The Effect of Multimedia Teaching Model of Music Course in Colleges and Universities Based on Classroom Audio Data Mining Technology

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Objectives: With the rapid development of information technology, multimedia teaching mode carries a large amount of audio-visual information, quickly occupies the music classroom in Colleges and universities, and becomes the mainstream teaching mode of music teaching in Colleges and universities.Methods: Based on this, this study uses classroom audio data mining technology to analyze the effect of multimedia teaching mode of music courses in Colleges and universities. The method of audio data mining is analyzed in college music multimedia classroom. The advanced embedded SOPC system is used to decode the MP3 audio files played in music courses by combining software and hardware. The performance of the multimedia teaching system in college music courses is optimized.Results:The hardware resources are made use of the flexibility of SOPC (System-on-a-Programmable-Chip) system. Reasonable allocation achieves the optimal design of teaching mode. Finally, the superiority of the algorithm is verified by testing. The test results show that the decoding speed and efficiency of audio files can be significantly improved by combining hardware and software. Conclusion: At the same time, the system has greater flexibility and expandable space, which can effectively promote the multimedia teaching effect of music courses in Colleges and universities. The research in this paper is helpful to the flexible transformation of multimedia teaching mode of music courses in Colleges and universities, and provides an important reference for the popularization of multimedia and the wide use of data mining technology in music courses in Colleges and universities.

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With the rapid development of computer technology and the globalization of economy, multimedia technology has penetrated into all areas of human life and become the most important high-tech means in today's world [1]. In today's education field, multimedia technology is becoming an indispensable auxiliary tool in modern teaching with its brand-new appearance and unique advantages[2]. However, many music educators have adapted to the traditional music teaching mode, which makes the teachers not good at using or unable to use multimedia technology properly in music teaching nowadays [3]. Today, many music teachers in Colleges and universities continue the "four one" model, that is, "a mouth, a book, a piano, a pen". This traditional teaching mode not only restricts the application and promotion of multimedia technology in music teaching in Colleges and Universities[4]. With the rapid development of information technology, multimedia teaching as an auxiliary means of traditional teaching, multimedia technology has its irreplaceable advantages. However, if we only blindly pursue its form and ignore its substantive characteristics, the teaching effect will inevitably be counterproductive [5]. Based on this, this paper discusses the multimedia teaching mode of music course in Colleges and Universities based on the technology of audio data mining in classroom, and analyses its effect.

SOPC can be programmed on-chip system. Using programmable logic technology, the whole system is placed on a silicon chip, called SOPC. Programmable on-chip system (SOPC) is a special embedded system: first, it is SOC, that is, the main logic function of the whole system is accomplished by a single chip; secondly, it is a programmable system with flexible design methods, which can be tailored, expanded and upgraded, and has the functions of software and hardware programmable in the system. In this paper, the SOPC system is used to study and analyze the audio data mining method of music multimedia classroom in Colleges and universities. The advanced embedded SOPC system is used to decode the multimedia audio files played in music courses through the combination of software and hardware. It provides a new idea and method for the multimedia teaching mode of music courses in Colleges and universities.

The innovation of this research lies in the design of SOPC system processing mechanism. Starting from a given collaborative system task, combining the characteristics of multimedia teaching of music courses in Colleges and universities, based on the technology of audio data mining in class, the task and resources needed are effectively analyzed. Through a series of transformation methods, special standards are complied with at the same time, and simulation and system functions are carried out. At the same time, collaborative simulation and system testing are carried out. The optimization of this system promotes the improvement of multimedia teaching effect of music courses.

In this study, the effect of multimedia teaching mode of music course in Colleges and universities is analyzed by using the technology of audio data mining in classroom. The method of audio data mining in music course in Colleges and universities is put forward. The performance of multimedia system is optimized and analyzed. The Huffman coding module is designed. Then the system simulation experiment is carried out, and the operating efficiency of the learning system with the multimedia teaching of music course combining software and hardware is tested.

