

Undergraduate Thesis Prospectus

Air Guitar

(technical research project in Electrical and Computer Engineering)

AI Music Assistants: Cool Tool or Career Takeover?

(STS research project)

By

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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.

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General Research Problem

How are emerging technologies changing music production?

The origins of music may be older than the appearance of man, with the earliest instruments being a pair of sticks or stones clashed to a rhythm by humanoid primates (Montagu, 2004). Since then, new instruments have been made to produce a wider variety of sound, music streaming services to distribute music worldwide, and personal media players to let consumers listen to music at any time or place. In 2018, music streaming services provided 47% of the record industry revenue, gradually making physical media obsolete (IFPI, 2019). Recently, Artificial Intelligence has made song recommendations to consumers, and aided musicians in both song composition and audio mastering for production (Marr, 2019).

Air Guitar

How can a functional Air Guitar be developed?

This ECE capstone project is advised by Harry Powell, and developed in collaboration with Karan Chawla, Eric Haukens, Jacob Holton, and Josie Li.

A direct application of technology is in new instruments. While many instruments have not changed in ages, some have changed to fulfill modern needs, such as the electric guitar, made to amplify music for large audiences. This project takes the electric guitar one step further, utilizing compact sensors and microprocessors to develop an Air Guitar. The Air Guitar aims to address several concerns with the traditional guitar: strained fingers from holding chords and strumming; large form factor, making it inconvenient and expensive to travel with (Mica, & L., J.); and inability to keep sound private when in public.

The goal of this project is to create a compact, stringless instrument that reads finger movements and outputs sound matching those of a conventional guitar via a standard audio jack. As an ECE capstone project, it must have a custom-designed printed circuit board and must use non-hobbyist microcontrollers.

There are a few modern instruments that fulfill parts of our goals. Misa Digital's Kitara is a "digital guitar", similar to an electric guitar in form-factor, but with a grid of buttons replacing the strings, and a touchscreen for strumming and picking. While the kitara is stringless and allows for standard audio output to headphones for private practice, it has a large form factor (Kitara). The Kurv Guitar is very close to an air guitar, consisting of the "Kurv", a device for the left hand to control chord using a button grid and fret change based on flicking motions, and a "Pick" to detect strumming, which both connect to a smartphone application to output sound. The Kurv Guitar is stringless, compact, and allows for personalized sound. However, the Kurv Guitar does not play like a traditional guitar, as the chord and fret selection is very different, making it a completely new instrument (Kurv Guitar).

There are three sources of information that will need to be collected and processed in real-time: chord, fret, and strumming. An android phone will run an application with a visual representation of the top three frets of the six strings (shown in Figure 1), which can be touched to set a chord. The coordinates touched are sent to the main processor by wire using UART (Universal Asynchronous Receiver Transmitter) protocol. An infrared distance sensor is used to measure distance from the user's waist to left hand, and sent to the main processor via I2C (Inter Integrated Circuit) protocol. An accelerometer 'pick' is used in the right hand to detect strumming. The accelerometer magnitude is sent to the main processor via a direct wired analog

voltage. The main processor used is a National Instruments myRIO, which collects information and runs the Karplus Strong String Synthesis Algorithm, a physical modeling algorithm for string instruments. The algorithm combines an impulse(derived from accelerometer) and expected string vibration frequency of a string(based on chord and fret) to produce a sound for the string, which is output via an audio jack built into the myRIO. The overall system diagram is shown in Figure 2. Testing will first be done on individual modules with simulated data as needed, with integration tests as communication protocols are implemented.

