Research Article

The Auxiliary Role of Artificial Intelligence in the Intelligent Creation and Conducting of Symphony

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Received 20 May 2022; Revised 12 June 2022; Accepted 23 June 2022; Published 14 July 2022

Academic Editor: Qiangyi Li

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In order to improve the effect of symphony intelligent creation and command, this paper combines artificial intelligence technology to study the symphony intelligent creation and command system. Moreover, this paper designs three common signal conditioning circuits, namely gain-adjustable circuit, universal high-order filter, and D/A converter, and implements them in a cross-coupled POTA-based FPAA array. In addition, this paper verifies the programmability and correctness of these three signal conditioning circuits through simulation analysis in cadence software. Finally, this paper builds a simulation system based on the requirements of symphony intelligent creation and conducting. Through the simulation evaluation, it can be seen that the symphony intelligent creation and command system based on artificial intelligence proposed in this paper has a good simulation effect in the symphony intelligent creation and command, and can play an important role in the symphony intelligent creation and command.

1. Introduction

Among the many musical forms, the symphony is the most complex. It involves many types of musical instruments, the works are the most complex, the sound produced is the most colorful, and the auditory and psychological effects on the audience and listeners are not comparable to other forms of music. The contribution of the symphony to society is different from the visible, tangible, and useable objects of natural science that can be represented by formulas, charts, and models. It affects people from the spiritual level. The music drifts in the air, but it resonates in people’s hearts. The emotions of happiness, anger, sadness, and music can be expressed and vented, and the soul can be purified.

Music memory is an impression and reflection of music or sound when people listen to and appreciate music, which is mainly expressed in the way of memory and cognition. Establishing a good musical memory can improve students’ musical practice ability, quick reaction ability and independent musical thinking ability. In this way, students can independently analyze all the music they come into contact with, whether classical, modern, popular, or ethnic and original [1]. Moreover, only in this way can students understand music, and have a real aesthetic experience. People’s response to music mainly consists of timbre, beat, rhythm, mode, tonality, strength, speed, etc. [2]. In the actual teaching process of symphony appreciation, most students have no experience in classical music appreciation and appreciate symphony for a long time. Therefore, how to make students perceive more and memorize more symphony or symphonic elements within the limited number of class hours becomes very important [3]. Professional appreciators may listen to a work a dozen times or even dozens of times in order to understand and memorize music more deeply. As for the actual situation such as the courses of symphony appreciation offered in colleges and universities, the school hours are limited, so the music can only be listened to. Then, for unfounded students, how to quickly establish musical memory in extensive listening is particularly important [4]. In music appreciation, only by making full use of the existing music memory can we get a better aesthetic experience from music appreciation. Therefore, the cultivation of the ability to quickly establish music memory in the teaching of symphony appreciation has become the
primary task of the curriculum [5]. Music can be said to be the most abundant language, and it can also express different emotions, and these languages and emotions are carried by elements such as different timbre, rhythm, rhythm, tonality, strength, and speed. Then, the establishment of preliminary musical memory actually starts with the identification and analysis of these elements. Only with a certain grasp of these elements can we mobilize the content in the music memory to analyze, compare, and combine when listening to music, so as to understand the music and generate the image of the music. The more the memory of music, the richer the understanding of music may be [6].

Pay attention to the high integration of playing skills and emotions. To correctly grasp and use emotion in a symphony performance, we must pay attention to the high integration of emotion and performance skills. Emotion is the way to show the artistic connotation of the work [7]. Symphony performance should not only show the notes in the score but also reflect the inner meaning of the instrumental work [8]. Symphony performers can reflect the inner spiritual connotation contained in symphony works by means of a reasonable understanding of the works and the integration of skills and emotions, so as to realize the composer’s creative intention [9].

