xxh1033 (g)

(1)

1	a
2	b
3	r
4	y
5	ƀ

a ƀ b a r ƀ a r r a y ƀ b y ƀ b a r r a y a r ƀ b a y

1 5 2 1 3 5 9. 3. 1 4. 7. 15. 8. 3. 13 4 9 7. 14.

5.	aƀ
7	ƀb
8	ba
9	ar
10	rƀ
11	ƀa
12	arr
13	ra
14	ay
15	yƀ
16	ƀby
17	yƀb
18	bar
19	rr
20	ray
21	ya
22	arƀ
3	ƀba
4	

1 5 2 1 3 5 9 3 1 4 7 15 8 3 13 4 9 7 14

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xxh10

② For $x \geq 0$

$$y = c^{-1}(x) = \frac{X_{max}}{u}\left[(1+u)^{\frac{x}{X_{max}}} - 1\right]$$

$$\frac{y \cdot u}{X_{max}} + 1 = (1+u)^{\frac{x}{X_{max}}}$$

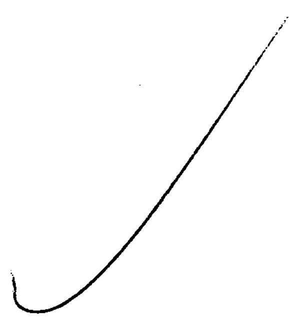
$$\ln\left[1 + u \cdot \frac{y}{X_{max}}\right] = \frac{x}{X_{max}} \cdot \ln(1+u)$$

$$X_{max} \cdot \frac{\ln\left[1 + u \cdot \frac{y}{X_{max}}\right]}{\ln(1+u)} = x$$

repalace y with x, $\Rightarrow$ $y = X_{max} \cdot \frac{\ln\left(1 + u \cdot \frac{x}{X_{max}}\right)}{\ln(1+u)}$ (1)

For $x < 0$.

$$y = c^{-1}(x) = -\frac{X_{max}}{u}\left[(1+u)^{\frac{-x}{X_{max}}} - 1\right]$$



$$-\frac{y}{X_{max}} \cdot u + 1 = (1+u)^{\frac{-x}{X_{max}}}$$

$$\ln\left[1 + u \frac{(-y)}{X_{max}}\right] = -\frac{x}{X_{max}} \cdot \ln(1+u)$$

$$x = -X_{max} \cdot \frac{\ln\left[1 + u \cdot \frac{(-y)}{X_{max}}\right]}{\ln(1+u)}$$

replace x with y $\Rightarrow$ $y = -X_{max} \frac{\ln\left[1 + u \cdot \frac{(-x)}{X_{max}}\right]}{\ln(1+u)}$ (2)

For (1) and (2), we get compressor function is

$$c(x) = X_{max} \frac{\ln\left(1 + u \frac{|x|}{X_{max}}\right)}{\ln(1+u)} \operatorname{sgn}(x) \quad \triangle$$

(3) subband 1 — 8 bits — stage 1

subband 2.3.4 — 4 bits — stage 2.

subband 5.6.7 — 2 bits. — stage 3.

Solution

1) stage 1: $t_1 = \dfrac{128 \times 128 \times 8}{9600} = \boxed{13.653\ (s)}$

stage 2. $t_2 = \dfrac{128 \times 128 \times 3 \times 4}{9600} = \boxed{20.48\ (s)}$

stage 3: $t_3 = \dfrac{256 \times 256 \times 3 \times 2}{9600} = \boxed{40.96\ (s)}$

Overall Transmission Time $T = t_1 + t_2 + t_3 = 75.093\ (s)$

2). $\dfrac{(9600 \times T)/8}{512 \times 512} = \dfrac{(9600 \times 75.093)/8}{512 \times 512} = 34.375\%$

For stage 1: $\dfrac{(9600 \times t_1)/8}{512 \times 512} = \dfrac{(9600 \times 13.653)/8}{512 \times 512} = \boxed{6.25\%}$

