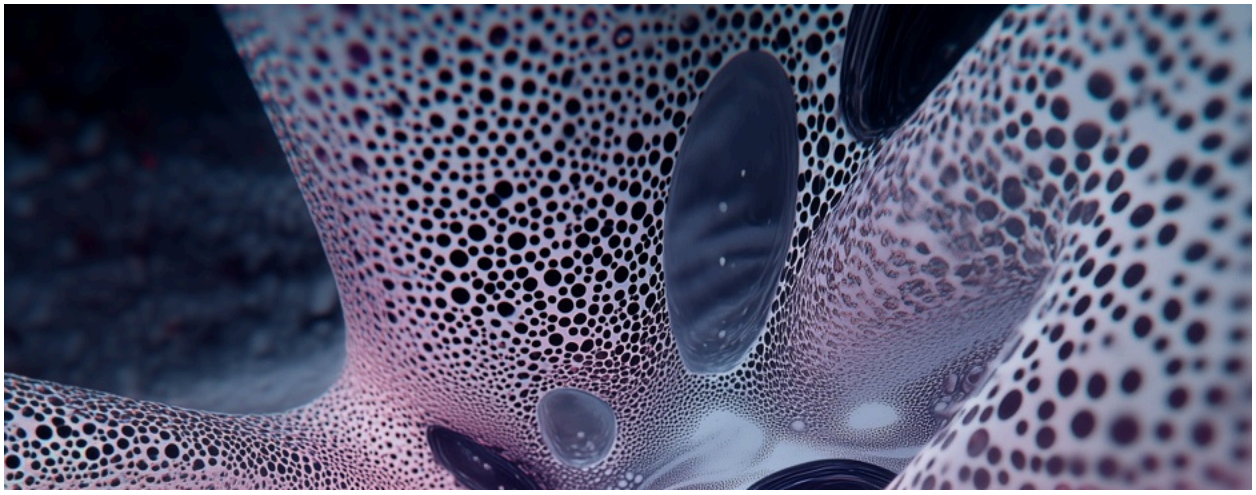
mit media lab

Fall 2019
Yiqi Zhao



SoundSculpt: Perception Enhancement through Audio AR

Yiqi Zhao

[Abstract]

The tradition and practice of sculpting dates back to ancient Greece and ancient China . Within the long evolution of sculpting, various tools and methodologies are developed. From hand shaping to digital sculpting with 3d software, sculpting gets easier and more convenient, but the sensory of volume, movement and massing tend to get eliminated. To regain the rich and pleasant experience, the AR game 3D SoundSculpt provides the user a chance to practice sculpting in a novel medium: sculpting with multi-sensory from inside out in space. In this experience, which is on an ios AR app connected to Bose Frames, the user is able to perform sculpting movements with sight, hearing, and touch.

[Hypothesis]

Audio collaborated AR sculpting(digital modeling) offers a more healing, integrated, inclusive, and effective methodology for designers and art lovers.

Audio collaborated AR sculpting(digital modeling) enhances design affordability for people who have visual impairments.

[Background/Purpose]

The dialogue of this research is between humans, design, and tools. The product focuses on digital times audiences who are designers and art lovers under high pressure, or daily anxiety, and would appreciate a light generative interface for a resting time.

