

COMPARING THE USE OF MIDI AND DIGITIZED AUDIO IN MULTIMEDIA SYSTEMS

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Abstract: Audio in the multimedia system is the most important part yet the most neglected of all the media used in multimedia systems. It is not incorrect to say that sound is given consideration when the application is almost ready. But the truth is, the application is never ready without an audio in any multimedia application. Whether it is an academic presentation or any video game, the effects added by audio are of utter importance. The MIDI and the digital audio are basically two audio techniques used in multimedia systems. Both the techniques have their own advantages and disadvantages and used as per the requirement of the particular application in which these are being used. MIDI audio presents several advantages to multimedia developers, including small file sizes, interactive responsiveness, and light processor load. However, it does require sound cards for playback. Digitized Audio converts sound into digital data for disk storage. Both of these techniques are reviewed and compared.

Keywords: ADC, DAC, Sampling, Quantization

1. AUDIO IN MULTIMEDIA SYSTEMS

Multimedia is a concept which includes multiple media elements such as text, graphics, animation and audio/video. The applications of multimedia include academic presentation, panoramic view of an architectural building, information systems, video games and many more. Multimedia System is a computer system capable of holding the information constituting of multimedia elements. If the multimedia system allows the user to control these elements, then the application would be called an interactive one. Audio has a vital role to play in Multimedia Systems. The use of audio in multimedia systems do not require highly specialized knowledge of harmonics, intervals, sine waves or the principles of acoustics but the only thing to know is that how the different types of sounds such as human voices, instrumental music etc can be incorporated into the computer. There are basically two types of audio that can be played on the multimedia systems i.e. Digitized Audio & MIDI.

1.1. Digitized Audio

Audio Signal can be stored as digitized one in the form of numbers. An audio signal is represented in digital memory with a binary code that stores a massive amount of numbers that are used to represent a signal. An **ADC (Analog to Digital Converter)** is a computer chip that is used to convert an analog signal into digital information. This process is called **sampling**. Digitized sound is normally called wave files and end with the extension .wav for PC and with .aif or .aiff for Macintosh. Digitized sound is nothing but a sampled sound. Every n^{th} sample of the signal is taken and stored as digital data in the form of bytes. Three sampling frequencies used in multimedia systems are

44.1 KHz, 22.05 KHz and 11.025 KHz. Sample sizes are 1 byte or 2 bytes. Audio resolution determines the accuracy with which the sound can be digitized.

The digital waveform to be reconstructed depends on the sampling frequency selected. It is very difficult to reconstruct the waveform if the sampling frequency selected is very low. Figure below shows the analog waveform converted into digital one using the sampling frequency as shown.



Figure 1.1(a) Original Waveform



Figure 1.1(b) Sampling Frequency



Figure 1.1(c) Reconstructed Waveform

Once the signal is represented as binary numbers, the signal is then converted back to an analog signal through a **DAC (Digital to Analog Converter)**. Each

sample value is rounded off to the nearest integer to create the waveform. This process is called quantization. But this process can create unwanted noise. Digital audio technologies include digital broadcasting techniques namely Digital Audio Broadcasting (DAB), HD Radio, Digital radio Mondiale (DRM), in band on channel (IBOC) and storage techniques like digital audio player, digital audio tape, CD, DVD, digital audio workstation and various audio file formats.

1.2. MIDI (Musical Instrument Digitization Interface)

Musical Instrument Digitization Interface (MIDI) provides a protocol or a set of rules, using which the musical note is directly recorded into the computer from musical instruments. A MIDI file is basically a list of commands to produce the sound. For example, pressing of a guitar key can be represented as a computer command. When the MIDI device processes this command, the result will be the sound from the guitar. The protocol provides an effective means of conveying musical information as electronic data. Since MIDI files are small in size, these can be embedded while loading of web pages and promptly played. Length of the MIDI files can be changed without degrading the quality of the signal. As the signals are stored as the notes played on the musical instrument, working on the MIDI files require knowledge of the music theory.

