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**Email of Convenor:** marius.preda @ imt . fr

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**ISO/IEC JTC 1/SC 29/WG 7 MPEG Coding for 3D Graphics and haptics**

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# Introduction

In this contribution, an evaluation platform [1] for Haptics Coding Phase 2 will be introduced. The platform will be provided along with test content to perform the evaluation of the proposed solutions for Haptic phase 2 focusing on interactive haptics. The platform is based on the MPEG SD standard [2]and aims at testing five identified scenarios.

# Use Case

For the evaluation of MPEG Haptic Phase 2, 5 initial scenarios were defined based on the requirements (defined in [3] and [4]) and use cases (defined in [5] and [6]). These 5 scenarios are detailed in Table 1 and will be used as a basis for the test contents of the evaluation platform. Additional scenarios covering other requirements and use cases may be added to the platform as the implementation of the MPEG Haptic Phase 2 standard progresses.

Table 1: List of scenarios to be integrated to the evaluation platform

|  |  |
| --- | --- |
| Scenario 1: | Simple interaction triggering temporal haptic signal   * Scene description:   + 2 moving spheres colliding * Interaction:   + Collisions trigger haptic phase 1 temporal signal * Reference device:   + vibrotactile device / kinesthetic device |
| Scenario 2: | Spatialized interaction   * Scene description:   + 1 moving sphere   + 1 body representation * Interaction:   + Collisions trigger haptic phase 1 temporal feedback at the proper body location based on the location of the interaction * Reference device:   + Multi-actuator vibrotactile device |
| Scenario 3: | Spatial interaction using Haptic Phase 1 texture   * Scene description:   + 1 plane associated with a Haptic phase 1 vibrotactile texture   + 1 sphere moving along one direction of the plane * Interaction:   + As the sphere moves along the plane, haptic feedback is rendered based on the Haptic phase 1 texture * Reference device:   + vibrotactile device / kinesthetic device |
| Scenario 4: | Spatial interaction with a 2D textures   * Scene description:   + 1 plane associated with a haptic material (2D texture)   + 1 sphere moving on the 2D texture * Interaction:   + As the sphere moves on the plane, haptic feedback is rendered based on the information on the 2D texture * Reference device:   + vibrotactile device / kinesthetic device |
| Scenario 5: | Spatialized interaction with a 2D texture   * Scene:   + 1 plane with a haptic material   + 1 moving user representation * Interaction:   + Collision between the user representation and the haptic material triggers haptic feedback on the user based on the position of the interaction on the texture * Reference device:   + Multi-actuator vibrotactile device |

# Program Description

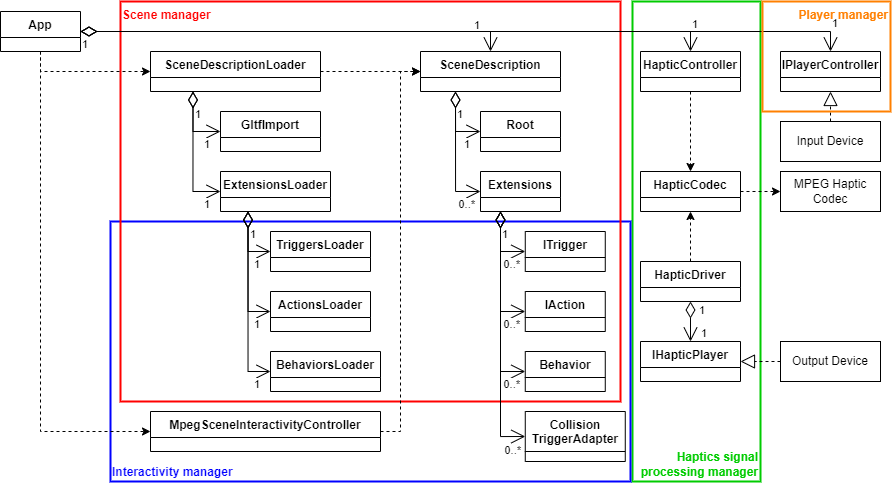


Figure 1 Class Diagram of the Program

In the program, the *Menu* serves as the scenario setting interface, after setting the scenario, the program run the *App*, where *App* serves as the entry point to the program. There are four major parts in this program as shown in Figure 1, namely scene manager, interactivity manager, haptics signal processing manager and player manager.

