

一、首先是使用 VS 运行项目文件生成.exe 可执行文件：

ldecod.exe	2022/10/2 0:47	应用程序	706 KB
ldecod.exe.recipe	2022/10/2 0:47	RECIPE 文件	1 KB
ldecod.log	2022/10/2 0:47	文本文档	16 KB
ldecod.sbr	2022/10/2 0:47	Source Browser ...	0 KB
ldecod.vcxproj.FileListAbsolute.txt	2022/10/2 0:47	文本文档	1 KB
lencod.exe	2022/10/2 0:47	应用程序	1,623 KB
lencod.exe.recipe	2022/10/2 0:47	RECIPE 文件	1 KB

二、通过对 encoder\_ai.cfg,encoder\_ra.cfg,encoder\_ldp.cfg 三个文件信息，发现文件内容一直，遂更改 encoder\_ai.cfg 文件的参数信息，从而对 test.yuv 文件进行编码。

输入文件参数信息：

```
#####
InputFile           = "E:\code\data\test.yuv"           # Input sequence, YUV 4:2:0
InputHeaderLength   = 0      # If the inputfile has a header, state it's length in byte he
FramesToBeEncoded   = 15   # Number of frames to be coded
SourceWidth         = 320   # Image width  in Pels, must be multiple of 16
SourceHeight        = 240   # Image height in Pels, must be multiple of 16
TraceFile           = "trace_enc.txt"
ReconFile           = "test_rec.yuv"
OutputFile          = "test.bit"
#####
```

1、第一次 encode 参数信息：

```
QPFirstFrame       = 25   # Quant. param for first frame (intra) (0-63)
QPRemainingFrame   = 29   # Quant. param for remaining frames (0-63)
QPBPicture         = 26   # Quant. param for B frames (0-63)
```

结果信息：

```
PS E:\code\ITM15.0\bin> .\lencod.exe -f .\encoder_ai.cfg
Parsing Configfile .\encoder_ai.cfg.....

-----
Input YUV file           : E:\code\data\test.yuv
Output IVC bitstream     : test.bit
Output YUV file          : test_rec.yuv
Output log file          : log.dat
Output statistics file   : stat.dat
-----

Frame  Bit/pic  QP   SnrY   SnrU   SnrV   Time(ms)  FRM/FLD  IntraMBs
Sequence Header
0(I)    117704    25  41.0954  44.2597  47.1284  41729      FRM
1(I)    117336    25  41.1165  44.1834  47.2373  24450      FRM
2(I)    117376    25  41.1685  44.4184  47.2705  25137      FRM
3(I)    117096    25  41.1980  44.4331  47.4015  25741      FRM
4(I)    117408    25  41.1669  44.5709  47.2942  26293      FRM
5(I)    117944    25  41.1662  44.6079  47.3541  30078      FRM
6(I)    118728    25  41.1823  44.6855  47.5020  29767      FRM
7(I)    120368    25  41.1704  44.4095  47.1704  26687      FRM
8(I)    120648    25  41.1810  44.5414  47.1746  31067      FRM
9(I)    119600    25  41.1186  44.4085  47.3288  29988      FRM
10(I)   120464    25  41.1581  44.2758  47.1223  33429      FRM
11(I)   119784    25  41.1907  44.3115  46.9705  26796      FRM
12(I)   119512    25  41.1737  44.1434  46.8792  25582      FRM
13(I)   119288    25  41.2362  44.1860  46.8562  26041      FRM
14(I)   119264    25  41.2248  44.4200  46.9815  26599      FRM
Sequence End

-----
Freq. for encoded bitstream : 30
Hadamard transform         : Used
Image (Encoding) format    : 320x240
Image (Recon) format       : 320x240
Error robustness            : Off
Fast Motion Estimation     : On
Search range               : 64
Num of ref. frames used in P pred : 5
Total encoding time for the seq. : 320.384 sec
Sequence type               : IPPP (QP: I 25)
RD-optimized mode decision : used
----- Average data all frames -----
SNR Y(dB)                   : 41.17
SNR U(dB)                   : 44.39
SNR V(dB)                   : 47.18
Total bits                  : 1782552 (I 1782552, P 0)
Bit rate (kbit/s) @ 30.00 Hz : 3565.10
Bits to avoid Startcode Emulation : 0
Bits for parameter sets     : 0
-----
Exit ITM 15.0 encoder ver 201606
```

## 2、第二次设置的参数信息：

```
QPFirstFrame      = 33 # Quant. param for first frame (intra) (0-63)
QPRemainingFrame  = 37 # Quant. param for remaining frames (0-63)
QBPBPicture       = 36 # Quant. param for B frames (0-63)
```

