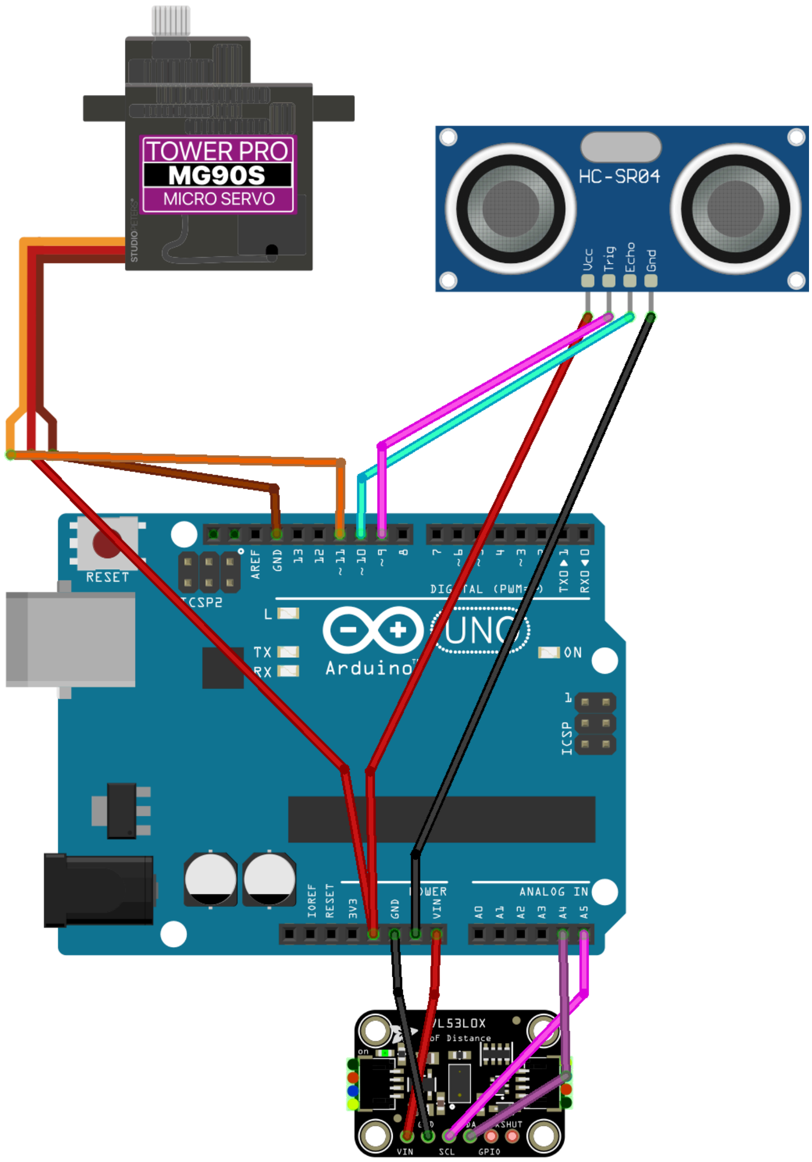
The system incorporates two distance sensors, a laser, and an ultrasonic sensor, all mounted on a servo that rotates 180°, drawing inspiration from the mechanics of a radar.

The mean of the distances detected at each angle governs a particle simulation in Processing. The program's particles create clusters when the sensors detect users or objects within a specified distance radius.

In the event that an object or user is positioned at a close distance from the sensors, a louder, distinct sound is emitted.

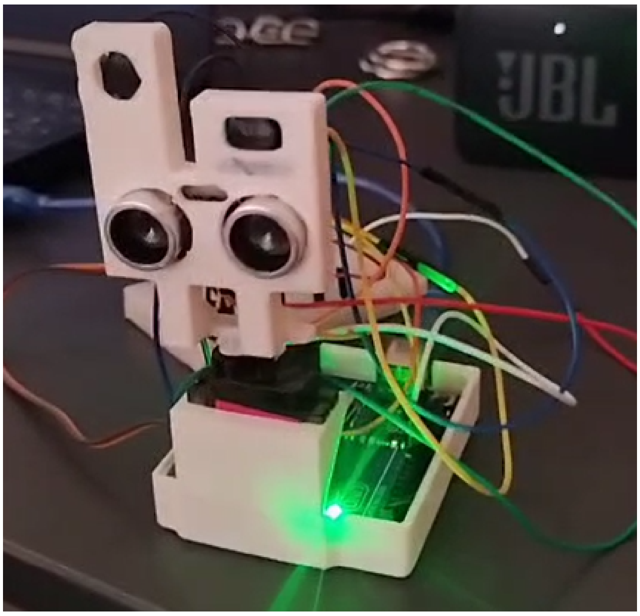
The microphone serves the primary function of detecting sounds and frequencies, and it facilitates interaction with the colors of the simulation. The colors of the simulation are altered based on the auditory stimuli received, and the background changes whenever a loud frequency is detected by the microphone.

