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Carter, Jr.

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(54) **ENHANCED MECHANICAL ACOUSTIC SOUND GENERATION SYSTEM AND METHOD**

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(52) **U.S. Cl.** **84/603**; 84/171
(58) **Field of Search** 84/603–605, 171, 84/172, 719

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,357,291 A	*	12/1967	Carmichael	84/267
3,711,617 A		1/1973	Evans	
4,058,045 A		11/1977	Jennings et al.	
4,084,473 A		4/1978	Kitashima et al.	
4,245,540 A	*	1/1981	Groupp	84/726
4,338,848 A		7/1982	Rhodes	
4,448,103 A	*	5/1984	Blakely et al.	84/718
4,450,749 A		5/1984	Stahnke	
4,704,931 A		11/1987	Nagai et al.	
4,744,281 A		5/1988	Isozaki	
4,768,412 A		9/1988	Sanderson	
4,914,750 A		4/1990	Lawson	
4,939,969 A	*	7/1990	Taguchi et al.	84/719
4,957,552 A		9/1990	Iwase	
5,020,410 A		6/1991	Sasaki	
5,031,501 A		7/1991	Ashworth	
5,058,173 A		10/1991	Ashworth	
5,142,961 A		9/1992	Paroutaud	
5,440,072 A	*	8/1995	Willis	84/645
5,524,519 A	*	6/1996	Matsunaga et al.	84/221

* cited by examiner

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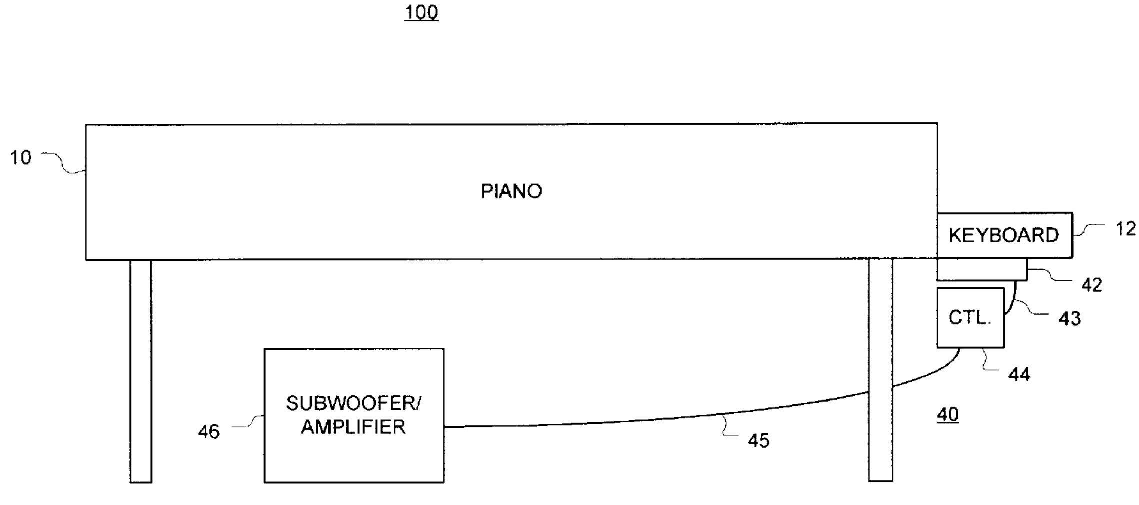
(57) **ABSTRACT**

Enhancing the sound quality of a mechanical acoustic sound generation device that has a plurality of notes that have a perceived sound quality that is lower that the perceived sound quality of corresponding notes produced by a second mechanical acoustic sound generation device by digital sampling the corresponding notes of the second device and playing them in conjunction with the notes of the first device when a note having a lower perceived sound quality is generated by the first device.