### 第二次运行的结果如下图：

```
PS E:\code\ITM15.0\bin> .\lencod.exe -f .\encoder_ai.cfg
Parsing Configfile .\encoder_ai.cfg.....

-----
Input YUV file      : E:\code\data\test.yuv
Output IVC bitstream : test.bit
Output YUV file     : test_rec.yuv
Output log file     : log.dat
Output statistics file : stat.dat
-----
```

Frame	Bit/pic	QP	SnrY	SnrU	SnrV	Time(ms)	FRM/FLD	IntraMBs
Sequence Header								
0(I)	64248	33	35.8937	40.6624	44.4333	10607		FRM
1(I)	63688	33	35.9058	40.6993	44.6468	9984	FRM	
2(I)	64000	33	35.9386	40.9051	44.4967	10263	FRM	
3(I)	64520	33	35.9666	40.8001	44.6593	9989	FRM	
4(I)	64488	33	35.9037	40.8507	44.7218	9955	FRM	
5(I)	65160	33	35.9377	40.9499	44.5683	10268	FRM	
6(I)	65704	33	35.9308	41.0576	44.5824	10320	FRM	
7(I)	66728	33	35.8808	40.7659	44.2896	10655	FRM	
8(I)	66792	33	35.9168	40.7844	44.5033	10648	FRM	
9(I)	66560	33	35.9090	40.7682	44.3895	10616	FRM	
10(I)	66616	33	35.8662	40.6490	44.4711	10673	FRM	
11(I)	66960	33	35.9534	40.7337	44.3100	10748	FRM	
12(I)	66744	33	35.9349	40.4507	44.0174	10875	FRM	
13(I)	66976	33	35.9508	40.5483	44.1110	11064	FRM	
14(I)	66296	33	35.9567	40.5904	43.9854	10868	FRM	
Sequence End								
-----								
Freq. for encoded bitstream		: 30						
Hadamard transform		: Used						
Image (Encoding) format		: 320x240						
Image (Recon) format		: 320x240						
Error robustness		: Off						
Fast Motion Estimation		: On						
Search range		: 64						
Num of ref. frames used in P pred		: 5						
Total encoding time for the seq.		: 157.533 sec						
Sequence type		: IPPP (QP: I 33)						
RD-optimized mode decision		: used						
----- Average data all frames -----								
SNR Y(dB)		: 35.92						
SNR U(dB)		: 40.75						
SNR V(dB)		: 44.41						
Total bits		: 985512 (I 985512, P 0)						
Bit rate (kbit/s) @ 30.00 Hz		: 1971.02						
Bits to avoid Startcode Emulation		: 0						
Bits for parameter sets		: 0						
-----								
Exit ITM 15.0 encoder ver 201606								
PS E:\code\ITM15.0\bin>								

## 3、第三次参数信息：

```
QPFirstFrame      = 47 # Quant. param for first frame (intra) (0-63)
QPRemainingFrame  = 44 # Quant. param for remaining frames (0-63)
QBPBPicture       = 41 # Quant. param for B frames (0-63)
```

### 第三次运行结果信息:

```
Exit ITM 15.0 encoder ver 201606
PS E:\code\ITM15.0\bin> .\lencod.exe -f .\encoder_ai.cfg
Parsing Configfile .\encoder_ai.cfg.....

-----
Input YUV file           : E:\code\data\test.yuv
Output IVC bitstream     : test.bit
Output YUV file          : test_rec.yuv
Output log file           : log.dat
Output statistics file    : stat.dat
-----
Frame  Bit/pic  QP   SnrY   SnrU   SnrV   Time(ms)  FRM/FLD  IntraMBs
Sequence Header
0(I)    11696  47  28.6446 36.4896 40.5252   808      FRM
1(I)    12016  47  28.7509 36.4600 40.0550   845 FRM
2(I)    11448  47  28.6677 36.6472 40.3834   852 FRM
3(I)    11520  47  28.6581 36.5460 40.3166   842 FRM
4(I)    11736  47  28.6470 36.6127 40.3381   938 FRM
5(I)    12016  47  28.6028 36.6527 40.1753  1011 FRM
6(I)    11960  47  28.5499 36.6143 40.2409  1015 FRM
7(I)    11696  47  28.4450 36.4193 40.2755   965 FRM
8(I)    12592  47  28.5260 36.4870 40.5197  1079 FRM
9(I)    11992  47  28.4323 36.3532 40.3584  1026 FRM
10(I)   12384  47  28.4642 36.1559 40.3297  1158 FRM
11(I)   11608  47  28.4345 36.3850 40.3360  1139 FRM
12(I)   12040  47  28.4998 36.1301 40.1417  1019 FRM
13(I)   11864  47  28.4560 36.1770 40.0224  1154 FRM
14(I)   11688  47  28.4322 36.2416 39.6880  1206 FRM
Sequence End

-----
Freq. for encoded bitstream : 30
Hadamard transform         : Used
Image (Encoding) format    : 320x240
Image (Recon) format       : 320x240
Error robustness           : Off
Fast Motion Estimation     : On
Search range               : 64
Num of ref. frames used in P pred : 5
Total encoding time for the seq. : 15.057 sec
Sequence type              : IPPP (QP: I 47)
RD-optimized mode decision : used
----- Average data all frames -----
SNR Y(dB) : 28.55
SNR U(dB) : 36.42
SNR V(dB) : 40.25
Total bits : 178288 (I 178288, P 0)
Bit rate (kbit/s) @ 30.00 Hz : 356.58
Bits to avoid Startcode Emulation : 0
Bits for parameter sets : 0
-----
```

