

## Electronic Acknowledgement Receipt

<b>EFS ID:</b>	44692282
<b>Application Number:</b>	63297305
<b>International Application Number:</b>	
<b>Confirmation Number:</b>	9409
<b>Title of Invention:</b>	METHOD OF USING IIR FILTERS FOR THE PURPOSE OF ALLOWING ONE AUDIO SOUND TO ADOPT THE SAME SPECTRAL CHARACTERISTIC OF ANOTHER AUDIO SOUND
<b>First Named Inventor/Applicant Name:</b>	Christopher L. Stone
<b>Customer Number:</b>	146807
<b>Filer:</b>	Joseph Bach/Kitty YUEN
<b>Filer Authorized By:</b>	Joseph Bach
<b>Attorney Docket Number:</b>	101690 013099
<b>Receipt Date:</b>	07-JAN-2022
<b>Filing Date:</b>	
<b>Time Stamp:</b>	11:49:21
<b>Application Type:</b>	Provisional

### Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	\$ 150
RAM confirmation Number	E202217B49551477
Deposit Account	090528
Authorized User	Kitty YUEN

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.21 (Miscellaneous fees and charges)

37 CFR 1.19 (Document supply fees)

**File Listing:**

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	A101690-013099_ADS_07January2022.pdf	1255941	no	8
			c36fb09e9c5d29acce1800bbdc65e0755ac29af3		
<b>Warnings:</b>					
<b>Information:</b>					
2	Specification	A101690-013099_Application_07January2022.pdf	295892	no	5
			b960b8ad77a0a8e94fb3e5c9b08eaa3788b3feffa		
<b>Warnings:</b>					
<b>Information:</b>					
3	Drawings-only black and white line drawings	A101690-013099_Drawings_07January2022.pdf	295893	no	2
			4e5e620857f0a680986fac7fd575b43924b4788b		
<b>Warnings:</b>					
<b>Information:</b>					
4	Fee Worksheet (SB06)	fee-info.pdf	37746	no	2
			c4d6022f80531ddd7ccbcdb23ae388e452cdb816		
<b>Warnings:</b>					
<b>Information:</b>					
<b>Total Files Size (in bytes):</b>			1885472		

**This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.**

**New Applications Under 35 U.S.C. 111**

**If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.**

**National Stage of an International Application under 35 U.S.C. 371**

**If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.**

**New International Application Filed with the USPTO as a Receiving Office**

**If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.**

## Electronic Patent Application Fee Transmittal

<b>Application Number:</b>				
<b>Filing Date:</b>				
<b>Title of Invention:</b>	METHOD OF USING IIR FILTERS FOR THE PURPOSE OF ALLOWING ONE AUDIO SOUND TO ADOPT THE SAME SPECTRAL CHARACTERISTIC OF ANOTHER AUDIO SOUND			
<b>First Named Inventor/Applicant Name:</b>	Christopher L. Stone			
<b>Filer:</b>	Joseph Bach/Kitty YUEN			
<b>Attorney Docket Number:</b>	101690 013099			
Filed as Small Entity				
<b>Filing Fees for Provisional</b>				
<b>Description</b>	<b>Fee Code</b>	<b>Quantity</b>	<b>Amount</b>	<b>Sub-Total in USD(\$)</b>
<b>Basic Filing:</b>				
PROVISIONAL APPLICATION FILING FEE	2005	1	150	150
<b>Pages:</b>				
<b>Claims:</b>				
<b>Miscellaneous-Filing:</b>				
<b>Petition:</b>				
<b>Patent-Appeals-and-Interference:</b>				
<b>Post-Allowance-and-Post-Issuance:</b>				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
<b>Extension-of-Time:</b>				
<b>Miscellaneous:</b>				
<b>Total in USD (\$)</b>				<b>150</b>

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

<b>Application Data Sheet 37 CFR 1.76</b>		Attorney Docket Number	101690-013099
		Application Number	
Title of Invention	METHOD OF USING IIR FILTERS FOR THE PURPOSE OF ALLOWING ONE AUDIO SOUND TO ADOPT THE SAME SPECTRAL CHARACTERISTIC OF ANOTHER AUDIO SOUND		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