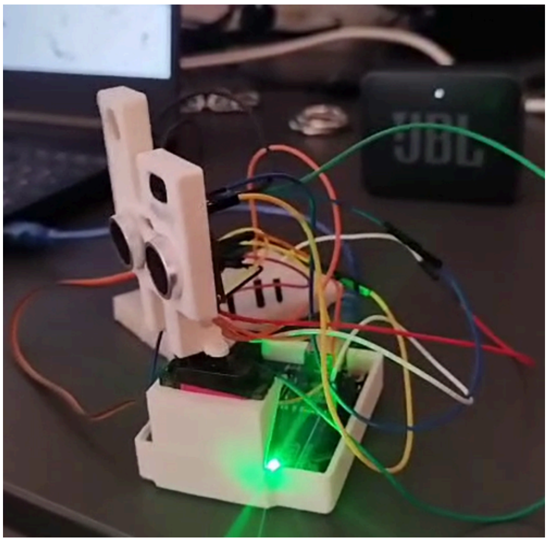
Arduino diagram

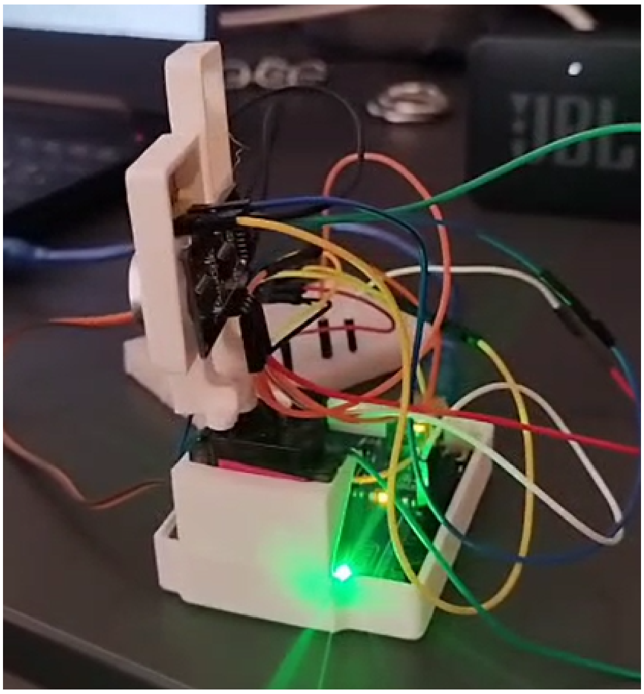


1. Arduino Uno
2. Breadboard
3. Laser distance sensor TOF VL53L1X
4. Ultrasonic distance sensor HC-SR04
5. Servo 180° MG90S
6. Cables

Assembling







The sensors are mounted on the servo, which contains a part that was fabricated using a 3D printer.

Initially, the microphone was connected directly to the Arduino, however, this configuration was subsequently altered to utilize a USB microphone connected to the personal computer.

