A SYSTEM FOR RECORDING ANALOG SYNTHESIZERS WITH THE WEB

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ABSTRACT

This paper proposes a system composed by hardware and software for remote access to real analog synthesizers using the World Wide Web. In this system, a MIDI submission can be implemented from outside a DAW (Digital Audio Workstation), or with a standard Web page, and we allow the user to submit its performance, select a set of parameters and get access to the resulting recording. The MIDI submission can be implemented from inside a DAW, using standard MIDI-to-CV converters (CV stands for Control Voltage) that can be used to play older analog synthesizers that do not support MIDI directly. The system software has at least two other attributions, which are to implement a queue, dispatching each job with the proper synchronization, and to make a set of presetting tasks. Among those, it is important to check if they have sent the MIDI file for errors, bounds and filter out undesired messages.

The last component is the user front-end. It must allow the user to submit its performance, select a set of parameters and get access to the resulting recording. The MIDI submission can be implemented from inside a plug-in running in a given DAW (Digital Audio Workstation), or with a standard Web page, and we choose the later as a first option. It requires the user to export each one of its MIDI performances from its DAW to a MIDI file on its computer's file-system, from where it can be uploaded, or even submitted to a server, with or without a DaW. Timepiece A/V MIDI USB interface.

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1. INTRODUCTION

We might think that every new technology inevitably replacethose that are already present. This is not true in many cases, especially in arts and music. Consider for example the traditional acoustic instruments used in classical music. Despite the impressive advancements in digital technology, it is not possible to record or digitally process a real acoustic instrument. With the advent of the digital technology, acoustic instruments were not replaced either for artistic expression or for their commercial production. Instead, they were used in a new way to create new sounds that could not be obtained with a traditional acoustic instrument. Today, many synthesizers are still heavily employed in modern pop music.

Synthesizers are electronic devices that generate sound. They are used in many different applications, from video games to music production. A synthesizer can be thought of as an electronic orchestra, capable of producing an almost limitless range of sounds.

2. SYSTEM ARCHITECTURE

A key aspect in the proposed system is the batched access model. It is like an "atomic service", to which the user submits a job and retrieves the expected result after some short time. This is a different scenario compared to real-time access, which requires tight timing control and, in case, with latency/throughput issues, as addressed in many works on network online music. The main reason for the batched access is to increase system usage. Real-time access to an analog synthesizer implies that whenever the system is being used, or available to a given user, it cannot be accessed by others. In other words, we need to serialize the users, something that cannot be implemented efficiently. The only way to do that is to reserve big time frames (like half-hours) for each user, resulting in poor system usage. In the proposed system, instead of being able to play with the synthesizer in real time, like in [4], the user is expected to prepare a job and submit it to a queue, where it will be processed shortly. To our knowledge this is the first work that addresses batched access to analog synthesizers.

The job can be described by a MIDI performance or employ another music notation format [2]. The system must be composed of a front-end, a software interface and a software processing system that implements the desired functions. Starting with the hardware, at least the real synthesizer, a computer, an audio interface and a MIDI interface are needed. The software system must be able to play the MIDI performance, be replaceable in many respects for future purposes and convert MIDI to audio. The MIDI specification is not always compatible with the proper synchronization, and to make a set of presetting tasks. Among those, it is important to check if they have sent the MIDI file for errors, bounds and filter out undesired messages.

The last component is the user front-end. It must allow the user to submit its performance, select a set of parameters and get access to the resulting recording. The MIDI submission can be implemented from inside a plug-in running in a given DAW (Digital Audio Workstation), or with a standard Web page, and we choose the later as a first option. It requires the user to export each one of its MIDI performances from its DAW to a MIDI file on its computer's file-system, from where it can be uploaded, or even submitted to a server, with or without a DaW. Timepiece A/V MIDI USB interface.

3. THE FIRST PROTOTYPE

The first prototype was implemented as a proof of concept for this service and is currently working privately. The goal for this implementation was to check its viability using standard technologies and also test the access model and usage. The system offers access to a Studio Electronics ATC-1 with the Moog-type filter installed [7], a synthesizer that inherits most of its circuits from the Minimoog [5]. The synthesizer is recorded using the Steinberg Cubase 6 Elements DAW and custom A/D hardware. The whole setup is running in an iMac connected to the synthesizer via the MOTU Timepiece A/V MIDI USB interface.