The MIDI data stream is a unidirectional asynchronous bit stream at 31.25 Kbits/sec with 10 bits transmitted per byte (a start bit, 8 data bits, and one stop bit). The MIDI interface includes three different MIDI connectors, labeled as IN, OUT, and THRU. The MIDI data stream is usually originated by a MIDI controller, such as a musical instrument keyboard, or by a MIDI sequencer. A MIDI controller is a device which is played as an instrument, and it translates that into a MIDI data stream in real time. A MIDI sequencer is a device which allows MIDI data sequences to be captured, stored, edited, combined, and replayed. The MIDI data output from a MIDI controller or sequencer is transmitted via the devices' MIDI OUT connector.

The recipient of this MIDI data stream is commonly a MIDI sound generator or sound module, which will receive MIDI messages at its MIDI IN connector, and respond to these messages by playing sounds. Figure 1.2 shows a simple MIDI system, consisting of a MIDI keyboard controller and a MIDI sound module.

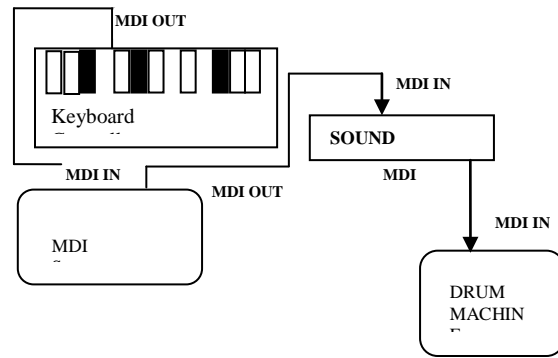


Figure 1.2. MIDI Interface

2. FILE FORMATS

Multimedia market has been able to create hundreds of file formats exist for recording and playing sound and music files. While many of these file formats are software dependant there are several well-known and widely supported file formats.

There are a variety of digital audio file formats which may be used for computer systems, CD, DVD, MP3 players etc.

Audio formats can be broken down into three main categories namely uncompressed, lossless and lossy compressed format.

Uncompressed audio formats are the formats that use no compression. This means all the data is available but the file size is going to be huge. One of the examples of this kind of format is a WAV audio file.

Lossless compression applies compression to an uncompressed audio file, but it doesn't lose information or degrade the quality of the digital audio file. The WMA audio file format uses lossless compression.

Lossy compression will result in some loss of data as the compression algorithm eliminates redundant or unnecessary information. MP3 and Real Audio files use a lossy compression.

Different file formats have different file sizes and qualities. All audio file have the following attributes

- File format
- Data rate
- Channels (mono, stereo, or multi-channel)
- Sample rate quality
- Bit depth quality
- Compressed or uncompressed format

2.1 Digitized Audio File Format

There are two main types of digitized audio files on a computer

PCM stands for Pulse Code Modulation. In this technique each number in the digitized audio file represents exactly one sample in the waveform.

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Common examples of PCM files are WAV files, AIFF files, and Sound Designer II files. Audacity supports WAV, AIFF, and many other PCM files.

The other type is **compressed files**. Earlier files used logarithmic encodings to compress more dynamic range out of fewer bits for each sample, like the u-law or a-law encoding in the Sun AU format. Modern compressed audio files use sophisticated psychoacoustics algorithms to represent the essential frequencies of the audio signal in far less space. Examples include MP3 (MPEG I, layer 3), Ogg Vorbis, and WMA (Windows Media Audio).

2.2 MIDI File Format

MIDI file is used to collect and store the messages and the timing information in a computer_file system, which is commonly called a MIDI file, or more formally, a Standard MIDI File (SMF). MIDI files are typically created using MIDI sequencers.

An SMF consists of one header chunk and one or more track chunks. There exist three different SMF formats; the format of a given SMF is specified in its file header. A Format 0 file contains a single track and represents a single song performance. Format 1 may contain any number of tracks, and represents a single song performance. Format 2 may have any number of tracks, each representing a separate song performance. Sequencers do not commonly support Format 2.

Most commonly used MIDI file formats are:

MIDI Karaoke File (.KAR) Format

MIDI-Karaoke files are an "unofficial" extension of MIDI files, used to add synchronized lyrics to standard MIDI files. SMF players play the music as they would a .mid file but do not display the lyrics.

