Women's Labor: Creating NIMEs from Domestic Tools

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ABSTRACT

This paper describes the creation of a NIME created from an iron and wooden ironing board. The ironing board acts as a resonator for the system which includes sensors embedded in the iron such as pressure, and piezo microphones. The iron has LEDs wired to the sides and at either end of the board are CCDs; using machine learning we can identify what kind of fabric is being ironed, and the position of the iron along the x- and y-axes as well as its rotation and tilt. This instrument is part of a larger project, *Women's Labor*, that juxtaposes traditional musical instruments such as spinets and virginals designated for "ladies" with new interfaces for musical expression that repurpose older tools of women's work. Using embedded technologies, we reimagine domestic tools as musical interfaces, creating expressive instruments from the appliances of women's chores.

Author Keywords

NIME, feminist, machine learning, domestic, virginals

CCS Concepts

•Human-centered computing → Sound-based input / output; •Computing methodologies → *Supervised learning by classification;*

1. INTRODUCTION

Women's Labor encompasses several components from instrument building, through workshops (such as those for the Csound instruments on stage) [8], to installations, compositions, and an evening-length production. We wish to spark conversation between the artists and the public about how and why we repurposed old domestic tools laden with functionalities traditionally pertaining to women to become new musical instruments. At heart, the project is a feminist initiative to revalue traditional women's work through re-imagining feminine technologies. In the evening-length production, Ho will juxtapose compositions by women for three NIMEs with under-represented works by past women composers written for historical instruments traditionally designated as "feminine" (such as the clavichord, fortepiano, and the pardessus de viole). At the premiere, a discussion panel with collaborators and experts on feminist technologies will follow. By expressibly commissioning women composers, *Women's Labor* doubly addresses the gender inequality that exists in the music field today. We bring attention to female composers and also invite people from all walks of life to play/perform with these haptic instruments, encouraging them to reflect upon the social/feminist history of these tools in their own domestic lives especially in the context of privilege [6]. In this paper we concentrate on the construction of our first instrument, an iron and ironing board.

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1.1 History

Creative director, Jocelyn Ho, conceptualized the initial idea for *Women's Labor* as an evening-length work combining works by female composers for new instruments created from older domestic tools used by women, combined with pieces for virginal keyboard instruments written by mainly forgotten female composers. She approached Margaret Schedel to help design the instruments and become the first commissioned composer. Schedel brought in Matthew Blessing as the technical director based on his previous work *JoyStyx* [4] and his dissertation *Musical Chairs*. Blessing created the programming structure for the sensor input, and the initial programming of mapping variables for interaction. We anticipate that each composer will refine the expressive capabilities of the instruments as they develop a unique gestural and musical language for their compositions. Blessing also designed the physical assemblage to be reproducible by others by following instructions hosted on our GitLab site [1]. These instructions include the schematics for 3D printing parts, a detailed bill-of-materials, and a complete software package for the system. The iron and ironing board are the first instrument designed by the team.

1.2 Embedded Acoustic Instruments

The instruments for *Women's Labor* are embedded acoustic instruments (EAIs); all components (the sensors, the processors and the speakers) are an integral part of the design. The body of the instrument itself is the resonator. There are no external elements, if needed the instruments can be amplified with microphones in the same way an acoustic instrument can be amplified. Although they are self-contained, the sonic profiles of unamplified EAIs change dramatically depending on the room they are in because the ratio between the strength of the direct sound and the strength of the reflected diffuse affect how reverberant the sound is perceived to be [10].

Edgar Berdahl refines the concept of EAIs using the following ontology: 1) "sensors that are connected via a sensor interface to an embedded computation unit;" 2) "a sound synthesizer implemented in software;" 3) "an output audio signal based on the sensor data;" and 4) "an audio amplifier [that] makes the output audio signal intense enough to power an internal transducer" [2].

