AUGMENTING TOUCH

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HTTPS://WWW.YOUTUBE.COM/WATCH?V=L7DGQ8SDDEQ

- AR's fundamental premise is to allow for the user to interact with a virtual world, seeing, feeling, hearing virtual objects

- Most AR Applications provide only for visual augmentation

- Azuma et al.
  " … a user might run his hand over the surface of a real desk […] Then the tactile effectors in the glove can augment the feel of the desk, perhaps making it feel rough in certain spots [Azuma 1997]".

AUGMENTING TOUCH

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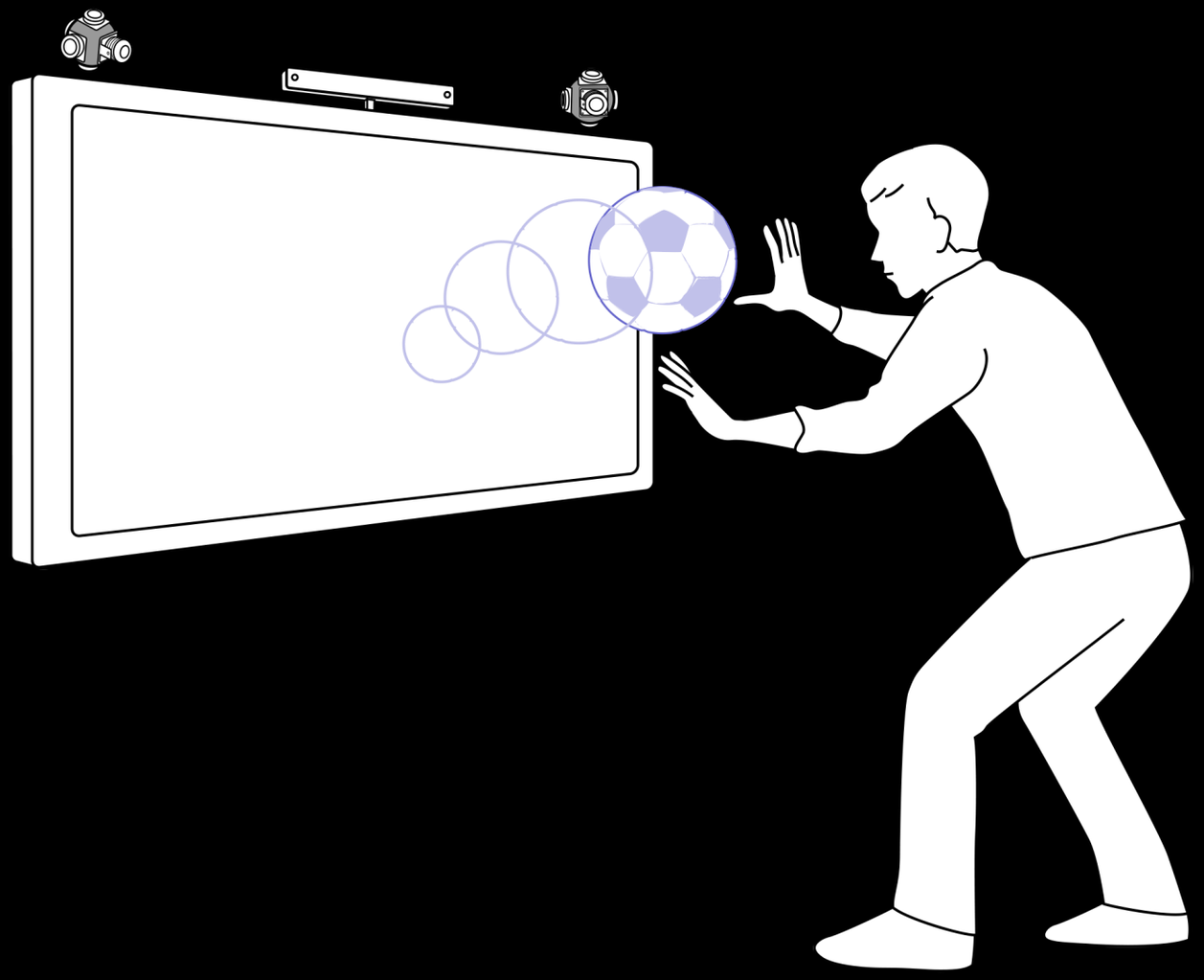
- Revel : Programming the Sense of Touch (Disney Research Pittsburg)
- Bau, Olivier, and Ivan Poupyrev. "REVEL: tactile feedback technology for augmented reality." ACM Transactions on Graphics (TOG) 31.4 (2012)

ENHANCING TOUCH

TACTILE FEEDBACK FOR AR

- Revel is based on Reverse Electrovibration.
- When sliding his or her fingers on a surface of the object, the user perceives highly distinctive tactile textures that augment the physical object.
- Paper & Demo : REVEL: Tactile Feedback Technology for Augmented Reality.