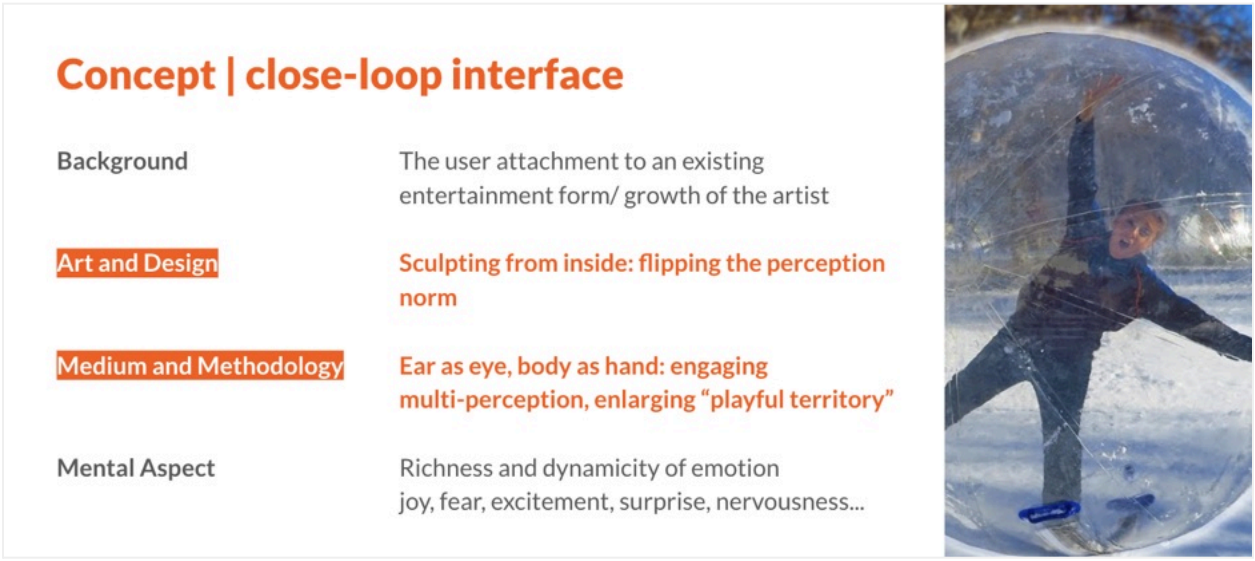
The broader goal to start this research falls into the vision of providing daily use convenient, playful digital products for emotion regulation and anxiety relief. The theoretical approach falls into two parts, the synesthesia simulation, and emotion regulation strategy.

Synesthesia refers to the production of a sense impression relating to one sense or part of the body by stimulation of another sense or part of the body. According to multiple pieces of research, the existence of a lower, unconscious degree of synesthesia in non-synesthetes is found widely for music perception.(Bragança) Vision, hearing and other senses are strongly connected. There are also many musicians who claim that they can hear the color of one piece of melody and can describe details as thick, dark, sweet, white...Based on the theory of synesthesia, sound cues could be intimately effective to enhance the act of touching and perception for motion, volume, acceleration.

Games with a goal and rewards are considered to have significant psychological impacts on the user. During the game experience, the user often enables the various types of cognitive emotion regulation like reappraisal, acceptance. The experience also reveals self-control and self-confidence building and fulfilling. Thus, highly structured games can be addictive while also effective for emotion regulation towards specific mental health and well-being seeks.

The main purpose of this research is to examine new possibilities for perception enhancement within design in digital platforms, specifically how we can enhance the experience of AR digital modeling(sculpting).

[Description of the design project.]



Overview:
In this game, the user will sculpt a virtual bubble from inside out according to the sound cues. At the initial stage, the user will be present inside a translucent small bubble, which is visible in the app. When the game starts, the user can push out the bubble surface while pressing the sculpt button on the app and swing the phone. The bubble will display manipulated surfaces with color gradients according to sound cues playing on the Bose Frame.
Artist Mode: generate your own bubble sculpture and view the design
Challenge Mode: reaching 100% accuracy on sculpting predetermined shapes [eg. perfect circle].

Context:

- daily lightweight play on a smartphone, between working sessions, during the coffee break
- effective for a positive reappraisal for emotion regulation, reduce anxiety and back to work
- refresh body and brain with multi-sensory activities in the space, also a body stretching time

Intended Audience:

- young adults with an appreciation for art and design, smartphone user, consumer electronics lover, people with fast living style, gamer

Product:

- IOS AR App with Bose Frames

Software:

- Unity

Test | Sound Effect

Clothes Friction

Balloon Inflate

Bubble Pop

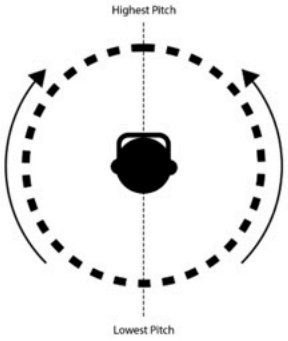
Water Drop

Squeezy

Based on sound testing with several participants, sound pitch is highly representative for surface manipulation