A typical use would be to have a mixed MIDI/audio production in the user’s DaW, where some of the MIDI tracks need emphasis and call for a higher quality, like in a solo or bass line. The user can then browse a set of sound samples from the system, select one and submit its job to record one or two tracks with a real analog synthesizer, increasing their quality in terms of timbre and articulation, for example. Musicians already know that such sounds stand up in the mix [1], unlike their digital emulations. If used for a few tracks or shorter passages, even moderate costs would be perfectly acceptable, mostly because the user would pay only for the duration of the performances.
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ABSTRACT

This paper proposes a system composed by hardware and software for remote accessing real analog synthesizers using the World Wide Web. In this system, a file with the user performance is submitted to the server, being played with an actual analog synthesizer, and a recording is made with samplers and synthesizers using the World Wide Web. In this system, what is not possible with both local or remote real time access to an analog synthesizer implies that whenever the system is being used, or available to a given user, it cannot be accessed by others. In other words, we need to serialize the users, something that cannot be implemented efficiently. The only way to do that is to reserve big time frames (like half-hours) for each user, resulting in poor system usage. In the proposed system, instead of being able to play with the synthesizer in real time, like in [4], the user is expected to prepare a job and submit it to a queue, where it will be processed shortly. To our knowledge this is the first work that addresses batched access to analog synthesizers.

1. INTRODUCTION

We might think that every new technology inevitably replaces the old one, and this is not true in many cases especially in arts and music. Consider for example the traditional acoustical instruments used in classical music. Despite the impressive advancements, and the possibility for certain articulations, possibly with digital audio, they were not replaced either for artistic expression neither for many commercial productions. It is true that most tracks in television advertisement are made with samplers and synthesizers, but on the other hand major movies still use soundtracks composed, performed and recorded by real orchestras with acoustical instruments.

The same can be said about analog synthesizers. They started to be replaced with the advent of the digital technology in the 80’s. There are many reasons for this trend to have been so hardly pursued. Powerful analog machines were big and expensive, their programming could not be easily stored, and they did not have a perfectly stable tuning, among others, all very important factors. They were also limited in their ability to reproduce complex initial transients that are characteristic of instruments like the piano.

Today, three decades later, we must acknowledge the fact that analog synthesizers still have. The synthesizers and computer software (plug-ins) available today are not only used to produce sounds like only digital technology can generate, but also try to mimic the old technologies, acoustical instruments, and the sounds of many analog synthesizers. This is already a sign that they form a class by themselves, real musical instruments capable of characteristic performances and nuances. Actual analog synthesizers are still heavily employed in modern pop music [1]. Descendents of the Moog synthesizers are used to provide the deep basses in genres like Rap, Dance, effects in electronic music, as well as solos in countless Jazz and Rock groups, just to mention a few examples. In summary, it is safe to say that while the digital revolution brought us incredible possibilities, better control, new sounds, everything widely accessible from simple consumer computers, the original analog machines that are already part of the music aesthetics will continue to be superior and irreplaceable in many aspects for years to come.

There is an accessibility issue, however. With few exceptions, analog synthesizers, both new and old, are more expensive than before. The construction must employ old techniques, components or practices that are not the mainstream today, while the original ones are getting older, so finding them in good shape is becoming harder. There are indeed collectors that have a good set of original machines, but just few people can access them, and new generations might not even get the chance to know how they sound, led to think that the plug-ins are accurate reproductions.

The contribution of this paper lies in this context. We propose a system that puts an analog synthesizer, or a collection of them, accessible through the Web, for recording performances submitted by the public. Furthermore, we propose a batched access model to the service so as to achieve a much higher efficiency, which is not possible with real-time access.

