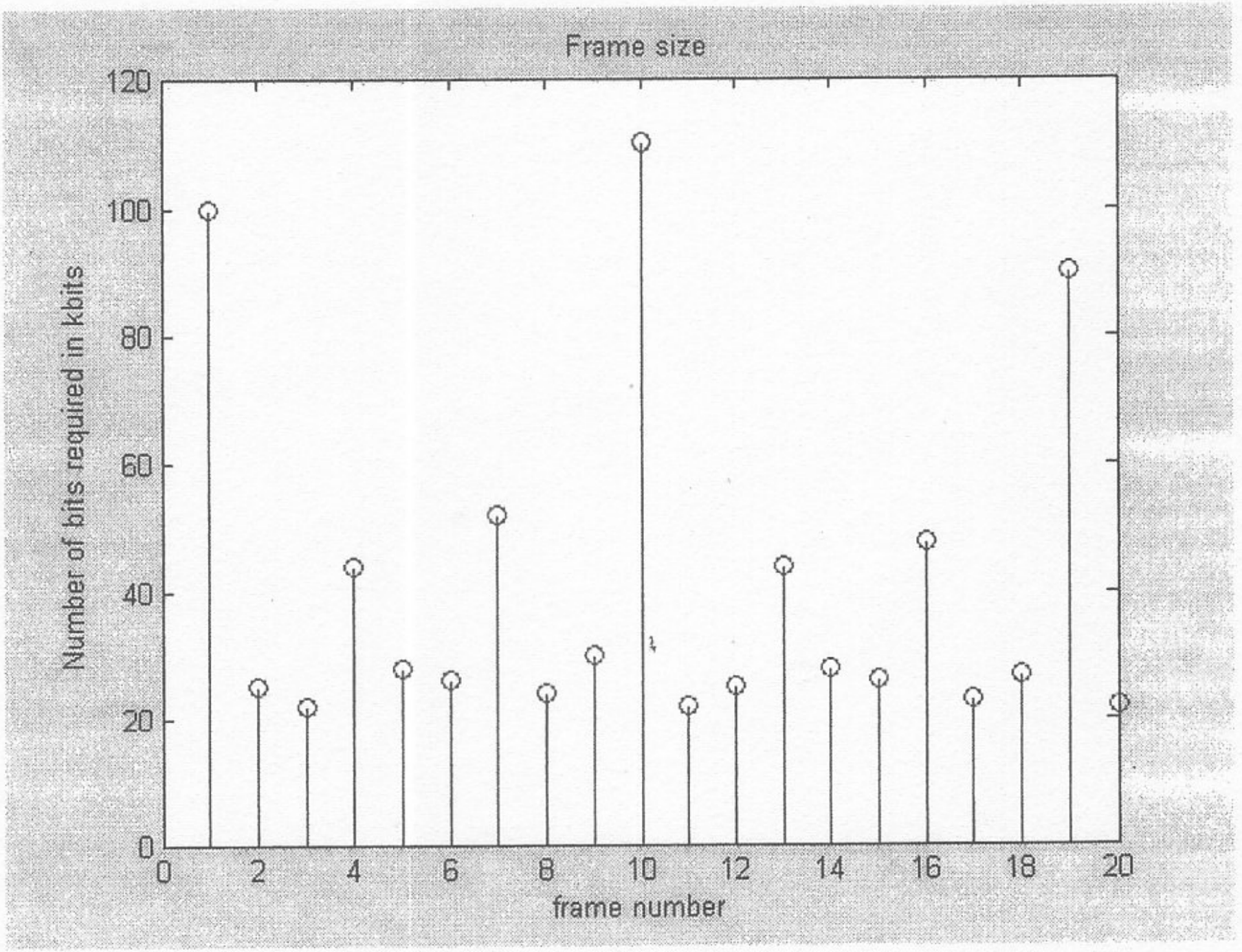
(a) (i) Line plot of the frame size against the frame number



From the line plot, it can be observed that the GOP structure is:

IBBPBBPBB

只含有一个I的情况

The data requirement for an uncompressed frame

=352*240*8* (1+1/2)

$= 352 \times 240 \times 8 + 176 \times 120 \times 8 \times 2$

8 bits/pixel; 4:2:0 scheme; for Cr and Cb

$= 1.014$ Mbits

Average number of bits required for a compressed I-frame

$= \frac{100 + 110 + 90}{3}$

$= 100$ kbits

Average number of bits required for a compressed P-frame

$= \frac{44 + 52 + 44 + 48}{4}$

$= 47$ kbits

Average number of bits required for a compressed B-frame

$= \frac{1}{13} \times \{25 + 22 + 28 + 26 + 24 + 30 + 22 + 25 + 28 + 26 + 23 + 27 + 22\}$

$= 25.23$ kbits

Average compression ratio for I-frame = $\frac{1.014 \times 10^6}{100 \times 10^3} = 10.14 : 1$

" " " " P-frame = $\frac{1.014 \times 10^6}{47 \times 10^3} = 21.57 : 1$

" " " " B-frame = $\frac{1.014 \times 10^6}{25.23 \times 10^3} = 40.19 : 1$

(a)(ii)

Effective compression ratio

The GOP structure is IBBPBBPBB

So, there are 1 I-frame, 2 P-frame and 6 B-frame in 1 GOP (9 frames)

The average compression factor for the video

$= \frac{1}{9} \times \frac{1}{10.14} + \frac{2}{9} \times \frac{1}{21.57} + \frac{6}{9} \times \frac{1}{40.19}$

$= 0.0378$

∴ Average compression ratio = $\frac{1}{0.0378} = 26.42 : 1$

Storage requirement for 120 min video (uncompressed)

$= 120 \times 60 \times 30 \times 1.014 \times 10^6$

$= 219 \times 10^9$ bits

Storage requirement for 120 min compressed video

$= \frac{219 \times 10^9}{26.42}$

$= 8.29 \times 10^9$ bits

$=$ 1036 Mbytes