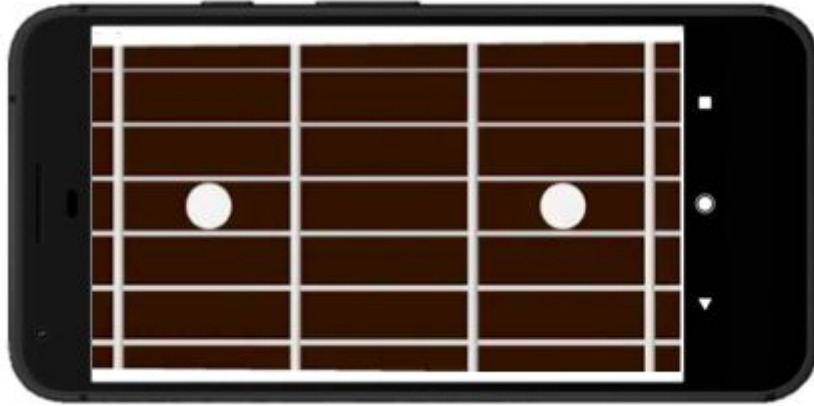


Figure 1. Sample App Interface

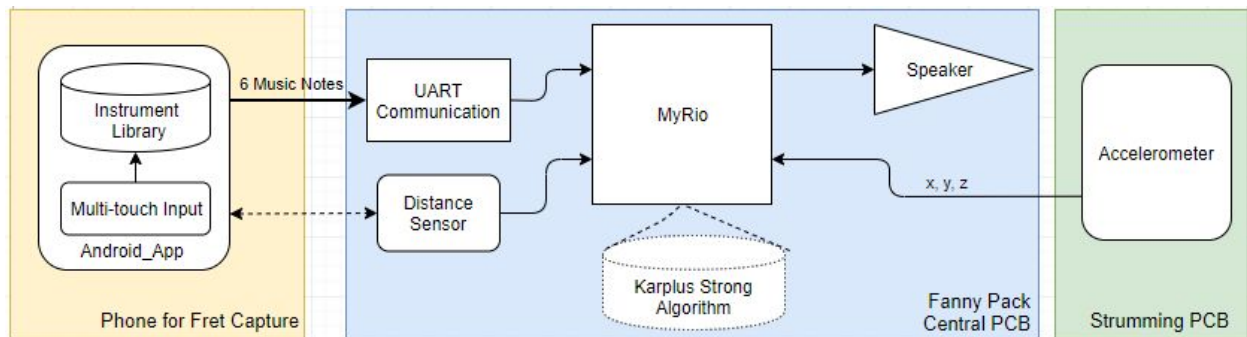


Figure 2. Block Diagram for Air Guitar

AI Music Assistants: Cool Tool or Career Takeover?

How are musicians reacting to the advent of AI in music?

Automation has disrupted employment, especially in manufacturing. It may contribute to an 11% decline in employment over the next 10 years (BLS, 2019). In one Chinese factory reported, robots displaced 90% of human workers, boosting productivity 250% (Javelosa, 2017). Automation has also displaced telephone operators, data entry keyers, and administrative assistants. AI expert Kai-Fu Lee claims that in jobs requiring creativity and compassion, AI may supplement humans, but will not replace them(Lee, 2018).

AI-music software companies, including Jukedeck, Amper, Poptun, and AIVA, generate music in real time from parameters such as mood or genre. Reviewing platforms, Thompson(2019) says the music “wasn’t brilliant or memorable, but it easily matched the quality of human work you’d hear in videos and ads”. To formally evaluate AI music, researchers executed a Turing test with five human-composed tracks and five AI composed tracks . Participants guessed which were composed by a human. Among 85 participants the accuracy was 46%, showing that the average participant could not distinguish human from AI compositions (Rajon, 2018).

Development of AI artists has economic, social, and philosophical implications. Many question the ethics of developing AI for creative jobs, and whether any product of AI can be considered creative. According to Herzmann(2018) of Adobe Research, the risk of unemployment due to AI is less significant than other economic consequences. Hertzmann also claims that because art is social, to be an artist, AI must become a “social agent”; otherwise it remains a tool. Human-composed music, like organic and locally sourced food, may have distinct

value. Despite the additional cost, studies show that diners generally prefer small, family-owned, local food vendors visible in the community (Lang & Lemmerer, 2019). Hence even if AI can generate music comparable to the top songs, demand for local, small scale, human-sourced music may endure.

AI and machine learning have generated music indistinguishable from human compositions at a fraction of the cost and time. Among musicians, the trend is controversial. Participants include skeptical musicians, pro-AI musicians, AI developers, businesses, video-game streamers, and concerned consumers.

Lucas Cantor, a composer who has used AI in his recent compositions, considers it a valuable tool, but no substitute for human composers (Barrett & Ward, 2019). Jack Nolan, co-founder of AI music platform Popgun agrees, attesting that “AI will help” human composers, “rather than replace them” (Dickson, 2017).

Oded Ben-Tal, a music technology lecturer, recognizes AI’s artistic limitations, yet asserts “entry-level jobs into the music industry will not be there in five or ten years” (Dickson, 2017). Taryn Southern is a songwriter known for her album of AI-aided songs, *I AM AI*. Like other songwriters with limited experience playing instruments, Southern works with a producer to develop composition to match her vision. Experimenting with various AI composition tools, she has found AI producers liberating and easier to work with than human producers, as she can get immediate results and readjust parameters until satisfied (Plaugic, 2017).

