Sensora-OS: Towards an Experience Operating System for Integrated Human Senses

Reference Architecture & Technical Specifl cation

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Abstract

Recent advances in mixed reality, spatial audio, haptics, olfactory displays, and brain–computer interfaces (BCIs) suggest that digital systems will soon be able to orchestrate not just visual and auditory content, but full multisensory experiences. However, these developments remain deeply siloed. In this paper, we introduce Sensora-OS, a conceptual "Experience Operating System" designed to abstract disparate hardware endpoints into a single sensory fabric. We define the Experience Graph (G_{exp}) as a novel data structure for synchronizing multisensory state transitions and introduce the Personal Sensory Profile (PSP) as a necessary governance kernel for physiological safety. We argue that a unified semantic layer is the realistic, technically coherent, and ethically necessary next step for human–computer interaction.

1.Introduction: The Transition to the Experience Age

The history of computing interfaces can be viewed as a progressive increase in bandwidth between the machine and the human sensorium. The command line utilized symbolic text; the Graphical User Interface (GUI) introduced 2D visual metaphors; and current Spatial Computing brings 3D visual and auditory presence.

However, human perception is not limited to sight and sound. It is an integrated phenomenon involving five distinct channels (vision, audition, olfaction, gustation, somatosensation) and internal proprioception.

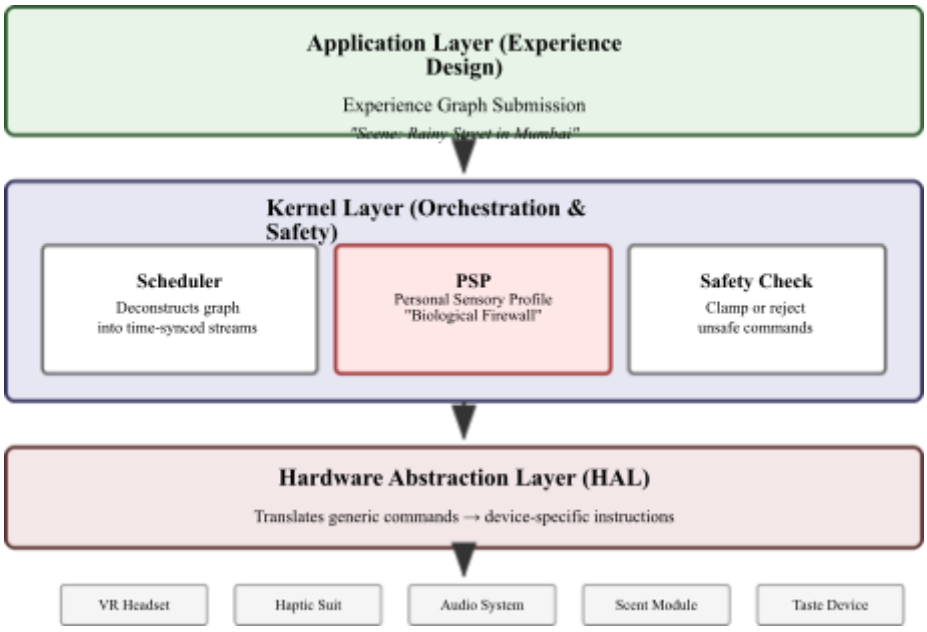
As we enter the "Experience Age," we face a critical architectural gap. While hardware vendors are producing advanced haptic suits, olfactory emitters, and neural interfaces, there is no unified software kernel to orchestrate them. Currently, a developer must write separate code for a VR headset, a haptic vest, and a scent diffuser, resulting in synchronization errors and "Sensory Dissonance."

Sensora-OS is proposed as the solution: a unified Operating System designed not to manage files, but to manage human experiences.

2. System Architecture

Sensora-OS is architected as a distributed, real-time operating system that sits between the Application Layer and the Hardware Layer.

Figure 1: Sensora-OS System Architecture



2.1 The Three Layers

The Application Layer (Experience Design): Applications no longer send raw commands (e.g., "turn on motor A"). Instead, they submit an Experience Graph—a semantic description of the desired state (e.g., "Scene: Rainy Street in Mumbai").

The Kernel Layer (Orchestration & Safety): The Scheduler deconstructs the graph into time-synced streams. The PSP (Personal Sensory Profile) acts as a biological firewall that checks every command against the user's safety limits (e.g., "Is this sound too loud for this user?" "Is this scent an allergen?").

The HAL (Hardware Abstraction Layer): Translates the generic commands into specific instructions for the connected devices (e.g., Meta Quest 3, Teslasuit, OVR Scent Module).