28 Claims, 3 Drawing Sheets



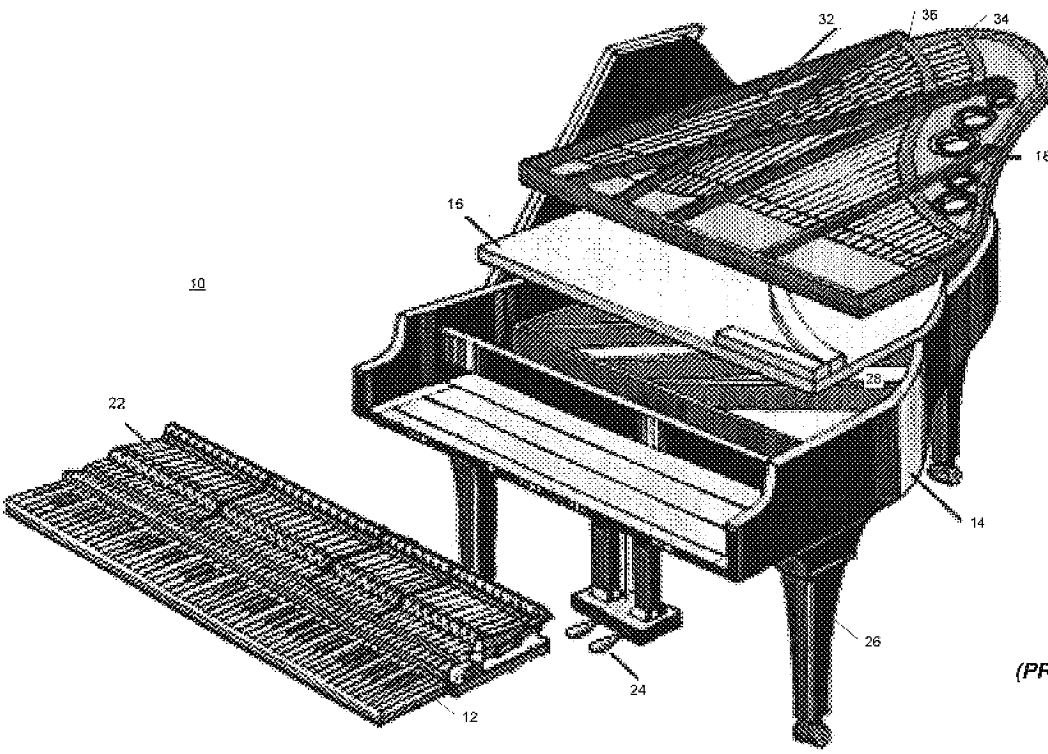


FIG. 1
(PRIOR ART)