AI music is already widely used as background music in public spaces and on game streaming sites, at a savings in royalties cost (Thompson, 2019). Mubert is a service that uses AI to generate unique copyright-free background music in real time. Users can avoid copyright

strike, or copy-strike. The CEO of Omlet Arcade, a game streaming site and Mubert partner, says it is an “innovative solution for empowering live streamers to drive their content quality without risking the dreaded copy-strike” (Rogers, 2019).

Like other AI applications, AI music may threaten human workers and culture. In response to an AI music article, one member of PCMag commented that they are “sick of the tech ‘geniuses’”, and warns that “We lose all humanity if this kind of research keep up and our vile media reports everything tech with breathless anticipation” (OgOggilby, 2017). At an event featuring a series of AI compositions, audience feedback indicated that many were surprised at how “organic” the music sounded. One guest wrote that they are “concerned for the cultural impact and the loss of the human beauty and understanding of music” (Brown, 2017).

References

- Barrett, M., & Ward, J. (2019, May 29). AI can now compose pop music and even symphonies. Here's how composers are joining in. *NBC News*, [nbcnews.com/mach/science/ai-can-now-compose-pop-music-even-symphonies-here-s-ncna1010931](https://www.nbcnews.com/mach/science/ai-can-now-compose-pop-music-even-symphonies-here-s-ncna1010931)
- Brown, M. (2017, June 2). An A.I. in London is Writing Its Own Music and It Sounds Heavenly. *Inverse*
<https://www.inverse.com/article/32276-folk-music-ai-folk-rnn-musician-s-best-friend>.
- BLS (2019, September 4th). Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook,
Assemblers and Fabricators,
<https://www.bls.gov/ooh/production/assemblers-and-fabricators.htm>
- Dickson, R (2017, December 23). AI Has Been Creating Music and the Results Are...Weird *PCMag*, [pcmag.com/news/357787/ai-has-been-creating-music-and-the-results-are-weird](https://www.pcmag.com/news/357787/ai-has-been-creating-music-and-the-results-are-weird)
- Hertzmann, A (2018 May 8), Can Computers Create Art? Adobe Research
- IFPI. (2019). Engagement with streaming drives growth of global music market.
<https://www.ifpi.org/facts-and-stats.php>.
- Javelosa, J. (2017, February 9). Production Soared After This Factory Replaced 90% of Its Employees With Robots. *Futurism*,
<https://futurism.com/2-production-soars-for-chinese-factory-who-replaced-90-of-employees-with-robots>.
- Kitara. (2019). *Misa Digital*, <https://misa-digital.myshopify.com/products/kitara>.
- Kurv Guitar. (2019, July 23). *Kurv Music*,
<https://www.kickstarter.com/projects/kurv/kurv-guitar>.
- Lee, K.-F. (2018, April). "How AI can save our humanity". [Transcript] *TED*
https://www.ted.com/talks/kai_fu_lee_how_ai_can_save_our_humanity.
- Lang, M., & Lemmerer, A. (2019). How and why restaurant patrons value locally sourced foods and ingredients. *International Journal of Hospitality Management*
- Marr, B. (2019, July 9). The Amazing Ways Artificial Intelligence Is Transforming The Music Industry.
<https://www.forbes.com/sites/bernardmarr/2019/07/05/the-amazing-ways-artificial-intelligence-is-transforming-the-music-industry/#538fa8055072>.

- Mica, & L., J. (2012, February 14). Text - H.R.658 - 112th Congress (2011-2012): FAA Modernization and Reform Act of 2012 *Congress*,
<https://www.congress.gov/bill/112th-congress/house-bill/658/text>
- Montagu, J. (2004). How Old Is Music? *The Galpin Society Journal*, 57, 171-182.
<http://www.jstor.org/stable/25163800>
- OgOggilby (2017, December 23). AI Has Been Creating Music and the Results Are...Weird
PCMag,
pcmag.com/news/357787/ai-has-been-creating-music-and-the-results-are-weird#comment-3675732148
- Plaugic, L (2017, August 27). Musician Taryn Southern on composing her new album entirely with AI *TheVerge*,
theverge.com/2017/8/27/16197196/taryn-southern-album-artificial-intelligence-interview
- Rajon. (2018, May 11). AI music composition passed Turing test: *Taiwan AILabs*.
<https://ailabs.tw/human-interaction/ai-music-composition/>.
- Rogers, S (2019, August 27). Mubert is bringing AI to Muzak, Eradicating Music Royalty Payments *GritDaily*,
gritdaily.com/mubert-is-bringing-ai-to-muzak-eradicating-music-royalty-payments/
- Thompson, C. (2019, March 20). What will happen when machines write songs just as well as your favorite musician? *MotherJones*,
motherjones.com/media/2019/03/what-will-happen-when-machines-write-songs-just-as-well-as-your-favorite-musician/