SLIGHT-DELAY SHAPED VARIABLE BIT RATE (SD-SVBR) TECHNIQUE FOR VIDEO TRANSMISSION

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by

AHMAD SUKI BIN CHE MOHAMED ARIF

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ABSTRAK

Matlamat utama tesis ini adalah bagi mempersembahkan satu bentuk baru Kadar Bit Pemboleh Ubah (VBR) untuk penghantaran video, yang memainkan peranan penting dalam penghantaran trafik video melalui Internet. Ini adalah kerana terdapat peningkatan mendadak dalam aplikasi media video melalui Internet, dan data video biasanya berciri trafik yang meletus secara mendadak, yang mengarah kepada ketidak-tetapan lebar jalur Internet. Algoritma baru pembentukan ini, yang dirujuk sebagai Sedikit Lengah - Pembentukan Kadar Bit Pemboleh Ubah (SD-SVBR), bertujuan untuk mengawal kadar kelajuan video untuk penghantaran aplikasi video. Ianya direka-bentuk berdasarkan algoritma Pembentukan Kadar Bit Pemboleh Ubah (SVBR) dan telah dilaksanakan dalam Penyelaku Rangkaian 2 (ns-2). Algorithma SVBR telah direka untuk aplikasi video masa nyata dan ia mewarisi beberapa keterbatasan dan kelemahan kerana pada proses-prosesnya terselit anggaran atau ramalan. SVBR mengalami beberapa masalah, seperti terjadinya penurunan mendadak kadar data yang tidak diingini, baldi limpah atas, kewujudan kadar data rendah, dan pengenerasian ketidak-tetapan negatif yang berulangan. Algoritma baru ini mampu menghasilkan satu kadar data tinggi dan pada masa yang sama kestabilan Pengkuantuman Parameter (QP) yang lebih baik pada babak video. Sebagai tambahan, kadar data diperbentuk dengan cekap untuk mengelakkan kenaikan atau penurunan mendadak yang tidak diingini, dan untuk mengelakkan baldi limpah atas. Bagi mencapai matlamat tersebut, SD-SVBR memiliki tiga strategi; memproses Kumpulan Gambar (GoP) hadapan babak video dan mendapatkan senarai QP-ke-kadar data, mendimensikan kadar data kepada penggunaan tinggi baldi-bocor, dan melaksanakan langkah secara berhati-hati dalam mengikuti nilai QP sebelumnya. Walau bagaimanapun, algorithma ini perlu disekalikan dengan algorithma yang dapat memberi maklum balas status rangkaian untuk memberi kebaikkan kawalan kadar video yang menyeluruh. Sebuah kombinasi beberapa klip video yang terdiri daripada berbagai kadar data video, telah digunakan untuk tujuan menilai prestasi SD-SVBR. Keputusan kajian menunjukkan bahawa SD-SVBR berjaya memperolehi nilai Nisbah Puncak Isyarat-kepada-Hingar (PSNR) yang hebat secara menyeluruh. Dalam pada itu, pada hampir kesemua kes, ia memperolehi satu kadar data tinggi tetapi tanpa baldi limpah atas, memanfaatkan penggunaan baldi dengan baik, dan yang menariknya, ia masih berupaya memperolehi satu ketidak-tetapan QP yang lebih rata.

ABSTRACT

The aim of this thesis is to present a new shaped Variable Bit Rate (VBR) for video transmission, which plays a crucial role in delivering video traffic over the Internet. This is due to the surge of video media applications over the Internet and the video typically has the characteristic of a highly bursty traffic, which leads to the Internet bandwidth fluctuation. This new shaped algorithm, referred to as Slight Delay - Shaped Variable Bit Rate (SD-SVBR), is aimed at controlling the video rate for video application transmission. It is designed based on the Shaped VBR (SVBR) algorithm and was implemented in the Network Simulator 2 (ns-2). SVBR algorithm is devised for real-time video applications and it has several limitations and weaknesses due to its embedded estimation or prediction processes. SVBR faces several problems, such as the occurrence of unwanted sharp decrease in data rate, buffer overflow, the existence of a low data rate, and the generation of a cyclical negative fluctuation. The new algorithm is capable of producing a high data rate and at the same time a better quantization parameter (QP) stability video sequence. In addition, the data rate is shaped efficiently to prevent unwanted sharp increment or decrement, and to avoid buffer overflow. To achieve the aim, SD-SVBR has three strategies, which are processing the next Group of Picture (GoP) video sequence and obtaining the QP-to-data rate list, dimensioning the data rate to a higher utilization of the leaky-bucket, and implementing a QP smoothing method by carefully measuring the effects of following the previous QP value. However, this algorithm has to be combined with a network feedback algorithm to produce a better overall video rate control. A combination of several video clips, which consisted of a varied video rate, has been used for the purpose of evaluating SD-SVBR performance. The results showed that SD-SVBR gains an impressive overall Peak Signal-to-Noise Ratio (PSNR) value. In addition, in almost all cases, it gains a high video rate but without buffer overflow, utilizes the buffer well, and interestingly, it is still able to obtain smoother QP fluctuation.