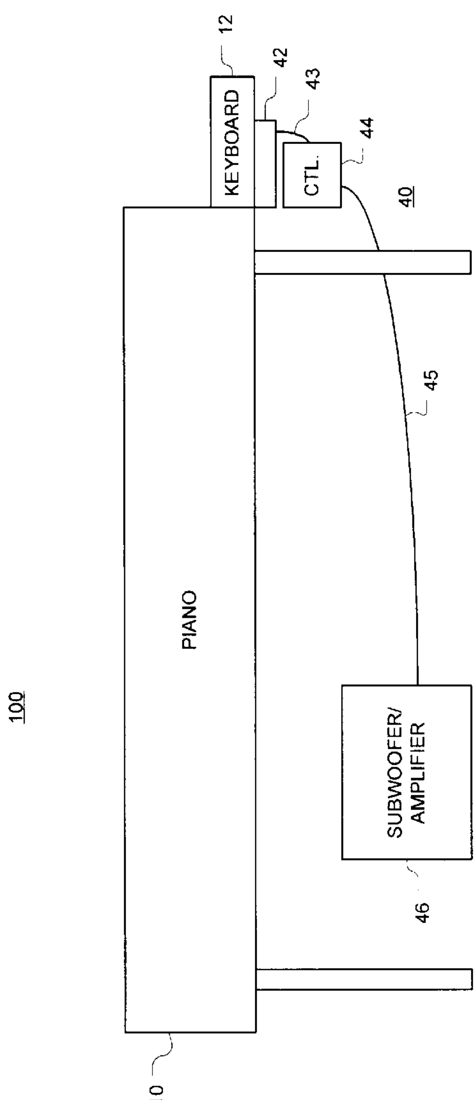

100
PIANO
10
KEYBOARD
12
42
43
CTL.
44
40
45
SUBWOOFER/
AMPLIFIER
46

FIG. 2

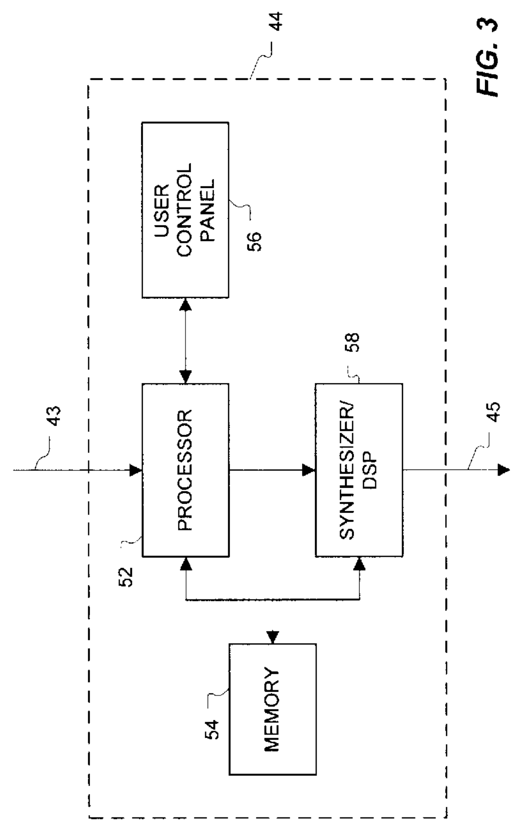

44
USER
CONTROL
PANEL
56
43
PROCESSOR
52
SYNTHESIZER/
DSP
58
45
MEMORY
54

FIG. 3

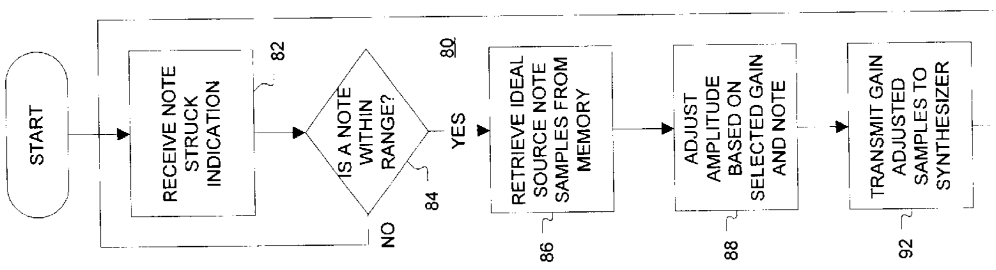


FIG. 6

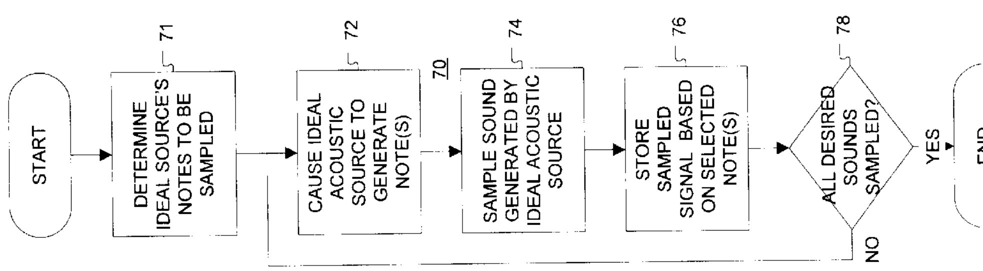


FIG. 5

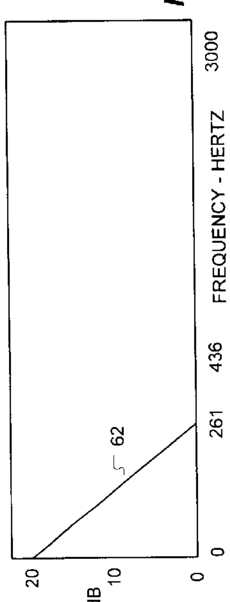


FIG. 4A

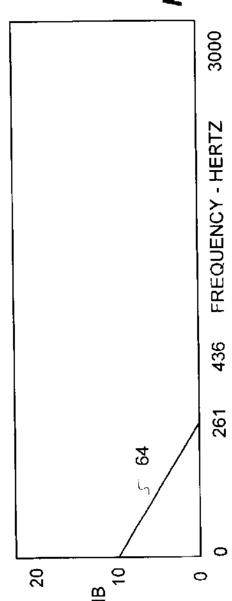


FIG. 4B

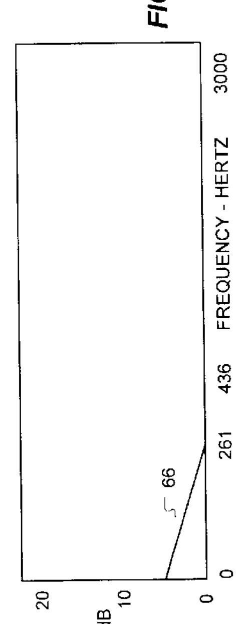


FIG. 4C

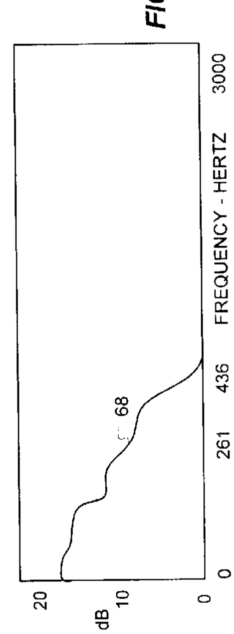


FIG. 4D

ENHANCED MECHANICAL ACOUSTIC SOUND GENERATION SYSTEM AND METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to enhancing the sound quality of mechanical acoustic sound generation devices, and more particularly enhancing the sound quality of mechanical acoustic musical instruments.