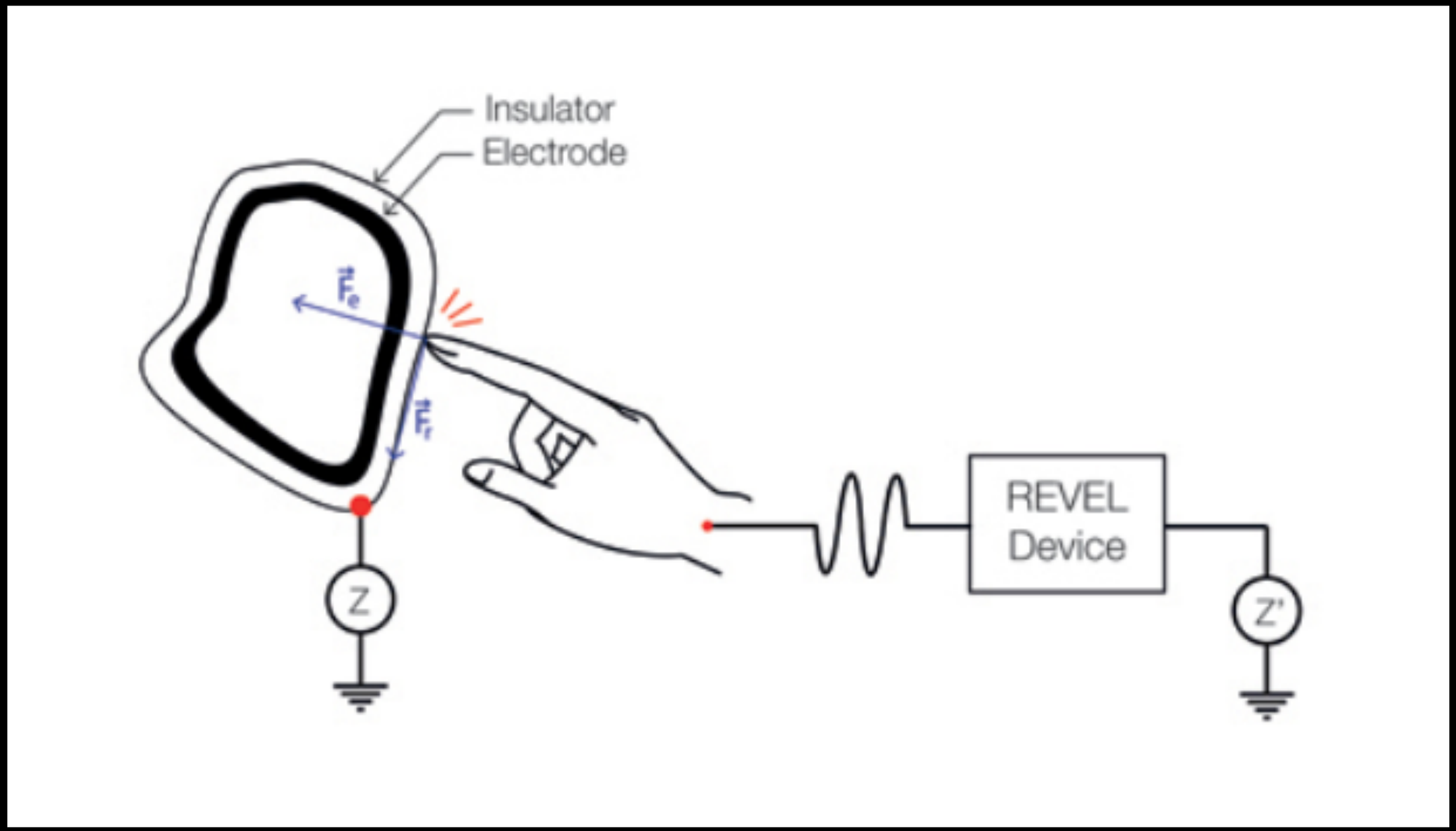
FEATURES

- Wearable tactile technology.
- Modifies the users tactile perception of the physical world.
- Current technologies enhance objects with various environmental actuators. In contrast, Revel can add artificial sensations to almost any surface

HOW DOES IT WORK ?

- Revel injects an imperceptible electrical signal into the user's body.
- Creates an oscillating electrostatic field around the skin of the user
- When touching a physical object covered with an electrode and insulator, the electrostatic force modulates the friction between the sliding finger and the object.
- The user perceives highly distinctive tactile textures overlying the physical object

HOW DOES IT WORK ?



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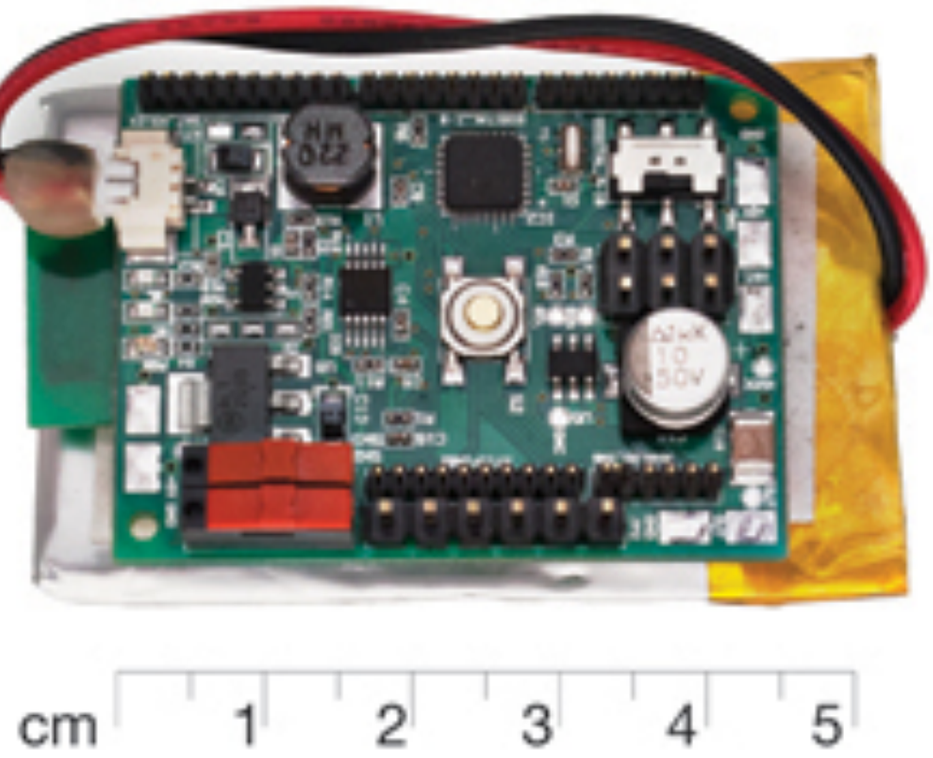


The REVEL hardware consists in a small signal generator. The board is powered by a 3.7V battery and equipped with on-board Bluetooth for wireless communication.

IMPROVEMENTS ON EARLIER WORK

- Force feedback systems (Phantom or billiARds)
    - Medical applications (surgery)
    - It requires instrumenting environments with complex haptics apparatus and limits user mobility
        - An Intermediate tactile apparatus is required
- Actuation of the Environment (eg Feelex, Senseg)
    - Physically alter environment to respond
    - Limitation on delicate tactile textures

IMPROVEMENTS ON EARLIER WORK

- Tangible Interfaces (Magic Paddle)
    - Using existing physical objects to enhance or interact AR visual displays.
    - Basic Haptics integrated.
- Wearable Haptics (Intrinsic Haptics)
    - Instead of instrumenting the environment, we instrument the user.
    - Gloves, Finger enhancements, tactile shoes, vests, etc

IMPROVEMENTS ON EARLIER WORK

REVEL generates arbitrary signals that can be applied anywhere on the user's body.

CATEGORIES OF HAPTIC AR

- Extrinsic
  - AR displays are integrated in the environment
  - Instruments objects and workspaces
  - Localized, not scalable
  - Generic & Public
- Intrinsic
  - Augment the user, altering the user’s perception
  - Wearable technologies or neurosensory stimulation
  - Scalable & ubiquitous
  - Private & Personalized

