Multimedia System

Homework 2

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1. Investigate Practical A/D Technology

1) PCM (Pulse Code Modulation)

Pulse-code modulation (**PCM**) is a method used to digitally represent sampled analog signals. It is the standard form of digital audio in computers, compact discs, digital telephony and other digital audio applications. In a PCM stream, the amplitude of the analog signal is sampled regularly at uniform intervals, and each sample is quantized to the nearest value within a range of digital steps.[i]

펄스 부호 변조(Pulse-code modulation, 줄여서 **PCM**)는 아날로그 신호의 디지털 표현으로, 신호 등급을 균일한 주기로 샘플링 한 다음 디지털 코드로 양자화 처리한다. PCM 은 디지털 전화 시스템에 쓰이며, 컴퓨터와 CD 등 디지털 오디오의 표준이다. [ii]

2) DPCM (Different Pulse Code Modulation)

Differential pulse-code modulation (**DPCM**) is a signal encoder that uses the baseline of PCM **but adds some functionalities based on the prediction of the samples of the signal.** The input can be an analog signal or a digital signal.

DPCM 은 PCM 을 기반으로 신호 샘플 예측을 함수화 한 것으로, 아날로그 신호 또는 디지털 신호를 입력할 수 있다.

If the input is a continuous time analog signal, it needs to be sampled first so that a discrete time signal is the input to the DPCM encoder.

- Option 1: take the values of two consecutive samples; if they are analog samples, quantize them; calculate the difference between the first one and the next; the output is the difference.
- Option 2: instead of taking a difference relative to a previous input sample, take the difference relative to the output of a local model of the decoder process; in this option, the difference can be quantized, which allows a good way to incorporate a controlled loss in the encoding.[iii]

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DIFFERENTIAL QUANTIZATION OF COMMUNICATION SIGNALS

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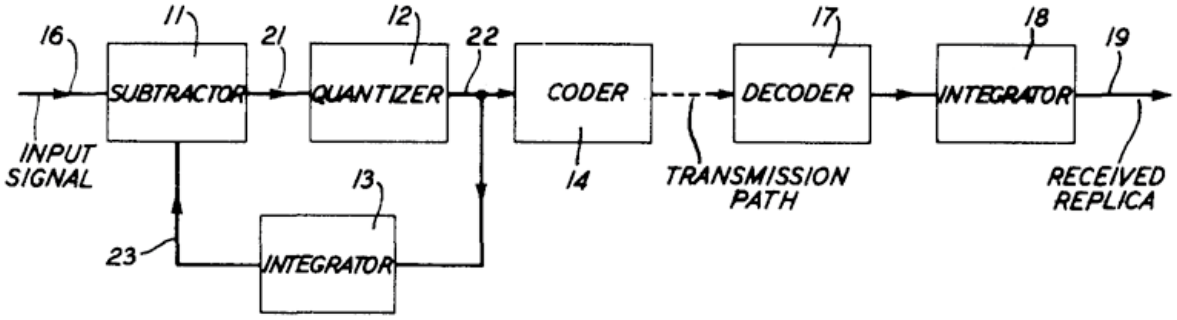
FIG. 1



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3) ADPCM (Adaptive Differential Pulse Code Modulation)

Adaptive differential pulse-code modulation (**ADPCM**) is a variant of differential pulse code modulation (DPCM) that varies the size of the quantization step, to allow further reduction of the required data bandwidth for a given signal-to-noise-radio.[v]

주어진 신호 -노이즈의 데이터 대역폭을 줄이고, 정량화 단계의 크기를 변경하는 적응형 DPCM 방식에 의한 음성부호화 기법을 주로 지칭한다.[vi]

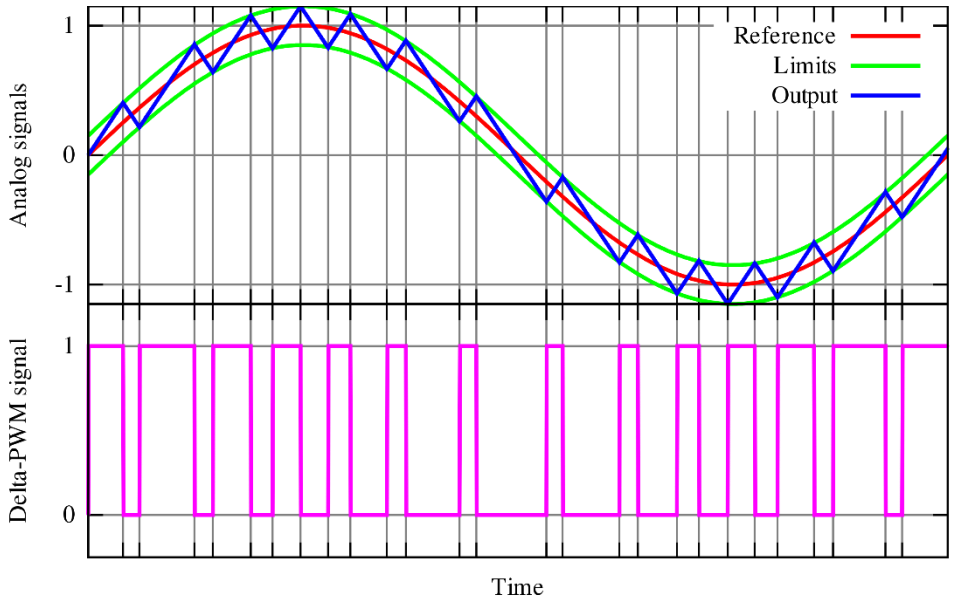
4) DM (Δ-modulation or delta modulation)

A delta modulation (DM or Δ-modulation) is an analog-to-digital and digital to analog signal conversion technique used for transmission of voice information where quality is not of primary importance. DM is the simplest form of DPCM where the difference between successive samples is encoded into n-bit data streams. In delta modulation, the transmitted data are reduced to a 1-bit data stream. Its main features are:[vii]

- The analog signal is approximated with a series of segments.
- Each segment of the approximated signal is compared to the preceding bits and the successive bits are determined by this comparison.