**Secrecy Order 37 CFR 5.2:**

<input type="checkbox"/>	Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)
--------------------------	---

**Inventor Information:**

Inventor	1				Remove
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Christopher	L.	Stone		
Residence Information (Select One) <input checked="" type="radio"/> US Residency <input type="radio"/> Non US Residency <input type="radio"/> Active US Military Service					
City	Oak Park	State/Province	CA	Country of Residence	US
Mailing Address of Inventor:					
Address 1	6592 Oak Springs Drive				
Address 2					
City	Oak Park	State/Province	CA		
Postal Code	91377	Country	US		
All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button.					Add

**Correspondence Information:**

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).	
<input type="checkbox"/> An Address is being provided for the correspondence information of this application.	
Customer Number	146807
Email Address	
	Add Email Remove Email

**Application Information:**

Title of the Invention	METHOD OF USING IIR FILTERS FOR THE PURPOSE OF ALLOWING ONE AUDIO SOUND TO ADOPT THE SAME SPECTRAL CHARACTERISTIC OF ANOTHER AUDIO SOUND		
Attorney Docket Number	101690-013099	Small Entity Status Claimed	<input checked="" type="checkbox"/>
Application Type	Provisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	2	Suggested Figure for Publication (if any)	

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

<b>Application Data Sheet 37 CFR 1.76</b>	Attorney Docket Number	101690-013099
	Application Number	
Title of Invention	METHOD OF USING IIR FILTERS FOR THE PURPOSE OF ALLOWING ONE AUDIO SOUND TO ADOPT THE SAME SPECTRAL CHARACTERISTIC OF ANOTHER AUDIO SOUND	

**Filing By Reference:**

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

**Publication Information:**

Request Early Publication (Fee required at time of Request 37 CFR 1.219)

**Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

**Representative Information:**

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer number will be used for the Representative Information during processing.

Please Select One:	<input checked="" type="radio"/> Customer Number	US Patent Practitioner	<input type="radio"/> Limited Recognition (37 CFR 11.9)
Customer Number	146807		

**Domestic Benefit/National Stage Information:**

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	<input type="text"/>	<input type="button" value="Remove"/>
Application Number	Continuity Type	Prior Application Number
<input type="text"/>	<input type="text"/>	<input type="text"/>
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the <b>Add</b> button.		<input type="button" value="Add"/>

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

<b>Application Data Sheet 37 CFR 1.76</b>	Attorney Docket Number	101690-013099
	Application Number	
Title of Invention	METHOD OF USING IIR FILTERS FOR THE PURPOSE OF ALLOWING ONE AUDIO SOUND TO ADOPT THE SAME SPECTRAL CHARACTERISTIC OF ANOTHER AUDIO SOUND	

## Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)<sup>i</sup> the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Application Number	Country <sup>i</sup>	Filing Date (YYYY-MM-DD)	Access Code <sup>i</sup> (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

## Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

- This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
- NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

<b>Application Data Sheet 37 CFR 1.76</b>	Attorney Docket Number	101690-013099
	Application Number	
Title of Invention	METHOD OF USING IIR FILTERS FOR THE PURPOSE OF ALLOWING ONE AUDIO SOUND TO ADOPT THE SAME SPECTRAL CHARACTERISTIC OF ANOTHER AUDIO SOUND	

## Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

**NOTE:** This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

### 1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

**A. Priority Document Exchange (PDX)** - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

**B. Search Results from U.S. Application to EPO** - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

### 2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

**NOTE:** Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

<b>Application Data Sheet 37 CFR 1.76</b>	Attorney Docket Number	101690-013099
	Application Number	
Title of Invention	METHOD OF USING IIR FILTERS FOR THE PURPOSE OF ALLOWING ONE AUDIO SOUND TO ADOPT THE SAME SPECTRAL CHARACTERISTIC OF ANOTHER AUDIO SOUND	

## Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

<b>Applicant</b>	1	<input type="button" value="Remove"/>	
<p>If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.</p>			
<input type="button" value="Clear"/>			
<input checked="" type="radio"/> Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor	
Person to whom the inventor is obligated to assign.		Person who shows sufficient proprietary interest	
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:			
<div style="border: 1px solid black; height: 20px; width: 100%;"></div>			
Name of the Deceased or Legally Incapacitated Inventor: <input type="text"/>			
If the Applicant is an Organization check here. <input checked="" type="checkbox"/>			
Organization Name	AUDIO IMPRESSIONS, INC.		
<b>Mailing Address Information For Applicant:</b>			
Address 1	6592 Oak Springs Drive		
Address 2			
City	Oak Park	State/Province	CA
Country	US	Postal Code	91377
Phone Number		Fax Number	
Email Address			
Additional Applicant Data may be generated within this form by selecting the Add button. <input type="button" value="Add"/>			

## Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

<b>Application Data Sheet 37 CFR 1.76</b>	Attorney Docket Number	101690-013099
	Application Number	
Title of Invention	METHOD OF USING IIR FILTERS FOR THE PURPOSE OF ALLOWING ONE AUDIO SOUND TO ADOPT THE SAME SPECTRAL CHARACTERISTIC OF ANOTHER AUDIO SOUND	

<b>Assignee</b>	1
-----------------	---

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here.

Prefix	Given Name	Middle Name	Family Name	Suffix

**Mailing Address Information For Assignee including Non-Applicant Assignee:**

Address 1				
Address 2				
City		State/Province		
Country <sup>i</sup>		Postal Code		
Phone Number		Fax Number		
Email Address				

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.

Add

**Signature:**

Remove

**NOTE:** This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). However, if this Application Data Sheet is submitted with the **INITIAL** filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Joseph Bach/		Date (YYYY-MM-DD)	2022-01-07	
First Name	Joseph	Last Name	Bach	Registration Number	37,771

Additional Signature may be generated within this form by selecting the Add button.

Add

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

<b>Application Data Sheet 37 CFR 1.76</b>	Attorney Docket Number	101690-013099
	Application Number	
Title of Invention	METHOD OF USING IIR FILTERS FOR THE PURPOSE OF ALLOWING ONE AUDIO SOUND TO ADOPT THE SAME SPECTRAL CHARACTERISTIC OF ANOTHER AUDIO SOUND	

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

## Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

## Method of Using IIR filters for the Purpose of Allowing one Audio Sound to adopt the same Spectral Characteristic of Another Audio Sound.

This invention utilizes a short in time length audio sample called the “target” sample. It is typically a sample of a music instrument, human voice, or sound effect, but not limited to any particular type of instrument or sound. The target sample is used to generate a setting for a specific type of multi-pole audio filter, called an IIR (Infinite Impulse Response) filter. The IIR filter is then applied to a “destination” audio sound, thereby transforming the destination sound into the timbral sonic characteristics of the target sampled sound.

The target sample can be either a short audio sample of anywhere between .0001 – 1000 milliseconds in time duration, or it can be derived from an IR sample. (see out IR patent: US10319353B2)

**The purpose of this invention:** Using IRs directly for the same purpose requires a significant demand on computer processing power. When multiple IR processors are required simultaneously, the computer will soon run out of processing power. IIR filters, on the other hand, require very little computer power by comparison. This allows more IIRs to be used simultaneously, where direct IR use would be too inefficient. For instance, it would conserve the computer power of portable medium devices, if IIR processing were to be used in lieu of direct IR processing.

**The reason for this invention:** To economize on RAM and HD footprints. For instance, by eliminating all the samples that can be replaced by IIRs via this invention, a music sample library consisting of one terabyte of over 100,000 sample, can be condensed to as little as 10 gigabytes with only 1000 samples. Again, this is especially important for portable medium device compatibility.

