Overview of Haptics Standardization

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Yeshwant Muthusamy, Ph.D. | Immersion Corporation
Philippe Guillotel, Ph.D. | InterDigital Corporation

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OUTLINE

• Introduction to Haptics
• Need for Standardization
• Current Standards Initiatives
  - Haptics Industry Forum
  - MPEG
  - Khronos
  - IEEE
  - ATSC
  - IETF
Touch lets you learn about the world through body movement

Touch lets you understand through active exploration

Touch creates belief in external reality

TOUCH IS FUNDAMENTAL TO PERCEIVING AND UNDERSTANDING THE WORLD

Touch enables extended proprioception

Touch facilitates affective interactions
Basics of Haptics

• Four classes of mechanoreceptors in the human body: Merkel, Ruffini, Pacinian, and Meissner
  • Receptors sense vibration, surface texture, deformation, and pressure
  • Work together to provide nerve pulses to the brain that are merged to create a haptic perception of the world
• The goal of a haptic actuator is to stimulate one or more of these mechanoreceptors to create a haptic experience

<table>
<thead>
<tr>
<th>ACTUATION TYPE</th>
<th>TYPE OF STIMULATION</th>
<th>RELEVANT MECHANORECEPTOR</th>
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<tbody>
<tr>
<td>Electromagnetic</td>
<td>Vibration</td>
<td>Pacinian</td>
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<tr>
<td>Piezoelectric</td>
<td>Vibration + Texture</td>
<td>Pacinian</td>
</tr>
<tr>
<td>Kinesthetic</td>
<td>Deformation + Force</td>
<td>Merkel + Meissner</td>
</tr>
<tr>
<td>Surface</td>
<td>Friction</td>
<td>Meissner + Pacinian</td>
</tr>
<tr>
<td>Other</td>
<td>Stretch + Deformation</td>
<td>Ruffini + Meissner + Merkel</td>
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• Mechanisms to encode, decode, and evaluate/measure performances of these haptic sub-modalities are quite different from those for audio and video.
• Unlike audio (two ears), human tactile sensors are distributed over 2 sqm of skin surface area – coding needs to account for this
• Perceptual coding optimization will need to uniquely exploit the properties of these receptors
• The range of frequencies of interest for haptics is 0 – 800 Hz
  • 5 Hz and below is particularly significant for kinesthetic haptics (force feedback)
INDUSTRY UPTAKE OF HAPTICS

Mobile

1.4B Units in 2021

Android and iOS both support advanced haptic playback APIs but use incompatible effect encoding

Gaming

100M+ Units in typical console life

PS5 implements advanced vibration and kinesthetic feedback but utilizes a proprietary effect encoding.

XR

Expected to grow to 50M+ Units with Meta Quest and PSVR

No standardized effect encoding currently in use.

Lack of consistent coding between and across these platforms limits content creator investment
Auto: Delightful and Usable Touchscreens
Virtual Reality controllers shift from a single controller to dual motion controllers.

Neither Oculus Touch nor HTC Vive controllers incorporate rumble.

Instead use single Linear Resonant Actuators (LRA) per controller with a limited multi-frequency band.

Haptics in Consumer VR

Full Body Touch Experiences
## Need for Haptic Standardization

<table>
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<th>Without Standards</th>
<th>With Standards</th>
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<tbody>
<tr>
<td>• Market fragmentation – Walled Gardens</td>
<td>• Standards harmonize haptics offerings from vendors</td>
</tr>
<tr>
<td>- Proprietary APIs</td>
<td>- Without compromising vendor differentiation</td>
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<td>- Incompatible HW-to-SW interfaces</td>
<td>• Content creators and application developers incentivized to incorporate richer haptic experiences</td>
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<td>- Different motor characteristics</td>
<td>- Leverage standard interfaces throughout the haptic stack</td>
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<td>• Content creators and application developers are de-incentivized to include haptics in their applications</td>
<td>• Walled gardens give way to a flourishing haptic ecosystem that benefits all stakeholders.</td>
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<td>- Changes to lower levels of the haptic stack typically necessitate changes to the upper layers</td>
<td></td>
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<tr>
<td>• Adverse impact on end-user adoption</td>
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Haptics Industry Forum

- HIF is a community for best practices and standards in touch media: [https://hapticsif.org](https://hapticsif.org)
- HIF Working Groups provide a platform for discussing cross-platform challenges, establishing best practices, and aligning on industry standards

29 industry members to date participate in an open, voluntary industry group with professionals from different platforms and verticals

All devices & platforms

Our goal is to support consistent, high quality touch playback on all devices, platforms and verticals

- 5 published RPs and Specifications
- 7 Active Working Groups
- 1 Published Book
- 2 Industry Liaison Relationships
Haptics in MPEG

- **MPEG ISOBMFF (Haptics in ISO Base Media File Format)**
  - Establish haptics as a first-order media type, along with audio and video, in all ISO media files (e.g., MP4)
  - Next step: flesh out the haptic codec-specific header ‘boxes’ in ISOBMFF

- **MPEG-DASH (Haptics in media streaming)**
  - Leverages the ISOBMFF standard above
  - Initial proposal made; waiting for haptic codec to be finalized
  - Will enable haptics to be part of all media streaming (Netflix, Hulu, etc.)

