VIDEO ERROR CORRECTION METHOD FOR DAMAGED IP PACKETS USING CHECKSUM-FILTERED LIST DECODING

ETS-105

BACKGROUND

In wireless networks, video packets are often affected by bit errors during their transport. Typically, when a packet is corrupted by such errors, it is discarded and error concealment methods are applied. However, error concealment creates undesirable artifacts in videos with complex motion. List decoding approaches have been proposed to repair video streams. They attempt to decode various versions of the received packets on which bits have been flipped until the resulting video meets certain conditions (valid video syntax, adequate number of decoded blocks, etc.). But these methods rely of soft information to rank the candidates, otherwise their computational complexity is prohibitive.

TECHNOLOGY

The technology identifies the possible locations of bit errors in a corrupted video packet by analyzing the pattern of the calculated UDP checksum. Such information is then used to repair the damaged packets (rather than discarding them) using list decoding.

The technology works under the following assumptions:

• The video packets are transmitted using the UDP/IP protocol and contain a checksum (the UDP checksum) permitting to identify corrupted packets and analyze the UDP pattern.

• The video packets are not extensively damaged (e.g. the bit error rate is less than 10-3).

• The corrupted video packets are not discarded (their content is reused in the proposed correction method).

COMPETITIVE ADVANTAGES

The method provides the following benefits:

• Significantly lower computational complexity compared to traditional list decoding approaches (97% fewer candidates for 1 bit in error, 99.6% fewer candidates when considering 2 bits in error, etc.)

• Works with hard information (0s and 1s) as well as soft information (e.g. log-likelihood ratio).

• Excellent quality compared error concealment (see results in Figures 1 to 4).

• Fully compatible with existing standards

APPLICATIONS

• H.264/HEVC video transmission over wireless networks.

• Can be combined with other error correction methods (FEC, AL-FEC, etc.)

TECHNOLOGY DEVELOPMENTAL STAGE

Workable prototype

INTELLECTUAL PROPERTY STATUS

Patent pending with priority date of September 2016.

BUSINESS OPPORTUNITY

The Technology is available for licensing.

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Sequence	QP	Average PSNR of reconstructed corrupted frame					
		Intact	JM-FC	STBMA	HO-MLD	CFLD	
City (704×576)	22	40.88	36.47	40.32 (+3.58)	39.60 (+3.12)	40.77 (+4.3)	88%
	27	36.63	34.38	36.43 (+2.05)	35.81 (+1.43)	36.6 (+2.21)	84%
	32	33.08	32.06	32.99 (+0.93)	32.79 (+0.73)	33.06 (+1)	86%
	37	30.05	29.54	29.99 (+0.45)	29.95 (+0.41)	30.01 (+0.46)	78%
Crew (704×576)	22	41.76	39.21	40.69 (+1.48)	40.25 (+1.04)	41.76 (+2.55)	86%
	27	38.52	37.25	38.07 (+0.82)	37.69 (+0.72)	38.51 (+1.27)	84%
	32	35.7	34.91	35.38 (+0.47)	35.33 (+0.42)	35.64 (+0.73)	82%
	37	32.99	32.58	32.82 (+0.25)	32.83 (+0.25)	32.96 (+0.39)	80%
Ice (704×576)	22	43.73	38.58	41.83 (+3.26)	41.78 (+3.2)	43.49 (+4.91)	76%
	27	41.45	37.25	39.69 (+2.43)	39.75 (+2.5)	41.31 (+4.06)	90%
	32	39	36.38	38.11 (+1.72)	38.02 (+1.63)	38.93 (+2.55)	76%
	37	36.43	34.55	35.94 (+1.39)	35.91 (+1.36)	36.39 (+1.84)	78%
Foreman (352×288)	22	41.34	37.41	39.31 (+1.9)	39.21 (+1.8)	41.06 (+3.65)	64%
	27	37.83	35.65	36.8 (+1.14)	36.59 (+0.94)	37.66 (+2.01)	52%
	32	34.68	33.61	34.14 (+0.53)	34.14 (+0.53)	34.57 (+0.96)	74%
	37	31.96	31.47	31.61 (+0.14)	31.73 (+0.26)	31.94 (+0.47)	90%
Opening ceremony (720×480)	22	39.32	38.26	38.55 (+0.29)	38.8 (+0.54)	39.32 (+1.06)	88%
	27	35.39	35.03	35.08 (+0.05)	35.11 (+0.09)	35.34 (+0.31)	84%
	32	31.39	31.2	31.24 (+0.04)	31.26 (+0.06)	31.39 (+0.18)	94%
	37	27.76	27.66	27.71 (+0.04)	27.72 (+0.06)	27.76 (+0.1)	92%
Whale show (720×480)	22	41	35.69	36.58 (+0.89)	36.96 (+1.28)	40.93 (+5.24)	68%
	27	36.37	33.54	34.22 (+0.68)	34.42 (+0.88)	36.34 (+2.8)	72%
	32	32.08	30.86	31.2 (+0.34)	31.16 (+0.31)	32.06 (+1.2)	84%
	37	28.36	27.89	27.99 (+0.1)	27.97 (+0.08)	28.33 (+0.44)	76%
Driving (720×480)	22	41	34	38.02 (+4.02)	37.28 (+3.28)	40.45 (+6.45)	70%
	27	37.05	32.72	35.7 (+2.98)	34.72 (+2)	36.91 (+4.19)	64%
	32	33.3	31.03	32.76 (+1.72)	32.17 (+1.14)	33.19 (+2.16)	82%
	37	30.05	28.96	29.79 (+0.84)	29.59 (+0.63)	30 (+1.04)	82%
Walk (720×576)	22	43.29	30.27	34.66 (+4.39)	33.79 (+3.51)	42.48 (+12.21)	76%
	27	39.33	29.65	34.77 (+5.12)	33.34 (+4.7)	39.14 (+9.5)	72%
	32	35.56	29.33	33.52 (+4.19)	32.65 (+3.32)	35.23 (+5.9)	82%
	37	31.91	28.59	31.21 (+2.61)	30.72 (+2.12)	31.78 (+3.19)	78%
Average gain over JM-FC			0	+1.6	+1.39	+2.79	79%

