Technical Review Paper Evaluation Form

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_____ / 30 Technical Content

- Current state-of-the-art and commercial products
- Underlying technology
- Implementation of the technology
- Overall quality of the technical summary

_____ / 30 Use of Technical Reference Sources

- Appropriate number of sources (at least six)
- Sufficient number of source types (at least four)
- Quality of the sources
- Appropriate citations in body of text
- Reference list in proper format

_____ / 40 Effectiveness of Writing, Organization, and Development of Content

- Introductory paragraph
- Clear flow of information
- Organization
- Grammar, spelling, punctuation
- Style, readability, audience appropriateness, conformance to standards

_____ **/ 100 Total - Technical Review Paper**

Music Synthesis for Low-Power Devices

Introduction

With the evolution and shrinkage of electrical appliances, music devices and similar analog devices will soon follow this trend. Compatibility with low-power devices, such as phones, are essential in advancing this field. Maintaining a high computational efficiency and producing an accurate sound are necessary conditions in order to proceed to the next stage. This paper briefly summarizes commercially available synthesizers, explains the mechanisms that make synthesizers, and describes the development of its systems.

Commercial Application/Availability of a Synthesizer

There are several producers of musical synthesizers such as Moog, Korg, Roland, and Yamaha. Based on the unique features of the synthesizer, the prices vary from $75 up to $8000. As an example, the Moog Matriarch possesses dual Envelope Generators, stereo Analog Delays, and stereo VCAs to enhance sound quality [1]. With these features, the Matriarch is priced at $2000. The Korg Kaossilator 2S offers only an onboard microphone and the ability to export songs, putting its price at $143 [2]. The Matriarch is designed for music studio producers, and the Kaossilator is designed for basic musicians.

Mechanisms of a Synthesizer

The primary method of synthesizing music is through a combination of segmenting and splicing together music clips. By segmenting the music clips into phrases, it becomes possible to create new musical works [3]. This process stems from the patch-based method, which extracts features based on pitch sequences of sub melodies. The patch-based method marks a series of notes as higher or lower pitch than the previous note for a certain length of notes. This series becomes a patch and can then be concatenated onto another patch to create a new melody. To support this method, music retargeting allows for the synthesizer to capture and consider the global structure of the piece of music [4]. Retargeting presents each patch as several jumps. The global structure will limit the number of jumps in a piece so that undesirable repetitions of segments will not occur.

Development of a Synthesizer

A synthesizer is mainly composed small analog devices. For synthetic musical sounds, synthesizers use MIDI, or Musical Instrument Digital Interface. MIDI controllers dictate the sounds by sending messages to a MIDI sound generator [5]. Afterwards, another message leaves the sound generator and is delivered to a sound processor, which outputs the sound stored in a sound file. The sound file is prepared independently from the synthesizer and is used as a reference for sounds.

Sounds are produced from the synthesizer in 3 different ways; oscillation, physical modelling, and sampling. Oscillators will take fluctuating signals and combine or separate components to create harmonics. Oscillators allow for frequency and amplitude modulation to produce complex tones or create a series of tonal changes. Physical modelling is when synthesizers use springs and material surfaces within an enclosed tube to produce tones. The benefit to this model is the production of realistic, dynamic tones, but requires energy to be injected into the system for it to vibrate. Sampling converts analog sounds into digital sounds through recording. The tones are unrealistic but can be combined and manipulated to produce dynamic changes.

To achieve a higher efficiency in synthesizers, Field-Programmable Analog Arrays (FPAAs) become more desirable. The FPAA device operates on less than 30 milliwatts, which is approximately three order of magnitude less than a conventional configurable chip [6]. Manipulation of electrons is required for the programming of an analog environment of a device. An FPAA chip has half a million of the parameters necessary, and can be utilized as a switch in the digital manner.

References

[1] Moog Music, “Matriarch,” 2019. [Online]. Available: https://www.moogmusic.com/products/matriarch. [Accessed: Sept. 29, 2019].

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[3] B. Zhu and X. Wang, “Real-time music synthesis by patch-based method,” *Proceedings of the 29th Chinese Control Conference*.

[4] S. Wenner, J.-C. Bazin, A. Sorkine-Hornung, C. Kim, and M. Gross, “Scalable Music: Automatic Music Retargeting and Synthesis,” *Computer Graphics Forum*, vol. 32, no. 2pt3, pp. 345–354, 2013.

[5] R. Kirk and A. Hunt, *Digital Sound Processing for Music and Multimedia*. Hoboken: Focal Press, 2013.

[6] Electronic Product Magazine, March 21, 2016. "New analog chip uses 1,000 times less electrical power (and can be built a hundred times smaller) than comparable digital devices"