2. Description of Related Art

Mechanical acoustic sound generation devices, in particular, mechanical acoustic musical instruments are created to produce high quality sound. These instruments' sound quality vary, typically as a function of their size and quality of their materials, construction, and mechanisms. For example, concert grand pianos that are large, very carefully engineered, and made with the highest quality materials and mechanisms produce very high quality perceived sound. Similarly, concert cellos that are large and constructed of the finest materials produce high quality perceived sound.

Due to costs, limited raw materials, and high volumes, all acoustic sound generation devices manufactured do not produce high quality perceived sound. Some more affordable devices, available to the average consumer, have a perceived sound quality far below their expensive counterparts. An object of the present invention is to enhance the sound quality of more affordable mechanical acoustic sound generation devices while not employing the expensive materials, mechanisms, or assembly methods of superior mechanical acoustic sound generation devices.

SUMMARY OF THE INVENTION

The present invention includes a system and method for enhancing the perceived sound quality of a first mechanical acoustic sound generation device. The first device is capable of producing a first plurality of notes each note having a fundamental frequency. In this first device, a second, smaller plurality of the first plurality of the notes have a perceived sound quality lower than the perceived sound quality of corresponding notes produced by a second mechanical acoustic sound generation device. The invention enhances the perceived sound quality of the first device by determining when a note is generated by the first mechanical device and determining whether the note is one of the second, smaller plurality of the first plurality of notes. When the determined note is one of the second, smaller plurality of the first plurality of notes, the invention generates an acoustic representation of a corresponding note digitally sampled from the second mechanical device. Thereby, enhancing notes produced by the first device with digital sampled representations of notes produced by the second device.

In one embodiment the first mechanical acoustic sound generation device is a mechanical acoustic musical instrument and the second mechanical acoustic sound generation device is a mechanical acoustic musical instrument. In another embodiment, the first mechanical acoustic sound generation device is a mechanical acoustic piano and the second mechanical acoustic sound generation device is a mechanical acoustic piano. For this embodiment the second, smaller plurality of the first plurality of notes have a fundamental frequency range from about 0 Hertz to 261 Hertz. Further, the invention generates an acoustic representation of a corresponding note digitally sampled from the second

mechanical device where the amplification of the acoustic representation of the corresponding note varies. In one embodiment, the amplification of the acoustic representation of the corresponding note varies linearly on a decibel scale with the greatest amplification at the lowest fundamental frequency range. In another embodiment, a user may select the overall amplification level of the acoustic representations of the corresponding notes.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exploded illustration of a prior art mechanical acoustic sound generation device (concert piano).

FIG. **2** is a block diagram of an enhanced mechanical acoustic sound generation device in accordance with the present invention.

FIG. **3** is a block diagram of an exemplary electronic sound generation controller of the enhanced mechanical acoustic sound generation device shown in FIG. **2** in accordance with the present invention.

FIG. **4A** is a graph of one exemplary high gain response for an enhancement signal in accordance with the present invention.

FIG. **4B** is a graph of one exemplary medium gain response for an enhancement signal in accordance with the present invention.

FIG. **4C** is a graph of one exemplary low gain response for an enhancement signal in accordance with the present invention.

FIG. **4D** is a graph of an exemplary variable gain response for an enhancement signal in accordance with the present invention.

FIG. **5** is a flowchart of a process of creating sound signals to be used in an electronic sound generation enhancement process in accordance with the present invention.

FIG. **6** is a flowchart of the electronic sound generation enhancement process in accordance with the present invention.

Like reference numbers and designations in the various drawings indicate like elements.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Throughout this description, the preferred embodiment and examples shown should be considered as exemplars, rather than as limitations on the present invention.

One embodiment of the present invention is presented in reference to FIG. **1**. FIG. **1** (Prior Art) is an exploded view of one mechanical acoustic sound generation device **10**, in particular a concert grand piano. The mechanical acoustic device **10** is a mechanical acoustic musical instrument (piano) that generates acoustic sound. The device **10** includes a keyboard **12**, case **14**, soundboard **16**, and frame **18**. The case **14** has legs **26** and damping pedals **24**. The frame **18** includes a plurality of tightly strung strings **32** divided into a bass section **32** and treble section **34**. The soundboard **16** is coupled to the frame **18** via the bridge **28**. The keyboard **12** includes an action **22** where the action **22** strikes string(s) **32** of the frame **18** when one or more keys of the keyboard **12** are struck and each key represents a musical note. The struck string(s) vibrate and the soundboard **16** receives the vibrations via the bridge **28** and amplifies the vibrations, producing the majority of acoustic sound/musical notes generated by the device **10**. The bridge **28**, frame **18**, other strings (due to harmonics) **32**, and case

14 also provide some of the acoustic sound generated by the device **10** when one or more keys of the keyboard **12** are struck or depressed (creating a "ching" effect).