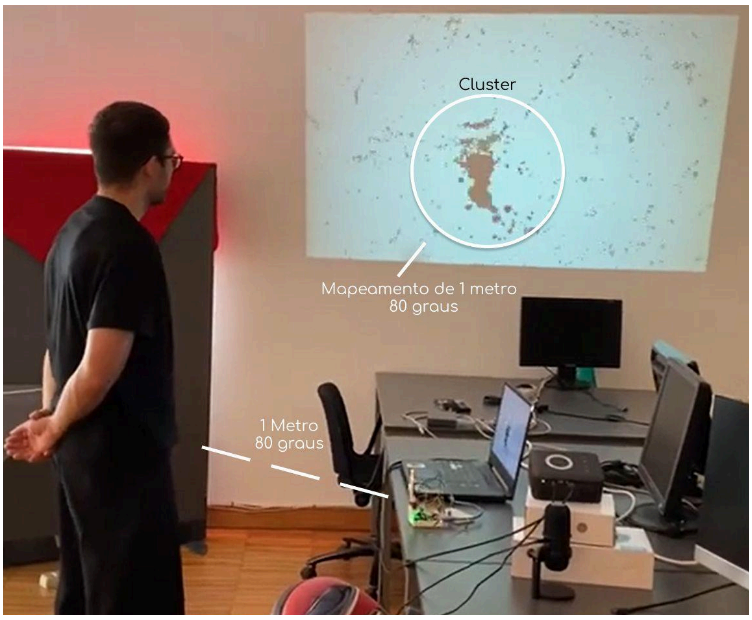
Functionalities

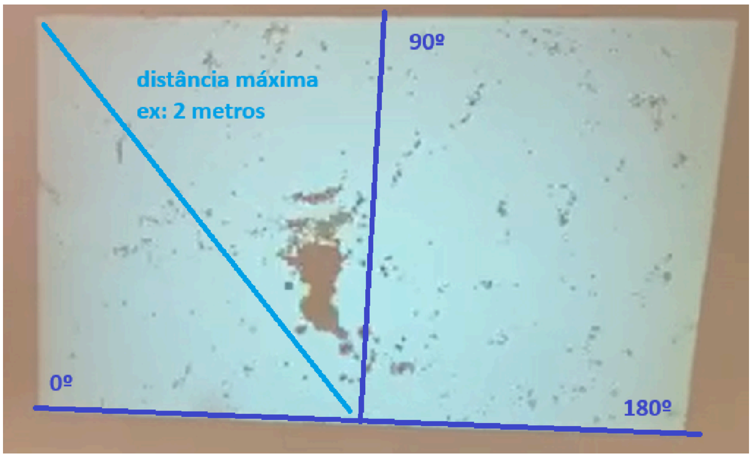
The system we designed generates particles that exhibit a propensity for agglomerations when in proximity to a designated target. This target is monitored through the identification of objects or users within the radar's effective range, and the target's position undergoes adjustments to maintain a constant distance from the radar. The manner in which these particles exhibit movement is characterized by its apparent randomness. However, their movement is not merely random, but rather, it generates distinct patterns characterized by a greater circularity. This phenomenon arises from the particles' perpetual alteration of direction and rotation. Should the target be moved at a velocity that exceeds the capability of the particles to maintain their course, the particles will cease to follow the cursor. It has been determined that the magnitude of the particles' increase in size is directly proportional to their proximity to the intended objective.

Furthermore, the subjects exhibit a reaction to the auditory stimuli, manifesting a change in their coloration through a continuous animation of waves. These waves are traced from the center of the canvas to its periphery, forming a circular trajectory. With each detection of noise, a new wave of color emerges, thereby creating a dynamic and continuous visual sequence. Upon detection of a high-frequency auditory stimulus, such as a clap of hands, the background color undergoes a transition, thereby providing a distinct visual experience.

The program has two features that enhance the experience. First, it plays an ambience sound while in display mode to make the experience more immersive. Second, when it detects something at a certain distance, a different louder sound fades in in reaction to the presence and fades out when the presence moves away.

Clusters





A cluster is formed by the particles on the distance detected by sensors from each respective angle.

The orientation of the Arduino is delineated in a semicircle configuration, analogous to a radar system, thereby facilitating efficient utilization of the available space and enhancing operational efficiency.

The distance is mapped in the semicircular projection according to a maximum detection range, which, by way of illustration, can be set at 2 meters.

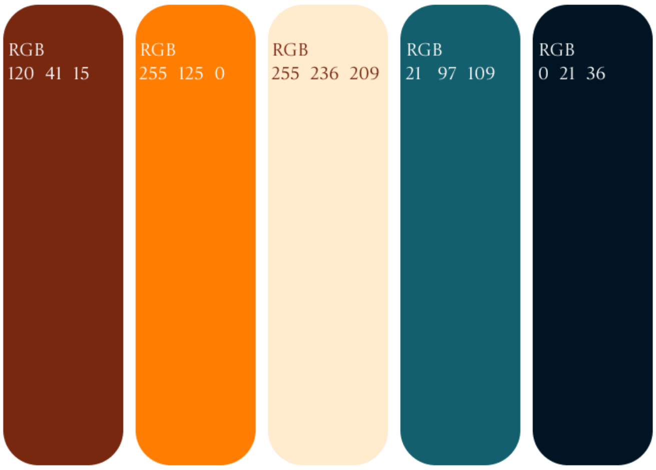
A target is delineated within the digital image, exhibiting mobility and reacting to the presences detected by the radar. It is situated at the core of the clusters. As the particles' proximity to the target increases, their size concomitantly grows, ultimately attaining a maximum size.

Sound

The device in question emits a constant background noise with the purpose of establishing an ambiance when in display mode.

In the detection of an entity at a specific distance from the radar apparatus, a distinctive, amplified acoustic emission is emitted, diminishing in amplitude upon the entity's recession

Color



Color palette used in for the project's identity.

These colors were picked to show a brand that brings together tech and people, and old ways with new ideas. The color set shows a fine mix where bold, fresh shades meet soft, natural tones catching the feel of a brand that looks ahead but stays true to its roots.

Whether it's a design space or a place for art, this look talks to those who hold on to the idea of moving forward while keeping hold of feelings, history, and realness. Each color has a role: to build trust, light up interest, and make a place that feels as smart as it is warm.

The particles undergo a color change in response to the ambient sound detected by the microphone.