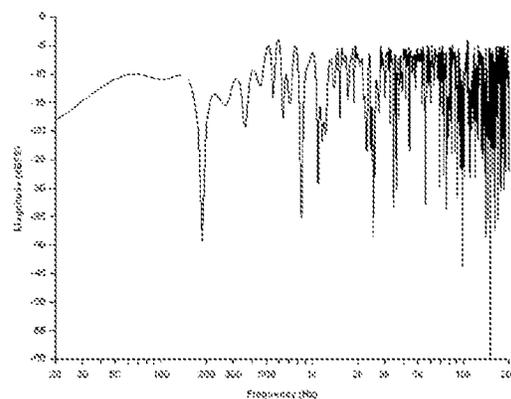
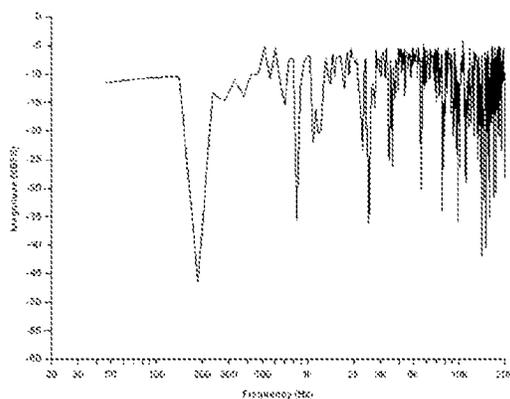
### Process Steps of Invention:

#### 1. Spectrum computation

We use the Fourier transform to compute the magnitude spectrum of the impulse response.

By adding trailing zeros (“zero padding”) to the IR we get more points in the magnitude spectrum, which is especially useful for low frequencies.

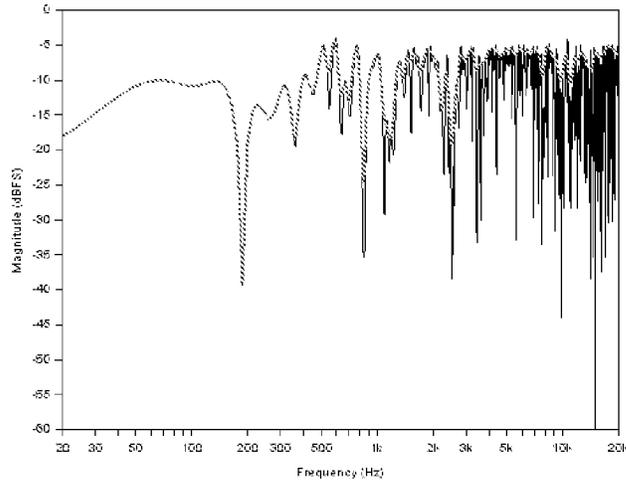
Examples: on left, no zero padding, on right, adding  $3*N$  zeros,  $N$  being original IR size)



## 2. Extract envelope

We compute the envelope by taking the maximum of each 1/16th octave bands. Then the result is smoothed using a running 1/16th octave gaussian window.

This allows us to have a much simpler curve to approximate especially in the high frequencies.



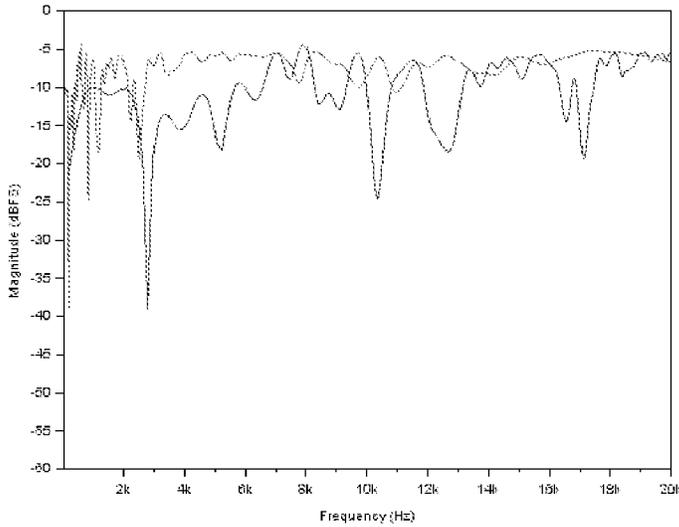
— IR magnitude spectrum

--- Spectral envelope

### 3. Frequency warping

The following Yule Walker algorithm approximates the curve on a linear frequency axis.

