Undergraduate Thesis Prospectus

Harmony in Isolation: A Vocal Harmonizer

(technical research project in Electrical and Computer Engineering)

Undefined Risks: Developing Artificial General Intelligence Safely

(sociotechnical research project)

by

Nathan Hunter

November 2, 2020

technical project collaborators:

Laura Gustad
Noah Mills

On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.
Nathan Hunter

Technical advisors:	Harry C. Powell, Department of Electrical and Computer Engineering Adam Barnes, Department of Electrical and Computer Engineering
STS advisor:	Peter Norton, Department of Engineering and Society

General research problem

How can digital automation be optimally implemented?

The human experience is becoming increasingly digitized. One study by McKinsey projects that 32% of American workers will transition to different occupations by 2030 as a result of digital automation (McKay, 2019). A Pew survey reveals that 48% of American young adults report going online "almost constantly" (Perrin, 2020). Given the omnipresence of digital technology today, we must choose to implement it right, whether in how we make music or in how we teach machines to think like us.

Harmony in isolation: a vocal harmonizer

How can vocal harmony be created in isolation?

This technical capstone project is the effort of three undergraduate fourth-years: Laura Gustad, Noah Mills, and the author (Nate Hunter). Our advisors are Prof. Harry Powell and Prof. Adam Barnes in the Electrical and Computer Engineering Department. Per department requirements, our solution must include hardware and embedded software components, and it must be complete by the end of the fall semester.

Due to the airborne transmission of the coronavirus, singing in groups is no longer safe, and many singers are forced to stop doing what they love (Naunheim, 2020). One solution to this problem is a vocal harmonizer: a device that harmonizes a person's voice to the chords played on a keyboard. This device allows a singer to sing into a microphone and hear his/her voice from a speaker in the pitches pressed on the keys, thus creating vocal harmony without a large group. A vocal harmonizer would also be instrumental in teaching harmony to students via "active experimentation", which may be more effective than learning by theory alone (Spies, 2015).

An existing device known as a vocoder can harmonize vocal input to keyboard input, typically to produce a synthetic or electronic sound. Vocoders such as the Roland JD-Xi are commonly used and available on the market (Roland, 2016). Musician Jacob Collier uses an advanced vocal harmonizer developed at MIT to harmonize his voice to his keyboard in a natural timbre (Collier, 2015). We hope to combine the sound quality of the latter with the accessibility of the former.

Our device integrates hardware and software to process input signals and produce an output signal (see fig. 1). Input signals are sent from a keyboard and a microphone to a printed circuit board (PCB). After the microphone signal is amplified, a codec on the PCB converts both signals from analog to digital. The digital signals are then processed on a myRIO embedded device. Software on the myRIO determines what frequencies compose the voice and keyboard signals and then generates an output signal containing the desired voice chord. The digital output signal is converted back to analog on the codec and finally played through an amp in real time.

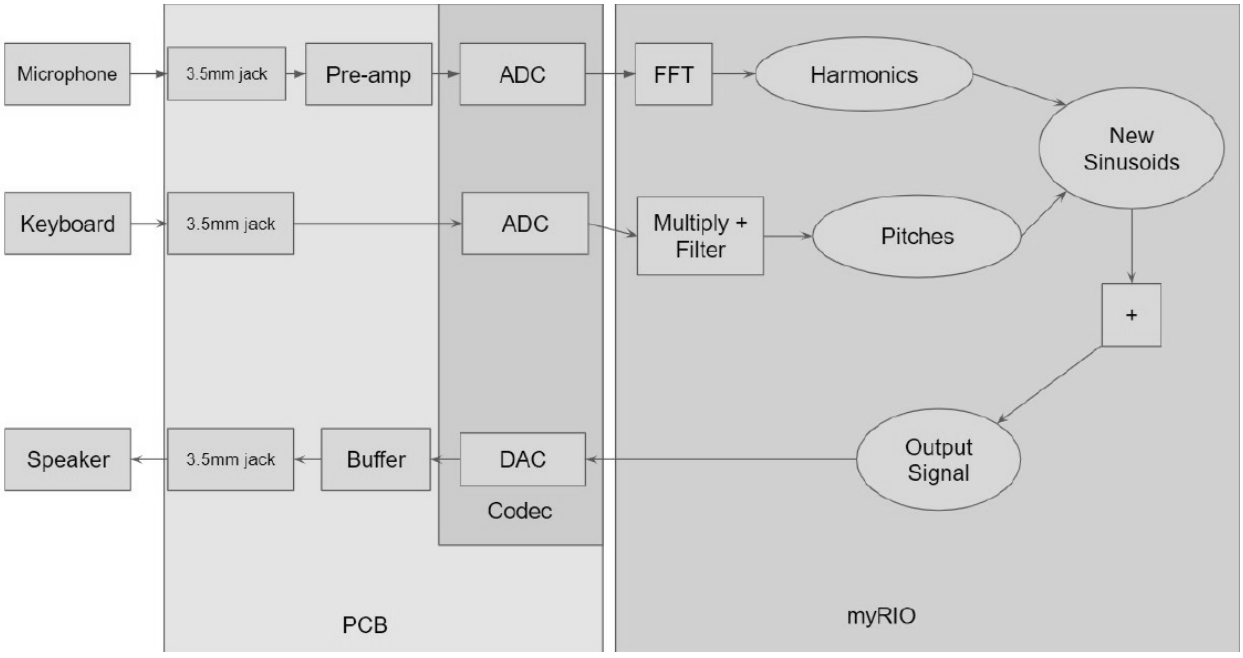

Figure 1. Block diagram of signal processing on vocal harmonizer (author).

Undefined risks: developing artificial general intelligence carefully

How are people mitigating undefined risks as artificial general intelligence is conceived?