Unless struck strings are damped, subsequent depressed keys may generate acoustic sound/musical notes that are "colored" by concurrently vibrating strings representing previous or simultaneously depressed keys (creating a "ring" effect). Also, the sound frequency spectrum generated when a string is struck varies as a function of the string length. In device **10**, the piano's bass section **34** string **32** lengths and some of the treble sections **36** string **32** lengths may affect the perceived sound quality of corresponding notes generated when these strings **32** are vibrated. Smaller, usually less expensive pianos have shorter bass section **34** strings and some shorter treble section **36** strings **32** compared to large, usually more expensive concert grand pianos. For example, the bass section **34** string **32** that generates the lowest musical scale D note when vibrated is about seven feet long in larger concert grand pianos (devices **10**) while generally four feet long or less in smaller, less expensive devices **10**. In addition, smaller pianos tend to have smaller soundboards made of less expensive materials where the device's **10** soundboard **16** size area and material composition may also affect the device's perceived acoustic sound quality. Other mechanical acoustic sound generation devices', such as cellos, violins, guitars, sound quality may also vary as a function of size, materials, and ultimately cost.

FIG. **2** is a block diagram of an enhanced mechanical acoustic sound generation device **100** in accordance with the present invention. The enhanced device **100** includes a mechanical acoustic sound generation device **10** and electronic sound generation enhancement system **40**. In an exemplary embodiment, the mechanical acoustic sound generation device **10** is modified to enhance its perceived sound quality where the device **10** is perceived to produce lower sound quality compared to a similar or related mechanical acoustic sound generation device, e.g., a smaller piano (baby grand, upright) modified so its perceived sound quality compares favorably to a larger, better constructed (materials and build quality), usually more expensive piano (concert grand). In particular, the electronic sound generation enhancement system **40** supplements the mechanical sound generated by the device **10** so its perceived sound quality compares more favorably with a similar device having a perceived high sound quality.

The inventor has noted that difference in perceived sound quality between high and low end devices generally varies along the frequency spectrum of the sounds generated by the devices with some spectrum sections having minimal differences and others having more significant differences (in perceived sound quality). For example high and low end pianos generally have the greatest difference in perceived sound quality at the lower end of their frequency spectrum of of the sounds they generate. Further, the perceived sound quality difference decreases as the generated sound's fundamental frequency increases to where at mid or higher level frequencies (of generated sound) the difference is not detectable or insignificant. The present invention determines this characteristic and provides variable enhancement based on the differences in perceived sound quality between corresponding high and low end mechanical acoustic sound generation devices in which the invention is employed.

In an exemplary embodiment, the invention samples the sounds generated by the corresponding higher perceived sound quality device for the notes that have a detectable or significant difference in sound quality. The exemplary embodiment then regenerates these sampled sounds using a synthesizer to enhance the lower end device when the device generates a sound in a region having a detectable or significant difference in perceived sound quality. In one embodiment a user of the enhanced device may selectably change the amplitude level or gain of these added sound signals. One exemplary enhancement system **40** for use with a piano is shown in FIG. **2** and explained with reference to FIGS. **3** to **6**.

The exemplary piano enhancement system **40** includes a controller **44**, an electric acoustic sound generation device **46**, and sound/note detection system **42**. The sound/note detection system **42** determines when one or more notes/sounds are in the process of being generated by the device **10** and transmits this information to the controller **44** via line **43**. When desirable (the perceived quality difference significant for one or more of the notes/sound being generated) the controller **44** generates an enhancement signal. The signal is transmitted to the electric acoustic sound generation device **46** via line **45** and converted to acoustic sound by the device **46** where the electrically generated acoustic sound merges with the device's lo mechanically generated acoustic sound, improving the perceived quality of the overall produced sound.

FIG. **3** is a block diagram of an exemplary controller **44** in accordance with the present invention. The controller **44** includes a main processor **52**, non-violate memory **54**, user control panel **56**, and synthesizer/Digital Signal Process ("DSP") **58**. The processor **52** may be a microprocessor or other device that can receive signals from the note detection system **42** and selections from the user control panel **56**. Exemplary use of the enhancement system **40** is presented with reference to FIGS. **4A** to **6** where the device **10** is a mechanical acoustic musical instrument, in particular a piano **10**. FIG. **5** is an algorithm of an exemplary process **70** of sampling the sounds generated by the corresponding higher perceived sound quality device that have a detectable or significant difference in sound quality than the device to be enhanced.