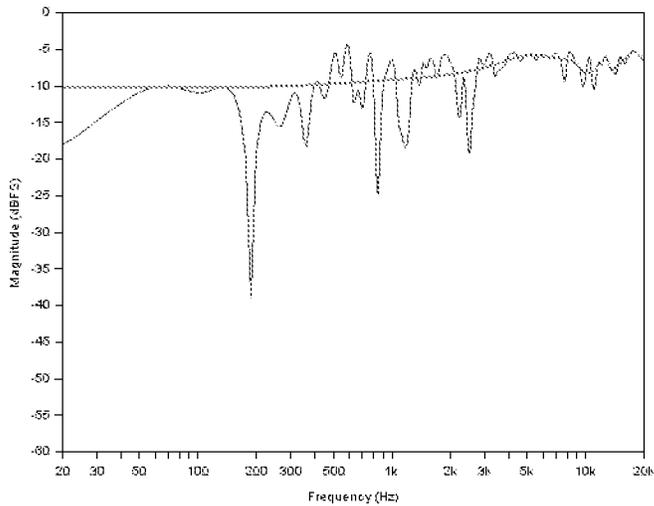
Because we are working with audio and humans hear frequencies on a logarithmic axis, we use “frequency warping” technique to simulate how the curve looks on a log axis on a linear axis.



- Envelope
- Warped envelope

Without this step, the algorithm would approximate high frequencies very well but the approximation for low/mid frequencies would be very poor viewed on a log frequency axis.

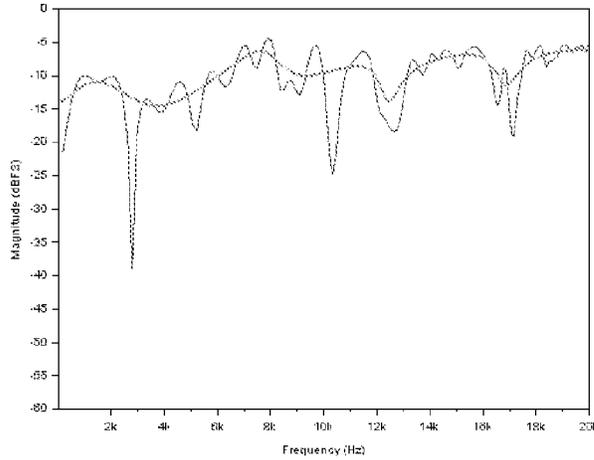
Example of filter approximation without frequency warping:



- Yule walker approximation

## 4. Yule Walker approximation

This step uses the “modified Yule-Walker equations” to compute the best IIR filter of a given order so that its magnitude response matches the envelope as closely as possible



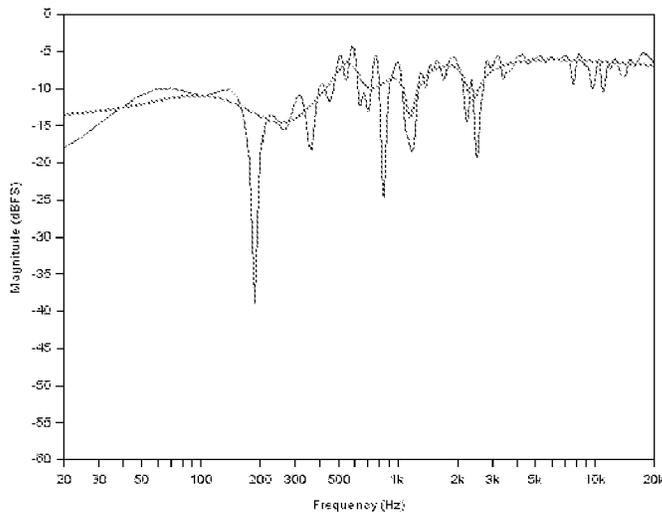
--- Envelope

... Approximation filter magnitude

## 5. Frequency unwarping

The resulting IIR filter is then approximating the warped envelope from step 3. We now need to unwarped the filter to get our final result.