REVERSE ELECTROVIBRATION

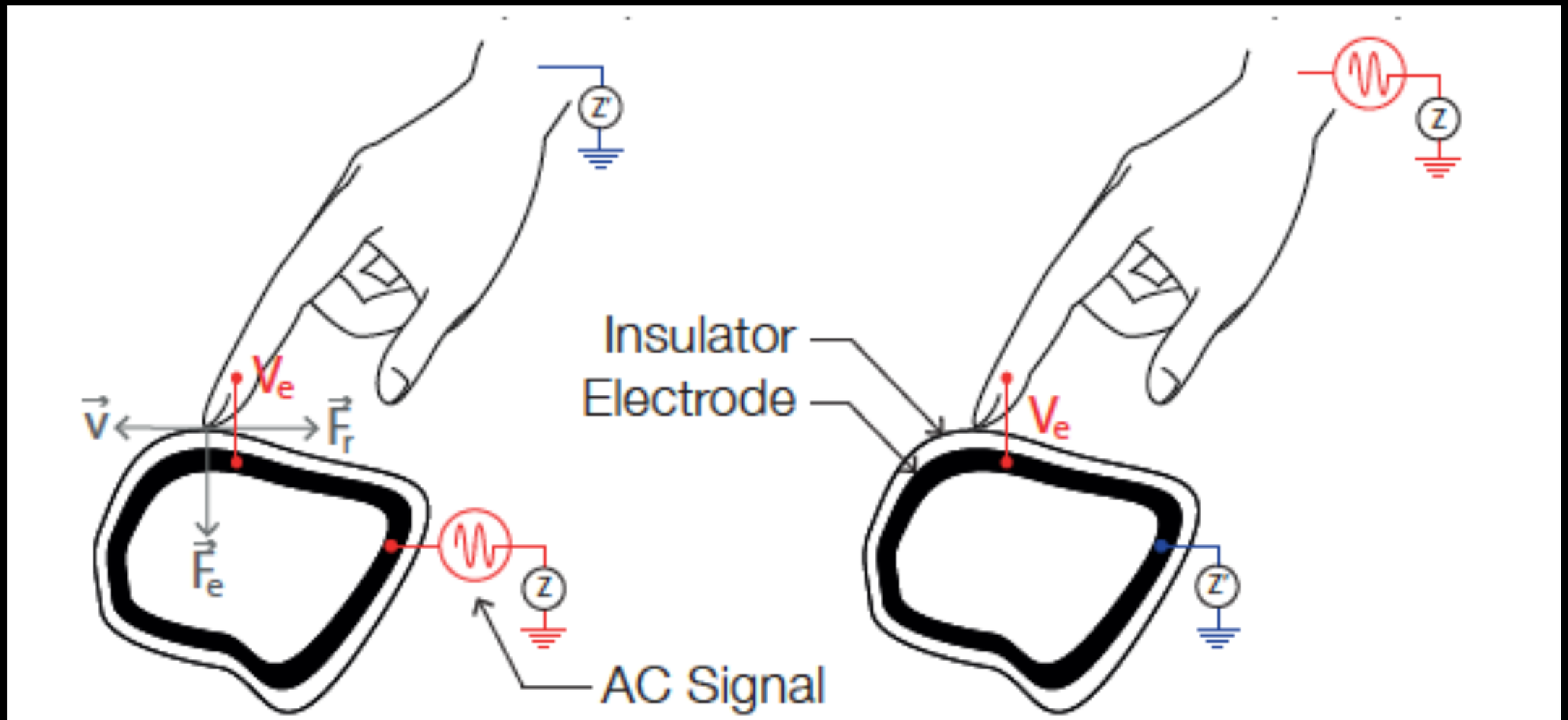
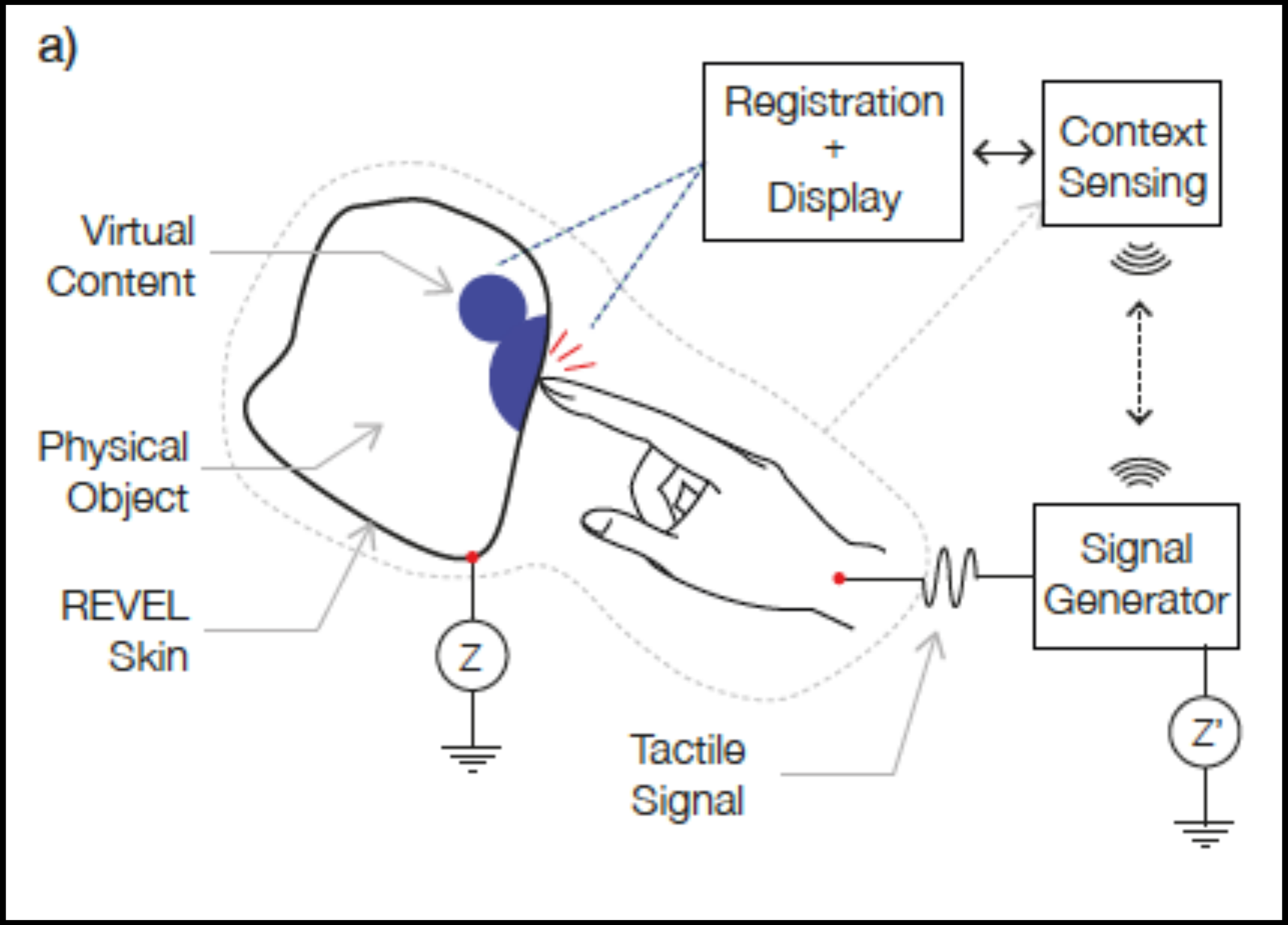