Symphony has its own unique aesthetic characteristics, which are mainly reflected in the nonconcrete, temporal, dynamic, sensual, and emotional aspects of its content and emotional expression. This requires the performer to cultivate the aesthetic emotion of the symphony and to appreciate and appreciate the beauty of the content and form of the symphony through imagination and association [10]. Specifically, performers can cultivate their aesthetic feelings for a symphony by regularly enjoying symphonies, concertos, symphonic suites, overtures, and symphonic poems. Appreciating these works helps performers to accurately grasp the emotional input of the works [11]. The correct use of emotional factors in symphony performance can help performers to accurately grasp the rhythm, rhythm and playing speed, accurately grasp the intonation and pronunciation in the performance, and improve the expressiveness of symphony performance skills. Players (trombone) should improve their comprehensive quality in daily life, cultivate their aesthetic feelings for symphony, and pay attention to the high integration of performance skills and emotions [12].

A symphony is a large-scale orchestral piece containing multiple movements, with profound connotations. It evolved from the Italian opera overture, and the name “symphony” comes from Greek, which means “to ring together.” The symphony contains the classical essence of European romanticism, with free forms of expression, rich emotions, and diverse expressions [13]. Symphony describes people’s lives and thoughts and feelings, one of which is called “sound and picture.” “Sound and Picture” mainly describes the life and scenery in the natural world, and the content is simple and easy to understand. When appreciating these musical works, you can feel the beauty of nature and life, give full play to your imagination, and feel the endless life of creatures. This has a positive effect on developing imagination and creative thinking. Symphony appreciation is to feel the emotion through the appreciation of the symphony. Quality education in colleges and universities has been placed in an important position. Strengthening quality education is an inevitable requirement to adapt to scientific development, and it is also a key factor in transforming educational ideas and concepts and cultivating innovative talents [14].

From the perspective of symphony appreciation, subjective means that the appreciator evaluates the expressive power and performance form of the symphony completely according to their own aesthetic pursuit, music perception, music cultural literacy, and music theory knowledge; objective means the appreciator’s thought., psychological tendencies, etc. are completely controlled by music, and they limit their own thoughts according to a fixed appreciation paradigm [15]. In fact, symphony appreciation is an activity that integrates subjective and objective. Only by grasping the balance between subjective consciousness and objective conditions, integrating one’s own emotions with those of music, and following the principle of unifying subjective and objective In order to better appreciate the symphony [16].

Sensibility is the most direct channel for individuals to perceive objective things. Rationality is a stable and systematic psychological paradigm and behavioral tendency formed by processing, combining, summarizing, and refining reasoning after accumulating certain perceptual materials. In symphony appreciation, sensibility is based on intuition to make aesthetic judgments on symphony; rationality is to obtain aesthetic pleasure and produce aesthetic perception through rational thinking and reflection on the basis of grasping the aesthetic value in the impression structure. The inspiration, drive, and inspiration brought to the appreciator will not dissipate in a short period of time, and will gradually be transformed into guidance for the appreciator’s thoughts and behaviors [17]. Therefore, in appreciating symphony, we should follow the basic principle of sensibility and rationality. On the other hand, we should avoid blindly pursuing short-term visual and auditory enjoyment, strive to build a complete and systematic aesthetic structure through the interweaving and integration of sensibility and rationality, complement each other in appreciation, and think about it in appreciation, to understand not only to feel the symphony’s magnificent sound effects and rich musical expression but also to deeply explore the symphony’s aesthetic value implication, cultural connotation, national charm and charm, so as to appreciate the symphony from multiple dimensions and multiple levels [18].

This paper combines artificial intelligence technology to study the intelligent creation and command system of symphony, improve the public influence of symphony, and improve the communication effect of symphony.

2. Intelligent Auxiliary Analysis

Algorithm for Symphony

2.1. Research on Programmable Analog Array Based on POTA

The programmable analog array based on cross-coupling POTA is mainly composed of programmable analog core units CAB connected through interconnection network.
This chapter first analyzes the principle of programmable analog array, then analyzes the POTA-based capacitance multiplier circuit and programmable interconnection network, and finally builds a CAB circuit, and uses CAB and hexagonal interconnection network to design a programmable analog array FPAA.

The programmable analog array (FPAA) is a programmable analog device similar to a programmable digital array (FPGA). It can control the port through digital programming according to the needs of analog circuits in practical applications, thereby changing the connection and component parameters of its internal unit circuits. Its biggest advantage is programmability, which can achieve the required functions like building blocks.