Chen et al. pointed out that compared with traditional music teaching mode, multimedia music teaching mode has some problems, but its advantages are also very obvious, which helps to improve students' subjective initiative and promote their active learning[6]. Hartnett J. L. pointed out that multimedia teaching can not only make use of computer system for professional music teaching, but also have many advantages in enriching music teaching content, enhancing students'interest and lightening the burden of teachers' work. It can also make use of teaching software to teach various professional theory courses[7]. Armenteros M. et al. pointed out that in the compulsory course of music theory, there are four basic courses, namely harmony, polyphony, musical form and orchestra. The traditional teaching methods of these courses have remained unchanged for decades. Teachers talk about students'listening, chalk and blackboard are the main teaching methods, and students' homework without sound is not conducive to the cultivation of students'music literacy [8]. Zhang X et al. applied genetic algorithm to music teaching and arranged multimedia materials of music teaching through the algorithm, which achieved good results and improved the vitality of music classroom [9]. Xu J et al. took harmony teaching as an example, introduced multimedia technology into music teaching. Through harmony teaching videos, students were indoctrinated with knowledge points, which improved the interaction between teachers and students, and achieved good results [10]. Alberts C M et al. pointed out that when music examples are involved in the course, teachers can only mark each part, instrument group, strength and speed on the blackboard with chalk. It is difficult for students to feel the changes of these elements in the music examples, while the rich display of multimedia can help students feel the detailed structure of the music in the dynamic music examples [11]. Pain et al. pointed out that in multimedia music teaching, teachers do a good job of courseware before class. Through professional software such as audio, video and so on, they break up and display the music examples in class according to the teaching requirements, and explain the difficult parts of the music examples to students in detail. Then, the music designed in the courseware can be played from any small beat by clicking manually, or can stop in any beat. A dynamic teaching method is more effective than a static one [12]. Harji M. B. pointed out that piano is the main teaching tool for teachers in the traditional Solfeggio and ear training course, and the addition of multimedia teaching tools helps to make static music teaching dynamic and activate the classroom [13]. Ollino M pointed out that there are many difficulties in the teaching process, such as single tone, repeated playing, learning effect cannot be taken into account. If multimedia teaching equipment is used in the course, teachers can make relevant course contents well in advance. Through multimedia equipment, the design of solfeggio music and ear training content can enable teachers to provide close-range guidance in the course of solfeggio training. And help students [14]. Jacquemart A. L. pointed out that multimedia equipment can produce synthetic teaching content, accurate pitch rhythm, sentence by sentence according to teachers'design and students' learning level, while the timbre, speed and tone can change with the content. This function of automatic play can relieve teachers'hard work of accompanying model singing, save time and effort, and cultivate students' good auditory basis for participating in various types of performances[15].

In a word, compared with traditional teaching methods, as long as teachers use multimedia equipment reasonably, they can effectively enhance students'interest, promote students' active learning and improve students'subjective initiative. In a word, multimedia teaching methods will surely achieve higher efficiency in the teaching of Solfeggio and ear training[16]. On this basis, this paper further applies the data mining method in order to play a certain role in promoting multimedia teaching in music classroom[17].

METHODS

Audio Data Mining Method

Multimedia music decoding operation of MAD code can be completed on PC host. The host can decode the audio file by running the decoding library of the audio file, and generate the audio file format developed by Microsoft[18]. Data in Pulse Coded Modulation (PCM) format is included in the data block of WAVE file. WAVE files are organized by samples. Single channel waveform file, representing the left channel is 0, the right channel is 1. In multichannel WAVE files, samples appear alternately. Each sample WAVE file contains an integer symbol. The length of the integer is appropriate to the minimum specified byte length of the required number of samples. Byte storage with lower effective bits takes precedence, which means that the higher the sample's amplitude bits, the higher the effective bits, and the other bits are 0. This is the waveform sampling data format[19]. The format of the file generated after decoding is PCM pulse, which is a lossless audio format. In order to decode MP3 audio files with MAD (MPEG Audio Decoder) decoding library on a custom SOPC system, it is necessary to adjust the code to ensure the normal operation of the system. Firstly, based on the host file system, the standard C library function is suitable for reading and writing PC files in Debug mode[20]. In Microsoft Visual C++ 6.0 environment, TraceMAD code needs to force player.c-) play_one() to open MP3 files in the path of "/ mnt/host/test.mp3", and then need to build a new engineering system in the software development environment NiosIIIDE to import the modified code.