The remainder of this paper is organized as follows: Section 2 explains the top-level system architecture and organization, highlighting key elements, while a first fully working prototype is described in section 3. Section 4 covers many aspects related to how a system like this should and should not be used, pointing out the real aggregate value, as well as the viability of commercial exploration. Section 5 discusses many options to address the most important challenge, which is the sound preview. Finally, section 6 enumerates goals and new perspectives that this system opens up.
If the accessing costs are really low, as we will propose ahead, bedroom or garage musicians, as well as experimentalists, can risk more trying to get different acoustic sounds with unexpected sounds and effects. Among the experimentalists we can include people that sample and heavily process audio sources. This group is always in search of new sound sources that can be processed further, and they can access the system to get just a few seconds of some sounds generated by a particular analog machine.

In a very large and, we think they also should be able to afford submitting many times the same part, experimenting with slightly different sounds and tuning parameters so the final sound gets exactly the way it should be.

4.2. Aggregate value and market span

Even for someone that has access to many interesting analog synthesizers, recording them properly requires expensive ADC (analog to digital conversion), preamps, wiring, a good Clock source and so on. When implementing a system that does recording exclusively in large scale, we can employ more expensive circuits, custom hardware, tune the recorder to the signal being recorded, offer a range of different sound flavours and employ many tricks that even a top-level studio cannot. As it was said before, a key issue for the system’s viability is the high scalability attainable with the batched access. It is yet to be verified whether users will adapt themselves to the system or not, but it certainly depends on the accessing costs. If we can prove that the cost for accessing the service is low, it is expected that people will recognize the possibilities, the aggregate value and the returns in terms of quality that they can get from the system and use it.

Let us assume that the market exists and is larger than what can be provided by a single synthesizer of a given kind. Based on this assumption we find that the system should be sized according to the demand so as to keep its utilization bounded by some parameter.

Assuming a basic M/M/1 queue model, for simplicity, with utilization rate $\rho = \lambda / \mu$ (of 50%, from basic queue theory we get that the number of clients in the queue is expected to be $N \approx \rho$, i.e., 25 clients for each system). For a given average job size the client is expected to wait twice this time (including the time to process the 1 client in the system, and its own job), which is a good quality of service. Assume now that a US$2,500.00 synthesizer is being operated by a computer system and accompanying audio/MIDI interfaces, also in the low value of US$2,500.00. Next, let us suppose that the system will charge only US$1.00 for each minute of sound played and recorded. At 50% of utilization, the system should deliver a revenue of around US$500 (remember that there is the overhead of the delays when processing each job). In such hypothetical scenario, the equipment would pay itself in just 10 days.

While we are ignoring the other costs of operating the service, the above numbers were presented to show that a US$1,000/minute target price is not unrealistic. Now by comparing this price (and the easy Web access) to the option of renting a keyboard or renting a high-quality recording studio, that can reach hundreds of dollars per hour, to do the same job, it becomes clear that this is an attractive alternative to many users. We can expect that a lot of people that would never be able to use the sound machines anyway will try the new service.

5. SOUND SELECTION AND PREVIEW

One of the biggest differences from having access to a synthesizer through this system as opposed to sitting in front of it is the preview of the rendered sound. Real time interaction with the synthesizer is not possible. Another problem is the programmability of the synthesizer parameters. Even though MIDI is a standard way to communicate parameter changes to the hardware, the way synthesizers implement these changes does vary. A composer might want to have an exact, accurate, and fast control of the synthesizer's parameters. Even though a simple solution for a synth and this is something such a system should be able to provide. There are a few options that can be used to work around both problems:

- Pre-recorded samples - there must be at least a standard sample for each sound, stored in a different server, that the user can browse and listen to them to choose the one it needs.
- User feedback before recording - a short segment of the submitted job can be recorded and given to the user before processing it completely. In this way he can check the sound and parameters, as volume, base pitch, and so on. Another option would be to allow a given number of re-recordings for the same performance with different parameters;
- VST plugins, software emulators - Software plug-ins can be provided as to mimic the sound of each program in the actual synthesizer. This with the musician can prepare its production as if it was listening to a low resolution copy of it, rendering the final high-quality option at the end. Considering that many companies today offer plug-ins that emulate classic synthesizers, those plug-ins could be calibrated (or the system calibrated) so that the sounds and parameters closely match. A database of calibrated sounds can also be supplied by the system itself, increasing its completeness with very little investment. Another different possibility would be to include access to the service when selling plug-ins. The user software and the service plug-in, from the beginning that she/he will be able to access the same sound from a real analog machine for its recordings.

