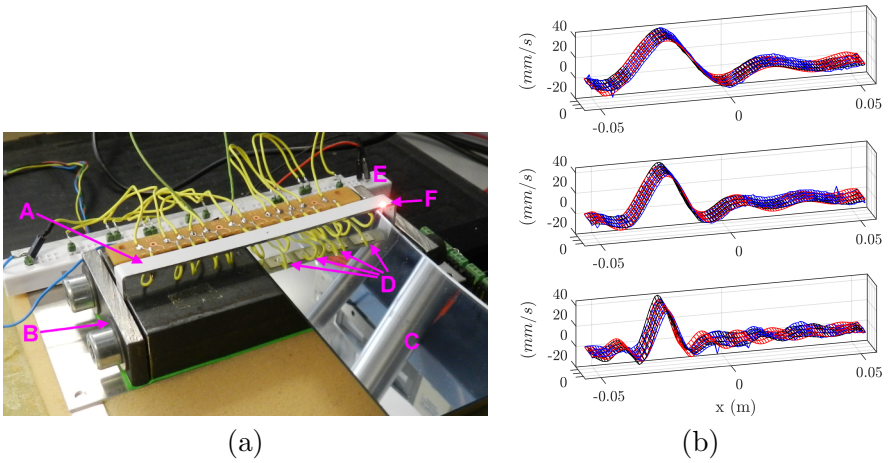
Open-loop transient control of modes for the generation of localized tactile tunable patterns on haptic devices

C. Giraud-Audine*[,1], E. Enferad[2], F. Giraud[2], M. Amberg[2] and B. Lemaire-Semail[2]

[1] Arts et Métiers Paris Tech, [2] Université de Lille,
EA 2697 - L2EP - Laboratoire d'Electrotechnique et d'Electronique de Puissance,
F-59000 Lille, France
e-mail: christophe.giraud-audine@ensam.eu

ABSTRACT

In the field of haptic, some researches focus on localized stimulations on screens to reduce the visual burden for e.g. automotive applications [1]. To that end, a velocity field is generated, where high velocities are produced within a chosen region at a given time. Time reversal or phased array have been studied on screens equipped with piezoelectric ceramics [2, 3]. However, these solutions can lack robustness or sharpness.
Closed loop (CL) control of the mode transients may address these issues for a reduced number of modes. Therefore, we propose to use the modal basis to reproduce a specified velocity field with a predefined transient. In this paper, a preliminary proof of concept toward CL is presented. We propose a methodology to select the modes and practically synthesize the voltages to achieve an open-loop controlled focusing in a prescribed time. Experiments are presented that show the versatility of the method and a good agreement with the theory for various velocity fields and a reduced number of modes which demonstrates the applicability of CL solutions.



(a) (b)

Figure 1: Experimental set-up (a) including a beam (A) excited by piezoelectric patches (D), and examples of controlled shapes and their modal projection (b) involving, from top to bottom, 6, 9 and 16 modes. Reference is in red, modal approximation in black and experimental in blue

REFERENCES

[1] Seung-Chan Kim, Tae-Hon Yang, Byung-Kil Han, Dong-Soo Kwon, Interaction with a display panel - an evaluation of surface-transmitted haptic feedback, in: 2008 International Conference on Control, Automation and Systems, IEEE, 2008, pp. 278–283.

[2] C. Hudin, J. Lozada, V. Hayward, Localized tactile feedback on a transparent surface through time-reversal wave focusing, IEEE Transactions on Haptics 8 (2) (2015) 188–198.

[3] J.-H. Woo, J.-G. Ih, Vibration rendering on a thin plate with actuator array at the periphery, Journal of Sound and Vibration 349 (2015) 150–162.