- Only the change of information is sent, that is, only an increase or decrease of the signal amplitude from the previous sample is sent whereas a no-change condition causes the modulated signal to remain at the same 0 or 1 state of the previous sample.

델타 변조(delta modulation, DM)는 Analog-to-digital 신호 변환 방법 중의 하나로서, analog signal 을 일련의 구간으로 나누어 각 구간의 근사치를 택한 뒤, 원본 신호 값과의 차이를 구하여 오차의 증가 또는 감소를 결정하고, 증가/감소 상태의 변화를 전송한다.[viii]



[ix]

5) ADM (Adaptive Delta Modulation)

Adaptive delta modulation is a modification of DM in which the step size is not fixed. Rather, when several consecutive bits have the same direction value, the encoder and decoder assume that slope overload is occurring, and the step size becomes progressively larger. Otherwise, the step size becomes gradually smaller over time. ADM reduces slope error, at the expense of increasing quantizing error. This error can be reduced by using a low-pass filter. [x]

6) Intercomparison

Division	PCM	DPCM	ADPCM	DM	ADM
Sampling frequency	8kHz	8kHz	8kHz	16kHz	16kHz
Number of Bps	8bit	4bit	4bit	1bit	1bit
Transmission speed	64kbps	32kbps	32kbps	16kbps	16kbps
Quantization staircase	256(28)	16(24)	16(24)	2(21)	2(21)
System configuration	Usually	Complex	Very complex	Very simple	simple
Noise	Quantization	Quantization		Flat / Overloaded	

2. Audio Format

1) Audio CD

The format is a two-channel 16-bit PCM encoding at a 44.1 kHz sampling rate per channel. Four-channel sound was to be an allowable option within the Red Book format, but has never been implemented.[xi]

Audio CD 는 2 개의 채널, 각 채널당 44.1 kHz, 6 bit 의 코드로 이루어진다.

2) SACD (Super Audio CD)

Super Audio CD (SACD) is a high-resolution read-only optical audio disc format that was designed to provide higher fidelity digital audio reproduction than the *Red Book*. SACD was in a format war with DVD-Audio, but neither has replaced audio CDs. The SACD standard is referred to as the *Scarlet Book* standard. Titles in the SACD format can be issued as hybrid discs; these discs contain the SACD audio stream as well as a standard audio CD layer which is playable in standard CD players, thus making them backward compatible.[xii]

SACD 전용 레이어는 스테레오 채널과 멀티채널 레이어로 나누어 사용했는데, 멀티채널의 경우 용량이 커져 DST 압축기술을 통해 압축하고 앞부분에 2 채널 DST 를 뒷부분에도 5.1 채널 DSD 를 추가하였다. SACD 의 기본 재생시간은 CD 와

동일한 72 분이지만, DST 압축을 통해 1 장에 SACD 에 최대 144 분까지 기록할 수 있다. 최근에는 네트워크 오디오, 고해상도 음원 서비스 등이 확대되며 SACD 에 사용된 DSD 음원이 다시 한번 주목받고 있다. 또한 2.8MHz DSD 에 이어 5.6MHz, 11.2MHz, 22.4MHz 등 업그레이드를 통해 음원시장을 장악해 나가고 있다.[xiii]

	CD	SACD	Human hearing
Dynamic range	90 dB; 120 dB	105 dB	120 Db
Frequency range	20 Hz – 20 kHz	20 Hz – 50 kHz	20 Hz – 20 kHz (young person); 20 Hz – 8 to 15 kHz (middle-aged adult)[xiv]

3) DVD – Audio

DVD-Audio (commonly abbreviated as DVD-A) is a digital format for delivering high-fidelity audio content on a DVD. DVD-Audio uses most of the storage on the disc for high-quality audio and is not intended to be a video delivery format. DVD-Audio has much higher audio quality than video DVDs containing concert films or music videos.[xv]

DVD-AUDIO 는 DVD 방식의 오디오 포맷으로서 CD 처럼 PCM 방식 신호를 가지고 데이터를 처리하는 포맷이다. DVD-VIDEO 는 음성 포맷으로서 PCM 96KHz/24bit 를 지원한다. 일반 PCM 방식으로 96KHz/24bit, 6 채널로 저장하면 60 분이라는 짧은 시간만 저장할 수 있기 때문에 이 비 압축 방식이 가능하다.[xvi]

4) XRCD (Extended Resolution Compact Disc)

JVC uses advanced dither algorithms (though without noise shaping) in their proprietary K2 technology to transfer the analog or digital source to physical disc. The company claims to have studied how inferior CD-remastering techniques

degrade the master tape sound and strives to minimize this loss. If analog, the source material is first converted to digital via JVC's patented K2 20-bit or 24-bit analog-to-digital converter.[xvii]

5) HDCD (High Definition Compatible Digital)

High Definition Compatible Digital, or HDCD is a Microsoft proprietary audio encode-decode process that claims to provide increased dynamic range over that of standard Redbook audio CDs, while retaining backward compatibility with existing Compact disc players.[xviii]

HDCD encodes the equivalent of 20 bits worth of data in a 16-bit digital audio signal by using custom dithering, audio filters, and some reversible amplitude and gain encoding; Peak Extend, which is a reversible soft limiter and Low Level Range Extend, which is a reversible gain on low-level signals. There is thus a benefit at the expense of a very minor increase in noise.[xix]

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[xix] https://en.wikipedia.org/wiki/High_Definition_Compatible_Digital