10.3.3 Distortions in the DM System :

[ASKED IN EXAM - MAY 2000, MAY 2001 !!!]

The DM system is subjected to two types of errors :

(i) Slope overload distortion and

(ii) Granular noise.

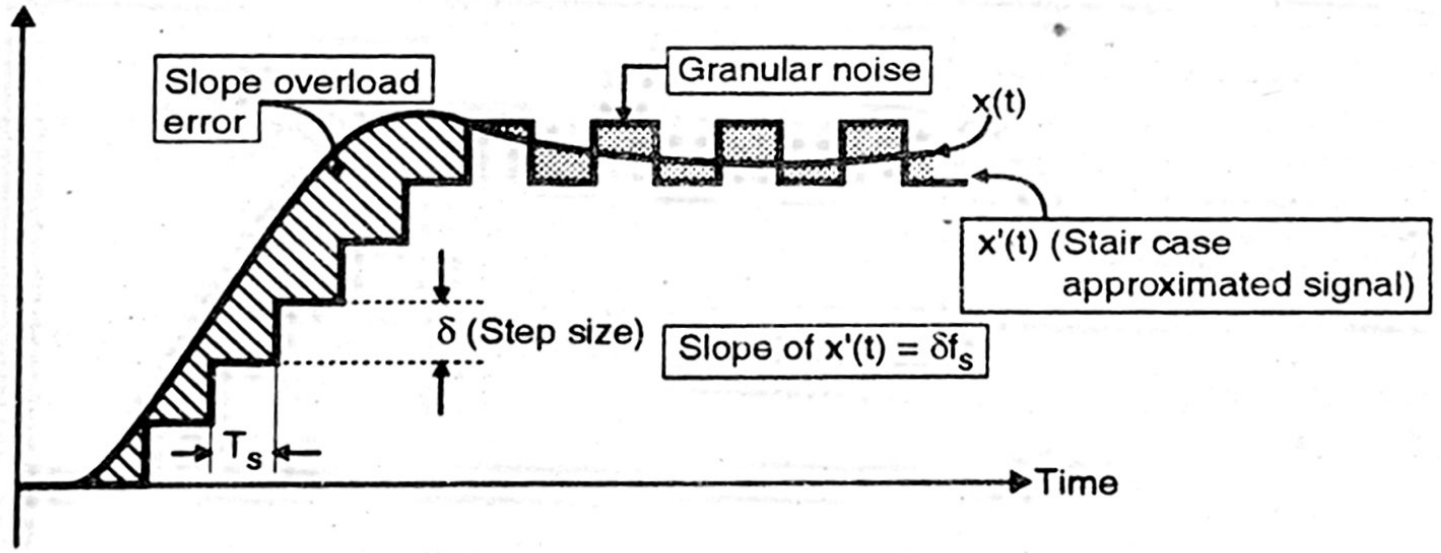

Fig. 10.3.4 : Distortions in D.M.

(i) Slope overload distortion :

Look at the Fig. 10.3.4. Due to small step size (δ), the slope of the approximated signal $x'(t)$ will be small.

$$\text{The slope of } x'(t) = \frac{\delta}{T_s} = \delta f_s \qquad \ldots (10.3.1)$$

If slope of the analog signal $x(t)$ is much higher than that of $x'(t)$ over a long duration then $x'(t)$ will not be able to follow $x(t)$, at all. The difference between $x(t)$ and $x'(t)$ is called as the slope overload distortion.

Thus the slope overload error occurs when slope of $x(t)$ is much larger than slope of $x'(t)$.

The slope overload error can be reduced by increasing slope of the approximated signal $x'(t)$. Slope of $x'(t)$ can be increased and hence the slope overload error can be reduced by either increasing the step size "δ" or by increasing the sampling frequency f_s. However with increase in δ the granular noise increases and if f_s is increased, signaling rate and bandwidth requirements will go up.