In step **71**, the process **70** determines which notes/sounds need to sampled from an ideal source (high quality mechanical acoustic sound generation device). For pianos, the inventor has noted that less expensive, smaller pianos produce low to mid frequency sounds having a perceived sound quality lower than a high quality, larger piano (ideal source) with the greatest difference at the lowest frequencies and least difference at the mid to upper frequencies of sound spectrum produced by the piano **10**. In one embodiment, the algorithm **70** determines that the device's **10** notes that need to enhanced range from its lowest note (musical scale bottom "A") to the note corresponding to the musical scale middle "C"(step **71**). Then the algorithm **70** causes the idea source to generate the notes to be sampled (step **72**), samples the notes as generated (step **74**), and stores the samples for each note (step **76**).

In the case of the piano **10** to be enhanced, the ideal source is caused to generate a range of notes from its lowest note to the note corresponding to the musical scale middle "C". In one embodiment, the ideal source is a Steinway D concert grand piano. The musical scale note middle "C" fundamental frequency is about 261 Hertz. Thus the ideal source is caused to generate notes that have a fundamental frequency ranging from 0 to 261 Hertz. In one embodiment, each note (mechanically generated acoustic sound) is sampled (at step **74**) using a digital sampling technique where the sampling rate is at least two times the fundamental frequency of the note to be sampled. In another embodiment the sampling rate is greater than two times the fundamental frequency to also sample harmonics of the generated note.

The digital samples representing the note produced by the ideal source are then stored at step **76**, in particular in the controller's memory **54** in the exemplary embodiment **40**. Steps **72**, **74** and **76** are repeated until all the notes to be generated have been sampled (step **78**). FIG. **6** is flowchart of an algorithm **80** for enhancing the perceived sound quality of device **10** by employing the samples generated and stored in algorithm **70**. In step **82**, an indication that device **10** is generating or in the process of generating one or more particular notes is received. In the enhanced device **100**, the note detection system **42** is key sensing system that determines when one or more keys of the piano's **10** keyboard **12** have been depressed or struck. Once a key is struck in a piano there is a delay (mechanical) before acoustic sound is propagated from the string to the soundboard and ultimately to a listener. An exemplary key sensing system is fully described in U.S. Pat. No. 5,001,339, which is assigned to the assignee of this invention and incorporated herein by reference. This key sensing system **42** employs opto-electronic sensors that generate a signal indicative of the displacement and the velocity of each struck or depressed key. These signals are provided the controller **44** via signal line **42**.

In the exemplary embodiment not all notes of the device **10** are enhanced, in particular (for the piano) only notes having a fundamental frequency from 0 to about 261 Hertz are enhanced. The algorithm **84** evaluates the struck key indications to whether one or more of its corresponding notes are within the frequency spectrum of notes to be enhanced, i.e., in the piano embodiment having a fundamental frequency between 0 and 261 Hertz. In the device **100**, the controller **44** scans the line **43** for struck key/notes signals and determines whether their corresponding fundamental frequency is within the frequency spectrum to be enhanced. When a note is within the enhancement frequency spectrum, the processor **52** retrieves the digital samples from the memory **54** representing the corresponding ideal source sampled note. Then the gain or energy of these samples are adjusted (step **88**) based on the user selected gain (user control panel **56**).

FIGS. **4**A to **4**D are examples of various embodiments of gain according the present invention. In the embodiments shown in FIGS. **4**A to **4**C, the gain across the notes to be enhanced is linearly reduced (on decibel dB scale). When a user increases or lowers the gain of the enhancement, the gain adjustment applies across the range of notes to be enhanced so the gain of all notes are reduced or increased based on the linearly decreasing amplification curve. FIG. **4**B, for example, illustrates a medium level gain selection for the amplification curve **64**. The lowest frequency samples (when generated) have about a 10 dB gain while frequency samples (having fundamental frequency) approaching 261 Hertz have very little gain. FIG. **4**A illustrates a high level gain selection for the amplification curve **62**. The lowest frequency samples (when generated) have about a 20 dB gain while frequency samples (having fundamental frequency) approaching 261 Hertz have very little gain. FIG. **4**C illustrates a low level gain selection for the amplification curve **66**. The lowest frequency samples (when generated) have about a 5 dB gain while frequency samples (having fundamental frequency) approaching 261 Hertz have very little gain. FIG. **4**D illustrates a variable amplification curve **68** where the enhancement extends to frequencies beyond 436 Hertz and is non-linear. Other amplification curves may be employed in the present invention. The gain modified samples are provided as an input to a synthesizer/DSP **58** (step **92**).

