An X6-1 transducer clip for the UltraFit headset

Saumya Raj[1], Jonathan Washington[2]

[1,2]Swarthmore College, USA

[1]sraj11@swarthmore.edu, [2]jonathan.washington@swarthmore.edu

Keywords: tools, hardware, headsets, stabilisation, 3D printing, Philips, Articulate Instruments

Introduction

This paper presents a 3D-printed adapter (clip) for using the Philips X6-1 transducer with the UltraFit headset [1] available from Articulate Instruments (AI). The clip is shown in Figure 1.

Headsets are a common approach to the problem of stabilisation of transducers in ultrasound tongue surface imaging (UTI) work; they are often considered less restrictive and more comfortable than other options, and have been shown to provide an acceptable level of stability.

The Philips X6-1 transducer is not widespread in UTI work, but is used in at least a couple laboratories that conduct this kind of work, including the Indiana University Speech Production Lab, and the Swarthmore College Phonetics Lab. Use with a Philips Epiq 7 ultrasound machine allows for 3D ultrasound capture at reasonable frame rates, as well as simultaneous 2D capture of midsagittal and lateral planes. These features result in the transducer being larger and heavier than most 2D ultrasound transducers used for UTI.

While a bespoke X6-1 adapter was available for the metal AI headset [2], that headset has several disadvantages as compared to the nylon UltraFit headset, and is considered superseded by the latter. The UltraFit headset is lightweight, easier to fit to participants, and despite being available for only about five years, is now widely used in stabilisation for UTI.
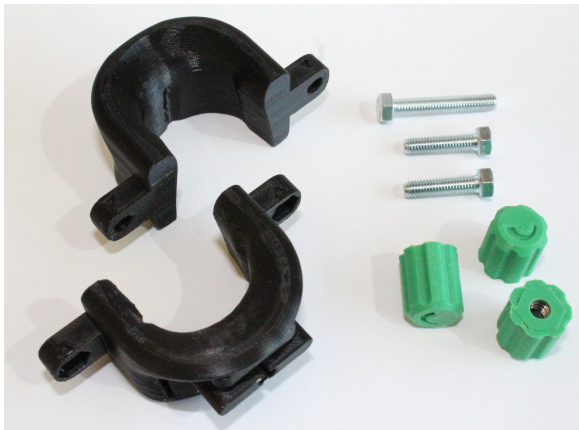
(a) A picture of the clip pieces.

(b) The UltraFit headset holding the X6-1 transducer using the clip, as modeled by the second author.

Figure 1: Pictures of the clip.

Development

The development of a clip for the UltraFit headset that would hold the X6-1 transducer entailed over 20 iterations of 3D scanning, measuring with calipers, design work, and prototyping. An early model SHINING 3D Einscan scanner was used for scanning the X6-1. Blender was used for initial design

and development, and then Fusion 360 was adopted due to ease of use. The final file was compiled on Cura software. The design files are made freely available for non-commercial use.[1]

Design

The headset clip is constructed from PLA of size 2.85 mm, a lightweight, durable polymer chosen for its balance of flexibility, rigidity, and smooth matte finish. The existing model of the clip was printed on an UltiMaker S5 3D printer with a layer height of 0.1mm (medium quality), infill density of 10% (the medium density makes it slightly lighter and softer), and grid pattern (provides good structural fit). Support material was used to ensure the overhangs and bridge were supported.

Like the stock UltraFit clips, the X6-1 clip consists of eight parts: two sides of the clip, three zinc M7 bolts, and three nuts. Two 2cm bolts hold the two sides of the clip together, and one 3cm bolt attaches the clip to the headset (Figure 1a; renderings in Figure 2a). Zinc nuts are encased in 3D-printed PLA cases designed to mimic those of the original UltraFit headset.