To do that we rotate each pole and zero of the filter using the warping factor we used in step 3.

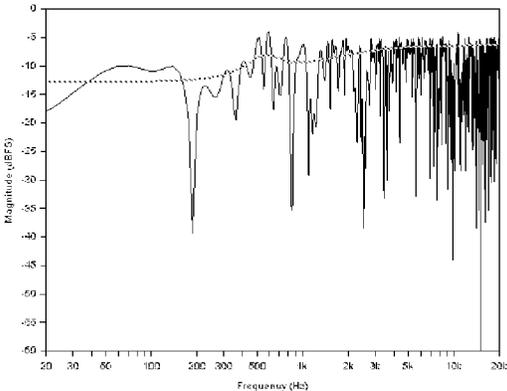


--- Envelope

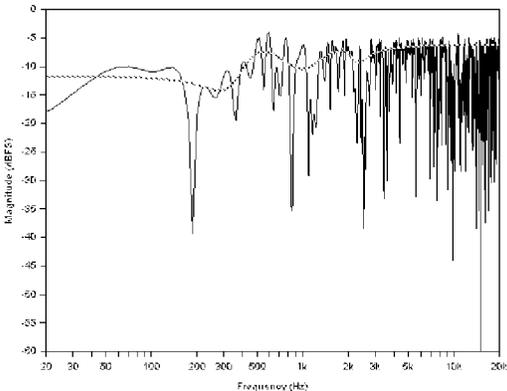
... Unwarped filter magnitude

# Final results

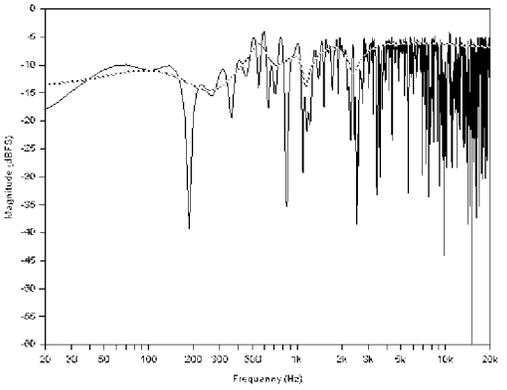
Order 3

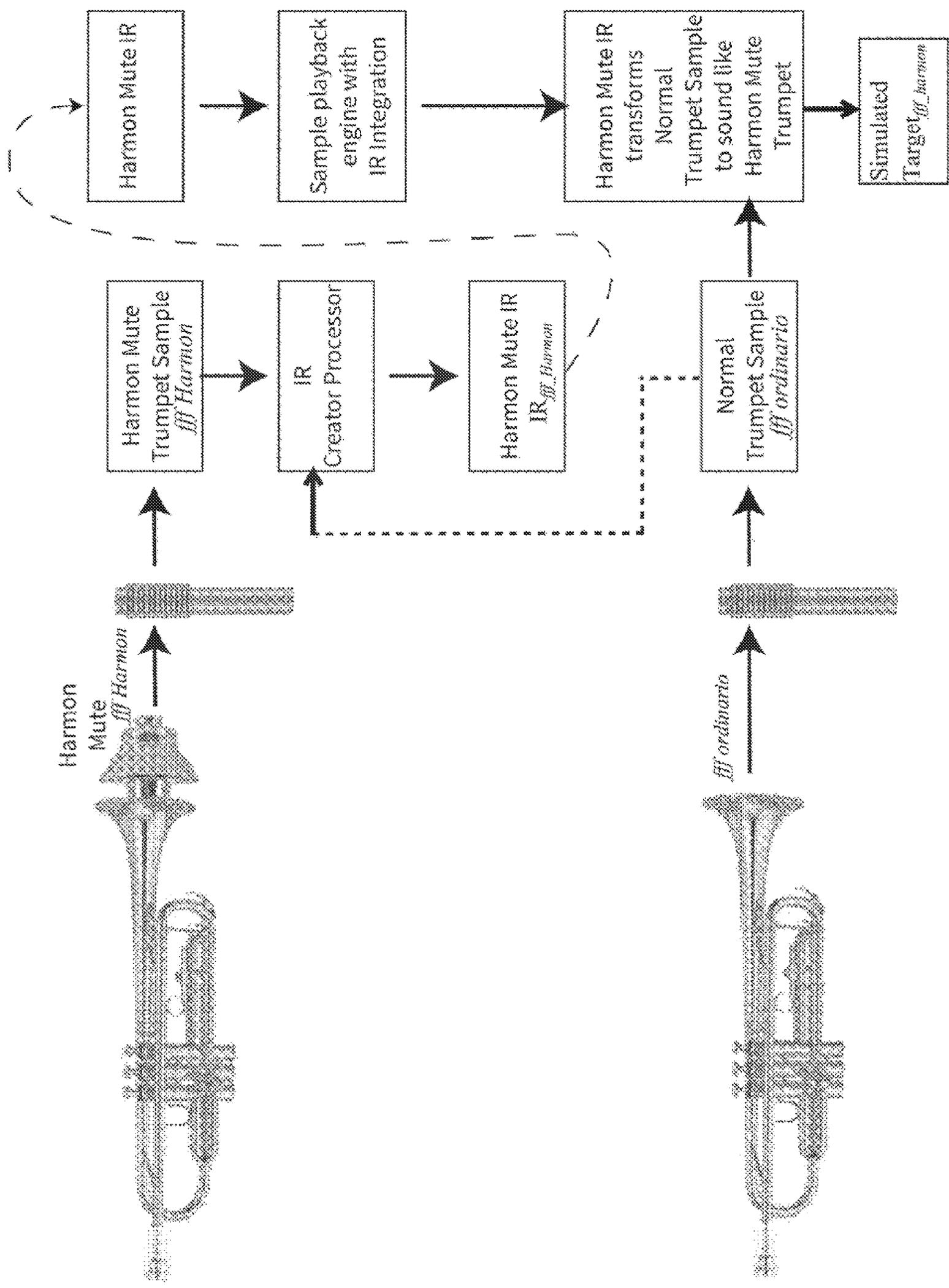