- **MPEG-I (Haptics in Immersive Media – AR/VR/Gaming)**
  - Phase 1: Develop a basic haptic codec standard – in CD ballot November 2022
  - Phase 2A: Add support for spatial haptics, scene description – CfP 1H 2023
  - Phase 2B: Add support for interactivity, avatars, XR experiences (metaverse) – CfP 1H 2024
MPEG-I Phase 1 Exemplary Use Cases

- Mobile Gaming
- Instagram/TikTok
- Mobile Streaming Media
MPEG-I Phase 2A Exemplary Use Cases

Intel True View

D-BOX Immersive Home Theater

Unity Metacast UFC fight on mobile
MPEG-I Haptics Phase 2B Exemplary Use Cases

- Virtual hand based immersive VR
- Tele-robotics with haptic feedback
- Tactile e-commerce
- Long-Distance Surgery
- Interactive Video Calling
- Training and simulation
Khronos OpenXR

• OpenXR is a platform API intended to standardize the interface between app developers/game engines and XR hardware devices

• Haptic extensions to the OpenXR API will provide developer-facing haptic interfaces transportable across a variety of XR platforms.

• **HIF Strategy**
  • Leverage XR expertise in HIF XR WG (InterHaptics, SenseGlove, Weart, Actronika, Immersion) to develop a haptics extension
  • Target: Haptics extension submission by Q422, leveraging HIF liaison with Khronos
IEEE P1918.1 and P1918.1.1

- **IEEE P1918.1**
  - Tactile Internet for 5G Applications; started in 2016
  - Telesurgery use cases mapped to TI Architecture
  - Currently in ballot

- **IEEE P1918.1.1**
  - Haptic Codecs for Tactile Internet; also started in 2016
  - Two kinesthetic codecs (with-delay and no-delay)
  - Vibrotactile codec
  - The IEEE codecs are:
    - Signal compression codecs with no descriptive elements
    - Actuator/hardware-specific
    - Not quite suitable for MPEG-I use cases
IEEE P2861.3

- Standard for Haptic Interface Enhancement for Mobile Gaming
- A new working group inside the IEEE Standards Association to develop a high performance mobile haptic API standard
- OEMs that implement this standard will be able to render Tencent gaming content, WeChat, etc.
- Standardization is ongoing
- Ideally, the haptics track would be incorporated into the broadcast content stream
  • Would require standardization of haptics in DASH/ROUTE and MPEG MMTP - a multi-year process
- Low-hanging fruit – sync up content with separate haptics file, leveraging existing ATSC 3.0 standards
  • Content-specific and device-specific haptics track retrieved from cloud during handshaking
  • Content stream and haptics played in synchronization on companion device

_A/380: ATSC Recommended Practice on Haptics for ATSC 3.0 published in Feb 2021_
IETF: HAPTICS AS A TOP-LEVEL MEDIA TYPE

- **IETF** – Internet Engineering Task Force
  - Internet standards body, developing open standards through open processes
  - Top-level media types: application, audio, font, image, message, model, multipart, text, video

- **Immersion proposal: haptics as a new top-level media type**
  - Introduced at IETF 109 (Nov 2020)
  - Progressed to Proposed Standard at IETF 113 (March 2022)
  - Approval as a Standards Track RFC (STD) expected in 2H 2022

- **How does it help the haptics community?**
  - An IETF haptics RFC will be a **foundational, enabling** standard
  - Will enable proliferation of haptics media in a **standardized manner** in all internet media and communications
  - Will enable IANA registration of multiple haptic sub-types under the ‘haptics’ top-level type. Just a few (suggested) examples:
    - haptics/mp4 – MP4 files with just haptics in them
    - haptics/ivs – Immersion’s haptic format
    - haptics/ahap – Apple’s haptic format
    - haptics/hmpg – MPEG haptics distribution format
    - haptics/hjif – MPEG haptics interchange format
    - haptics/mih1 – MPEG haptics streaming format
    - haptics/hiev – IEEE P1918.1.1 vibrotactile coding format
    - haptics/hiekd – IEEE P1918.1.1 with-delay kinesthetic coding format
    - haptics/hiekn – IEEE P1918.1.1 no-delay kinesthetic coding format
  - Aligns perfectly with other haptics standardization activities (MPEG, OpenXR, etc.)
  - Will facilitate adoption of haptics by the industry – benefitting all stakeholders in the haptics value chain
Thanks for Listening!

Questions?