The fully assembled clip weighs approximately 45g. This does not significantly affect the weight of the headset, approximately 300g on its own. However, the X6-1 probe is relatively heavy at about 270g. The cable is also hefty; half of its 2m length adds about 120g of potential weight for a seated participant. The probe thus approximately doubles the weight of the headset.
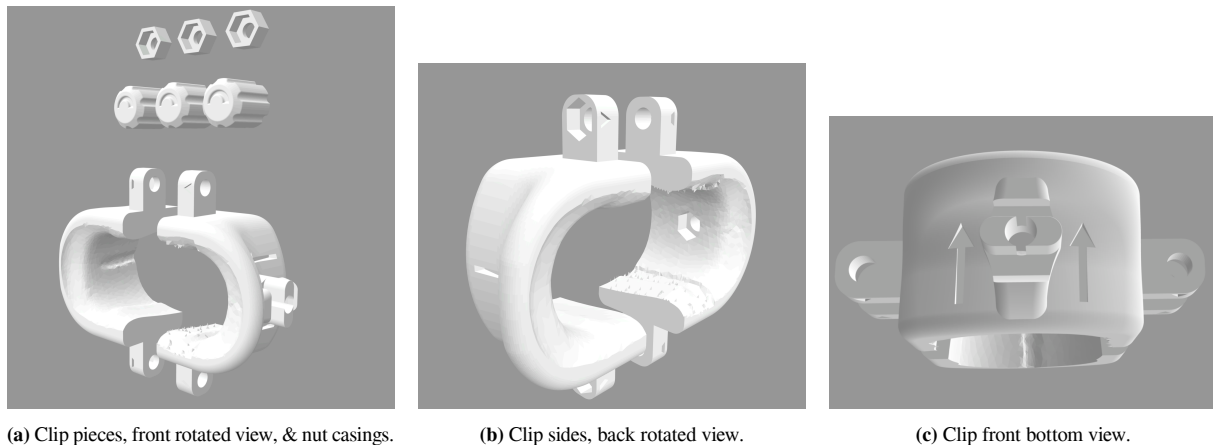

(a) Clip pieces, front rotated view, & nut casings.   **(b)** Clip sides, back rotated view.   **(c)** Clip front bottom view.

Figure 2: Renderings of the clip design

Future Work

The clip relies on the existing ability of the UltraFit headset to maintain stability, with a reported error range of ≤3mm [3]; future work will evaluate stability while using the clip and an X6-1 transducer. Additionally, the clip is currently configured for subject-facing orientation of a thin rubber detail on the X6-1; however, standing practice is to point the rubber detail away from a subject. Future work will flip this orientation; in the meantime, an Epiq 7 setting flips the direction of acquisition so that acquired images are not affected.

Conclusions

Despite the larger size and added weight of the X6-1 transducer, with the use of the clip, the UltraFit headset is sturdy and is able to perform normally. This openly licensed clip adds to the availability of stabilisation methods for UTI.

References

[1]   Spreafico, L., Pucher, M., & Matosova, A. (2018). Ultrafit: A speaker-friendly headset for ultrasound recordings in speech science. *Proceedings of Interspeech 2018, 19th Annual Conference of the International Speech Communication Association*, 1517–1520. https://doi.org/10.21437/Interspeech.2018-995

[2]   Scobbie, J. M., Wrench, A. A., & van der Linden, M. (2008). Head-probe stabilisation in ultrasound tongue imaging using a headset to permit natural head movement. *Proceedings of the 8th International Seminar on Speech Production*, 373–376. https://doi.org/20.500.12289/1099

[3]   Pucher, M., Klingler, N., Luttenberger, J., & Spreafico, L. (2020). Accuracy, recording interference, and articulatory quality of headsets for ultrasound recordings. *Speech Communication*, *123*, 83–97. https://doi.org/10.1016/j.specom.2020.07.001

---

[1] The style file is available from https://github.com/SwatPhonLab/X6-1_UltraFit_clip under a Creative Commons Attribution-NonCommercial-ShareAlike license (CC BY-NC-SA 4.0).