Interaction Layer A | MIDI Orientation

Frame: Orientation
Head Up & Down - Volume Up & Down
Head Left & Right - Pitch Up & Down
Coordinates: Mapped to sound quality
Grid system on bubble circle

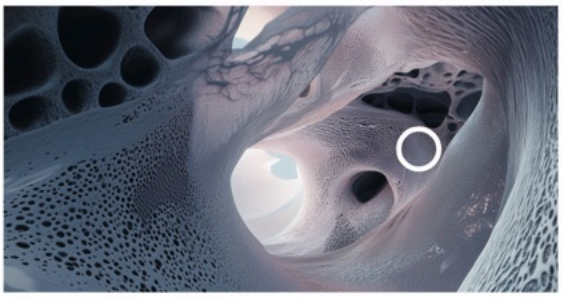


MIDI Layer A: Bubble track (continuance)
Responsive to head orientation
MIDI Layer B: Sculpt Behavior (add-ons)
Behavior 1 - slide over
Behavior 2 - stay pushing
Behavior 3 - push harder

Viewer side

Camera 1 rotating around outside the bubble
Camera 2 tracking the center of manipulation

Virtual bubble display can be viewed in VR or recorded together with the sound track generated from users



3D Interactive VJ
Sharing
Performing

Methodology:

- - Artist Mode:
  - set up initial virtual bubble mesh [white translucent]
  - map sound pitch of a pre-designed sound cue to a predetermined color hue range
  - map color hue range to the desired distance of arm motion range
  - new bubble mesh [color hue and manipulated shape]
- - Challenge Mode:
  - set up initial virtual bubble mesh [white translucent]
  - Set up target virtual bubble mesh [constant one color translucent]
  - map sound pitch of a pre-designed sound cue to a predetermined color hue range
  - map color hue range to the desired distance of arm motion range
  - new bubble mesh [color hue and manipulated shape]
  - perform mesh boolean difference and output accuracy%
- - Direction Track:
  - Bose Frame, spacial direction

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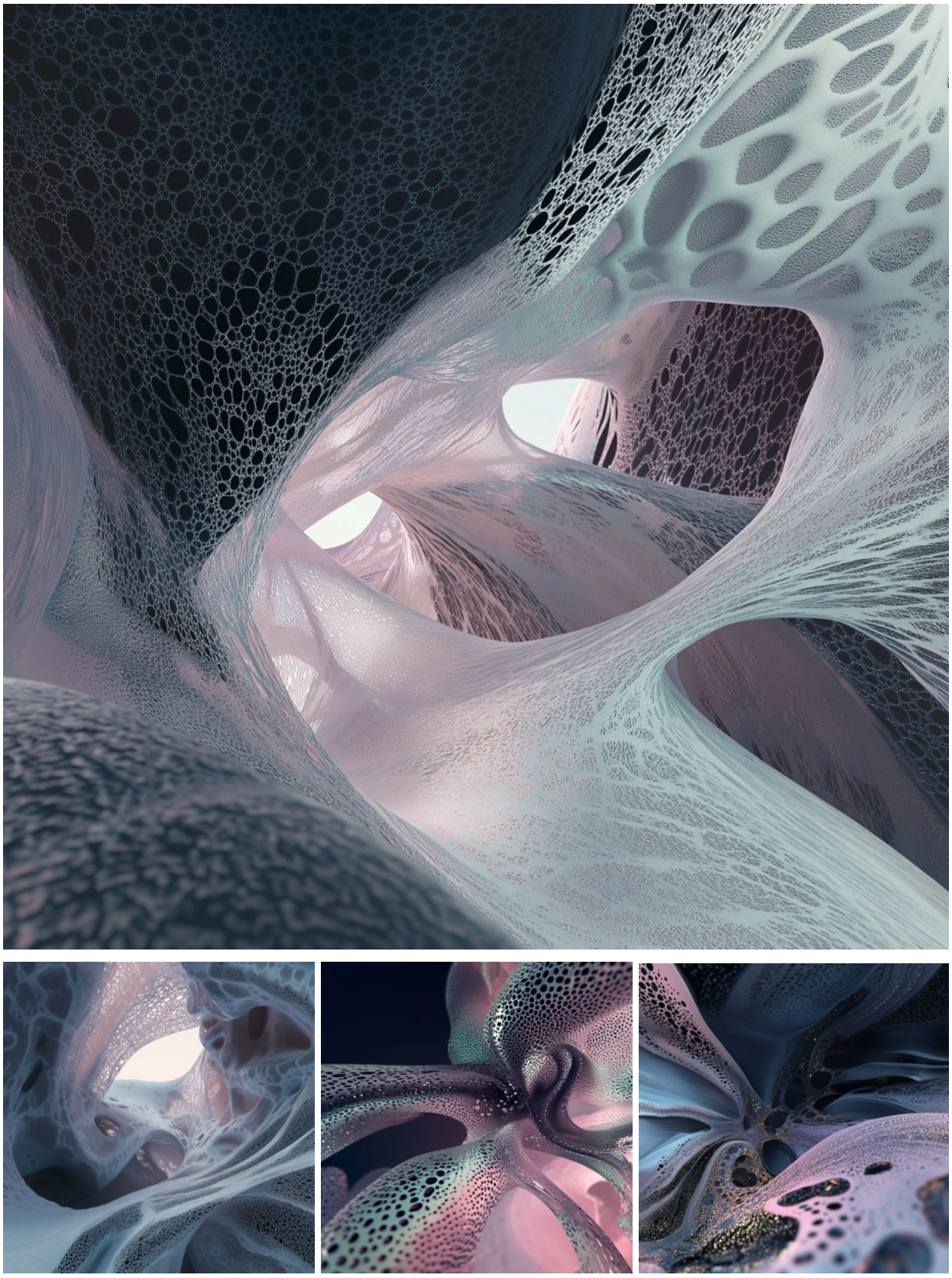
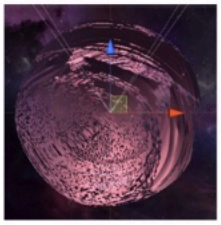