The general principle model of FPAA is shown in Figure 1.

In FPAA, the programmable capacitor matrix generally uses a 4 bits capacitor matrix, which requires 15 identical unit capacitors, as shown in Figure 1. In the integration process, the capacitance is generally realized by the interstage capacitance of MOS. The unit capacitance must be larger than the parasitic capacitance generated by the substrate and the wiring. The parasitic resistance and parasitic capacitance generated by its connection and the parasitic capacitance of the CMOS transmission switch itself have a great influence on the programmable capacitance matrix. Based on this problem, this paper proposes a capacitance multiplier circuit. Figure 2 shows the programmable capacitance matrix.

In this paper, the capacitance multiplication circuit realized by Miller’s theory is used to replace the programmable capacitance matrix. The principle of the capacitance multiplication circuit is shown in Figure 2. The left side is the simplified capacitance multiplier circuit, and the right side is the equivalent circuit. The voltage amplitude at both ends of the capacitor is \( V_C \), the current flowing on the capacitor is \( i_C \), and the current source whose output current is \( k \) is connected in parallel with the capacitor, then there is

\[
(k + 1)i_c = C_{eq} \frac{dV_C}{dt}
\]  

(1)

The relationship between current \( i_c \) and capacitance can be expressed as
Then, there is
\[(k + 1)i_c = C_{eq} \frac{dv_c}{dt} \]  
\[= (k + 1)C_c \frac{dv_c}{dt}. \]

Thereby, the equivalent capacitance can be expressed as
\[C_{eq} = (k + 1)C_c. \]  

Among them, the current gain \(k\) can be controlled by digital programming.

The schematic diagram of the designed programmable capacitance multiplier circuit based on cross-coupling POTA is shown in Figure 3. The capacitance multiplier circuit is composed of 3 cross-coupled POTAs and a grounding capacitor, which requires no other passive components and is easy to integrate. Among them, POTA1 and POTA3 are single-terminal outputs, while POTA2 are three-terminal outputs.

It can be seen from Figure 3 that
\[I_{o1} = g_{m1}V_{in}, \]  
\[I_{o1} = I_{o3} = g_{m3}V_B, \]  
\[I_{o2} = I_{in} = g_{m2}V_A, \]  
\[V_B = I_{o2} \frac{1}{sC}. \]

Among them, \(g_{m1}, g_{m2}, \) and \(g_{m3}\) are the transconductances of POTA1, POTA2, and POTA3, respectively.

Combining formulas (5)–(8), the equivalent impedance of the capacitance multiplier circuit can be obtained as
\[Z_{in} = \frac{V_{in}}{I_{in}} = \frac{g_{m3}}{s g_{m3} C}. \]  

It can be seen from 9 that the circuit can be equivalent to a capacitance multiplier circuit, and the capacitance of its equivalent capacitance is
\[C_{eq} = \frac{g_{m1} C}{g_{m3}} = K_m C. \]  

Among them, \(K_m\) is the capacitance gain. Substitute (9) into (10), we can see
\[K_m = \frac{g_{m1}}{g_{m3}} = \frac{V_{b1}}{V_{b3}}. \]

It can be known from expression (11) that the gain of the capacitance multiplier circuit can be adjusted linearly only by changing the control voltage \(V_b\) of the cross-coupled POTA, and it is easy to control and implement.

The above structure and working principle of the capacitance multiplier circuit are analyzed under ideal conditions. Under nonideal high-frequency conditions, due to the influence of device nonideal factors, especially the existence of parasitic capacitance, the performance of the circuit will be adversely affected. Figure 4 is a simplified cross-coupled POTA small-signal equivalent model under nonideal conditions. In the figure, \(C_0\) and \(C_i\) are the total parasitic capacitance of the POTA output and input, respectively, and \(G_m\) is the total conductance of the output. Combined with the POTA small-signal equivalent circuit to reanalyze the capacitance multiplier circuit in Figure 3, the equivalent input impedance \(Z_{in}\) of the circuit can be re-expressed as
\[Z_{in} \approx \frac{s^2 C_A C_B + g_{m2} g_{m3} s C_B g_{m1}}{s C_B g_{m2} g_{m3}} \approx \frac{s C_A + g_{m3}}{s C_B g_{m1}}. \]

