Reconfigurable flexible haptic interface using friction modulation

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I. Introduction

To recreate texture on human's machine interfaces, haptic technologies using ultrasonic lubrication are studied for several years [1]. This solution have been demonstrated with flat and rigid material and a simple geometry. Today, the trend is to develop new adaptive interactive surfaces, such as foldable and rollable displays. Researchers have developed haptic solutions that are capable of producing vibrotactile stimulation but cannot use ultrasonic lubrication [2]. Considering this, our recent work [3] shows the possibility for the development of a new kind of haptic interface based on a hybrid solution combining rigid haptic pixels and a polymer matrix.

II. Development

Previous works have allowed us to introduce and validate the concept of haptic pixel. This one is composed of three main elements: a square glass plate of surface 1 cm² and thickness 500 μm, a PZT actuator of diameter 5 mm and thickness 150 μm and a polymer film, here we choose a 75μm thick KAPTON film (Fig. 1). This haptic pixel, when activated at its resonance frequecy (32 kHz), creates a flexural wave ($\lambda = 3$ mm) in the KAPTON film and allows to obtain texture sensations thanks to the technique of ultrasonic lubrication.

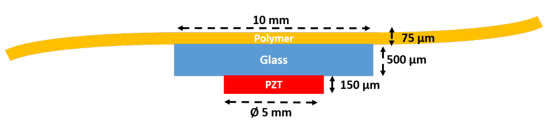

Fig. 1. Haptic pixel concept

The interface, presented Fig. 2, consists in a matrix of 9 pixels spaced 10 mm apart, and was made with an innovative process which contains two main parts: (i) the fabrication of the rigid vibrating pixels on a 500 µm thick glass wafer and (ii) the realization of the flexible matrix on a KAPTON film laminated with a thermal release tape REVALPHA on a Silicon wafer.

III. Electromechanical validation

Vibrational measurements are used to confirm the displacements on the surface. For example, as shown in Fig 3, we can choose to drive five PZT ceramics to achieve an "L" shape. A displacement of 4 µm peak-to-peak is measured at 20 Vpp on the active area. The sensation of friction reduction will therefore be localized around this "L" shape.

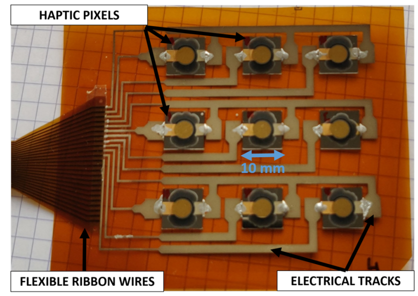

Fig. 2. Bottom view of the flexible haptic interface

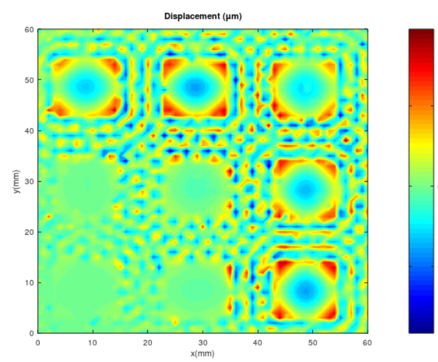

Fig. 3. Vibrational measurements for a "L" shape

Thus by choosing the PZT ceramics to actuate different shapes can be configured on this 9-pixels surface (point, line, diagonal, etc).

IV. Perspectives

This solution can therefore be used for guidance or shape recognition applications and adapted thanks to its flexibility to different supports: wristband, car dashboard, etc. Further work will be carried out to validate this new haptic surface with tribological and psychophysical measurements in a specific use case.

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References

[1] C. Basdogan et al., "A Review of Surface Haptics: Enabling Tactile Effects on Touch Surfaces," in IEEE Transactions on Haptics, vol. 13, no. 3, pp. 450-470, 1 July-Sept. 2020.
[2] J. Yin et al., "Wearable Soft Technologies for Haptic Sensing and Feedback," Advanced Functional Materials, p. 2007428, Dec. 2020.
[3] Le Magueresse, R. et al.(2022). Preliminary Design of a Flexible Haptic Surface. In: , et al. Haptics: Science, Technology, Applications. EuroHaptics 2022. Lecture Notes in Computer Science, vol 13235. Springer, Cham.