The synthesizer **58** converts the samples into an analog signal. It is further amplified and converted into acoustic sound via subwoofer/amplifier **46** and cable **45**. In one embodiment the synthesizer **58** is conventional, such as the synthesizer described in U.S. Pat. No. 4,953,437, which is assigned to the assignee of this invention and which is incorporated herein by reference. The subwoofer is a high quality electromechanical transducer, in particular a speaker that accurately reproduces lower frequency analog signals. A different frequency range speaker or a plurality of speakers having different optimal ranges may be employed depending on the frequency range of the enhancement notes to be generated. Generally, the subwoofer speaker **46** emits sounds from both the front and rear of a cone. In one embodiment the speaker acoustic beam emitted from the cone front is oriented towards to a listener and the acoustic beam emitted from the cone rear is oriented towards to the soundboard. It is noted that using the present invention effectively lengthens the strings of piano in which is employed. For example, when the piano's **10** four foot D string is vibrated, the samples corresponding to the vibrated seven-foot long D string of a concert grand piano is produced by the synthesizer **58** and emitted from the subwoofer **46**. The synthetically-produced sound of the seven-foot D string then melds with the mechanically, acoustically produced sound of the piano's **10** four-foot D string, thereby effectively lengthening the string in the acoustic piano.

While this invention has been described in terms of a best mode for achieving this invention's objectives, it will be appreciated by those skilled in the art that variations may be accomplished in view of these teachings without deviating from the spirit or scope of the present invention. For example, the present invention may be implemented using any combination of computer programming software, firmware or hardware. As a preparatory step to practicing the invention or constructing an apparatus according to the invention, the computer programming code (whether software or firmware) according to the invention will typically be stored in one or more machine readable storage mediums such as fixed (hard) drives, diskettes, optical disks, magnetic tape, semiconductor memories such as ROMs, PROMs, etc., thereby making an article of manufacture in accordance with the invention. The article of manufacture containing the computer programming code is used by either executing the code directly from the storage device, by copying the code from the storage device into another storage device such as a hard disk, RAM, etc. or by transmitting the code on a network for remote execution.

What is claimed is:

1. An enhancement system for a first mechanical acoustic sound generation device, the device capable of producing a first plurality of notes each note having a fundamental frequency and where a second, smaller plurality of the first plurality of the notes have a perceived sound quality lower than the perceived sound quality of corresponding notes produced by a second mechanical acoustic sound generation device, comprising:

a) means for determining when a note is generated by the first mechanical device;

b) means for determining whether the note is one of the second, smaller plurality of the first plurality of notes; and

c) means for generating an acoustic representation of a corresponding note digitally sampled from the second mechanical device when the determined note is one of the second, smaller plurality of the first plurality of notes.

2. The enhancement system of claim 1, wherein the first mechanical acoustic sound generation device is a mechanical acoustic musical instrument and the second mechanical acoustic sound generation device is a mechanical acoustic musical instrument.

3. The enhancement system of claim 1, wherein the first mechanical acoustic sound generation device is a mechanical acoustic piano and the second mechanical acoustic sound generation device is a mechanical acoustic piano.

4. The enhancement system of claim 3, wherein the second, smaller plurality of the first plurality of notes has a fundamental frequency range from about 0 Hertz to 261 Hertz.

5. The enhancement system of claim 4, wherein the means for generating an acoustic representation of a corresponding note digitally sampled from the second mechanical device varies the amplification of the acoustic representation of the corresponding note.

6. The enhancement system of claim 4, wherein the means for generating an acoustic representation of a corresponding note digitally sampled from the second mechanical device varies the amplification of the acoustic representation of the corresponding note linearly on a decibel scale with the greatest amplification at the lowest fundamental frequency range.

7. The enhancement system of claim 6, further comprising means for enabling a user to selectably alter the overall amplification level of the acoustic representations of the corresponding notes.

8. An enhancement system for a first mechanical acoustic piano, the first piano capable of producing a first plurality of notes each note having a fundamental frequency and where a second, smaller plurality of the first plurality of the notes have a perceived sound quality lower than the perceived sound quality of corresponding notes produced by a second mechanical acoustic piano, comprising:

a) key sensing mechanism coupled to the keyboard of the first piano;

b) a processor coupled to the key sensing mechanism, the processor determining when a key sensed by the key sensing mechanism as being depressed corresponds to a note that is one of the second, smaller plurality of the first plurality of notes;

c) a synthesizer coupled to the processor, the synthesizer generating an analog representation of a corresponding note digitally sampled from the second piano when processor indicates that sensed key corresponds to a note that is one of the second, smaller plurality of the first plurality of notes; and

d) a speaker coupled to the synthesizer to generate electromechanical acoustic representations of the synthesizer's analog signals.