### 4、第四次参数信息和结果信息如下:

```
QPFfirstFrame = 55 # Quant. param for first frame (intra) (0-63)
QPRremainingFrame = 52 # Quant. param for remaining frames (0-63)
QPBpicture = 56 # Quant. param for B frames (0-63)
```

```
Bits for parameter sets : 0
-----
Exit ITM 15.0 encoder ver 201606
PS E:\code\ITM15.0\bin> .\lencod.exe -f .\encoder_ai.cfg
Parsing Configfile .\encoder_ai.cfg.....

-----
Input YUV file           : E:\code\data\test.yuv
Output IVC bitstream     : test.bit
Output YUV file          : test_rec.yuv
Output log file           : log.dat
Output statistics file    : stat.dat
-----
Frame  Bit/pic  QP   SnrY   SnrU   SnrV   Time(ms)  FRM/FLD  IntraMBs
Sequence Header
0(I)    4304  55  26.3463 35.3171 38.6488   307      FRM
1(I)    4008  55  26.2275 35.2371 38.7151   307 FRM
2(I)    3888  55  26.2394 35.4589 38.7757   308 FRM
3(I)    3992  55  26.2905 35.4160 38.8644   306 FRM
4(I)    4024  55  26.2389 35.4031 38.4958   587 FRM
5(I)    4112  55  26.2591 35.5148 38.9614   770 FRM
6(I)    4160  55  26.1736 35.4873 38.9347   840 FRM
7(I)    3976  55  26.1460 35.1417 38.8179   745 FRM
8(I)    4224  55  26.0881 35.2416 38.7276   741 FRM
9(I)    4168  55  26.1348 35.0723 38.2231   614 FRM
10(I)   4088  55  26.0754 35.1325 38.4287   308 FRM
11(I)   4184  55  26.1706 35.1854 38.7894   333 FRM
12(I)   4264  55  26.1801 34.9180 38.3965   331 FRM
13(I)   4152  55  26.1384 34.9006 38.0966   323 FRM
14(I)   4176  55  26.1511 34.9320 37.9298   304 FRM
Sequence End

-----
Freq. for encoded bitstream : 30
Hadamard transform         : Used
Image (Encoding) format    : 320x240
Image (Recon) format       : 320x240
Error robustness           : Off
Fast Motion Estimation     : On
Search range               : 64
Num of ref. frames used in P pred : 5
Total encoding time for the seq. : 7.124 sec
Sequence type              : IPPP (QP: I 55)
RD-optimized mode decision : used
----- Average data all frames -----
SNR Y(dB) : 26.19
SNR U(dB) : 35.22
SNR V(dB) : 38.59
Total bits : 61752 (I 61752, P 0)
Bit rate (kbit/s) @ 30.00 Hz : 123.50
Bits to avoid Startcode Emulation : 0
Bits for parameter sets : 0
-----
Exit ITM 15.0 encoder ver 201606
```



四次运行的结果信息汇总如下表：

次数	SNR Y(dB)	SNRU(dB)	SNR V(dB)	PSNR(dB)(411)	码率(kbps)
1	41.17	44.39	47.18	42.71	3565.10
2	35.92	40.75	44.41	38.14	1971.02
3	28.55	36.42	40.25	31.81	356.58
4	26.19	35.22	38.59	29.76	123.50