At the same time, the attributes of the system library need to be modified. Click Software Components to add the host-based file system 5.3 interface as shown in the figure. Select Altera Host Based File System and select Addthiss of tware component. Compiling MAD Project in Nios II IDE, eliminating compilation errors and Debug As Nios II Hardware, can decompress MP3 files from PC to WAV files on PC on Nios II processor and verify the correctness of decoding. After decoding MP3 audio files through a custom SOPC hardware system, in order to verify the correctness of decoding, it is necessary to input the PCM stream generated after decoding into the playback system. This part of the task is implemented in the audio_wave.c file. The IOWR statement is used to complete the input data of the audio playback module. The "data []" string stores the data after decoding. Because the Audio FIFO port data is defined as l6bit, it is spliced into l6bit data by bit or operation. Because this test reads MP3 audio files stored on PC host through JTAGUART, the sound played is incoherent due to the limitation of reading speed. In order to improve the reading speed, it is necessary to call SD card reading module to read audio data files through SD card to improve the speed of data transmission.

Multimedia System Performance optimization

Because of the large amount of computation in multimedia music decoding, it needs memory that can read programs quickly. The main program currently set up is SRAM (Static Random-Access Memory) memory, which can read data relatively slowly. So it is necessary to execute the program through Onchip Memory memory in order to improve the running speed, so that MP3 files can be played uninterruptedly and continuously. However, the storage resources provided on the experimental board can not meet the needs of the whole program. At this time, the flexibility of SOPC system can be brought into full play. In NiosIDE environment, some programs can run in Onchip Memory memory through custom settings to improve the speed of data reading. For the use of Onchip Memory memory, there are several choices: program memory, read-only memory, read-write data memory, stack memory and stack memory. Tests show that the decoding program can not run correctly in all cases, but the use of Onchip Memory memory makes the program read faster and plays a role in the continuous playback of audio files. The test statistics are shown in Table 1.

Table 1
Operation of Some Programs on Onchip Memory

Program memory	√								
Read only memory		√							
Read/Write data memory			√	√	√	√			
Heap memory				√	√		√	√	
Stack memory					√	√		√	√
Operation condition	Cannot run	Cannot run	normal	normal	Cannot run	nor mal	nor mal	Can not run	nor mal

Multimedia audio decoding is composed of many steps and processes. Improving the efficiency of any part of the decoding process will improve the efficiency of the whole decoding process. The data of multimedia audio files need to be moved from SD card to SRAM and then from SRAM to MAD decoding database, which consumes a lot of system resources in the process of data transmission and reduces the efficiency of operation. Compared with the delay caused by data entering MAD decoding library from SRAM, the delay caused by reading data from SD card to SRAM is not large. Because the SD Card Buffer corresponds to the Buffer in the file "play.c", it occupies very little storage space, and the SD card uses SPI transmission protocol to transmit data, which has a faster transmission speed. The delay of the system mainly comes from the process of data entering MAD decoding library from SRAM. In this paper, experimental methods are used to determine the effects of various allocation schemes. The results are shown in Table 2.

Table 2
Operations of Different Caches

Instruction Cache	Data ache	Data Cache	Audio fifo(M4k)	Total Memory Bit	Compilation results	Effectiveness (44K, 320kbps)
16kbytes	16k bytes	32bytes	32	88%	error	Speed increased by 35%, with discontinuity
16kbytes	8k bytes	32bytes	32	74%	adopt	Speed increased by 23%, stable broadcasting Speed increased by 17%, stable broadcasting
8kbytes	16k bytes	32bytes	32	74%	adopt	
8kbytes	16k bytes	4bytes	32	82%	adopt	Speed increased by 12%. There was a pause Effectiveness (44K, 320kbps)
16kbytes	8k bytes	4bytes	32	79%	adopt	
8kbytes	4k bytes	4bytes	64	82%	adopt	Speed increased by 35%, with discontinuity
8kbytes	8k bytes	4bytes	64	92%	adopt	Speed increased by 23%, stable broadcasting
8kbytes	8k bytes	32bytes	64	87%	Error x	Speed increased by 17%, stable broadcasting
8kbytes	4k bytes	32bytes	64	79%	adopt	Speed increased by 12%. There was a pause