Among them, \(C_A = C_{o1} + C_{i2} + C_{o3}, C_B = C_{i3} + C_{o2} + C. \)

It can be seen from the expression (12) that the input impedance of the capacitance multiplier circuit can be equivalent to a series connection of an inductance \(L\) and a capacitance \(C\) in a nonideal case. When the frequency \(\omega\) of the circuit is low, the transconductance value of POTA is much larger than the accommodation of the parasitic capacitance \(C_A\), so there is \(s C_A / (g_{m1} g_{m2}) \ll g_{m3} / (s C_B g_{m1})\), and the circuit exhibits capacitive characteristics at this time. When \(\omega\) continues to increase, the accommodation of the parasitic capacitance \(C_A\) also continues to increase, and the impact on the performance of the circuit also continues to increase. When \(s C_A / (g_{m1} g_{m2}) \ll g_{m3} / (s C_B g_{m1})\), the circuit exhibits inductive characteristics. When the frequency is \(\omega \ll \sqrt{g_{m2} g_{m3} / (C_A C_B)}\), the circuit is capacitive, and when the frequency is \(\omega \ll \sqrt{g_{m2} g_{m3} / (C_A C_B)}\), the circuit is inductive.

In a programmable circuit, generally speaking, the state information of a programmable switch needs 1 bit of space to store, and the more switches there are, the longer the configuration bits are required. Therefore, a special memory can be used to store these configuration data, such as SRAM. For the \(m \times n\)-scale FPAA array \((m \geq 1, n \geq 1)\), in Figure 5, if
the $m \times n$ CABs are arranged in order, a total of $22m \times n$ bits of storage space (a single CAB requires 22 bits of configuration bits). Since the circuit connection adopts switch sharing technology (that is, adjacent CABs share a programmable switch), the number of programmable switches is reduced. Looking at the array from top to bottom, $m$ adjacent CABs in each column share $(m-1)$ programmable switches, and the scale of $n$ columns requires $(m-1) \times n$ programmable switches. Looking at the array from left to right, the $m$ CABs in each column share $(2m-1)$ programmable switches with the CABs in the adjacent column on the right, and the scale of $n$ columns shares $(2m-1) \times (n-1)$ programmable switches. Therefore, for a size of $m \times n$, the total length $L$ of configuration bits required for the array is

$$L = 22mn - (2m - 1) \times (n-1) - (m-1) \times n.$$  

### 2.2. Application of FPAA in Signal Conditioning

The programmable gain-adjustable circuit is shown in Figure 6. It consists of two programmable cross-coupling POTA, in which the second POTA realizes the function of a resistor, and converts the current signal $I_{O1}$ output by the previous stage POTA into a voltage signal $V_O$, thereby realizing voltage amplification. When the parameters of the two linearly adjustable POTA are completely matched, its input-output relationship is

$$V_O = I_{O1}R = \frac{g_{m_1}}{g_{m_2}}(V_{in^+} - V_{in^-}).$$  

Then, the voltage gain of the circuit is

$$A = \frac{V_0}{V_{in^+} - V_{in^-}} = \frac{g_{m_1}}{g_{m_2}} = \frac{V_{b1}}{V_{b2}}.$$  

It can be known from expression (15) that the gain can be adjusted by changing the ratio of the floating DC voltage $V_{b1}$ to $V_{b2}$. The specific implementation method can be configured by data through the memory, and the magnitude of $V_b$ can be digitally controlled to realize the change of the voltage, so as to realize the adjustable gain of the amplifier.

On the basis of adjustable cross-coupling POTA, a high-order universal current-mode filter is implemented in this paper by means of single input and single output. According to Figure 7 and mathematical derivation, the transfer function is

$$I_{out} = \frac{b_n s^n + b_{n-1} s^{n-1} + b_{n-2} s^{n-2} + \ldots + b_2 s^2 + b_1 s + a_0}{I_{in}} a_0 s^0 + a_{n-1} s^{n-1} + a_{n-2} s^{n-2} + \ldots + a_2 s^2 + a_1 s + a_0.$$  

Among them, $I_{in}$ is the input current and $I_{out}$ is the output current.