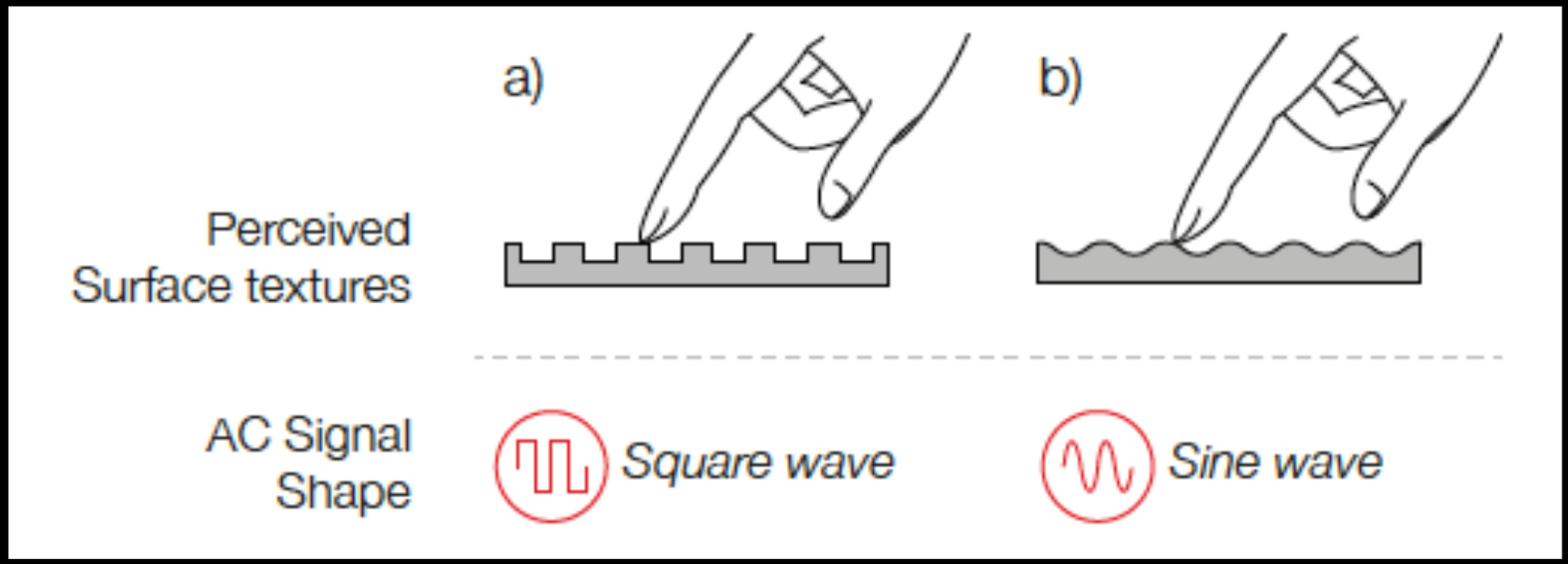
Figure 3: *Electrovibration versus Reverse electrovibration: (a) AC signal is injected into the object; (b) AC signal is injected into the user. Both produce equivalent tactile sensation.*

REVERSE ELECTROVIBRATION



HAPTIC TEXTURES FROM SIGNALS

- Signal generator creates the tactile sensations
- An increase in amplitude of the signal makes the tactile sensation more prominent
- Shape/frequency/amplitude provide a variety of tactile sensations



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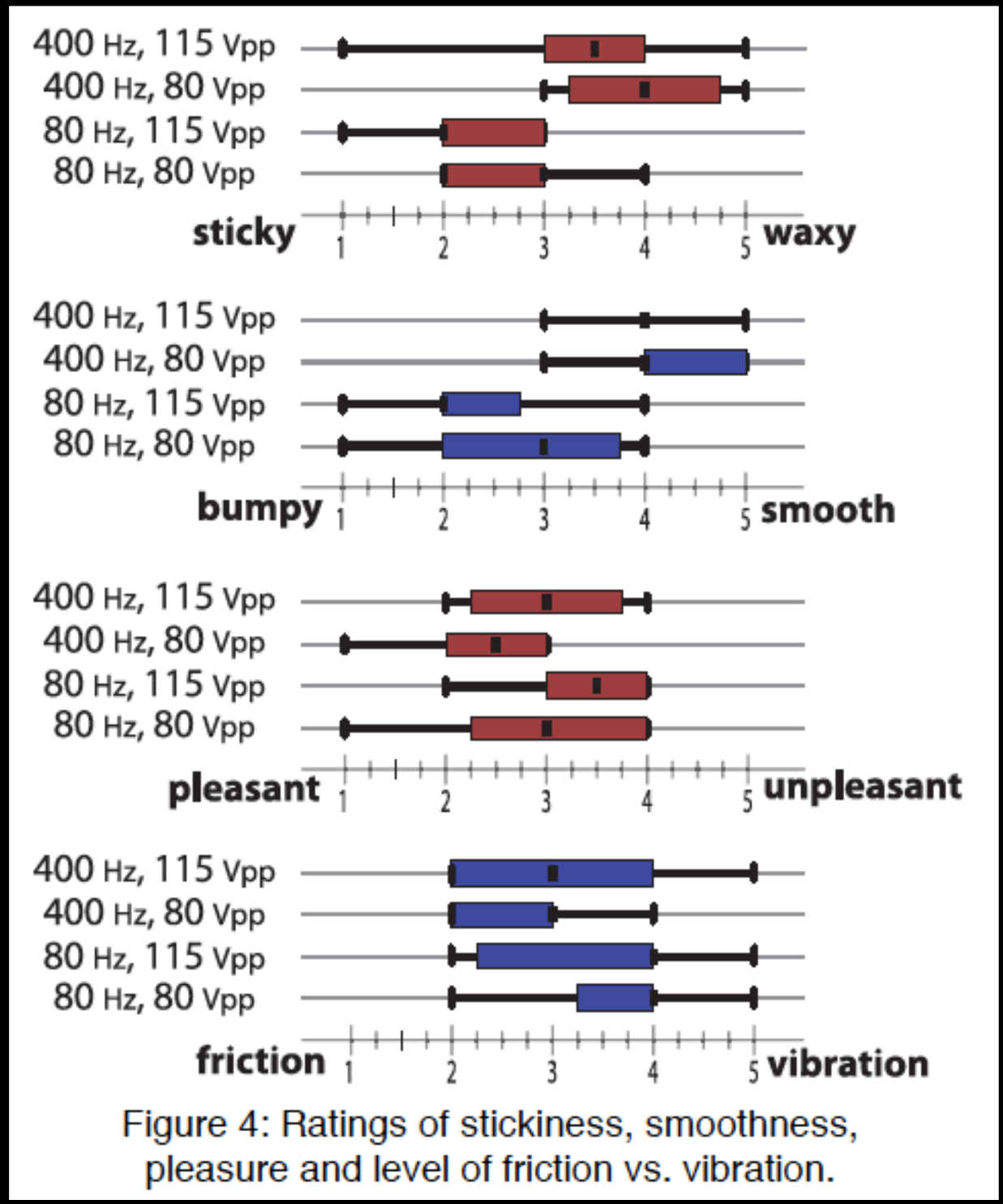


Figure 4: Ratings of stickiness, smoothness, pleasure and level of friction vs. vibration.

