Experiencing different 1 Degree-of-Freedom rotary actuators across iterations of TorqueTuners in musical applications

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Abstract. The addition of haptic feedback in digital musical instruments (DMIs) can improve performance control and expressivity. The TorqueTuner is a family of embedded rotary force-feedback modules that enable DMI designers to map haptic effects to musical parameters, facilitating straightforward haptic integration. In this demonstration, we present 3 TorqueTuner iterations based on different motors and drivers: 1) the newly redesigned Mechaduino (forked from an obsolete open-source servo platform by Tropical Labs), 2) the Mjbots Moteus (a high-power industrial motor), and the Makerfabs MaTouch SmartKnob (a self-contained device with a display). Attendees will interact with and compare each iteration, experiencing rotary haptic effects applied to a live musical context. Ultimately, we aim for this demonstration to lead to greater and easier integration of haptics into DMIs.

Keywords: Force-feedback haptics · musical applications.

1 Introduction

Force-feedback haptics remain at a relatively early stage of development [1]. Many challenges hinder the democratization of force feedback for musical applications, including limited modularity, replicability, affordability, usability [2].

2 TorqueTuner: 3 iterations sharing a joint infrastructure

The TorqueTuner is a self-contained force-feedback module introduced by Kirkegaard et al. in 2020 for integration in digital musical instruments [3]. We present 3 TorqueTuner iterations with different magnetic encoders, motors, and controllers. All iterations share the same set of demos (pitch wheel, turntable, string plucker) and infrastructure (libmapper and webmapper). All iterations use Libmapper as infrastructure to network devices and their communication [4] and Webmapper (Libmapper's web-based UI) for the real time control of mappings between devices and to run the same demo applications across devices. Please watch our demo video.

The first iteration builds upon the Mechaduino, an open-source Arduino-compatible servo platform designed by Tropical Labs for closed-loop control of a NEMA-17 stepper motor using a magnetic rotary position sensor, that we connected via I2C to an ESP32 board for wireless connectivity. Long after the original Mechaduino went out of production around 2022, we upgraded the design with KiCad for production in 2026. The second iteration was migrated by Niyonsenga et al. [5] to the open-source MJBots Moteus platform, featuring a 12-winding, 3-phase brushless motor (MJ5208), connected to a Raspberry Pi 4. The third iteration only requires flashing a custom firmware for the Makerfabs MaTouch SmartKnob, a third-party low-cost off-the-shelf self-contained product consisting of a Brushless DC motor (Xiaomi Pentie 3205), a touch LCD display, a battery, and a microcontroller with wireless network capabilities (ESP32-S3).

3 Technical requirements

We require: a table and 5 power outlets (needed), and a stereo speaker (ideal).

References

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4 Ethics Statement

The forces experienced during this demonstration are comparable to those sustained when operating standard musical interfaces, with no feasible risk of injury to participants. Participation is entirely voluntary, and participants can dismiss at any time. No data will be gathered during this demonstration. We will protect the privacy of attendees: we will ask consent from attendees before taking optional pictures.

5 Acknowledgments

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6 Space Planning Diagram

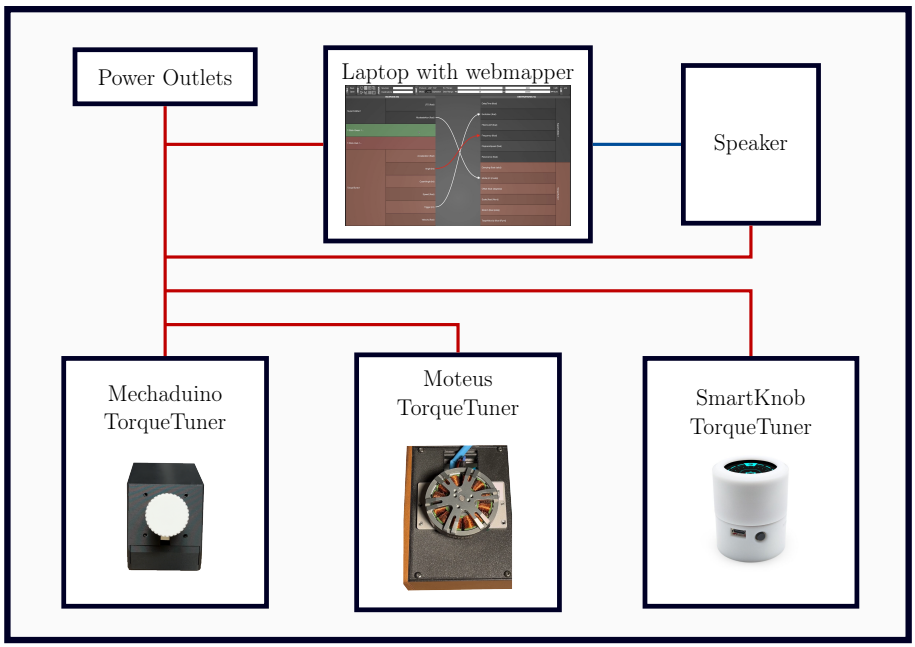

Fig. 1. A labeled diagram of the intended table layout for the TorqueTuner demo, with the three devices in the front facing participants. The red lines indicate power connections, while the blue line is an audio connection.