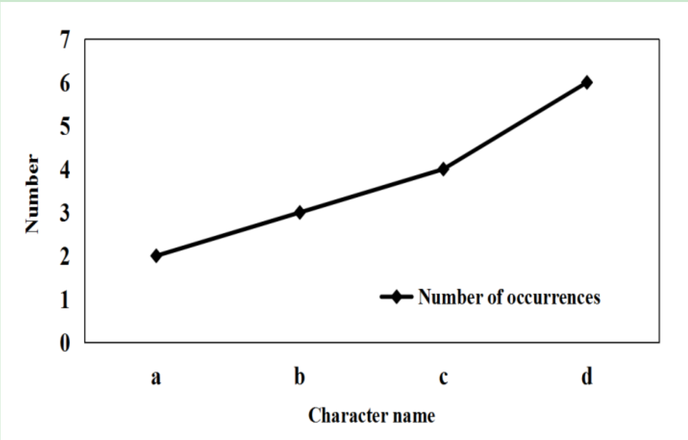
Because on-chip memory utilization can not reach 100%, nor too high, if too high, Quartus compiler fitter this step will be too dense to wiring and error. The test results show that adjusting the allocation of cache resources can improve the decoding efficiency to varying degrees and achieve a certain effect. Through the combination of hardware and software, the system is optimized.

Huffman Coding Module Design

Huffman encoding formats can be compressed and coded for different types of data formats to reduce the space resources occupied by data. The first information that this decoding method needs to obtain is the frequency of various symbols. Minimum redundancy coding is the basis of Huffman coding. Statistical completion of the frequency of different symbols, for the most frequent symbols, its coding length is the longest. For the symbol with the smallest frequency, the coding length is the shortest. This coding method can occupy the least space resources. The Huffman decoding process consists of the following steps: First, to calculate the frequency of each different character in the data, it is necessary to scan the data as a whole.

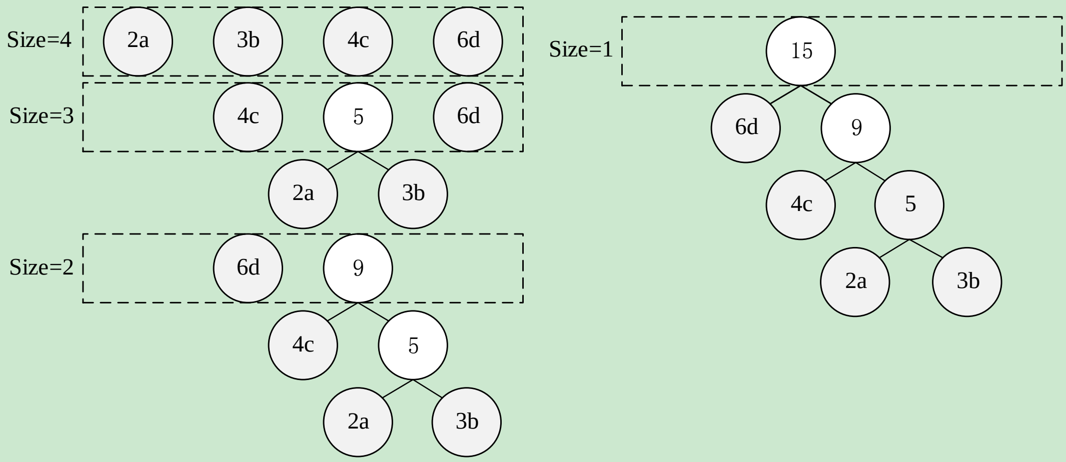
After scanning the input data, a statistical table is generated, which records the frequency of each different character. This statistical table is called a frequency table. This frequency table is also an integral part of the file header, which needs to create a different character array record and count the frequency of its occurrence to reduce its proportion. Huffman tree is a binary tree. The way to build Huffman tree is to use greedy strategy. Building Huffman tree is the most important part of Huffman coding. The construction of Huffman tree requires the following steps. First, the frequency of characters is represented by numbers. Each character is a single node number. For example, if we encode the string "aabbbccccdddddd", the character frequency is shown in Figure 1.

Figure 1
Character Frequency



The process of greedy strategy is to count the two characters with the least number of occurrences. The frequencies of the two trees need to be added together. Then merge. Assign the result of the merge to the new root node. Initially there are four characters so there are four single-node trees. This process is repeated, because the lowest frequency trees are merged, so there will eventually be only one tree. This completes the Huffman tree construction process. The merging process is shown in Figure 2.