TACTILE RENDERING & REGISTRATION

- Signal generator creates the tactile sensations
- An increase in amplitude of the signal makes the tactile sensation more prominent

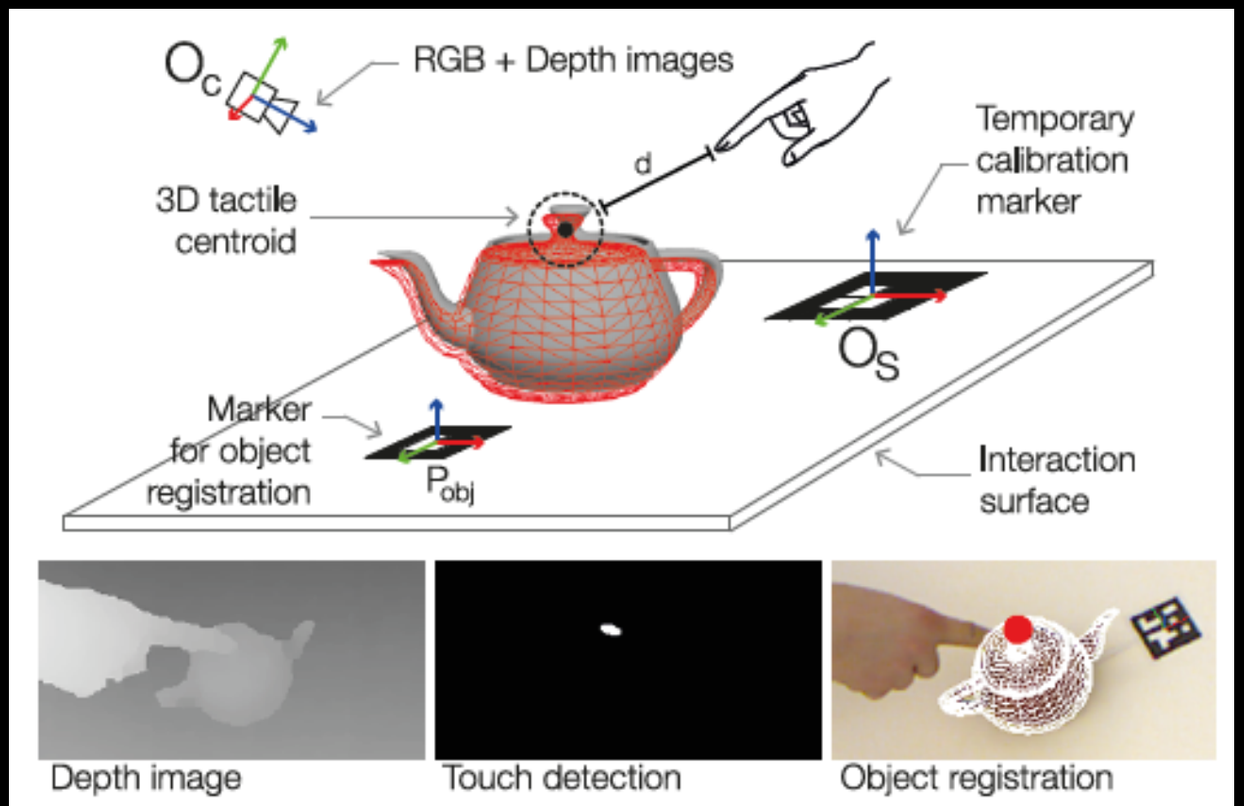


Figure 12: *Touch sensing on surfaces and objects in REVEL.*

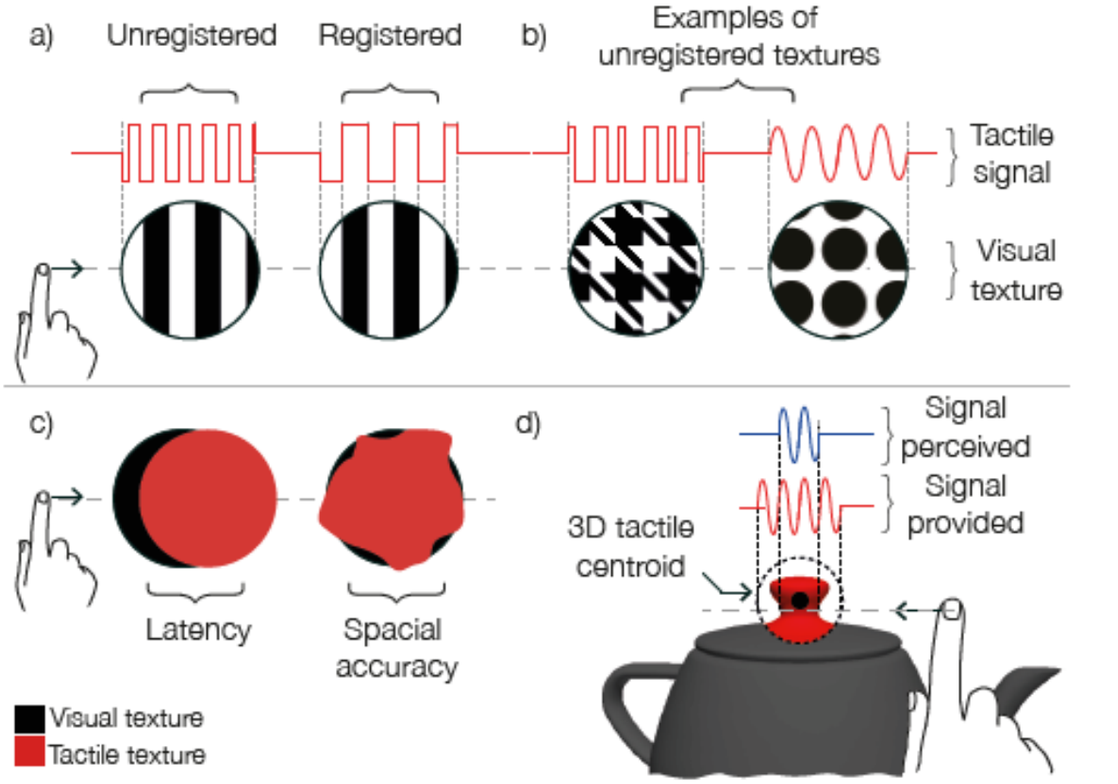


Figure 11: *Rendering tactile textures*

APPLICATIONS OF ELECTROVIBRATIONS

Figure 12: A visual star field in concert with a tactile layer conveying radiation intensity.

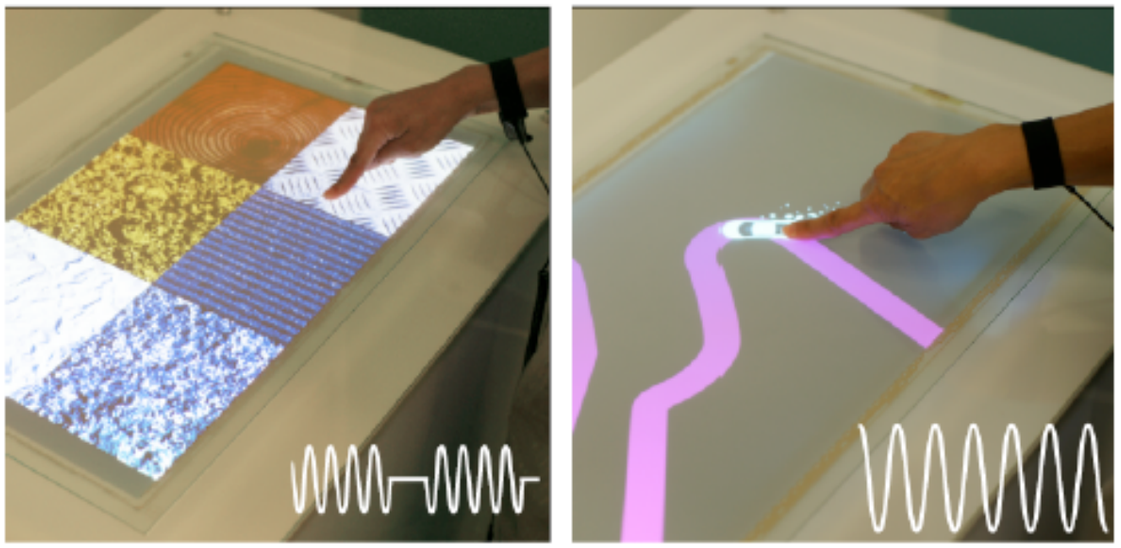


Figure 11: Left: different textures produce different sensations, e.g. simulated corduroy. Right: a racing track where friction increases as the car "squeaks" around corners.