Figure 1: Average PSNR for proposed CFLD on H.264 compared to JM frame copy (JM-FC), STBMA [1], and HO-MLD [2]. The last column shows the percentage of packets fully corrected by the proposed approach.

Sequence	QP	Average PSNR of reconstructed corrupted frame			
		Intact	HM-FC	CFLD	
Class B Sequences					
BQ Terrace (1920×1080)	22	38.89	35.16	35.76 (+0.6)	58%
	27	36.3	34.32	35.68 (+1.36)	82%
	32	33.76	32.37	33.66 (+1.29)	92%
	37	31.17	30.26	31.15 (+0.89)	89%
Basketball Drive (1920×1080)	22	39.89	32.53	38.49 (+5.95)	84%
	27	38.23	32.28	37.67 (+5.39)	90%
	32	36.7	31.81	36.47 (+4.66)	96%
	37	34.8	31.51	34.8 (3.29)	100%
Cactus (1920×1080)	22	39.20	36.82	37.89 (+1.07)	76%
	27	36.74	34.59	36.25 (+1.66)	88%
	32	34.65	33.56	34.59 (+1.03)	98%
	37	32.31	31.55	32.03 (+0.48)	96%
Kimono (1920×1080)	22	42.15	36.69	41.62 (+4.93)	90%
	27	40.04	36.10	39.81 (+3.71)	96%
	32	38.20	34.78	38.07 (+3.29)	98%
	37	35.30	33.40	35.30 (+1.9)	98%
Park Scene (1920×1080)	22	40.11	37.39	39.63 (+2.24)	82%
	27	37.33	35.42	37.19 (+1.77)	96%
	32	34.83	33.86	34.74 (+0.88)	94%
	37	32.17	31.58	32.17 (+0.59)	100%
Average gain over HM-FC			0	+2.35	91%
Class C Sequences					
Basketball Drill (832×480)	22	40.44	31.9	39.91 (+8.01)	94%
	27	37.41	30.84	37.06 (+6.22)	94%
	32	34.66	30.07	34.56 (+4.49)	98%
	37	32.11	29.21	32 (+2.8)	98%
BQ Mall (832×480)	22	39.84	31.04	39.16 (+8.12)	92%
	27	36.91	30.03	36.23 (+6.2)	92%
	32	33.86	29.69	33.48 (+3.79)	94%
	37	30.68	27.83	30.5 (+2.67)	92%
Party Scene (832×480)	22	38.14	32.57	35 (+2.43)	72%
	27	34.66	31.32	33.52 (+2.2)	84%
	32	31.07	29.38	30.98 (+1.6)	96%
	37	27.76	26.94	27.47 (+0.53)	94%
Race Horses (832×480)	22	39.29	26.01	35.94 (+9.93)	70%
	27	36.21	25.48	35.16 (+9.68)	90%
	32	32.6	25.8	32.18 (+6.38)	92%
	37	29.44	24.98	29.32 (+4.34)	96%
Average gain over HM-FC			0	+4.97	91%

Figure 2: Average PSNR for proposed CFLD on HEVC compared to frame copy applied to HM (HM-FC). The last column shows the percentage of packets fully corrected by the proposed approach.

[1] Y. Chen, Y. Hu, O. C. Au, H. Li, and C. W. Chen, "Video error concealment using spatio-temporal boundary matching and partial differential equation," IEEE Trans. Multimedia., vol. 10, no. 1, pp. 2–15, 2008.

[2] F. Caron and S. Coulombe, "Video error correction using soft-output and hard output maximum likelihood decoding applied to an H.264 baseline profile," IEEE Trans. Circuits Syst. Video Technol., vol. 25, no. 7, pp. 1161–1174, 2015.