Interaction Layer A | MIDI Orientation



Frame: Orientating user with head rotation data
Head Up & Down - Volume Up & Down
Head Left & Right - Pitch Up & Down
Coordinates: True North = Strongest Sound Cue
Rotationaudiopitch(c#) - Grid system on bubble circle/domain mapping

User Head Horizontal Plane	North	East	South	West	North	Volume
Six dof/80ms		[0,180]				[1.5,0.5]
Six dof/80ms				[180,360]		[0.5,1.5]

User Head Vertical Plane	Front	Down	Back	Up	Front	Pitch
Six dof/80ms	[0,90]					[1.0,0.5]
Six dof/80ms		[90,180]				[0.5,1.0]
Six dof/80ms				[270,360]		[1.5,1.0]
Six dof/80ms			[180,270]			[1.0,1.5]

Interaction Layer B | MIDI Sculpt

mousebeat(c#) on Bubble object

On Mouse Left Down
Trigger /bubble inflation/ sound
On Mouse Right Down
Trigger /rocket beats/ sound

mouseinput(c#) on Origin (Vector3.zero)

Public variable
pressure force 50
pressure offset 0.1

The mouseinput is constructed with raycast hit from origin(Bose Frame) to the virtual bubble surface

If ray hit on bubble mesh, the script will loop through all vertices of the bubble and apply pressure to the vertices (calculated with vertices velocity)

Pressure offset ensures that all vertices are push inward rather than push apart from each other

sculpt(c#) on Bubble object

Public variable
bounce speed 20
stiffness 3.0
resistance 0.3

On Mouse Left Down
slide
On Mouse Right Down
push (keep pushing, if the beats rhythm matches bubble soundtrack, it indicates true south)

The sculpt determines how all the vertices will perform under user's mouse behavior
The slide triggers vertices to return to initial location after bouncing
Bonce speed is how long it will take vertices to stop by delta time
Stiffness is how deep the vertices will bounce

The push triggers vertices to update to a new location
Resistance calculates a%/100% if the bubble will deform to current vertices location

Approach:

- - make a color hue slider in unity to control the Bose Frame sound cue
- - deploy a functional ios app for swinging phone controlled bubble manipulation
- - marry the two and adjust

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