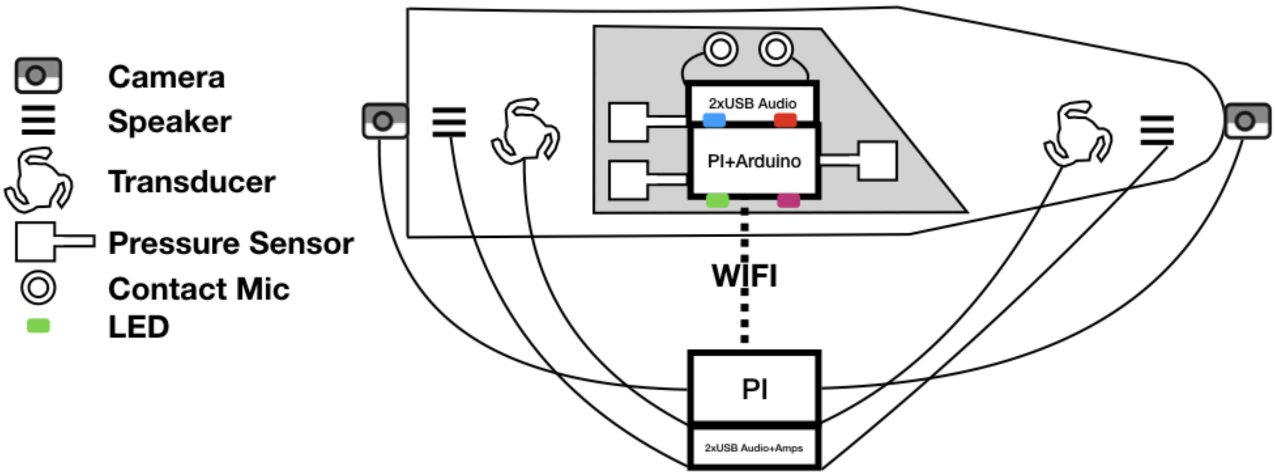

Figure 1: Ironing Board Sensing/Producing Schematic

Luca Turchet proposes a category called Smart Musical Instruments (SMIs) that are similar, they have 1) a system for capturing the user's interaction with the instrument; 2) a low-latency, highly reliable, and interoperable wireless communication system interfacing with WLANs and WANs; 3) an embedded computation unit implementing the intelligent component; 4) memory; and 5) power supply. Optional features include: 1) an embedded sound delivery system; 2) acoustic sound source; 3) inputs/outputs for wired connectivity; 4) a system for haptic display; 5) and a system for visual display. There is some overlap between SMIs and EAIs–our iron is not networked externally (it has a LAN between two boards) and we do use an acoustic sound source of the iron on cloth, but we feel these instruments fall more under the EAI designation [12].

The benefit of both EAIs and SMIs embedding the processing system in the instrument is that the computer is only used for the gear; it will not experience state changes from other uses. The drawback is that single-board computers have a much more limited processing power compared to laptop or desktop systems. We decided the benefits of an embedded instrument outweighed the drawbacks. For this instrument we are using two single-board computers, one manages the inputs and machine learning, while the other manages synthesis and audio output.

Figure 2: Exterior of Iron on Ironing Board.

1.3 Reproducibility

Beagle boards were one of the first single-board computers that could be used for embeddable systems. Both Bela [11] and Satellite CCRMA [3] were among the first developers to address the issue of creating reproducible instruments because "in the DMI community, published papers typically contain insufficient detail to fully replicate an instrument design, especially in regard to aesthetic choices and fine details of craftsmanship which are important to the performer experience but might not follow established scientific processes... DMI [digital musical instrument] toolkits, by providing a common platform for designers, reduce the barriers to exchanging fully functioning designs" [9].

It is important for us to fully document the creation process of these instruments not only to provide instructions for the workshops, but also to allow composers to build their own versions of the instruments in order to work with them while writing pieces. We also anticipate being able to travel more easily by purchasing larger items (such as ironing boards) and creating large 3D printable parts (such as the iron enclosure) on-site, and hosting the entire software distribution on Ho's GitLab repository so we can easily download the operating system and our programs onto new boards.

2. IRON

Our system consists of an antique ironing board with transducers and speakers, and a 3D printed charcoal iron (see Figure 2), an iron with a large cavity for coals or heated slugs, with measurements taken from an antique iron that was too heavy to manipulate expressively. To perform the instrument, one simply irons different pieces of cloth.

2.1 Sensing

In order to create an expressive instrument we designed several inputs to the system. On the iron itself we have three pressure sensors that allow us to measure how hard the performer is pressing. There is one pressure sensor at the tip, and two at the rear giving information about rocking and tilting. The iron also has contact microphones that we use to understand what kind of fabric is being ironed. On the ironing board are two cameras which we use to track LEDs on the iron itself allowing us to track X/Y-position and angle of the iron. All inputs except the camera inputs go into a Raspberry Pi inside the iron. The cameras are wired into a second PI under the ironing board.

