Source   : PTT Research, Netherlands

Title   : PSTN Video Coding on 8 and 16 kbit/s using a down scaled
            H.261 codec

Purpose : Information

1   Introduction

CCITT WP XV/1 has taken up studies on video codecs at bitrates below 64
kbit/s. As an example in this paper a down scaled H.261 codec is described.
The modifications to the codec are none. Both in simulations and in experimental hardware, working with a modem on PSTN, is shown that a codec working
fully to the H.261 syntax can produce an acceptable coding result.
In a tape demonstration is shown that a QCIF resolution with a frame rate
6.25 Hz gives acceptable pictures.
Although many technical problems remain to be solved, a video bitstream conforming to H.261 can be a step towards interworking of PSTN videophone
service with ISDN.

2   H.261 at ultra low rates

Although H.261 during it's development has been optimized for bitrates ranging
from 64 kbit/s to 2 Mbit/s, experiments at much lower rates (8 and 16 kbit/s)
already give acceptable outputs. For the experiments a QCIF resolution is used.

3   Simulation results

For simulations reference model 8 (RM8) is used. The buffer size is set to 1600
bits. Simulations are carried out for the sequences Claire and Salesman. The
spatial resolution is QCIF and the temporal resolution 6.25 Hz for Claire and
5 Hz for Salesman. For the sequence Claire statistics are included in this paper
(annex A).

4   Experimental hardware

The tape demonstration shows the output of the decoder after a transfer through
internal PABX analogue lines. The hardware has already been tested on local

and interlocal (long distance) PSTN connections, with similar results.

The system has the following components:

- Camera interface

- Encoder

- Two modems

- Decoder

- Monitor interface

4.1 Camera Interface

The camera interface can accept both PAL and RGBS 50 Hz signals. It converts the analogue video signal into a digital QCIF signal. The transfer of pictures is asynchronous. A signal trigger signal from the encoder starts the transfer of a new picture to the encoder. A maximum of 25 pictures per second can be reached.

4.2 Encoder

The encoder produces a H.261 bitstream except for the BCH forward error correction. Motion compensation is not being used. The frame rate of the outgoing pictures varies from an average of 1 Hz up to 6 Hz. A 1920 bits transmission buffer is used.

4.3 Modems

Two types of modems have been tested for this application:

- V.32 (9600 bps)

- V.32bis (14400 bps)

For the tape demo the V.32bis modem is used. Thanks to asynchronous transfer between encoder and modem at a maximum of 19200 bps and MNP5 compression and error correction, about 15 kbit/s is transferred.

4.4 Decoder

The decoder is a H.261 implementation, except that it does not accept motion compensated macro blocks.

4.5 Monitor Interface

The monitor interface produces analogue RGBS signals at 50 Hz.

4.6 Results

Experience with the experimental hardware has shown that for PSTN-videophone service the quality of service is negatively influenced by:

- Long call set up procedure.
  The call set up of the modems takes over 2 seconds.

- Long end-to-end delay for video.
  Due to the error correction in the modems the end to end delay is over 2 seconds.

- A low spatial and temporal resolution.
  The spatial resolution is QCIF (what is sufficient for videophone scenes), but due to the lack of motion compensation the frame rate drops to less than 2 Hz.

5 Tape demonstration

The accompanying tape shows the results of the hardware codec simulation results at 8 and 16 kbit/s.

- hardware codec 8 kbit/s

  - Debbie (live)

- hardware codec 16 kbit/s

  - Debbie (live)
  - Claire
  - Dawn

- simulations 8 kbit/s

  - Claire
  - Salesman

- simulations 16 kbit/s

  - Claire
  - Salesman

6 Conclusion

A codec based on H.261 can be used in a PSTN environment.
A hardware implementation shows an acceptable quality. Simulations show that further improvements are possible to improve the experimental hardware by adding motion estimation and motion compensation.
For a videophone service in PSTN the following items need to be studied: call set up duration, end-to-end delay, spatial and temporal resolution for video. Interworking with existing videophone services needs further study.

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A Statistics Claire 8 kbit/s

Statistics Reference Model 8

PTT Research Neher Laboratories
Visual Communications Research
Date : 22 - 6 - 1992

Sequence : CLAIRE
Modification : 8 kbit/s
Number of tracks for statistics : 99   Temporal resolution : 6.3 Hz

Item			15th pict.	mean seq
1. RMS for luminance			5.535	5.610
2. SNR for luminance			33.268	33.164
SNR for chrominance(U)			34.726	35.057
SNR for chrominance(V)			38.487	38.787
3. Mean value of step size			31.267	32.450
4. Mean value of the number of non-zero coefficients			1.833	2.685
5. Mean value of the number of zero-coefficients			6.704	5.904
6. Block type of Macro	Fixed		69	71
	Coded		17	14
	Coded MC		9	6
	Fixed MC		2	2
	Intra		0	1
	Coded + Q		1	4
	Coded MC + Q		0	1
	Intra + Q		1	0
7. Block type of Y	Fixed		319	322
	Coded		29	31
	Coded MC		15	17
	Fixed MC		29	22
	Intra		4	4
8. Block type of UV	Fixed		171	174
	Coded		3	3
	Coded MC		1	2
	Fixed MC		21	17
	Intra		2	2
9. Number of bits	Macro attributes		240	248
	End of block		108	117
	Motion vectors		49	60
	Coefficients	Y	508	709
		U	28	20
		V	12	16
		Total	548	745
	Total		945	1170

Bits for first frame	9570
Number of forced to fixed mb's	0
Bits stuffed due to buffer underflow	0

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B   Statistics Claire 16 kbit/s

Statistics Reference Model 8

PTT Research Neher Laboratories
Visual Communications Research
Date : 22 - 6 - 1992

Sequence   : CLAIRE
Modification   : 16 kbit/s
Number of tracks for statistics : 99   Temporal resolution : 6.3 Hz

Item			15th pict.	mean seq
1.	RMS for luminance		4.324	4.347
2.	SNR for luminance		35.414	35.382
	SNR for chrominance(U)		36.253	36.651
	SNR for chrominance(V)		39.902	40.401
3.	Mean value of step size		19.818	19.586
4.	Mean value of the number of non-zero coefficients		3.057	4.057
5.	Mean value of the number of zero-coefficients		9.841	8.894
6.	Block type of Macro	Fixed	66	63
		Coded	15	20
		Coded MC	12	9
		Fixed MC	0	1
		Intra	0	1
		Coded + Q	4	4
		Coded MC + Q	1	1
		Intra + Q	1	0
7.	Block type of Y	Fixed	308	305
		Coded	32	45
		Coded MC	33	27
		Fixed MC	19	15
		Intra	4	4
8.	Block type of UV	Fixed	165	169
		Coded	5	6
		Coded MC	12	6
		Fixed MC	14	15
		Intra	2	2
9.	Number of bits	Macro attributes	333	318
		End of block	176	180
		Motion vectors	50	55
		Coefficients Y	1340	1777
		Coefficients U	102	72
		Coefficients V	48	40
		Total	1490	1889
		Total	2049	2442

Bits for first frame	9570
Number of forced to fixed mb's	0
Bits stuffed due to buffer underflow	0