**Scene manager**

The scene manager contains functions to load the scene description files and store the scene related data. For scene description file loading, the *SceneDescriptionLoader* is used. *SceneDescriptionLoader* loads the glTF files through *Gltfimport* (i.e., *glTFast* plugin)and *ExtensionsLoader*, where *glTFast* is used to load the basic glTF and *ExtensionsLoader* is used to load MPEG glTF extensions. It is noted that the loaded data is stored in several objects of *SceneDescription* class, e.g., the data loaded by *Gltfimport* is stored in *root* object*,* and the data loaded by *ExtensionsLoader* is stored in several corresponding objects (e.g, *ITriggers, IActions, Behavior*).

**Interactivity manager**

The interactivity manager contains functions to control MPEG interactivity related glTF extension. The *MpegSceneInteractivityController* can control *ITriggers, IActions* and *Behavior* for related data update. Firstly, *ITrigger* update is invoked by the *MpegSceneInteractivityController,* and the date update is based on the *CollisionTriggerAdapter,* where *CollisionTriggerAdapter* can obtain collision information from Unity. Then, *Behavior* update is invoked based on the *ITrigger* state and the internally built state machine. After the *Behavior* update, a corresponding *IAction* can be triggered for haptic signal playback.

**Haptics signal processing manager**

Regarding the haptic signal processing, the program can perform the rough data acquisition, signal encoding, signal decoding and signal playback. For rough data acquisition and signal encoding, the program uses the *HapticController* function to obtain the rough data from haptic material, and invokes the *HapticCodec* for haptic signal encoding. It is noted that the rough data acquisition and signal encoding procedure are performed only when haptic material extension is used; otherwise, the program obtains encoded haptic signal from HMPG files directly. For the signal decoding and playback, the program uses *HapticDriver* to invoke *HapticCodec* for the signal decoding and further transport haptic signal to *IHapticPlayer* for playbackon the reference devices.

**Player manager**

Player manager contain functions to obtain user’s pose information from reference input devices.

# Reference devices

A number of potential reference devices have been studied and considered for integration with the evaluation platform. These reference devices with their characteristics and support of the different scenarios are detailed in Table 2. Here the devices were compared based on their rendering capabilities and whether they could be used as input devices.

Table 2: List of reference devices considered for the evaluation platform

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Scenario | | | | | Haptic modalities | | | |  |  |
|  | 1 | 2 | 3 | 4 | 5 | Electrotactile | Vibrotactile | Kinesthetic | Temperature | Nb actuators | Input |
| Haptic Phase 1 - Vivrotactile - Reference Device | X |  | X | X |  |  | x |  |  | 1 | No |
| Geomagic Touch | X |  | X | X |  |  | x | x |  |  | Yes |
| Razer Kraken V3 Pro Headset | X |  | X | X |  |  | x |  |  | 2 | No |
| Razer controller | X |  | X | X |  |  | x |  |  | 2 | Yes |
| Razer cushion seat (6 actuators on the back and legs) | X | X | X | X | X |  | x |  |  | 6 | No |
| Actronika Vest (20 actuators back and front of the upper body) | X | X | X | X | X |  | x |  |  | 20 | No |
| SenseGlove Nova | X |  | X | X |  |  | x | x |  | 3 | Yes |
| SenseGlove Nova 2 | X |  | X | X |  |  | x | x |  | 3 | Yes |
| Weart - TouchDiver | X |  | X | X |  |  | x | x | x | 3 | Yes |
| HaptX Gloves G1 (or DK2) | X |  | X | X |  |  |  |  |  | >20 | Yes |
| Positron haptic seat | X |  | X | X |  |  | x | x |  |  | No |
| Teslasuit | X |  | X | X |  | x |  |  |  |  | No |

The Geomagic Touch has been selected as the first reference device for the evaluation platform as it allows to cover most scenarios, it was already used in Phase 1 and it can also be used as an input device. For spatialized haptic rendering the most appropriate devices are the Razer cushion and the actronika vest. Both are still considered as candidates reference devices for phase 2 at this stage. The HaptX gloves, the Positron seat and the Tesla suit were considered but will not be used for the evaluation platform due to their price range.

Further studies will be carried out to select the reference devices from this list.

# Demonstration

The first implementation of the platform currently contains the test content for the scenario 1 and scenario 4, i.e., collision of two spheres and spatial interaction with a 2D textures.

For scenario 1, as shown in Figure 2, the small ball can go across the boundary of the large ball, once collision between the balls is detected, haptic feedback will be generated. It is noted that Geomagic Touch and keyboard can be used as input device to control the position of the small ball, and Geomagic Touch is used as output device to playback haptic signal.