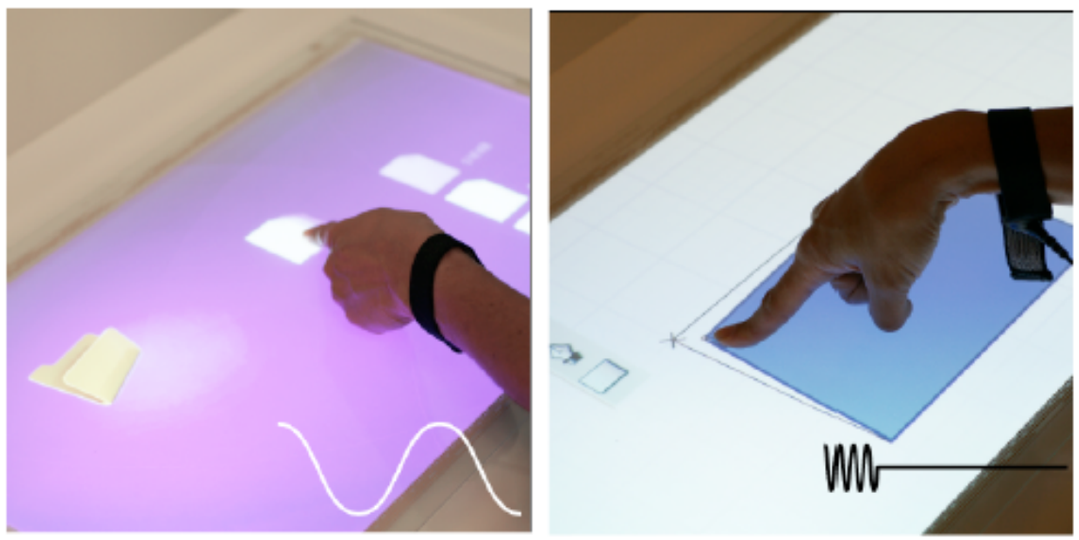
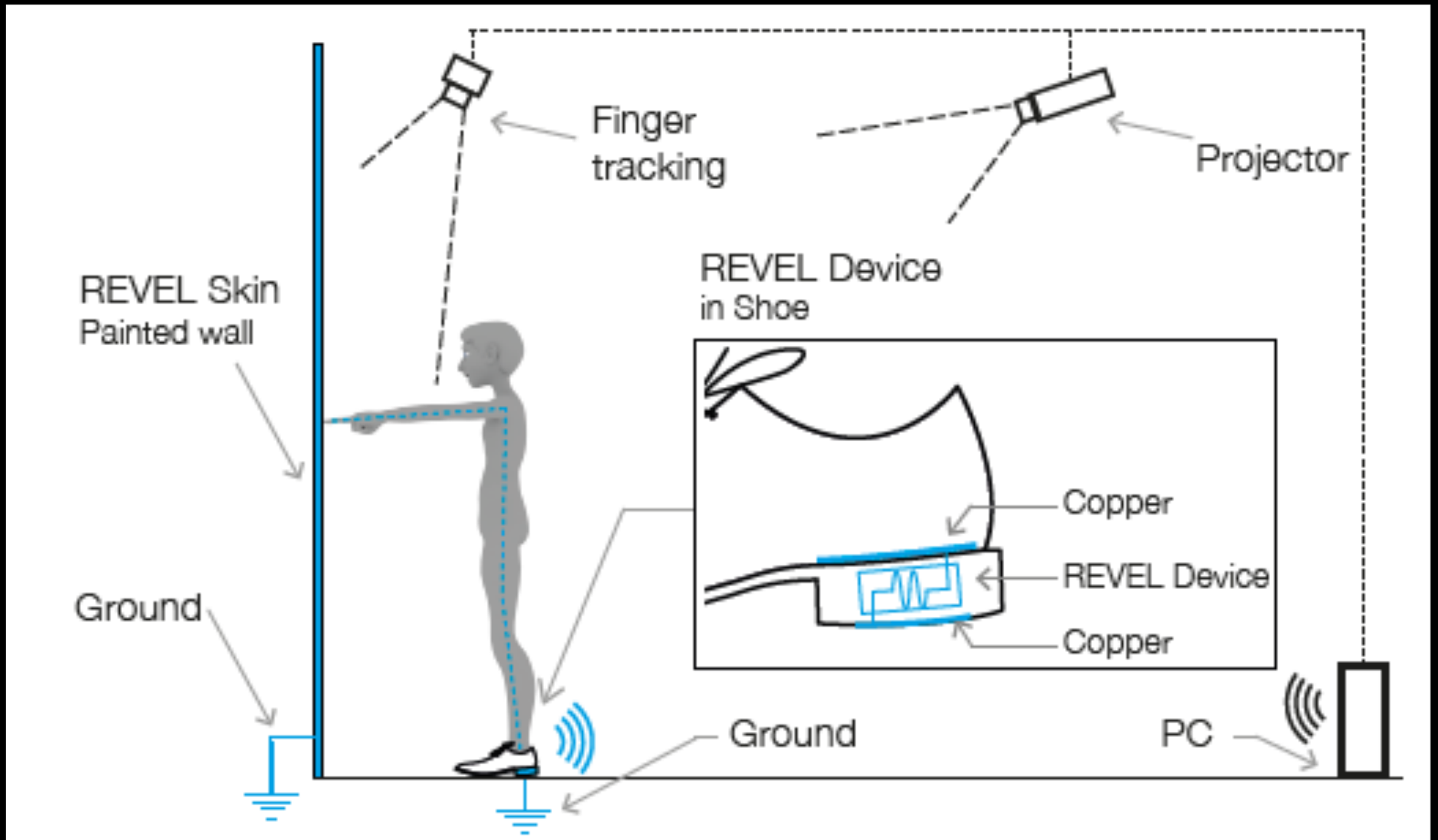


Figure 13: Left: Files being dragged to a folder have variable levels of friction based on their size. Right: Vibration diminishes as an object is dragged into alignment with neighboring items.

Figure 14: Friction between a user's finger and the touch surface decreases as the user increasingly erases a projected image by rubbing it.

