Low Frequency Feedback Drones: A non-invasive augmentation of the double bass

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ABSTRACT
This paper illustrates the development of a Feedback Resonating Double Bass. The instrument is essentially the augmentation of an acoustic double bass using positive feedback. The research aimed to reply the question of *how to augment and convert a double bass into a feedback resonating one, without invasively modifying the instr*ument. The conversion process illustrated here is applicable and adaptable to double basses of any size, without making irreversible alterations to the instruments.

Author Keywords
Feedback Resonating Double Bass, Augmented Instruments, Acoustic Feedback Instruments, Bela

CCS Concepts
• **Hardware → Sound-based input / output**; • Human-centered computing → Auditory feedback; • Applied computing → Sound and music computing;

1. INTRODUCTION
Processes of instrument augmentation are not new [1, 2]. My interest for this project was in string instrument augmentations and feedback processes. Influential works were the Overtone Fiddle [3], the Self-Resonating Feedback Cello [4, 5], the feral cello [6], the Magnetic Resonating Piano [7], the Feedback Resonance Guitar [2], Half-Closed loop [8] as well as the ongoing work of Halldór Úlfarsson, halldorophone [9] a cello-like feedback instrument. The double bass augmentation presented here is a non-invasive one. The resulting instrument is a Feedback Resonating Double Bass (Figure 1). The non-invasive aspect of it is essential to the project.

1.1 Rationale of the project
I play the d. bass in both experimental and classical music setups. I wanted to augment my instrument without causing irreversible damage to it by drilling holes, as is the case with the feedback resonating cellos [4, 5]. Often I do not do not travel with my instrument, due to its size, but rather procure instruments when I perform far afield. Therefore, I envisioned a system that could be easily fitted to instruments I am provided with, without causing damage.

2. DESIGN AND CONSTRUCTION
Hence I designed a system constituting a feedback resonating d. bass, the design relies on a modular structure that can potentially be placed and adjusted to any d. bass. The augmentation employs electromagnetic capsules to pickup the sound of its vibrating strings. After a series of amplification stages the sound feeds back to the instrument through tactile transducers that attached on the instrument's body.

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Figure 1. The two sides of the instrument.

2.1 The Input Stage and Bela
A 3D modeled and printed bracket is fixed on to the fingerboard holding smaller, adjustable brackets for the electromagnetic pick-ups. This bracket is fully adaptable to any fingerboard and has already been used on instruments of different sizes (i.e. 1/4 up to 4/4). Four CycFi[1] Nu Series Modular Active electromagnetic capsules were used to pick up the string vibrations. These capsules have a built-in pre-amplifier and near-flat frequency response. Each pick-up was sits in its own bracket mounted on the main bracket. The pick-up brackets allow the adjustment of the distance between pick-up and string. This adjustability contributes greatly in the fine-tuning of both the dynamic and spectral range of detected sound. The Nu Series pick-ups require three pins to be connected: a 5V input, a GND pin and the signal output. The pick-ups were powered by one of the 5V outlets from Bela[2], as they consume the minimal Amperage of 375μA (Figure 2).

The output of the pick-ups was fed into four audio inlets of the Bela board. Bela Audio Expander Capelet[3] was used to increase the audio inlets, as by default a Bela has only a stereo input. To control the input gain, four analogue slider potentiometers were introduced. The Bela was programmed in SuperCollider. The only hardcoded audio processing was a chain of two Low Pass Filters at the frequency of 4000Hz eliminating a bit of system noice coming from the pick-ups power supply.

2.2 Output Stage and Power Supply
The strings signal is eventually output out of Bela's stereo outlet. As there was a four channel input (one for each string) and only a single stereo inlet to the amplifier, the four pick-up signals are mixed as L&R before routing to amp. The signals from the first and third pick-ups (i.e. first and third strings) were assigned to the left outlet, while

[1] www.cycfi.com/projects/nu-series
[2] https://bela.io/
[3] https://shop.bela.io/bela-audio-expander-capelet

the second and fourth strings were assigned to the right. The stereo Bela output was then fed into a Sony DSX-A200UI —car— amplifier, dedicated to drive a set of tactile transducers. Between the Bela and the amplifier two volume pedals were introduced to control the audio dynamics that would feed back to the instrument (Figure 2.). To playback the output signal a total of four transducers were used, two Dayton Audio BST-1 50 Watts 8Ω bass shakers and two Rock Wood 100W 4Ω mid range shakers. The four transducers were coupled in pairs, with a bass and a mid range transducer per channel (left and right output channels from the Sony amplifier). A single silent 500W ATX PC Power Supply Unit (PSU) powered the instrument. The Bela is powered with one of the 5V power outlets of the PSU. The Sony amplifier is powered by one of the 12Voutputs. The capsules are powered through Bela.

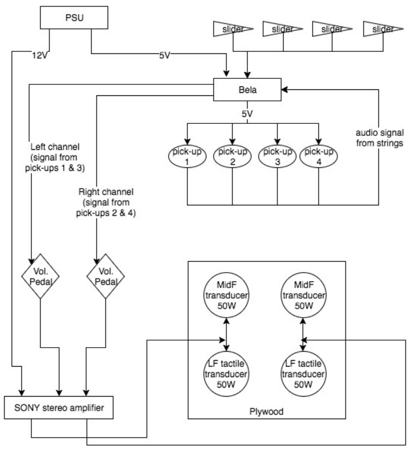

Figure 2. Equipment, signal and wiring diagram.

2.3 The assemblage

The four transducers were mounted upon a thin layer of plywood. The low frequency range transducers were placed right below the mid range ones and they were coupled. The left output of the signal (i.e. output signal from strings one and three) were driving the transducers at the left side of the instrument, while the right output of the signal (strings two and four) drove the transducers at the right side of the instrument.

The plywood that held the four transducers was fixed in place by two custom-made wood-clamps that were running horizontally across the body of the instrument. However, for different sized instruments ratchet straps are used. Here I need to declare that wood-clamps and ratchet straps placed properly do not harm the instrument as they are methods that are even used from d. bass luthiers. This particular assemblage allows a resonating type of feedback propagating along the body of the instrument through its vibration (Figure 3). It explores positive feedback principles [10] and the use of pick-ups and transducers, as they have been explored by other authors [11]. This time however the augmentation of the instrument follows a non-invasive method and can be easily adjusted to other instruments.

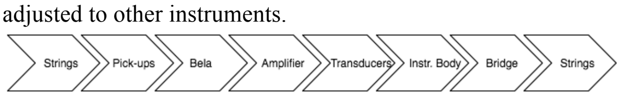

Figure 3. Feedback audio path from strings to strings.

3. PERFORMANCE

The instrument is currently tuned A-E-A-E (from high to low strings). It has already been successfully used in performances. And it is the new instrument member of a previously existing trio for two feedback resonating cellos and Threnoscope [12]. The feedback resonating double bass provides me with sounds that I was unable to produce before. Also, it offers inspiration to explore further the uncharted aural territories of the d. bass; an instrument I am well familiar with, which I have an opportunity to rediscover given the change in character caused by this augmentation process. Currently further experimentation is taking place about its tuning, the coupling and position of the transducers, as well as sound manipulation processes run on Bela via SuperCollider.

4. CONCLUSIONS

Based on the experience of building and performing with the instrument, the process resulted in the following:

- The design of a feedback resonating double bass, which has been successfully used in performances.
- A non-invasive method for augmenting virtually any double bass.
- A versatile and adaptable kit/method that can be applied to augment a large, classical string instrument.

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