(ii) Granular noise :

When the input signal $x(t)$ is relatively constant in amplitude, the approximated signal $x'(t)$ will hunt above and below $x(t)$ as shown in Fig. 10.3.4. The granular noise is similar to the quantization noise in the PCM system. It increases with increase in the step size δ. To reduce the granular noise, the step size should be as small as possible. However this will increase the slope overload distortion.

In the linear delta modulator the step size δ is not variable. If it is made variable then the slope overload distortion and granular noise both can be controlled. A system with a variable step size is known as the adaptive delta modulator (ADM).

Eventhough the DM system is developed to reduce the bandwidth requirement, due to the slope overload problem the BW reduction can't be achieved practically. Hence the linear DM systems are not used in any practical applications.

Advantages of delta modulation :

(i) Low signaling rate and low transmission channel bandwidth, because in delta modulation, only one bit is transmitted per sample.

(ii) The delta modulator transmitter and receiver are less complicated to implement as compared to PCM.

Disadvantages of delta modulation :

(i) The two distortions discussed earlier i.e. slope overload error and granular noise are present.

(ii) Practically the signaling rate with no slope overload error will be much higher than that of PCM.

The slope overload error can be reduced by using another type of delta modulation, called as adaptive delta modulation (ADM).

10.4 Adaptive Delta Modulation (ADM) :

[ASKED IN EXAM - DEC. 97, 98, MAY 99, 2000, 2002, MAY 2003, DEC. 2003 !!!]

In the ADM system, the step size is not constant. Rather when the slope overload occurs the step size becomes progressive larger and therefore $x'(t)$ will catch up with $x(t)$ more rapidly. The ADM transmitter is as shown in Fig. 10.4.1.

10.6 Comparison of Digital Pulse Modulation Systems :

The PCM, DM, ADM and DPCM all are digital pulse modulation systems. Table 10.6.1 shows the comparison of these systems.

Table 10.6.1 : Comparison of PCM, DM, ADM and DPCM

Sr. No.	Parameter	PCM	DM	ADM	DPCM
(1)	Number of bits per sample	N can be 4, 8, 16, 32, 64 etc.	N = 1	N = 1	N is more than 1 but less than that for PCM
(2)	Step size	Depends on the number of Q levels.	Step size is fixed	Step size is variable	Step size is fixed
(3)	Distortions / errors	Quantization error	Slope overload and granular noise	Granular noise	Slope overload and granular noise
(4)	Signaling rate and bandwidth	Highest	Low, if the input is slow varying	Lowest	Lower than PCM
(5)	System complexity	Complex	Simple	Simple	Simple
(6)	Feedback from output	No feedback	Feedback is present	Feedback is present	Feedback is present
(7)	Noise immunity	Very good	Very good	Very good	Very good
(8)	Use of repeaters	Possible	Possible	Possible	Possible

10.7.2 Comparison of Analog and Digital Modulation :

[ASKED IN EXAM - MAY 2002 !!!]

Sr. No.	Analog modulation	Digital modulation
1)	Transmitted modulated signal is analog in nature.	Transmitted signal is digital i.e. train of digital pulses.
2)	Amplitude, frequency or phase variations in the transmitted signal represent the information or message.	Amplitude, width or position of the transmitted pulses is constant. The message is transmitted in the form of code words.
3)	Noise immunity is poor for AM, but improved for FM and PM.	Noise immunity is excellent.
4)	It is not possible to separate out noise and signal. Therefore repeaters can not be used.	It is possible to separate signal from noise. So repeaters can be used.
5)	Coding is not possible.	Coding techniques can be used to detect and correct the errors.
6)	Bandwidth required is lower than that for the digital modulation methods.	Due to higher bit rates, higher channel bandwidths is needed.
7)	FDM is used for multiplexing.	TDM is used for multiplexing.
8)	Not suitable for transmission of secret information in military application.	Due to coding techniques, it is suitable for military applications.
9)	Analog modulation systems are AM, FM, PM, PAM, PWM etc.	Digital modulation systems are PCM, DM, ADM, DPCM etc.