APPLICATIONS OF ELECTROVIBRATIONS



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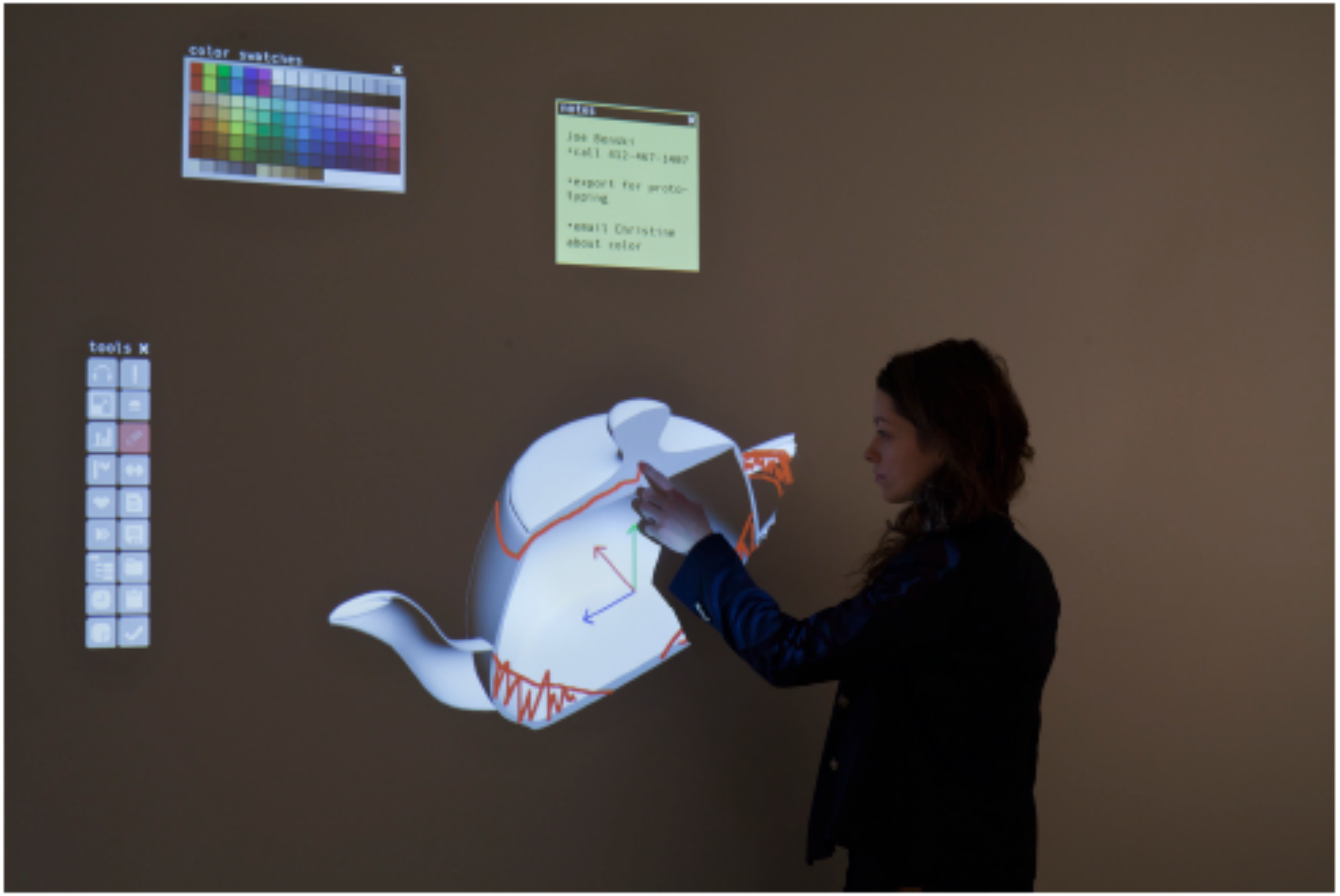
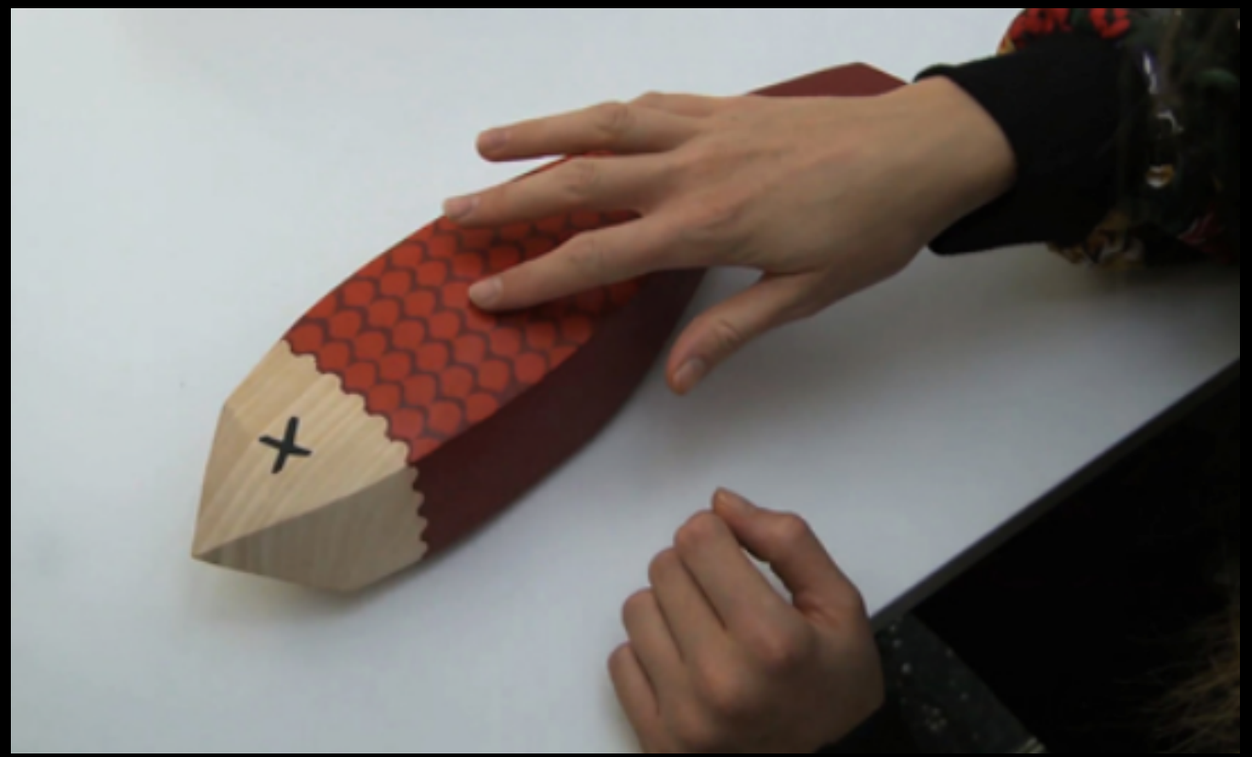


