2021 IEEE World Haptics Conference (WHC)
July 6-9, 2021. Montreal, Canada

Multimodal Haptic Armrest for Immersive 4D Experiences

Nathan Pollet, Emanuel Uzan, Patricia Batista Ruivo, Tal Abravanel,[1]
Aishwari Talhan, Yongjae Yoo, and Jeremy R. Cooperstock[2]

2021 IEEE World Haptics Conference (WHC) | 978-1-6654-1871-3/21/$31.00 ©2021 IEEE | DOI: 10.1109/WHC49131.2021.9517151

***Abstract*— Inclusion of haptic effects is gaining popularity as an essential feature for immersive 4D entertainment experiences. In the present WIP, we introduce our ongoing development of a multimodal haptic armrest and the research it enables. The functioning prototype provides vibrotactile sensations using large and small vibration motors, and generates airflow, thermal, and poking sensations using a fan, a Peltier module, and solenoids, respectively. When actuated appropriately, these haptic stimuli can allow users to experience an enhanced level of immersion when consuming content without large, expensive peripherals. This platform is being used to support our research on automatic haptic content generation mechanisms.**

I. Introduction

The 4D cinema experience has been growing steadily for the past decade. However, especially during the present pandemic, content viewing is shifting increasingly towards at-home consumption, propelled by streaming services such as Netflix and Disney+. While a massive amount of content is already available on these platforms, the home theatre equivalent of the 4D experience available in movie theatres [1], [2] has yet to gain significant popularity, in part due to the high cost of the associated systems. To address this barrier to adoption, we investigate the feasibility of augmenting the armrests of regular chairs with haptic effects that can offer some portion of the experience available to cinema-goers. As a starting point, our aim was to develop a reasonably small, robust, and low-cost armrest device capable of providing a diverse range of haptic feedback.

II. Implementation

We selected haptic feedback modes of *strong (structural) vibration*, *light buzz-like vibration*, *airflow*, *thermal* and *poking* sensations. The haptic actuators utilized to provide the sensations are summarized in Table I. All actuators were controlled using an Arduino Mega board and were powered by a computer power supply.

Figure 1 shows the device, with and without the cloth cover, used to hide electrical wiring (see supplementary video[1]). The external structure consists of a hard foam material, chosen for its ease of crafting. The large vibration motors are embedded inside the armrest to provide strong shaking sensations. All other actuators are placed on the top surface of the foam material. The cooling fan is covered by a perforated air duct to prevent possible contact between the user and fan blades.

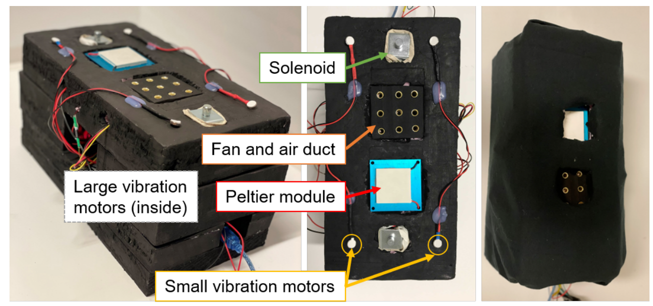

Fig. 1: Prototype armrest, side view (left panel), top view (middle) and top view with cover (right).

TABLE I: Haptic Modes and Implementation of the Armrest

Modality	Parts	Quantity
Strong vibrations	Large vibration motors (Jinrong JQ24-35F580C, Driver: DFRobot DRI0002)	2
Light vibrations	Small vibration motors (Seeed Tech; 316040004, Driver: Sparkfun TB6612FNG)	4
Airflow	Cooling fan (Sunon; PMD1206PTB2-A), an air duct	1
Thermal	Peltier Module (TEC-12706; 40mm square, Driver: DFRobot DRI0002)	1
Poking	Push-Pull Solenoids (Sparkfun; 416, shaft length: 10 mm, controlled by relay switches)	2

III. Ongoing and Future Work

We are presently extending the software components of this system, and adding computer control so that the armrest can be used to deliver effects in conjunction with arbitrary media. In this respect, we plan to develop an authoring environment for the armrest, which could ultimately be extended to an algorithm that automatically extracts features from audiovisual content. We plan shortly to conduct a user study to assess user experience of the associated haptic effects.

[1]N. Pollet, E. Uzan, P. B. Ruivo, and T. Abravanel are affiliated to the Department of Mechanical Engineering, McGill University, 3480 Rue University, Montréal, H3A 0E9, Quebec, Canada.

[2]A. Talhan, Y. Yoo, and J. Cooperstock are with the Department of Electrical and Computer Engineering, Centre for Intelligent Machines (CIM), and Centre for Interdisciplinary Research in Music, Media and Technology (CIRMMT), McGill University. {aishwari, yyoo, jer}@cim.mcgill.ca

This study was supported by McGill MECH Capstone program, InterDigital Corporation, and NSERC grant RGPIN-2017-05013

[1]https://bit.ly/32Nnq2j

References

[1] J. Lee, B. Han, and S. Choi, "Motion effects synthesis for 4d films," *IEEE Trans Vis Comput Graph*, vol. 22, no. 10, pp. 2300–2314, 2015.
[2] F. Danieau, J. Fleureau, P. Guillotel, N. Mollet, M. Christie, and A. Lécuyer, "Toward haptic cinematography: Enhancing movie experiences with camera-based haptic effects," *IEEE MultiMedia*, vol. 21, no. 2, pp. 11–21, 2014.