6. GOALS AND PERSPECTIVES

The main contribution of this paper is the proposal of a new service of batched access to analog synthesizers operated as analog servers. The batched access (not in real time) is key to enable high utilization, increasing hardware efficiency and decreasing the access costs. The service can make expensive or rare analog machines easily available to high quality recordings for everyone interested. We identified that it is quite straightforward to put a modern MIDI-equipped analog synthesizer online, as it was demonstrated in our working prototype. A new service like this should help to improve the quality of new recordings ranging from the most modest beginners up to top artists, in accordance with new trends in social music production [8], as it provides access to a larger variety of sound sources for all.

The system may also help to preserve the entire sound palette that many generations of synthesizers could create by promoting the continuous use of real analog synthesizers of all times. Many synthesizers that are not MIDI capable can be controlled with specific hardware. Even synthesizers that do not have CV inputs and cannot be programmed remotely can be controlled with a dedicated hardware work on them. This investment might be interesting not only from the economic point of view, but also to help keep iconic instrument sounds and work for future generations in an affordable and cost-effective way. The variety of analog machines that can be placed available as servers is very large, and we think of the system as an analog farm or analog cloud.

Finally, we can also extend the idea to automate real acoustical instruments so that expensive ones could be accessed by the public. This can include pianos, electric pianos, organs of all types and varieties, and the list goes on. As the system’s economic advantage lies in the higher utilization rates, there are also other analog sound processes employed in audio productions that can be analyzed as alternatives to be installed as analog servers.

As future work, it is our intention to open a new version of the system to the public as soon as possible so that we can check the demand, see how it is actually going to be used and evaluate the impact that it has in the field.

**REFERENCES**


If the accessing costs are really low, as we will propose ahead, bedroom or garage musicians, as well as experimentalists, can risk more trying to get different sounds and effects. Among the experimentalists we can include people that sample and heavily process audio sources. In a completely different environment, producers and session musicians have an enormous experience and usually know exactly what they need for that part being produced. They want total control and the ability to predict the resulting sound. As professionals, however, they are also used to know how things will sound at the end even when they are hearing only a preview. So it may be perfectly acceptable for them to work with software plug-ins during the major part of the production and then ask for a higher quality rendering at the end, even for most of the tracks. If this is an important production, they also should be able to afford submitting many times the same part, experimenting with slightly different sounds and tuning parameters so that the final sound gets exactly the way it should be.

4.2. Aggregate value and market span

Even for someone that has access to many interesting analog synthesizers, recording them properly requires expensive ADCs (analog to digital conversion), preamps, wiring, a good Clock source and so on. When implementing a system that does recording exclusively in large scale, we can employ many circuits, custom hardware, the tuner to the signal being recorded, offer a range of different sound flavours and employ many tricks that even a top-level studio cannot. As future work, it is our intention to open a new version of the system to the public as soon as possible so that we can check the demand, see how it is actually going to be used and evaluate the impact that it has in the field.

4.3. Relationship with the traditional options

A few questions arise as we consider it for commercial application. How about the alternatives already used by the music industry today? Will a system like this substitute them, decreasing their market? Should someone avoid buying an analog synthesizer and use the service instead? Should someone avoid buying a virtual analog plug-in? Is the system exclusively for people that do not have analog machines? The answer for all these questions is expected to be negative. This proposal creates a new, that completes the alternatives that musicians already use. An analog synthesizer online does not replace the experience of having a real keyboard to play with, listen to, learn from, know how to program or play live. Many musicians can afford to have dedicated, analog and vintage machines, and the service does not replace them. But they will be possibly interested in accessing many others made available from a synthesizer farm. This should also increase the interest in software plug-ins to test and arrange the production before asking the tracks to be rendered by real machines. Even people that own synthesizers may find useful to ask the automated system to record the final track with the very same synthesizer, but with a superior recording process. Therefore, the availability of such a service can provide additional reasons to seek for analog synthesizers and plug-ins, helping to increase the overall market.

