Tiny trainable instruments

by

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Abstract

Tiny trainable instruments is a collection of instruments for media arts, using machine learning techniques and deployed in microcontrollers.

Thesis Supervisor: Tod Machover
Title: Muriel R. Cooper Professor of Music and Media

Acknowledgments

UROPs Peter Tone, Maxwell Wang

Opera of the Future

Future Sketches

Family and friends

Contents

List of Figures

List of Tables

Chapter 1

Introduction

1.1 Context

This thesis is the capstone project of my master's program, between the academic years 2019-2

The work presented here has been developed mostly working remotely during the COVID19 pandemic.

TODO: include photograph of my desk at home.

As part of the research that directly informed this thesis, I highlight the classes I took, including:

1. Comparative Media Studies, by Sasha Costanza-Chock
2. Recreating The Past, by Zach Lieberman

Some other projects I created during these years include:

1. SiguesAhi
2. Open Drawing Machine, with Gaurav Patekar
3. Introduction to networks for artists

[1, John Maeda, 2001]

Opera of the Future Future Sketches 2019-2021

1.2 Section sample

Nulla sed sem finibus, vehicula quam at, vulputate tellus[1]

1.2.1 Subsection sample

1. Item 1.

[1]Here is a sample footnote referencing figures **??** and B-1.

Chapter 2

Background

2.1 Instruments

2.1.1 BASTL

BASTL Kastle, two iterations and a spinoff: Kastle, Kastle v1.5, Kastle Drum.

Based on Arduino, GitHub repository with alternate firmware.

Breadboard patching with jumper cables, inputs and outputs robust enough to allow for mistakes in connections.

2.1.2 Critter & Guitari

Organelle computer for sound, scriptable, Linux operating system + Pure Data software.

ETC and EYESY computers for visuals, scriptable, Linux operating system + Python

/ pygame environment or openFrameworks.

2.1.3 monome

Aleph: sound computer

Norns: sound computer, currently on its second iteration, with expanded hard drive. Also there is a DIY versionm which is cheaper and runs on a Raspberry Pi. Norns is a Linux machine, running SuperCollider for the sound engine, and Lua scripts.

2.1.4 Shbobo

Peter Blasser's Shbobo

Shnth and Shtar

Shlisp language and Fish IDE.

github.com/pblasser/shbobo

2.2 Education

Mitch Resnick's book Lifelong Kindergarten

Low floor, wide walls, high ceiling

Peers, projects, passion, play

Gene Kogan and Andreas Refsgaard

2.3 Machine learning

ml5.js

Runway

TinyML Professional Certificate HarvardX

2.4 Digital rights

Electronic Frontier Foundation

Edward Snowden

Design Justice Network

Chapter 3

Early experiments

3.1 Microcontrollers

Arduino

Teensy: MIDI plug in.

3.2 Machine learning

Class at School of Machines by Gene Kogan and Andreas Refsgaard

Chapter 4

Tiny trainable instruments

4.1 Design principles

1. Cheap
2. Privacy

4.2 Technology

Arduino microcontoller

Arduino library KNN

TensorFlow Lite Micro

4.3 Programmable / remix

4.4 Philosophy and experience

4.5 Inputs

Enumerate sensors from the Arduino Nano 33 BLE Sense

4.6 Outputs

The different outputs were picked, because of their low cost, ubiquity, and possibilities of expansion and combining them.

4.6.1 Buzzer

4.6.2 Servo motor

4.6.3 MIDI

We wrote functionalities to manipulate MIDI innstruments, and included examples to interface with some popular and cheap MIDI instruments, such as the Korg volca beats.

4.6.4 Thermal printer

4.7 Development

Team with Peter Tone and Maxwell Wang.

We have a shared Google Drive folder, where we all share notes about our research and development of the library and the educational material.

Peter has done research on code and data structures.

Maxwell researches ways of teaching our topics, and has been documenting and writing the documentation and tutorials.

4.8 Opera of the Future projects

Squishies Fluid music

Chapter 5

Project evaluation

5.1 Digital release

GitHub repository

Arduino library

PDF zine for explaining, reference as the PDF booklet for monome norns

5.2 Audience engagement

5.3 Workshop

Applied to grant at CAMIT for teaching the workshops in English in USA, and in Chile in Spanish, remotely over Zoom.

Each workshop consists of 2 sessions of 3 hours each, spread over a weekend.s

5.4 Multimedia show

Livestreamed show with multiple artists incorporating Tiny Trainable Instruments to their practice.

Chapter 6

Conclusion

This thesis project is a

6.1 Future work

6.1.1 Education

New workshops, using multimedia outputs.

6.1.2 Artist workflow

Training instead of programming.

6.1.3 Packaging

Low hanging fruit is to package a Tiny Trainable Instrument with a set of particular outputs, on a perfboard or PCB.

The next step would be to create enclosures.

6.1.4 Gallery

Appendix A

Tables

Table A.1: Armadillos

Armadillos	are
our	friends

Appendix B

Figures

Figure B-1: Armadillo

Bibliography

[1] John Maeda. *Design by Numbers*. The MIT Press, first paperback edition, 2001.