Figure 3: Pressure Sensor Assembly in-progress

2.2 Mapping

Creative director Ho decided that the interaction of the ironing board should relate to a keyboard interface with low sounds on the left and higher sounds on the right. In combination with information from the pressure sensors connected with an Arduino (see Figure 3), the Y-axis controls the envelope shape, while the the rotation of the iron, determined by the CV on the LED signals, controls distortion. The pressure sensors, developed from Plusea's *Conductive Thread Pressure Sensor*[1], also control the volume which is linked to timbre; the harder the performer presses the louder and brighter the sound.

Finally we use Wekinator [5] on the sounds of the fabrics being ironed to set the initial sonic palette. A piece of cloth made from different types of material changes timbre as the iron passes over it while a single type of material without seams retains a individual audio profile. We designed the system so that composers will easily be able to add refinement to enhance the expressivity of the instrument without altering the fundamental relationships developed by the initial team.

2.3 Producing

The Raspberry Pi inside the iron (See Figure 4) communicates via a LAN to another Pi under the ironing board. The final audio signal is sent from the second Pi to audio amplifiers and then to transducers mounted on the ironing board, creating a unique signature for each ironing board, as well as upward-facing speakers mounted to the underside of the board with cutouts to allow the unfiltered sound to propagate freely.

[1]`www.instructables.com/id/Conductive-Thread-Pressure-Sensor`

Figure 4: Interior of iron: showing Pi, battery, Arduino, and USB audio interfaces.

Figure 5: Underside of Ironing Board: showing speakers, transducers, USB audio interfaces, amplifiers, & battery.

Distortion is not created in software, rather we reserve the highest volume for signals which cause the speaker cone to rattle against the ironing board. In this way each board has a unique distortion profile, and we save processing power.

Performers control the mixing of the acoustic signal to the four outputs (See Figure 5) through manipulating the pressure on the iron; symmetrical pressure results in the signal coming from the speakers while asymmetrical pressure adds in the transducers. Panning subtly follows the location of the iron along the X-axis. The input from the contact microphones can also be amplified into the synthesized signal by changing the acceleration of the iron; a steady velocity results in no microphone input. This signal is not prioritized and may be delayed, adding a layer of randomness among all the carefully controlled sonic result.

3. CONCLUSION

The iron and ironing board are part of a larger group of NIMEs built by Ho, Schedel and Blessing using the tools of traditional women's household work. The other instruments will be made from a drying rack and an embroidery stand [7] and have completely different gestural control, embodied acoustic properties and sonic profiles. In addition to pieces for these solo NIMEs, we will encourage composers to write for the instruments in multiples–a chorus of the same instrument or a small chamber ensemble made up of the different NIMEs combined with acoustic instruments.

4. REFERENCES

[1] womenslabor. `https://gitlab.com/J_piano/womensLabor`.

[2] E. Berdahl. How to make embedded acoustic instruments. In *NIME*, pages 140–143, 2014.

[3] E. Berdahl and W. Ju. Satellite ccrma: A musical interaction and sound synthesis platform. In *NIME*, pages 173–178, 2011.

[4] M. Blessing and E. Berdahl. The joystyx: a quartet of embedded acoustic instruments. In *NIME*, pages 271–274, 2017.

[5] R. Fiebrink and P. R. Cook. The wekinator: a system for real-time, interactive machine learning in music. In *Proceedings of The Eleventh International Society for Music Information Retrieval Conference (ISMIR 2010)(Utrecht)*, 2010.

[6] L. Hayes. Enacting musical worlds: Common approaches to using nimes within performance and person-centred arts practices. In *Proceedings of the 2015 Conference on New Interfaces for Musical Expression. Baton Rouge, LA*, volume 31, 2015.

[7] J. Ho, M. Schedel, and M. Blessing. Women's labor: an installation and concert of new and old "feminine" insstruments. In *Proceedings of the Alliance of Women in Media Arts and Technology Conference*. AWMAT, 2019.

[8] A. Hofmann, B. Waerstad, and K. Koch. Csound instruments on stage. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, volume 16, pages 291–294.

[9] A. P. McPherson and F. Morreale. Technology and community in toolkits for musical interface design.

[10] J. Meyer. *Acoustics and the performance of music: Manual for acousticians, audio engineers, musicians, architects and musical instrument makers.* Springer Science & Business Media, 2009.

[11] F. Morreale, G. Moro, A. Chamberlain, S. Benford, and A. P. McPherson. Building a maker community around an open hardware platform. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, pages 6948–6959. ACM, 2017.

[12] L. Turchet. Smart musical instruments: vision, design principles, and future directions. *IEEE Access*, 7:8944–8963, 2019.