TOWARDS A 3D PRINTED ACOUSTIC SENSOR INSPIRED BY HAIR-LIKE STRUCTURES OF INSECTS: A STUDY OF HAIR SHAPE AND SIZE

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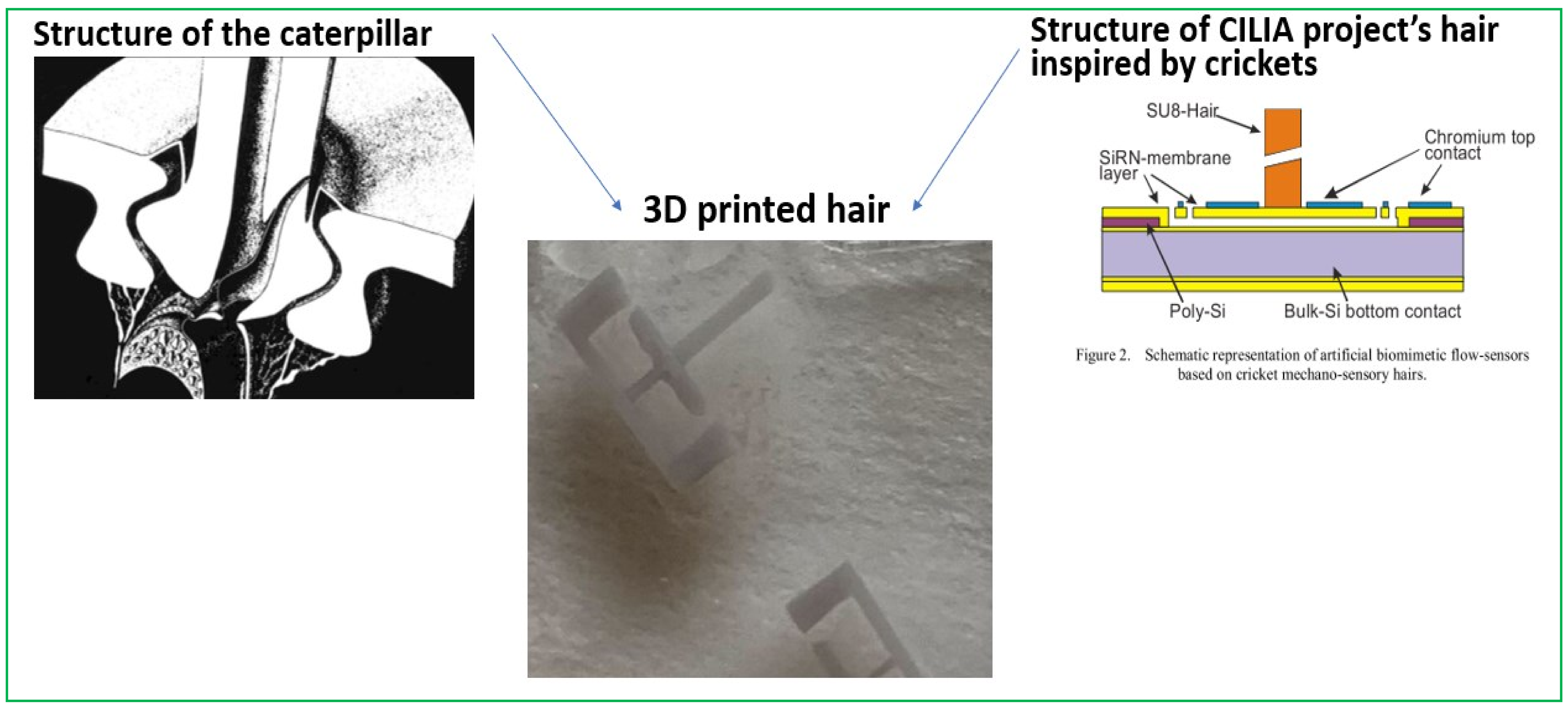
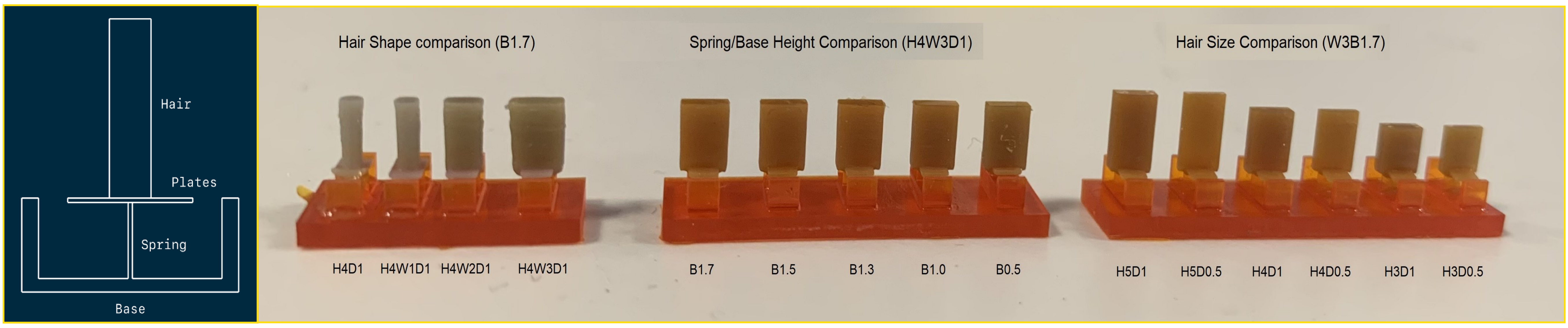
INTRODUCTION