9. The enhancement system of claim 8, further comprising a memory coupled to the synthesizer, the memory storing digital samples of notes produced by the second piano.

10. The enhancement system of claim 8, wherein the second piano is a concert grand piano.

11. The enhancement system of claim 10, wherein second, smaller plurality of the first plurality of notes has a fundamental frequency range from about 0 Hertz to 261 Hertz.

12. The enhancement system of claim 11, wherein the processor modifies the gain of the digital samples of the corresponding note of the second piano.

13. The enhancement system of claim 11, wherein the processor modifies the gain of the digital samples of the corresponding note of the second piano so the amplification of the acoustic representation of the corresponding notes varies linearly on a decibel scale with the greatest amplification at the lower fundamental frequency range.

14. The enhancement system of claim 11, further comprising a user selectable gain controller coupled to the processor and the processor modifies the gain of the digital samples of the corresponding note of the second piano so the amplification of the acoustic representation of the corresponding notes varies linearly on a decibel scale with the greatest amplification at the lower fundamental frequency range and based on the user selected gain.

15. A method for enhancing the perceived sound quality of a first mechanical acoustic sound generation device, the device capable of producing a first plurality of notes each note having a fundamental frequency and where a second, smaller plurality of the first plurality of the notes have a perceived sound quality lower than the perceived sound quality of corresponding notes produced by a second mechanical acoustic sound generation device, comprising the steps of:

a) determining when a note is generated by the first mechanical device;

b) determining whether the note is one of the second, smaller plurality of the first plurality of notes; and

c) generating an acoustic representation of a corresponding note digitally sampled from the second mechanical device when the determined note is one of the second, smaller plurality of the first plurality of notes.

16. The method of claim 15, wherein the first mechanical acoustic sound generation device is a mechanical acoustic musical instrument and the second mechanical acoustic sound generation device is a mechanical acoustic musical instrument.

17. The method of claim 15, wherein the first mechanical acoustic sound generation device is a mechanical acoustic piano and the second mechanical acoustic sound generation device is a mechanical acoustic piano.

18. The method of claim 17, wherein the second, smaller plurality of the first plurality of notes have a fundamental frequency range from about 0 Hertz to 261 Hertz.

19. The method of claim 18, wherein the step of generating an acoustic representation of a corresponding note digitally sampled from the second mechanical device varies the amplification of the acoustic representation of the corresponding note.

20. The method of claim 18, wherein the step of generating an acoustic representation of a corresponding note digitally sampled from the second mechanical device varies the amplification of the acoustic representation of the corresponding note linearly on a decibel scale with the greatest amplification at the lowest fundamental frequency range.

21. The method of claim 20, further comprising the step of receiving a user selected overall amplification level of the acoustic representations of the corresponding notes and applying the overall amplification to the variable amplification of the acoustic representations of the corresponding notes.

22. A method of enhancing the perceived sound quality of a first mechanical acoustic piano, the first piano capable of producing a first plurality of notes each note having a fundamental frequency and where a second, smaller plurality of the first plurality of the notes have a perceived sound quality lower than the perceived sound quality of corresponding notes produced by a second mechanical acoustic piano, comprising steps of:

a) determining when a key of the keyboard of the first piano is depressed;

b) determining when a depressed key corresponds to a note that is one of the second, smaller plurality of the first plurality of notes;

c) generating an analog representation of a corresponding note digitally sampled from the second piano when the sensed key corresponds to a note that is one of the second, smaller plurality of the first plurality of notes; and

d) generating an electromechanical acoustic representations of the analog representation.

23. The method of claim **22**, further the step of storing digital samples of notes produced by the second piano.

24. The method of claim **23**, wherein the second piano is a concert grand piano.

25. The method of claim **24**, wherein second, smaller plurality of the first plurality of notes has a fundamental frequency range from about 0 Hertz to 261 Hertz.

26. The method of claim **24**, further comprising the step of modifying the gain of the digital samples of the corresponding notes of the second piano.

27. The method of claim **23**, further comprising the step of modifying the gain of the digital samples of the corresponding note of the second piano so the amplification of the acoustic representation of the corresponding notes varies linearly on a decibel scale with the greatest amplification at the lower fundamental frequency range.

28. The method of claim **23**, further comprising the steps of receiving a user selected gain and modifying the gain of the digital samples of the corresponding notes of the second piano so the amplification of the acoustic representation of the corresponding notes varies linearly on a decibel scale with the greatest amplification at the lowest fundamental frequency range and based on the user selected gain.

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