Artificial intelligence (AI) algorithms are still narrowly specialized. The next technological leap will likely be artificial general intelligence (AGI), or humanlike reasoning and general problem-solving in a machine. Electronic circuits fire about a million times faster than biological circuits, so an AGI machine with the resources of just one human could complete 20,000 years of human reasoning in one week (Harris, 2016). Such powerful machine intelligence could harm or even extinguish humanity. However, because AGI has never been approximated, its risks are undefined. How can people possibly mitigate such risks today?

Numerous researchers have investigated how AI is regulated. Yeung and Lodge (2019) distinguish the regulation of decision-making algorithms from more general regulations, and propose an AI regulation model. Yampolskiy (2018) examines the ethics of AI and the consequences of open development for AI control.

Some CEOs (such as Elon Musk and Bill Gates) and philosophers (such as Thomas Metzinger and Nick Bostrom) warn of AGI's dangers (Parkin, 2015). For instance, Elon Musk tweeted, "Hope we're not just the biological boot loader for digital superintelligence. Unfortunately, that is increasingly probable" (Parkin, 2015). In a TED talk, neuroscientist/philosopher Sam Harris warned, "I'm going to describe how the gains we make in artificial intelligence could ultimately destroy us. … And yet if you're anything like me, you'll find that it's fun to think about these things. And that response is part of the problem" (Harris, 2016).

OpenAI is an AI R&D company with a mission to "ensure that artificial general intelligence … benefits all of humanity" (OpenAI, 2020). One of its cofounders, Greg

Brockman, explained his initial motivation: “What if it’s even just a 1% or 0.1% chance that [AGI is] happening in the next five to 10 years? Shouldn’t we think about it very carefully?” (Hao, 2020). OpenAI’s critics, however, accuse it of hypocrisy. Many doubted the company’s promises of “openness and transparency” after they declined to publicly release the text-generating model GPT-2 (Hao, 2020). Rutgers University Prof. Britt Paris argued, “It seems like they don’t really have the capabilities to actually understand the social” (Hao, 2020).

DeepMind, an AI R&D company under Google, has a dedicated Ethics and Society Team, stating, “Securing safe, accountable, and socially beneficial technology cannot be an afterthought” (DeepMind). The Partnership on AI is a collective that promotes safe and collaborative AI. Its “SafeLife” project integrated safety metrics into AI algorithms (Wainwright, 2019). In the federal government, the Office of Management and Budget legislates regulations on AI; too leniently, some say (Vought, n.d.).

References

Collier, J. (2015, November 19). Jacob Collier: WTF is a harmoniser?: EFG London Jazz Festival Preview. Retrieved November 02, 2020, from https://youtu.be/DnpVAyPjxDA

DeepMind (n.d.). Ethics & Society Team. Retrieved November 02, 2020, from https://deepmind.com/about/ethics-and-society

Hao, K. (2020, July 14). The messy, secretive reality behind OpenAI's bid to save the world. Retrieved October 08, 2020, from https://www.technologyreview.com/2020/02/17/844721/ai-openai-moonshot-elon-musk-sam-altman-greg-brockman-messy-secretive-reality/

Harris, S. (2016, June). Can we build AI without losing control over it? Retrieved November 02, 2020, from https://www.ted.com/talks/sam_harris_can_we_build_ai_without_losing_control_over_it?language=en

McKay, C., Pollack, E., & Fitzpayne, A. (2019, April). *Automation and a Changing Economy : Part I : The Case for Action* (Publication). Retrieved November 2, 2020, from https://assets.aspeninstitute.org/content/uploads/2019/04/Automation-and-a-Changing-Economy_The-Case-for-Action_April-2019.pdf

Naunheim, M. R., Bock, J., Doucette, P. A., Hoch, M., Howell, I., Johns, M. M., ... Carroll, T. L. (2020). Safer Singing During the SARS-CoV-2 Pandemic: What We Know and What We Don't. *Journal of Voice*. doi:10.1016/j.jvoice.2020.06.028

OpenAI. (2020, September 02). OpenAI Charter. Retrieved October 08, 2020, from https://openai.com/charter/

Parkin, S. (2015, June 14). Science fiction no more? Channel 4's Humans and our rogue AI obsessions. Retrieved October 08, 2020, from https://www.theguardian.com/tv-and-radio/2015/jun/14/science-fiction-no-more-humans-tv-artificial-intelligence

Perrin, A., & Kumar, M. (2020, May 30). About three-in-ten U.S. adults say they are 'almost constantly' online. Retrieved November 02, 2020, from https://www.pewresearch.org/fact-tank/2019/07/25/americans-going-online-almost-constantly/

Roland JD-Xi - How to use Vocoder and Auto Pitch. (2016, March 29). Retrieved November 02, 2020, from https://youtu.be/cya4LSk8Tis

Spies, B. (2015). Introducing music students to harmony – an alternative method. *Education as Change, 19*(1), 165-187. doi:10.1080/16823206.2014.943258

Vought, R. (n.d.). *Memorandum for the heads of executive departments and agencies : guidance for regulation of artificial intelligence applications* (United States, White House, Office of Management and Budget).

Wainwright, C., & Eckersly, P. (2019, December 04). Introducing SafeLife: Safety Benchmarks for Reinforcement Learning. Retrieved October 08, 2020, from https://www.partnershiponai.org/safelife/

Yampolskiy, Roman V., editor. *Artificial Intelligence Safety and Security.* CRC Press/Taylor & Francis Group, 2018.

Yeung, K., & Lodge, M. (2019). Algorithmic Regulation. *Oxford Scholarship Online.* doi:10.1093/oso/9780198838494.001.0001