By introducing $n+1$ internal variables, we get:

$$I_{out} = \frac{b_n s^n I_{in} + b_{n-1} s^{n-1} I_{in} + b_{n-2} s^{n-2} I_{in} + \ldots + b_2 s^2 I_{in} + b_1 s I_{in} + a_0 I_{in}}{a_0 s^0 + a_{n-1} s^{n-1} + a_{n-2} s^{n-2} + \ldots + a_2 s^2 + a_1 s + a_0} = I_{out(0)} + I_{out(1)} + I_{out(2)} + \ldots + I_{out(n-1)} + I_{out(n)}.$$  

\[17\]
general filter as an example for design analysis to illustrate. Combining several CABs. Now, we take the second-order FPAA, the higher-order general filtering can be achieved by taking different combinations of the output current signals. By taking different values of \( n \), filters of different orders can be realized. In FPAA, the higher-order general filtering can be achieved by combining several CABs. Now, we take the second-order general filter as an example for design analysis to illustrate.

A second-order universal filter based on cross-coupled POTA is shown in Figure 8. It consists of 5 POTAs and two capacitance multiplier circuit units. According to the above analysis of the high-order general filter, it can be known that the transfer function of the second-order filter is

\[
I_{out} = \frac{b_2s^2I_{in} + b_1sI_{in} + a_0I_{in}}{a_2s^2 + a_1s + a_0} = I_{out(0)} + I_{out(1)} + I_{out(2)}.
\]

(19)

It can be known from expression (19) that when the output is \( I_{out(0)} \), the filter realizes the function of low-pass filtering, and when the output is \( I_{out(2)} \), the filter realizes the function of high-pass filtering. When the output is \( I_{out(1)} \), the filter realizes the function of band-pass filtering, and when the output is \( I_{out(0)} + I_{out(2)} \), the filter realizes the function of band-stop filtering. After calculation and analysis, it can be known that the pole frequency of the filter can be expressed as

\[
\omega = \sqrt{\frac{g_{m1}g_{m2}}{C_{EQ1}C_{EQ2}}}. \tag{20}
\]

The circuit consists of 5 cross-coupled POTAs and 4 CMOS transistors. Here, CMOS transistors are used as switches. The output of POTA0 is all fed back to the input, forming an equivalent resistance, its equivalent resistance is \( 1/g_{m0} \), and the input is a 4-bit digital signal (b1, b2, b3, b4) represents the state of the corresponding position programmable switch, and the corresponding switch state is opposite to it), the reference voltage is \( V_{ref} \), and \( V_O \) is the output voltage signal. According to the port characteristics of the OTA, the output voltage of the D/A converter can be expressed as

\[
V_0 = (b_1g_{m1} + b_2g_{m2} + b_3g_{m3} + b_4g_{m4})V_{ref}\left(\frac{1}{g_{m0}}\right). \tag{21}
\]
Figure 8: Schematic diagram of high-order general-purpose filter.
If the transconductance value of the cross-coupled POTA satisfies $g_{m1} = 2g_{m2} = 4g_{m3} = 8g_{m4} = g_{m}$, the output voltage can be written as

$$V_0 = V_{ref} \left( \frac{1}{g_{m}} \right) \left( \frac{b_1}{1} + \frac{b_2}{2} + \frac{b_3}{4} + \frac{b_4}{8} \right). \tag{22}$$

It can be seen from expression (22) that a 4-bit cross-coupled POTA-based D/A converter can be realized as long as the DC voltage of the POTA is adjusted to $V_{b1} = 2V_{b2} = 4V_{b3} = 8V_{b4}$ and an appropriate programmable switch state is selected.

