# Demos

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# Demos: Støjbox XYZ and Støjbox Spring

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## ABSTRACT

This paper describes the features, development process, and demonstration of two prototypes of new desktop instruments: Støjbox XYZ, and Støjbox Spring. The highlight of the Støjbox XYZ is a 3-dimensional controller designed to augment existing sensor technologies, thereby increasing the expressiveness of the synthesizer interface by letting musicians simultaneously access three different sound parameters with a single finger. The main element of the Støjbox Spring is a spring reverb tank that can be played directly (with the addition of an internal feedback path incorporating various effects), or used as an effect unit for other instruments. The method of iterative prototyping was used in the development of these instruments, and the work contributes with the bespoke designs and demonstrations of the prototypes.

## 1. INTRODUCTION


Figure 1. Støjbox XYZ

Støjbox XYZ is a desktop synthesizer designed with the goal of allowing for more expressive control over the sound parameters. It has an interface that features an XYZ controller, allowing users to simultaneously control multiple sound parameters by moving fingers in the X-, Y- and Z-directions. It also includes a menu system that can be navigated using an encoder and push buttons, allowing the aforementioned XYZ controller to be dynamically mapped to the sound parameters. The menu system also features an LFO section that allows the user to select the LFO shape and the LFO mapping. Finally the menu allows for control over effects and provides access to a pitch envelope. Other features include 16 knobs allowing for more traditional synthesizer interactions. Støjbox XYZ uses these 16 knobs to alter the following fixed parameters: oscillator, filter, LFO, and the ADSR envelopes of amplitude and filter cutoff.

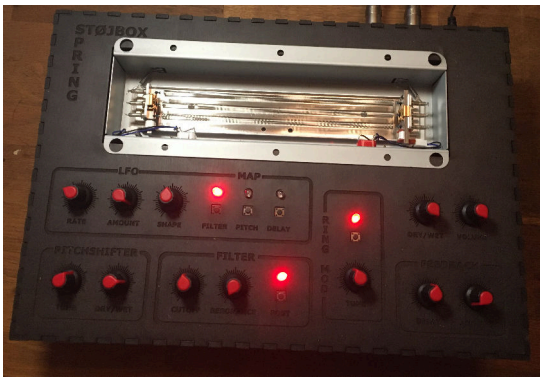


Figure 2. Støjbox Spring

Støjbox Spring extends upon the standard spring reverb effect, by allowing the output of the spring to be fed back in to the input of the spring reverb, though additional digital effects. Spring reverbs on their own have a fixed decay time that depends on the size of the spring reverb tank used. However, by applying feedback the decay time can be increased. When increasing the amount of feedback, the spring reverb will eventually start to self oscillate, and thus create a reverb with an infinite decay time. The Støjbox Spring allows for the possibility to animate the reverb, augmenting it by applying various effects to the feedback path. With these features and the direct spring manipulation in mind, the Støjbox Spring can't be regarded as just an audio effect, but is instead an expressive feedback instrument in its own right.

## 2. SOUND PROCESSING

The processor used in the Støjbox XYZ and the Støjbox Spring is the Daisy Seed, an embedded platform for music creation, created by Electro-Smith. The Daisy Seed is a small board with an ARM Cortex-M7 MCU, running at 480MHz with an external 64MB of SDRAM added for audio memory [1].

The Støjbox XYZ supports 16 voices of polyphony and uses a variable waveshape oscillator for sound generation. The oscillator has three parameters, besides the pitch, that

can be controlled. The first is waveshape, which sets the waveform to either a square, or a "saw/tri/ramp" waveform (which can be interpolated between these). The second oscillator parameter is the pulse width, which sets the pulse width of the square waveform, or determines whether the "saw/tri/ramp" waveform takes shape as a sawtooth, triangular or ramp waveform. The final parameter sets the frequency of the sync oscillator. Støjbox XYZ incorporates a lowpass filter, allowing the user to have control over the cutoff frequency and resonance of the filter. The Støjbox has three ADSR envelopes dedicated to the amplitude, filter and pitch. The Støjbox XYZ also features an LFO, with the user having control over the rate, amount, mapping and shape of the LFO. Finally, the Støjbox XYZ also includes three effects that can be applied to the sound. These effects include reverb, chorus and overdrive. The order of the effect chain is overdrive first, then chorus, and finally reverb.