XMF File Formats

XMF (eXtensible Music File), is the format that store SMF chunks with instrument data in DLS format (Downloadable Sounds). The XMF container is a binary format.

RIFF-RMID File Format

On Microsoft Windows, the system itself uses proprietary RIFF-based MIDI files with the ".rmi" extension. A RIFF-RMID file, however, is simply a Standard MIDI File wrapped in a RIFF (Resource Interchange File Format) chunk.

Extended RMID File Format

This is a method for bundling one Standard MIDI file (SMF) image with one Downloadable Sounds (DLS) image using the RIFF container technology.

Extended MIDI File (.XMI) Format

The XMI format is a proprietary extension of the SMF format but XMI is not an official standard.

3. CHOOSING THE RIGHT AUDIO FORMAT

The variety of file formats can repeatedly prove awe-inspiring for someone new to the world of multimedia. There are a number of commonly used digital file types

within the audio realm. Different multimedia application may choose or support different file types, depending on proprietary alliances, compatibility, and the type of work primarily associated with the software. As a result it is often indistinct which file types should be considered for specific delivery and use, and the information surrounding this can often be deceptive.

3.1 Comparison between MIDI and Digitized Audio

Comparison	MIDI	Digitized Audio
Representation	Shorthand representation of music stored in numeric form	Sampling is done to convert the data into digital form
Device Independence	Device dependent	Device Independent
File Size	200 to 1000 times smaller than Digitized Audio	Larger File Size
Memory Requirement	Less storage space	Large Storage space
Edit Options	Easily editable and all the information retainable	Difficult to edit.
Quality	Better when played on high quality MIDI device	Not so better
Playback	Does not have consistent playback quality	Consistent playback quality
Analogy	Vector Graphics	Bitmap Image
Ease to incorporate	Must have knowledge	Does not require much knowledge

3.2 Advantages & Disadvantages

Both the file formats have their own advantages as well as disadvantages. Discussed first the advantages of MIDI over digitized audio:

1. MIDI files are much smaller than digitized audio files, and the size of MIDI file is completely independent of playback quality. Broadly, MIDI files will be 200 to 1000 times smaller than CD-quality digitized audio files. As MIDI files are small, they don't take up as much RAM, disk space, and CPU resources.

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2. In some cases, MIDI files may sound better than digital audio files if the MIDI sound source you are using is of high quality.
3. You can change the length of a MIDI file (by varying its tempo) without changing the pitch of the music or degrading the audio quality.

Now for the disadvantages:

1. Because MIDI data isn't sound, you can be certain that playback will be accurate only if the MIDI playback device is identical to the device used for production.
2. MIDI cannot easily be used to play back spoken dialog.

There are two additional and often more compelling reasons to work with digital audio:

1. A wider selection of application software and system support for digital audio is available for both the Macintosh and Windows platforms.
2. The preparation and programming required for creating digital audio do not demand knowledge of music theory; working with MIDI data usually requires an ounce of acquaintance with musical scores as well as audio production.

There are many applications of Digital Audio and Midi being used together:

- Modern Recording Studio -- Hard Disk Recording and MIDI
- Analog Sounds (Live Vocals, Guitar, Sax etc) -- DISK
- Keyboards, Drums, Samples, Loops Effects -- MIDI
- Sound Generators: use a mix of
- Synthesis
- Samples
- Samplers -- Digitize (Sample) Sound then
- Playback
- Loop (beats)
- Simulate Musical Instruments
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4. CONCLUSION

MIDI files give **an understandable benefit** for music and sound with your computer, as long as you do not depend on original live sound recordings. Sound cards are getting better and more powerful than ever before. To have a 32 voice MIDI orchestra on your sound card is already a reality, not to say standard, and the orchestra is growing in newer sound cards doubling the numbers of voices to 64 and using better quality sampled sounds in their wave tables. With MIDI files you have the "sheet-music" for this orchestra. Speakers might be a limitation to the multimedia application but the file formats are already exceeding the limits

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