For stage 2. $\dfrac{(9600 \times t_2)/8}{512 \times 512} = \dfrac{(9600 \times 20.48)/8}{512 \times 512} = \boxed{9.375\%}$

For stage 3 $\dfrac{(9600 \times t_3)/8}{512 \times 512} = \dfrac{(9600 \times 40.96)/8}{512 \times 512} = \boxed{18.75\%}$

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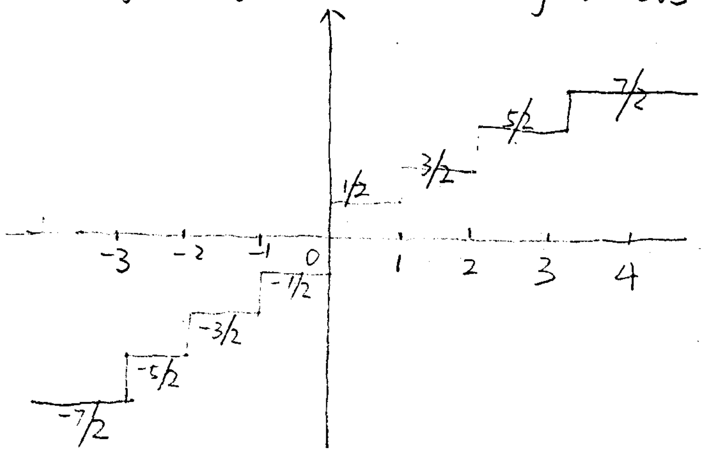
xxh1033

) 3 bit uniform quantizer : # of Levels $M = 2^3 = 8$

$$\Delta = \frac{2\times 4}{8} = 1$$



input	mapping		Quantizer output		Inverse mapping	Quantization
$X_1 = -0.8$	→	-1.6	→	-1.5	→ $\boxed{-0.75}$	0.05
$X_2 = 1.2$	→	2.13	→	2.5	→ $\boxed{1.75}$	0.55
$X_3 = 0.5$	→	1.0	→	0.5	→ $\boxed{0.25}$	-0.25
$X_4 = 0.6$	→	1.2	→	1.5	→ $\boxed{0.75}$	0.15
$X_5 = 3.2$	→	3.467	→	3.5	→ $\boxed{3.25}$	0.05
$X_6 = -0.3$	→	-0.6	→	-0.5	→ $\boxed{-0.25}$	0.05

$$\sigma_q^2 = \frac{(0.05)^2+(0.55)^2+(-0.25)^2+(0.15)^2+(0.05)^2 \ldots}{6}$$

$= 0.0658$

without Mapping

		quantization error
$X_1 = -0.8$	→ $\boxed{-0.5}$	0.3
$X_2 = 1.2$	→ $\boxed{1.5}$	0.3
$X_3 = 0.5$	→ $\boxed{0.5}$	0
$X_4 = 0.6$	→ $\boxed{0.5}$	-0.1
$X_5 = 3.2$	→ $\boxed{3.5}$	0.3
$X_6 = -0.3$	→ $\boxed{-0.5}$	-0.2

$$\sigma_q^2 = \frac{(0.3)^2+(0.3)^2+(-0.1)^2+(0.3)^2+(-0.2)^2}{6}$$

$= 0.053$

Comment:

From the input source, the probability of the data falling into the interval [-1, 1] is bigger than that of falling into other intervals such as [-4, -1), (1, 4]. So we use the companding function to stretch the interval [-1, 1], after companding, it will occupy [-2, 2] 4 quantization level. It means we operate finer quantization during the interval [-1, 1], consequently, the quantizat

rrors are reduced for interval [-1, 1]. Of course, this will
t be true for the values outside the [-1, 1] interval. However,
e probability of the data falling outside the interval [-1, 1] is
aller, so we can get better overall quantization effect.