Figure 2
Huffman Tree Merging Process



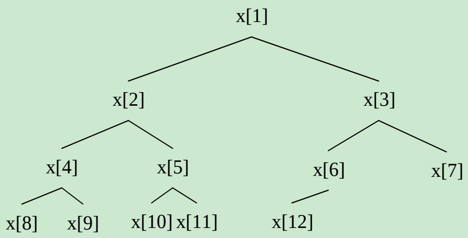
Each leaf node of the binary tree represents a character when the data is finally encoded. The encoding process is a path from the root node to the leaf node. For coding, the following rules should be followed: from the root node, if the leaf node enters the right direction, it needs to be coded as 1, and if the left subtree, it needs to be coded as 0. Each byte has only two states: 0 and 1. From the Huffman tree in the figure above, we can see that the Huffman coding table is finally generated as shown in Table 3.

Table 3
Huffman Coding Table

Character	Frequency	Code	Code length
a	2	110	3
b	3	111	3
c	4	10	2
d	6	0	1

Hoffman code is the last leaf node for code path, so there is no code overlap. No leaf node is the ancestor or descendant of another leaf node. This means that the encoding result of any character is unique. In decoding, this feature ensures that ambiguity is avoided. The length of the encoding is determined by the frequency of different characters appearing in the data. The longer the code length, the shorter the frequency of the characters and the lower the coding length. In order to compress better, it is necessary to make a big difference in the frequency of each different character. The greedy strategy is embodied in the merging process of trees. In the process of merging, the tree with the smallest frequency of root nodes is selected to merge. At the same time, a priority queue data structure is needed to help complete the construction of the tree. Priority queue is a data structure that maintains a set of elements. Its function is to extract the smallest elements from the elements and insert new elements. Implementing priority queues uses heaps in data structures. Minimum heap is a data structure. In storage mode, one-dimensional linear table storage elements are used. These elements logically form a binary tree. A logical binary tree of the smallest heap is shown in Figure 3.

Figure 3
Minimum Heap Logical Binary Tree



The task of the minimum heap is to extract the smallest elements and insert operations, so in order to maintain the characteristics of the heap, each insert and extract has to adjust the nodes. For priority queues, there are two basic operations: inserting new elements and extracting the smallest elements. The Huffman tree is constructed and Huffman code table is obtained. In order to decompress, a file header is needed to ensure the correctness of the Huffman tree constructed by decoding. Huffman decoding first needs to know the address information of the location stored in the code table. Base address and offset address are two main components of memory address. Code table information generated during encoding is stored in memory, and the starting address of code table information is stored in base address. The information of the code table serial number is stored in the base address signal register, and the information of the code table signal is output at the same time as the code stream signal. By calculating the offset address, the data of the offset address is determined by the order of the code table, so the information of the offset address can be obtained by the order of the code table. The final value is the combination of the decoded base address and the offset address.

RESULTS

Experimental Environment

After compiling software engineering, connect the USB interface and download the corresponding hardware engineering files to the target board through USB-Blaster. At this time, the FPGA chip has completed the corresponding configuration according to the previous hardware design. Under the environment of Nios II IDE, the communication mode of this project is set to JTAG. Set all memory to SDRAM. Through Nios II hardware, a new configuration project is built in the running configuration interface, the corresponding path of hardware configuration file storage is selected, and the target communication mode is chosen as USB-Blaster. Applying the above configuration, the whole audio playback system project can run in Nios II hardware environment by clicking the Run button.

Analysis of Experimental Results

In order to test the efficiency of the system with hardware and software, the multimedia audio files with the sampling frequency of 44K and 320kbps are selected to play when the clock of the system is 75M. Running the software project through the hardware of NiosII processor system, the console can see that the data in the display SD card is read into the system cache, read correctly, and then link the headphone or speaker to the audio output interface to hear clear and smooth multimedia audio files. The whole decoding work is accomplished by pure software, adding floating-point multiplication module, adding floating-point multiplication module and adding floating-point multiplication and Huffman module at the same time. The performance ratio of the system is obtained by comparing the pure software decoding method with other decoding methods. The test results show that different methods of multimedia music decoding using hardware and software combination can achieve different efficiency results as shown in Table 4. It can be seen that the combination of hardware and software has a lot of help to improve the efficiency of the whole system. After adding floating-point multiplication and Huffman module, the decoding efficiency has been greatly improved. The correctness of the whole system design is verified.