Order 6

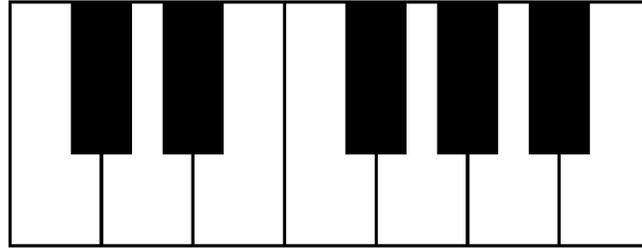


Order 10



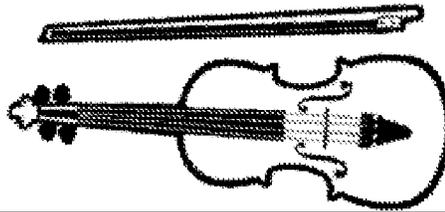


MIDI MUSIC KEYBOARD



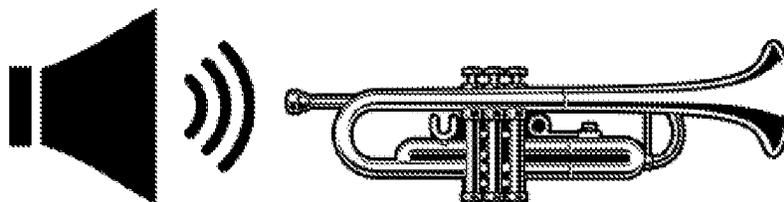
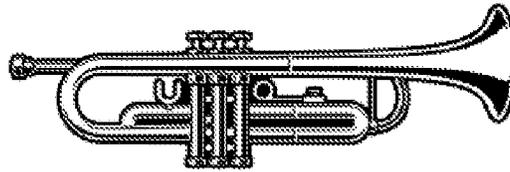
SAMPLE PLAYBACK ENGINE

Violin Sample



IIR FILTER

Trumpet IIR Coeficient



Violin transformed into the  
sound of a Trumpet