**** 

(a) (b)

Figure 2 Demonstration of scenario 1 using Geomagic Touch

For scenario 4, as shown in Figure 3, when a small ball slides across a haptic material, haptic signal feedback is generated and played by Geomagic Touch. The intensity of the haptic signal can also be observed in the curve.

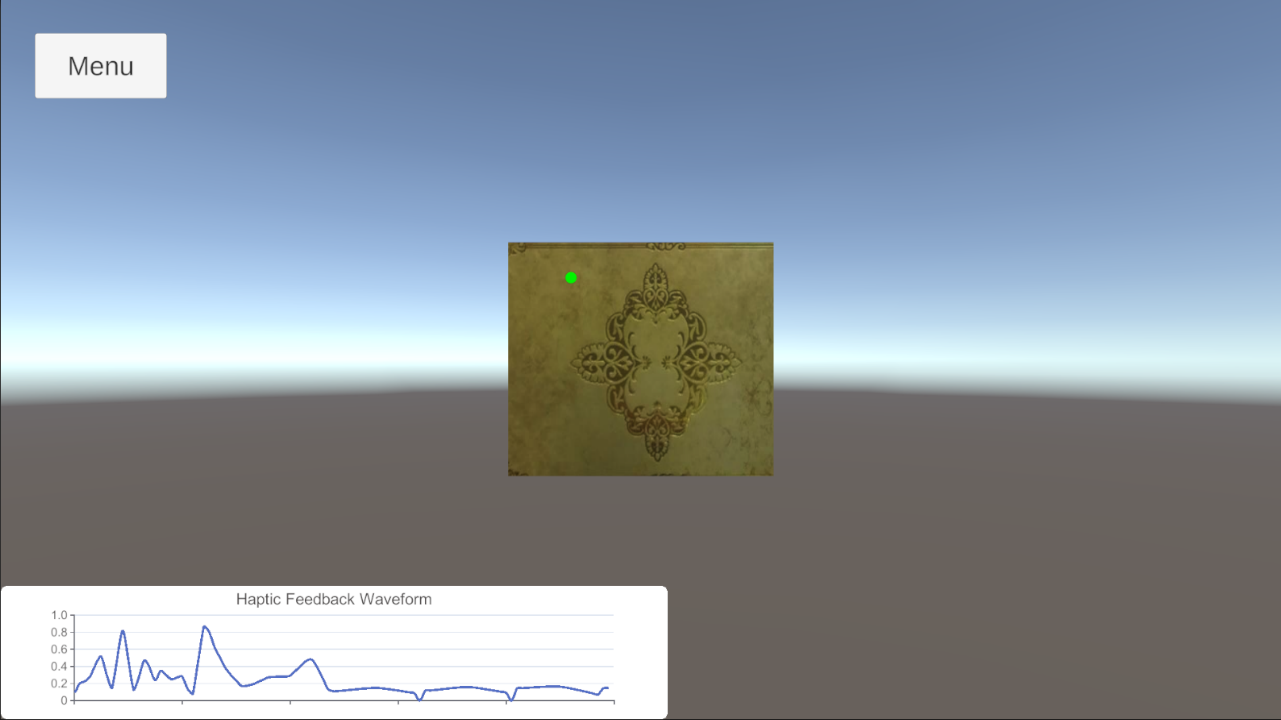


Figure 3 Demonstration of scenario 4

# Evaluation platform software

The evaluation platform for phase 2 is available on the MPEG gitlab at the following address:

<https://git.mpeg.expert/MPEG/3dgh/haptics/software/evaluation_software_phase_2>

# Reference

[1] https://github.com/wmtlab/HapticSceneDescription

[2] “Potential improvements of ISO/IEC 23090-14 CDAM 2: Support for Haptics, Augmented Reality, Avatars, Interactivity, MPEG-I Audio, and Lighting” N00861,July, 2023

[3] MDS20700 WG02 N00098, “Requirements for MPEG-I Phase 2”, MPEG135, July 2021.

[4] m57990, “Proposed Updates to the Haptics Requirements in Section 4.8 of WG02 N00098”, MPEG136, October 2021.

[5] N19513, “MPEG-I Haptics Use Cases”, MPEG131, July 2020.

[6] MDS20966 WG02 N00139, “Updated MPEG-I Phase 2 Haptics Use Cases”, MPEG136, October 2021