3. The Experience Graph (G_{exp})

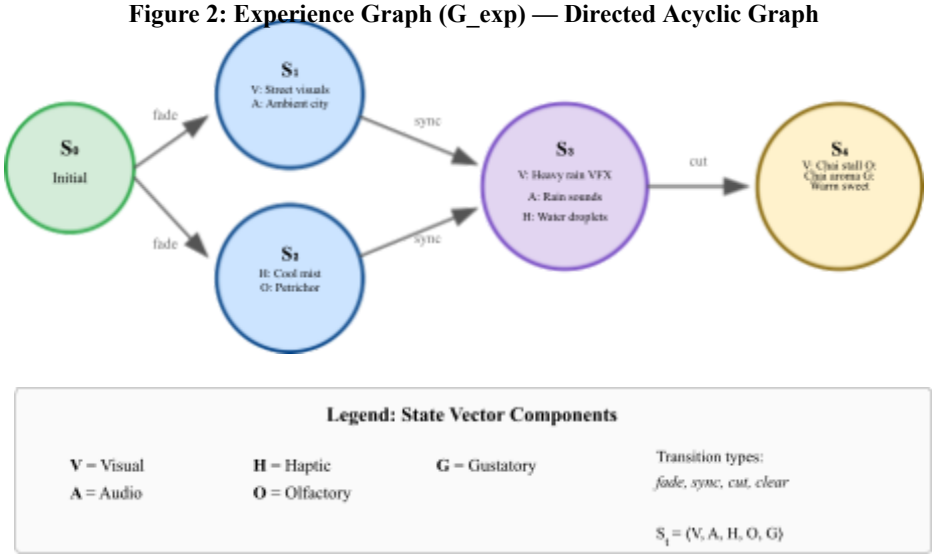
To solve the synchronization problem, we replace the traditional "frame" model with a graph model. We define an experience as a Directed Acyclic Graph (DAG), denoted as $G_{exp} = (V, E)$,

where: **Nodes (V)** represent Sensory States. A single state S at time t is a vector:

$$S_t = \langle V_{isual}, A_{udio}, H_{aptic}, O_{lfactory}, G_{ustatory} \rangle$$

Edges (E) represent Transitions. These define how one state morphs into another (e.g., a "Hard Cut" vs. a "Slow Fade").

Figure 2: Experience Graph (G_exp) — Directed Acyclic Graph



3.1 Addressing Olfactory and Gustatory Decay

Unlike light and sound, which disappear instantly when the source stops, smell and taste persist. The Experience Graph includes specific parameters for Clearing:

Olf_Decay: The estimated time for a scent to dissipate.

Active_Clear: A flag triggering an airflow purge or neutralizing agent before the next node begins.

4. The Personal Sensory Profile (PSP)

The most critical innovation of Sensora-OS is safety. A visual glitch is annoying; a haptic or neural glitch can be physically harmful.

The Personal Sensory Profile (PSP) is a locally stored, encrypted user file that dictates the boundaries of the system.

4.1 The Safety Matrix

The PSP enforces limits across four dimensions:

Modality	Limit Parameter	Example Constraint
Vision	Max_Lumens	"Limit strobing to < 5Hz (Epilepsy Guard)"
Haptics	Max_Newton	"Limit impact force to 10N (Bruise Prevention)"
Audio	Max_dB	"Cap volume at 85dB for durations > 15 mins"
Chemo	Blacklist_ID	"Block Chemical ID #402 (Peanut Derivative)"

4.2 The "Biological Firewall"

If an application requests an experience that exceeds the PSP limits (e.g., a horror game trying to deliver a painful electric shock), the Kernel intervenes, clamping the output to the safe maximum or rejecting the command entirely.

5. Hardware Class Definitions

Sensora-OS categorizes peripherals into five distinct classes. The OS is hardware-agnostic, meaning it works with any brand that writes a driver for these classes.

Class V (Vision): AR/VR Headsets, Smart Glasses, Holographic displays.
Reference Device: Sensora VISTA (modifled MR Headset).

Class A (Audio): Spatial Audio emitters, Bone conduction.
Reference Device: Sensora AURIS.

Class H (Somatosensory): Vibrotactile suits, Thermal sleeves, EMS pads.
Reference Device: Sensora HAPTI-Weave.
Class O (Olfactory): Micro-fluidic scent synthesis, piezo-electric atomizers.
Reference Device: Sensora AROMA Pin.

Class G (Gustatory): Electrical tongue interfaces, thermal taste actuators.
Reference Device: Sensora GUSTO Cap.

6. Roadmap & Integration Timeline

The transition to full multisensory computing is a decade-long endeavor. HumanSoft proposes the following critical path:

Phase 1: Foundation (2025–2027)

Publication of the G_{exp} Open API. Formation of the Sensora Scientific Advisory Council (SSAC) to define safety standards. Alpha release of the HAL for Visual + Audio + Vibrotactile Haptics.

Phase 2: The Chemical Layer (2027–2029)

Standardization of "Scent Primitives" (Primary odors). Integration of Class O (Olfactory) devices into the consumer stack.

Phase 3: The Neural Bridge (2030+)

Integration of non-invasive BCI (Brain-Computer Interfaces) for state-reading (detecting stress/focus) to dynamically adjust the Experience Graph.

7. Conclusion

Sensora-OS is not a product; it is a protocol. Just as TCP/IP allowed disparate networks to form the Internet, Sensora- OS allows disparate sensory devices to form a unified reality.

We invite the academic and engineering communities to join us in defining these standards. The question is not if multisensory computing will arrive, but how it will be governed. We argue for a future that is open, interoperable, and fundamentally safe for the human organism.

8. References

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