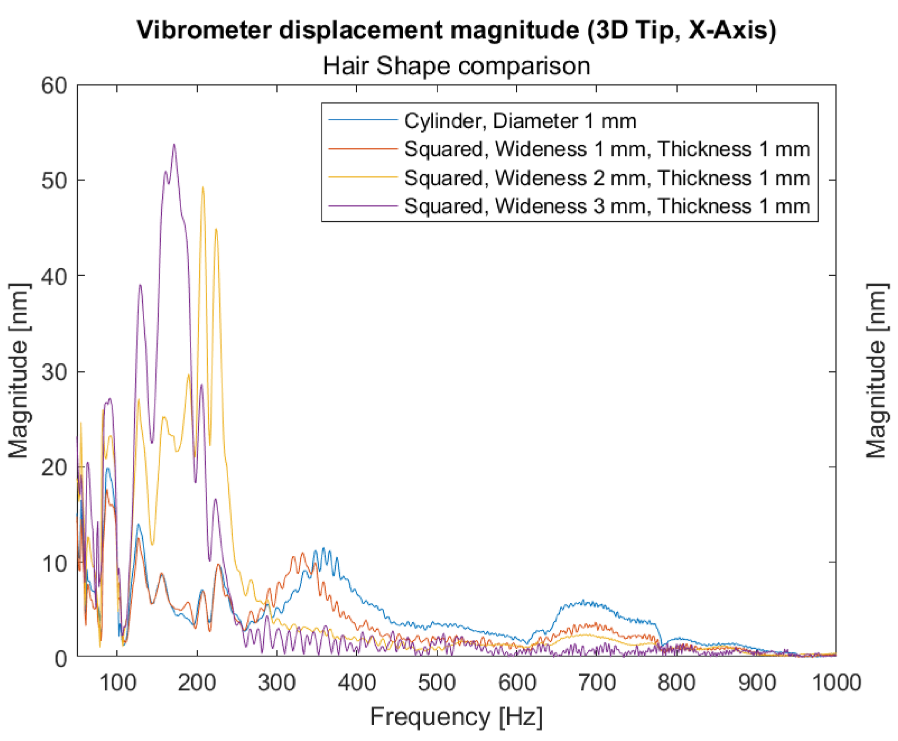
Over ages insects evolved to be smaller and more efficient with several miniature sensing mechanisms reacting to the environment around them. The hair-like structures, called *trichobothria* or *trichoid sensilla*, are fascinating mechanisms that allow insects to react to airflow and low-frequency, near field, sound [1, 2]. Nevertheless, it is thought that from this sensing structure, other sensing mechanisms are derived by a change on the hair structure. This includes sensing of odours, acceleration, touch, temperature, as well as a gyroscope-like mechanism [2]. This project proposes the use of advanced 3D printing techniques to create a sensor inspired by the trichoid sensilla of insects. Inspiration comes, in particular, from the sensilla structure of the caterpillar *Barathra brassicae* [3], and one from the crickets previously studied in the EU CILIA project [4]. The focus is on developing a mechanical structure that responds to sound. Arrays of sensors that react at different sound frequencies allow frequency content measurement of a sound without the need for computationally expensive digital processing techniques (DSP).