In Expression (22), $b_4$ is the least significant bit (LSB) and $b_1$ is the most significant bit (MSB). The output voltage of digital input (0001) with the least significant bit LSB is $V_{0LSB} = (V_{ref} g_{m}/g_{m0})/8$, and the output voltage of digital input (1000) with the most significant bit MSB is $V_{0MSB} = 8V_{0LSB}$. When the digital bit inputs are all “1” (1111), the output maximum voltage is $V_{0max} = 15V_{0LSB}$.

### 3. The Symphony Intelligent Creation and Command System Based on Artificial Intelligence

The interactive system consists of three parts: (1) mobile phone application; (2) server application; (3) visual client. The three parts run on three different devices. Mobile applications can run on any mobile device such as a mobile phone or laptop that can run a modern web browser that supports HTML5 (Figure 9). The application can be run by multiple mobile devices simultaneously. The server application runs on a network server workstation. Since the server software Node.js is a cross-platform software, this web server workstation can be used on any operating system such as Windows, macOS, or Linux. These devices can communicate over wired or wireless networks. Moreover, all these configurations make the OpenSymphony interactive system have very good cross-platform capabilities.

During a live performance, the visualization client can change the content of the performance by setting some parameters. Among them, there are a number of players and music modes to choose from. These parameters will be uploaded to the server for extraction by the mobile application. The number of players determines how many groups the audience will be divided into. Providing a choice of music modes is a requirement, and having different combinations of music modes can develop different music styles and user interactions.

Figure 10 depicts the communication method between the visualization client and the server. Every time the visualization client starts, an “initializer” routine is called to initialize everything. It includes starting the initialization program on the server to clear the cache to prepare for a new performance, calling the “player counter” to notify the server of the number of players, and calling the “optional music mode modifier” to set the available music modes. Then, the visualization client will call the “Data Extractor” once per second to obtain all audience data from the server to the “Visualizer” for data visualization. The visual client can set the available music modes at any time through the “optional music mode modifier” to produce various performance effects.

The D/A converter is implemented in the FPAA array built on the cadence software, and the simulation analysis is carried out. The circuit is designed and simulated using TSMC0.18um CMOS process. During simulation, the bias current is $I_b = 50\mu A$, the power supply voltage is $VDD = 3.3V$, and the reference voltage is $Vref = 0.5V$. The resistance $11g_{m0}$ of OTA0 is set as a fixed value $c$, and the DC voltage $V_{g}$ is adjusted to make $V_{bi} = 2V_{b2} = 4V_{b3} = 8V_{b4}$ and then the response curve of the 4 bit D/A converter is obtained by controlling the programmable switch state as shown in Figure 11.

Through simulation research, it is verified that the artificial intelligence assistance method proposed in this paper can play a certain role in the creation and intelligent simulation of symphony. On this basis, the effect of artificial intelligence in the symphony intelligent creation and command system is evaluated, and the results shown in Table 1 are obtained.

![Interactive system components](image.png)
Figure 10: Functional modules of the symphony smart creation system.

Figure 11: Simulation curve of D/A converter.

Table 1: The effect evaluation of the symphony intelligent creation and command system based on artificial intelligence.

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based on artificial intelligence proposed in this paper has a good simulation effect and can play an important role in the symphony intelligent creation and command.

4. Conclusion

The symphony has a rich and varied structure, including Symphonic Rhapsody, Symphonic Capriccio, and so on in addition to the four-movement structure. In addition, symphonies of different structural types are also very flexible in terms of structural composition, which can create a richer layered sound effect, can be magnificent and magnificent, and can be subtle and introverted. Grasping the structure and content of a symphony is one of the basic methods of symphony appreciation. When analyzing the structure of a work, the appreciator needs to have certain knowledge of music theory and music perception. This paper combines artificial intelligence technology to study the intelligent creation and command system of the symphony, so as to improve the public influence of the symphony and improve the communication effect of the symphony. Through the simulation evaluation, it can be seen that the symphony intelligent creation and command system based on artificial intelligence proposed in this paper has a good simulation effect, and can play an important role in the symphony intelligent creation and command.

Data Availability

The labeled dataset used to support the findings of this study is available from the corresponding author upon request.

Conflicts of Interest

The author declares no competing interests.

References