2025 IEEE World Haptics Conference (WHC)
Suwon Convention Center, Suwon, Korea
July 8 ~ 11, 2025

Automatic Haptic Rendering Pipeline using AI Models

Jeongwoo Kim
Interaction Laboratory
POSTECH
Pohang, Republic of Korea
jwkim0417@postech.ac.kr

Jaejun Park
Interaction Laboratory
POSTECH
Pohang, Republic of Korea
jjpark17@postech.ac.kr

Uison Ju
Interaction Laboratory
POSTECH
Pohang, Republic of Korea
uison1229@postech.ac.kr

Seungmoon Choi
Interaction Laboratory
POSTECH
Pohang, Republic of Korea
choism@postech.ac.kr

Abstract—**This work presents an automatic haptic rendering pipeline that leverages AI models to estimate the material properties of objects and convert them into haptic rendering coefficients. Our pipeline provides four haptic properties, stiffness, damping, dynamic friction, and static friction, with decent quality while significantly reducing generation costs.**

1. Introduction

In this work, we present an automatic haptic rendering pipeline using AI models with two steps: 1) estimating the physical material properties of objects based on the images and 2) converting them into parameters appropriate for haptic rendering. Our pipeline provides four haptic properties: stiffness, damping, dynamic friction, and static friction, allowing users to experience virtual objects with various kinesthetic haptic devices.

2. Material Property Estimation

Similar to [1], we designed a material property estimation pipeline with two AI models: BLIP-2 [2] and GPT-4 [3]. BLIP-2 describes an object's material and type for each multi-view image. GPT-4 generates the most credible label with the results of BLIP-2 and estimates material properties based on the label. We select four material properties: hardness (in MPa), loss factor, static friction, and dynamic friction, physically related to our target haptic properties. We repeated 100 estimations and filtered outliers using the interquartile range and Z-scores to minimize hallucinations.

3. Conversion Algorithm for Haptic Rendering

To render the estimated material properties of the object, we implemented a simple coefficient conversion algorithm with two factors: the maximum cutoff and the Weber fraction coefficient. The maximum cutoff limits the maximum value of each material property to account for the varying force ranges of the haptic device. The Weber fraction coefficient adjusts object properties to enhance their perceptual distinguishability; as the Weber fraction coefficient increases, the material property values of different objects are separated further apart.

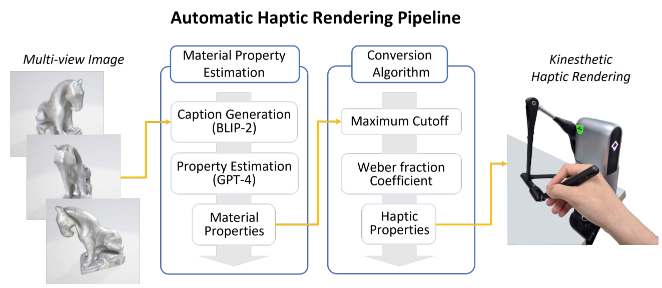

Figure 1. The user experiences the kinesthetic haptic feedback created by the automatic haptic rendering pipeline using AI models.

4. Demo Scenario

We will demonstrate two scenarios that showcase our automatic haptic rendering pipeline. In the first scenario, users experience ten haptic assets generated through the pipeline. The 3D meshes of the haptic assets are created using Meshy [4], and users can observe how different haptic properties are applied to objects. In the second scenario, users explore how varying the Weber fraction coefficient produces different results for the same objects.

Acknowledgments

This research was supported by the National Research Foundation of Korea(NRF) funded by the Korea government(MSIT) (No. RS-2024-00451947).

References

[1] A. J. Zhai, Y. Shen, E. Y. Chen, G. X. Wang, X. Wang, S. Wang, K. Guan, and S. Wang, "Physical property understanding from language-embedded feature fields," in *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, pp. 28296–28305, June 2024.

[2] J. Li, D. Li, S. Savarese, and S. Hoi, "Blip-2: Bootstrapping language-image pre-training with frozen image encoders and large language models," in *International conference on machine learning*, pp. 19730–19742, PMLR, 2023.

[3] OpenAI, "Gpt-4 technical report," *CoRR*, vol. abs/2303.08774, 2023.

[4] Meshy, "Meshy ai," 2025. [Online; accessed 23-April-2025].