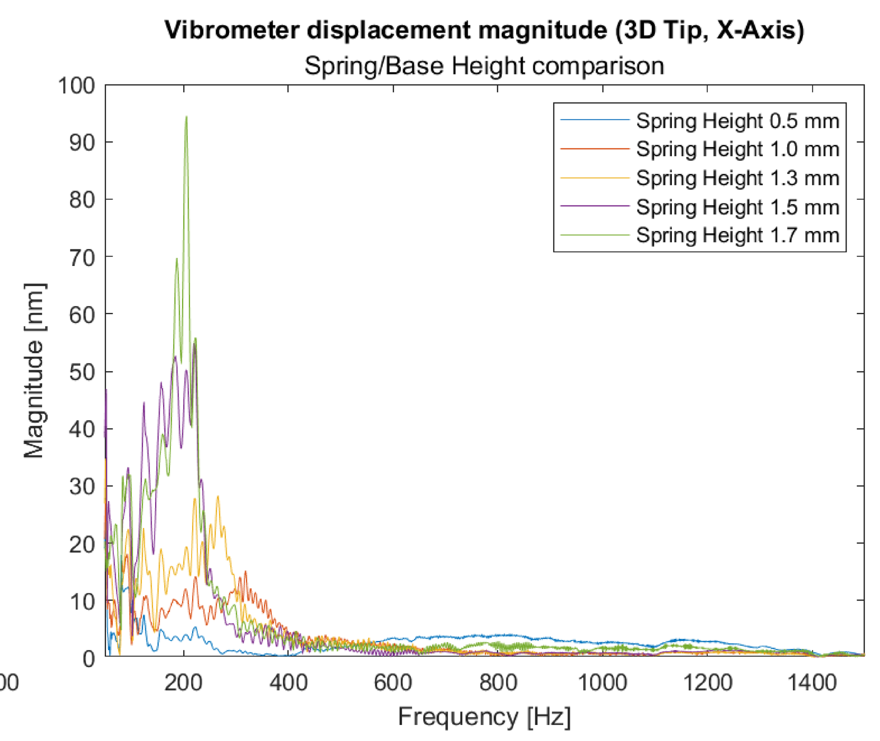
METHODOLOGY

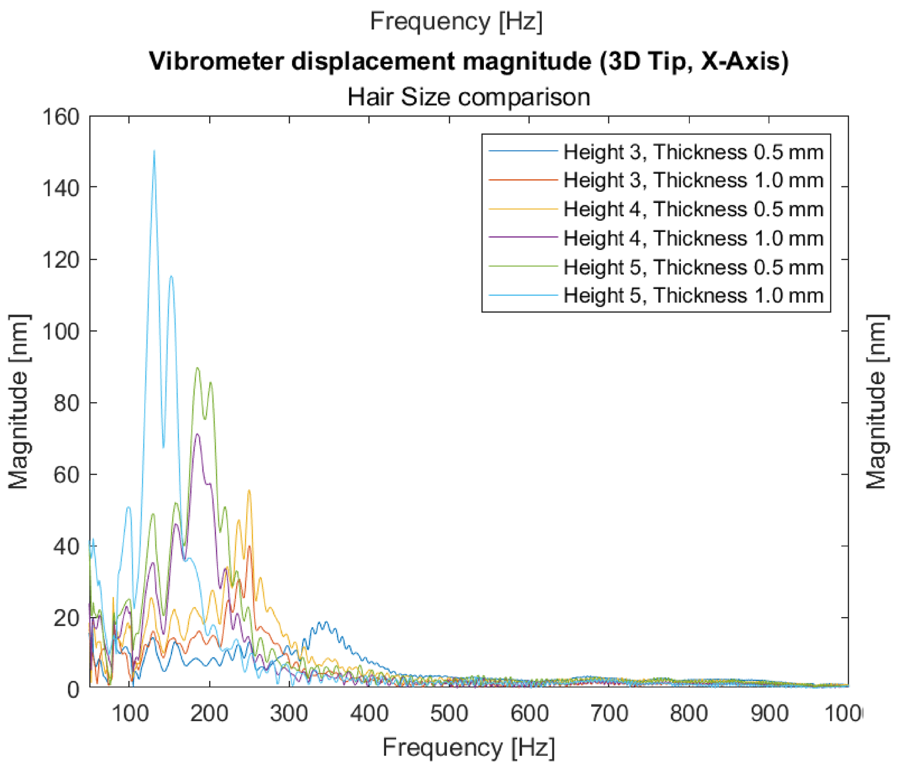


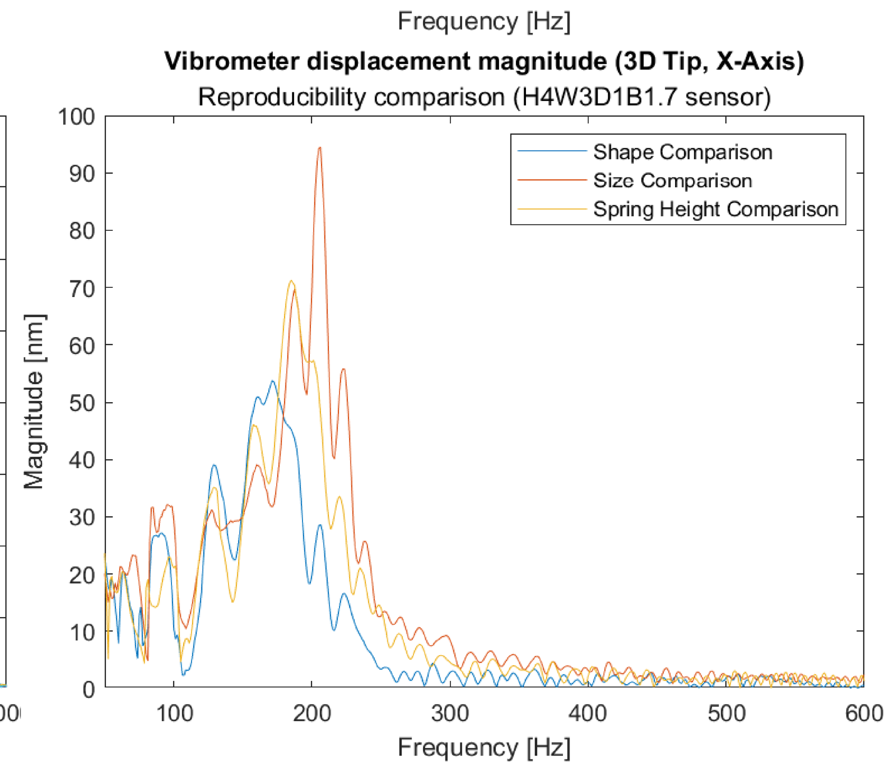
The sensors are printed by using an Asiga MAX X27 3D printer. The displacement of the hair was then measured using a 3D-Laser Doppler Vibrometer (Polytec MSA-100) and a speaker. The conducted tests changed the hair shape and size or the base/spring height.

For the hairs the sizes are indicated (in mm) as height, **H**, wideness, **W**, depth/diameter, **D**. While the base/spring height is indicated with **B**.









RESULTS

- The cylindrical hair and its nearest squared version have a similar response, albeit the former has a slightly higher resonant frequency. The wider the hair the lower the resonant frequency and the higher the displacement. For smaller hairs the displacement of the resonant frequency is equal to other structural noise.
- The lower the spring height the lower the displacement, the higher the resonant frequency and the noisier is the movement.
- The higher the hair the higher the displacement and the lower the resonant frequency.
- The sensor is somewhat reproducible, better care in the printing process could improve it.

CONCLUSIONS

The obtained results are promising but they need to be validated by making the plates capacitive and recording an electric signal in response to the acoustic stimulus. Combinations of other materials and structures need to be studied to get a better understanding of the sensor's response.

ACKNOWLEDGMENTS

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