使用 python 实现绘制 PSNR 曲线：

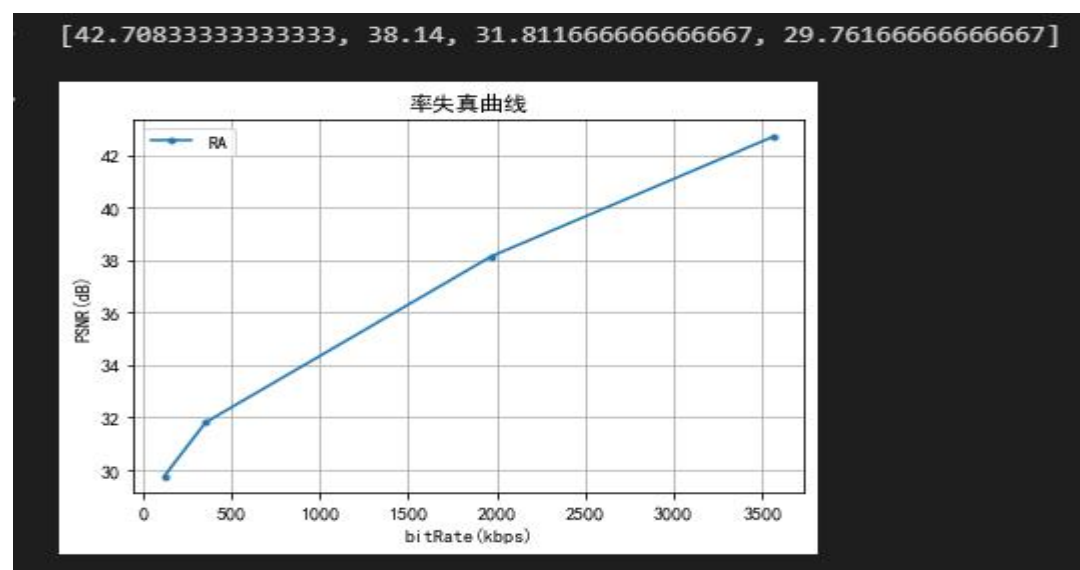
```
import matplotlib.pyplot as plt
plt.rcParams['font.sans-serif'] = ['SimHei']

# 数据信息
data_list = [[ 41.17,44.39,47.18],[ 35.92,40.75,44.41],[ 28.55,36.42,40.25],[26.19,35.22,38.59]]
bit_rate = [3565.10,1971.02,356.58,123.50]
psnr_list = []
m_res = 0

# 计算加权PSNR
for value in data_list:
    m_res = (value[0] * 4/6) + (value[1]* 1/6) + (value[2] * 1/6)
    psnr_list.append(m_res)
print(psnr_list)

# 绘制曲线
plt.figure()
plt.plot(bit_rate, psnr_list, '-.', label='RA')
plt.title('率失真曲线')
plt.ylabel('PSNR(dB)')
plt.xlabel('bitRate(kbps)')
plt.legend()
plt.grid(True)
plt.show()
```

PSNR 曲线如下图：



3、解码：

对第四次运行的结果进行 decode:

```
Exit ITM 15.0 encoder ver 201606
PS E:\code\ITM15.0\bin> .\ldecod.exe .\decoder.cfg
-----
Decoder config file           : E:\code\ITM15.0\bin\ldecod.exe
-----
Input IVC bitstream          : test.bit
Output decoded YUV 4:2:0     : test_dec.yuv
Output status file           : log_dec
Input reference file          : test_rec.yuv
-----
Frame  TR   QP   SnrY   SnrU   SnrV   Time(ms)  FRM/FLD  Bits  EmulateBits
Sequence Header
0(I)    0   55  0.0000  0.0000  0.0000    9      FRM      0      2
1(I)    0   55  0.0000  0.0000  0.0000    6      FRM      0      2
2(I)    0   55  0.0000  0.0000  0.0000    5      FRM      0      2
3(I)    0   55  0.0000  0.0000  0.0000    4      FRM      0      2
4(I)    0   55  0.0000  0.0000  0.0000    5      FRM      0      2
5(I)    0   55  0.0000  0.0000  0.0000    7      FRM      0      0
6(I)    0   55  0.0000  0.0000  0.0000    6      FRM      0      0
7(I)    0   55  0.0000  0.0000  0.0000    5      FRM      0      0
8(I)    0   55  0.0000  0.0000  0.0000    5      FRM      0      0
9(I)    0   55  0.0000  0.0000  0.0000    6      FRM      0      0
10(I)   0   55  0.0000  0.0000  0.0000    6      FRM      0      0
11(I)   0   55  0.0000  0.0000  0.0000    5      FRM      0      0
12(I)   0   55  0.0000  0.0000  0.0000    4      FRM      0      0
13(I)   0   55  0.0000  0.0000  0.0000    4      FRM      0      0
14(I)   0   55  0.0000  0.0000  0.0000    4      FRM      0      0

min bbv_buffer_size in bitstream is 1

min bbv_buffer_size in bitstream is 0
min initial bbv_delay(0) time is -nan(ind)(s)
Sequence End

Second(s)      Bitrate(bit/s)
0              32

----- Average SNR all frames -----
SNR Y(dB)      : 0.00
SNR U(dB)      : 0.00
SNR V(dB)      : 0.00
Total decoding time : 0.081 sec
```

使用 YUView 进行视频的检查：