Figure 13: *Enhancing interactive walls with tactile feedback.*

APPLICATIONS OF ELECTROVIBRATIONS



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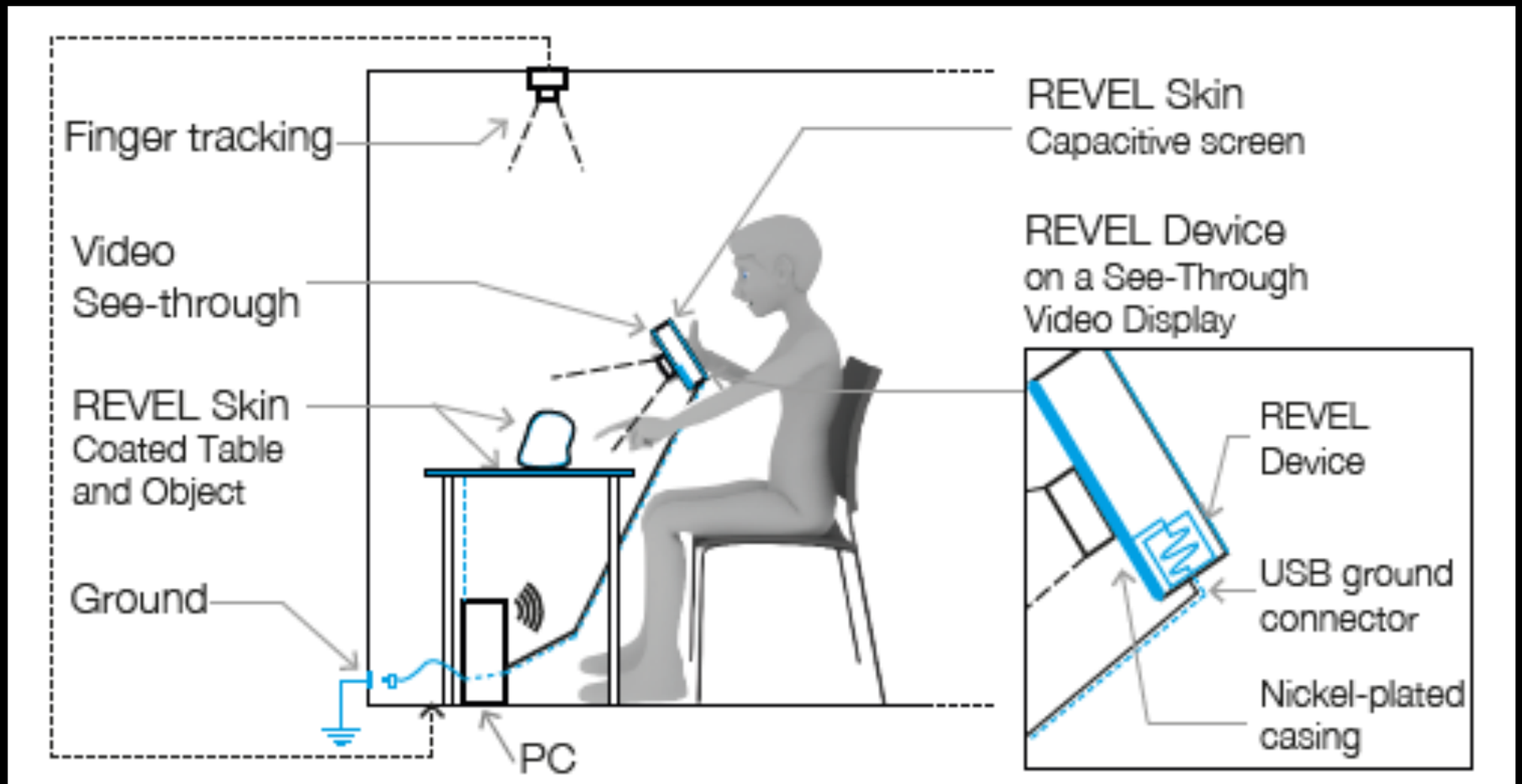

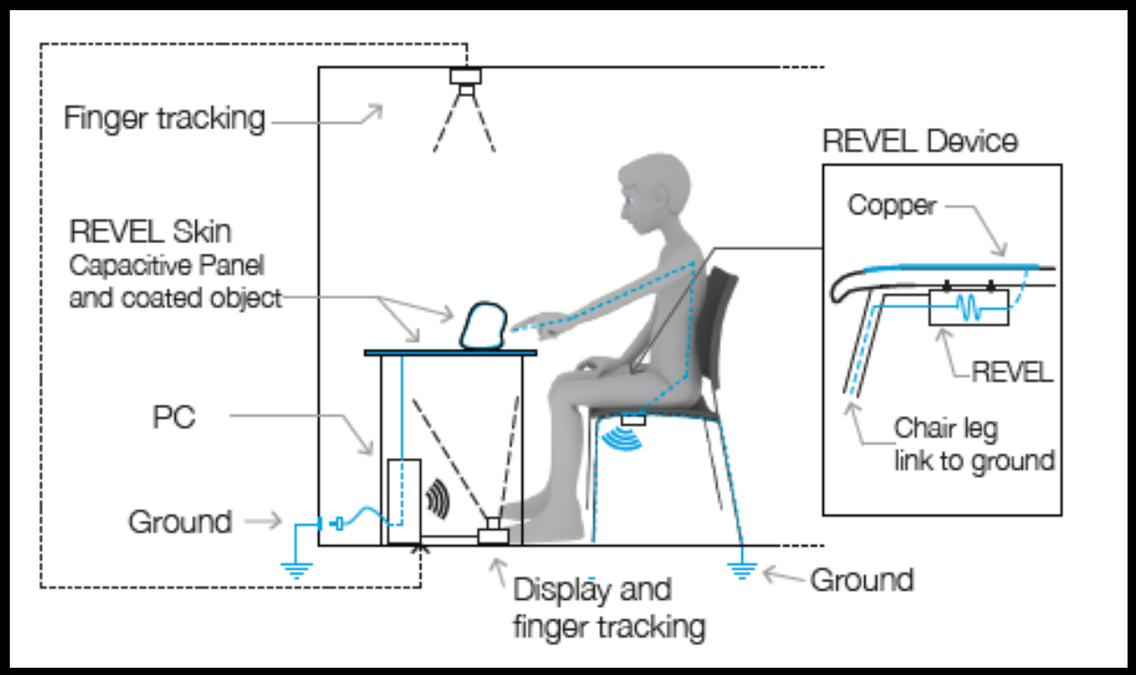

AUGMENTING SOUND

IN AUDIO

GUIDED BY VOICES

- Uses a wearable computer and a location based system
- Audio is played corresponding to the user's location
- A fantasy game environment is generated where players move around the real world triggering events in the virtual ones
- Paper : Guided by Voices : An Audio Augmented Reality System

AUGMENTING VISION

ENHANCING SIGHT/UX

LEGO

- Lego has made several advances into Augmented Reality in the past few years.
- Lego Retail introduced Lego Digital Box - allowing users to view a built & animated version of the lego set they are purchasing.
- Since then, studies have been done analyzing the use of AR & Lego as an educational tablet.
- Paper : Augmenting a child's reality: Using educational tablet technology