Table 4
Comparisons of Software and Hardware Implementation With Decoding Method

Realization way	Time (s)	Performance ratio
Pure Software Implementation	4.326×10-4	1
Implementation of adding floating-point multiplication module	2.323×10-5	18.62
Implementation of adding floating-point multiplication module	1.864×10-5	23.21
Adding Floating Point Multiplication and Huffman Module to Realize	1.013×10-5	42.70

The hardware of the whole SOPC system occupies 6075 logic units of EP2C35F48418 chip and 18% of the chip resources. Among them, 5311 LUT tables are used to realize the combined logic function, 3305 registers are used, 96384 bits of memory are used, and one PLL is used. After compiling, the system runs hardware physical diagram, as shown in Figure 4.

Figure 4
Hardware Circuit Board of the System

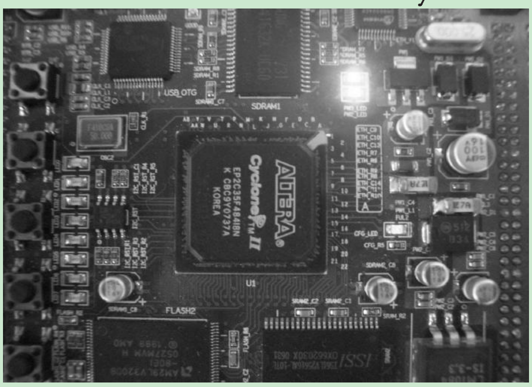


Figure5
Line Transmission Mode Timing (start)

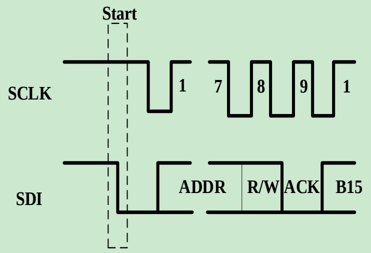
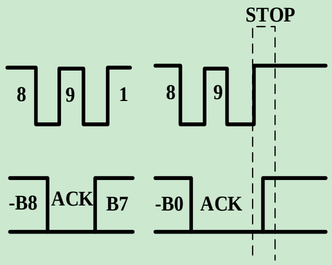


Figure 6
Wire Transmission Mode Timing (stop)



The decoding of multimedia audio files is realized based on MAD decoding database. Firstly, the MAD decoding database is introduced, and the decoding principle and the decoding process are analyzed. Then the decoding database is transplanted to SOPC system by modifying the corresponding code. In order to improve the efficiency of MP3 decoding, the flexibility of SOPC system is fully utilized to optimize the design of multimedia audio decoding, including acceleration through Onchip Memory, optimization of Buffer size and optimization of Cache size. The most important feature of SOPC technology is that it can realize the combination of software and hardware. The floating-point multiplication and Huffman decoding are implemented by hardware, and the operation efficiency of the whole system is improved by the combination of software and hardware.

DISCUSSION

At present, multimedia technology has been gradually used in music classes, but there are still some obstacles in the application process, which needs further optimization. Based on this, this paper studies the design process of multimedia teaching system for SOPC music courses in Colleges and universities and the method of software and hardware co-design based on classroom audio data mining technology, constructing a basic SOPC system as the whole system. On the basis of this system, the design of relevant decoding and interface modules is carried out. Finally, the test is carried out. Through experiments and tests, this paper draws the following conclusions: the SD card communication module, audio configuration module and I2C data communication module are designed by Verilog Hardware Description Language. The design is correct, reasonable and can run normally; the decoding of multimedia audio files is realized on the basis of MAD decoding database, which runs smoothly in the decoding process and has high decoding accuracy. The optimization of Buffer size and Cache size is realized. The transplantation of MP3 decoder on SOPC system is realized. After transplantation, the two systems are well connected and occupy 18% of the chip resources. The result is ideal.

This paper still has some optimization space. In the future research, this paper plans to expand the decoding scope of the system, and try to use this technology to decode other audio and video format files, so as to facilitate the management and application of files.

Human Subjects Approval Statement

This paper did not include human subjects.

Conflict of Interest Disclosure Statement

None declared.

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