The Støjbox Spring features a spring reverb tank that can be fed back in to itself. The level of feedback can be adjusted, as well as the delay length (in number of samples). Additionally, the feedback signal can be manipulated by several effects, including a pitch shifter, a ring modulator, and a low pass filter. The pitch shift effect allows users to transpose the pitch of the feedback signal in the range of two octaves (one up, one down). It also features dry/wet control, allowing users to mix the pitch shifted signal with the original signal. One of the pushbuttons allows a ring modulation effect to be applied to the feedback signal, by multiplying the feedback signal with a sine wave oscillator (tuned in the range from 50 Hz to 5 kHz). The filter used in the Støjbox Spring is a Moog ladder style lowpass filter, and provides fixed controls for both cutoff and resonance. The filter can be applied to the output of the spring reverb tank instead of the feedback signal by pressing another button. The Støjbox Spring also includes an LFO that can be mapped to one or multiple parameters including the filter cutoff, the pitch shifter and the feedback delay. Users can control the amount, rate and the shape (sine, square, sawtooth or ramp) of this LFO.

The Støjbox spring can be used as an insert effect, and has wet/dry control allowing the user to mix the input of the Støjbox Spring with the output of the spring reverb tank. In this way, it can be used on its own as a feedback instrument (without any input signal), by setting the wet/dry control to 100% wet. The springs in the reverb tank are exposed to the user, which allows for interacting and "playing" them by striking or grabbing. The Støjbox spring interface includes 12 knobs and five buttons. Each of the five buttons has a dedicated red LED indicating the current state of the buttons. Being a feedback instrument, the produced sound can quickly become chaotic and unpredictable, therefore simple one-to-one mappings were chosen for all the knobs, in order to allow for some predictability when controlling the sounds.

### 2.1 XYZ controller

The XYZ controller uses the Trill Square by Bela as an XY pad. The Trill Square is a square shaped capacitive touch sensor capable of sensing a two dimensional position from a single touch. The Trill Square was designed for the Bela platform, but it works with any platform that supports communication through I2C, such as the Daisy [2]. In order to get the Z-dimension of the XYZ controller, a ratiometric linear hall-effect sensor a magnet were utilized. Kitchen sponges were used for the spring mechanism, as they proved to provide the best tactile response of readily available materials.

## 3. CONCLUSION

Støjbox XYZ is a new desktop synthesizer with an interface designed for the purpose of allowing augmented expression. The additional expression was incorporated by designing an XYZ controller. Custom mapping of the XYZ controller was an important feature for the authors, since it allows for more freedom and offers users to express themselves through their mapping design choices.

In order to create the custom mappings, a menu system was implemented. This menu system also allows for more functionality, such as selecting LFO mapping and LFO shapes, limiting parameters, applying effects, and adding a pitch envelope. Støjbox XYZ has proven to fulfill its main goals, but there is still plenty of room for future improvements in the areas of synthesis, and design improvements to reduce friction.

The Støjbox Spring extends on the well known spring reverb effect by allowing the output of the spring reverb to be fed back into its input through various effects, and thus contributes to the ever-growing family of feedback instruments [3]. The Støjbox Spring can be used as a standalone feedback instrument, but also offers the possibility to be used as an insert effect.

We have outlined the features and development process of the Støjbox XYZ and the Støjbox Spring in this work, while also explaining the authors' motivation and concepts for these two prototype instruments. Initial testing points towards both being very engaging to play, and while somewhat similar in appearance, they have vastly different sonic outputs. Readers are encouraged to see video documentation of the instruments in use, at the following web link: `https://tinyurl.com/5ewncs52`

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## 4. REFERENCES

[1] Electro-Smith Daisy Seed. [Online]. Available: https://www.electro-smith.com/daisy/daisy

[2] Bela Trill Square. [Online]. Available: https://shop.bela.io/products/trill-square

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