4.4. Simple cost estimate

As it was said before, a key issue for the system’s economic viability is the high scalability attainable with the batched access. It is yet to be verified whether users will adapt themselves to the service, but it certainly depends on the accessing costs. If we can prove that the cost for accessing the service is low, it is expected that people will recognize the possibilities, the aggregate value and the returns in terms of quality that they can get from the system and use it. Let us assume that the market exists and is larger than what can be provided by a single synthesizer of a given kind. Based on this assumption we find that the system should be sized according to the demand so as to keep its utilization bounded by some parameter. Assuming a basic M/M/1 queue model, for simplicity, with utilization rate \( \rho = \lambda / \mu \) (of 50%, from basic queue theory we get that the number of clients in the queue is expected to be \( N \approx \rho \) with \( \rho < 1 \)). For this given a average job size the client is expected to wait twice this time (including the time to process the 1 client in the system, and its own), which is a good quality of service. Assume now that a US$2,500.00 synthesizer is being operated by a computer system and accompanying audio/MIDI interfaces, also in the total value of US$2,500.00. Next, let us suppose that the system will charge only US$1.00 for each minute of sound played and recorded. At 50% of utilization, the system should run almost 24 hours per day, generating a revenue of around US$500 (remember that there is the overhead of the delays when processing each job). In such hypothetical scenario, the equipment would pay itself in just 10 days.

While we are ignoring the other costs of operating the service, the above numbers were presented to show that a US$1,000/minute target price is not unrealistic. Now by comparing this price (and the easy Web access) to the option of renting a keyboard or renting a high-quality recording studio, that can reach hundreds of dollars per hour, to do the same job, it becomes clear that this is an attractive alternative to many users. We can expect that a lot of people that would never be able to use the standard alternatives will try the new service.

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- Pre-recorded samples - there must be at least a standard sample for each sound, stored in a different server, that the user can browse and listen to them to choose the one it needs;
- User feedback before recording - a short segment of the submitted job can be recorded and given to the user before processing it completely. In this way he can check the sound and parameters, as volume, base pitch, and so on. Another option would be to allow a given number of re-recordings for the same performance with different parameters;
- VST plugins, software emulators - Software plug-ins can be provided as to mimic the sound of each program in the actual synthesizer. With this option, the musician can prepare its production by some parameter calibration. An assumption is that the system should be sized according to the demand so as to keep its utilization bounded by some parameter. Assuming a basic M/M/1 queue model, for simplicity, with utilization rate \( \rho = \lambda / \mu \) (of 50%, from basic queue theory we get that the number of clients in the queue is expected to be \( N \approx \rho \) with \( \rho < 1 \)). For this given a average job size the client is expected to wait twice this time (including the time to process the 1 client in the system, and its own), which is a good quality of service. Assume now that a US$2,500.00 synthesizer is being operated by a computer system and accompanying audio/MIDI interfaces, also in the total value of US$2,500.00. Next, let us suppose that the system will charge only US$1.00 for each minute of sound played and recorded. At 50% of utilization, the system should run almost 24 hours per day, generating a revenue of around US$500 (remember that there is the overhead of the delays when processing each job). In such hypothetical scenario, the equipment would pay itself in just 10 days.

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The system may also help to preserve the entire sound palette that many generations of synthesizers could create by promoting the continuous use of real analog synthesizers of all times. Many synthesizers that are not MIDI capable can be controlled with specific hardware. Even synthesizers that do not have CV inputs and cannot be programmed remotely can be controlled with a dedicated hardware work on them. This investment might be interesting not only from the economic point of view, but also to help keep iconic instruments and methods for future generations in an affordable and cost-effective way. The variety of analog machines that can be placed available as servers is very large, and we can think of the system as an analog farm or analog cloud.

Finally, we can also extend the idea to automate real acoustical instruments so that expensive ones could be accessed by the public. This can include pianos, electric pianos, organs of all types and varieties, and the list goes on. As the system’s economic advantage lies in the higher utilization rates, there are also other analog sound processes employed in audio productions that can be analyzed as alternatives to be installed as analog servers. As future work, it is our intention to open a new version of the system to the public as soon as possible so that we can check the demand, see how it is actually going to be used and evaluate the impact that it has in the field.

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