DECLARATION

Some of the work presented in this thesis have been published as listed below.

[1] A. Suki M. Arif, Osman Ghazali and Suhaidi Hassan, A Survey on Buffer and Rate Adaptation Optimization in TCP-Based Streaming Media Studies, International Conference on Network Applications, Protocols and Services 2008 (NetApps2008), ISBN 978-983-2078-33-3, on 21 - 22 Nov. 2008. [This paper has appeared in IEEE Xplore. Indexed by Scopus and IEEE Xplore]

[2] A. Suki M. Arif, Suhaidi Hassan, Osman Ghazali and Shahrudin Awang Nor. "Evalvid-RASV: Shaped VBR Rate Adaptation Stored Video System," in the Proceedings of *The 2010 International Conference on Information and Network Technology (ICINT 2010)*, Shanghai, China, vol. 5, pp. 246-250, Jun 2010. [This paper has been included in the IEEE Xplore and CSDL, and submitted to INSPEC, Thomson ISI Proceeding (ISTP), Ei Compendex for indexing.]

[3] Shahrudin Awang Nor, Suhaidi Hassan, Osman Ghazali and A. Suki M. Arif. "Friendliness of DCCP towards TCP over Large Delay Link Network," in the Proceedings of *The 2010 International Conference on Information and Network Technology (ICINT 2010)*, Shanghai, China, vol. 5, pp. 286-291, Jun 2010. [This paper has been included in the IEEE Xplore and CSDL, and submitted to INSPEC, Thomson ISI Proceeding (ISTP), Ei Compendex for indexing.]

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[9] A. Suki M. Arif, Suhaidi Hassan, Osman Ghazali, Mohammed M. Kadhum “Design of a New Shaped Control Algorithm for a Video Application,” Accepted to International Journal of Digital Content Technology and its Applications (JDCTA), 2011. [JDCTA Publications Indexed @ ISI Thomson(under review), Elsevier, EI(Confirmed), SCOPUS(Confirmed), INSPEC(confirmed), PROQUESTS(confirmed) and many other citation databases]. ***This paper has received encouraging comments, “The work is solid and comprehensive. Overall presentation of this paper is good.”***]

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ABBREVIATIONS

AQM	Active Queue Management
ASMP	Adaptive Smooth Multicast Protocol
ASSP	Adaptive Smooth Simulcast Protocol
AVC	Advanced Video Coding
BDP	Bandwidth Delay Product
B-frame	Bi-directional-frames
BL	base layer
bps	bits per second
C	chroma/chrominance
CBR	Constant Bit Rate
CIF	Common Intermediate Format
CZD	Czenakowski distance
DCCP	Datagram Congestion Control Protocol
DCT	Discrete Cosine Transform
DRS	Dynamic Rate Shaping
ECN	Explicit Congestion Notification
EL	enhancement layer
FGS	Fine Granular Scalability

fps	frame per seconds
GCRA	Generic Cell Rate Algorithm
GloMoSim	Global Mobile Simulator
GoP	Group of Picture
GS	Guaranteed Service
GUI	Graphical User Interface
HoD	Histogram of Difference
IEC	International Electrotechnical Commission
I-frame	Intra-frames
IFTP	Internet Friendly Transport Protocol
ISO	International Organization for Standardization
ITU-T	Telecommunication Standardization Sector of the International Telecommunications Union
JVT	Joint Video Team
LDA+	Loss-Delay Based Adaptation Algorithm
LPR	Linear Proportional Response
MB	Macroblock
MDC	Multiple Description Coding
MOS	Mean Opinion Score
MPEG	Moving Picture Experts Group
NAM	Network Animator
NCA	Nominee-Based Congestion Avoidance
NF	Neural-Fuzzy
ns-2	Network Simulator 2

NTSC	National Television Standards Committee
PAL	Phase Alternating Line
PEVQ	Perceptual Evaluation of Video Quality
P-frame	Predictive-frames
PSNR	Peak Signal-to-Noise Ratio
QCIF	Quarter Common Intermediate Format
QoS	Quality of Service
QP	Quantization Parameter
RAP	Rate Adaptation Protocol
RBF	Rule-Based Fuzzy
R-D	Rate-Distortion
REAL	Realistic And Large
RLA	Random Listening Algorithm
RR	Receiver Report
RTCP	Real-Time Transport Control Protocol
RTP	Real-time Transport Protocol
RTT	Round-Trip Time
SD-SVBR	Slight Delay - Shaped Variable Bit Rate
SNR	Signal-to-Noise Ratio
SR	Sender Report
SVBR	Shaped Variable Bit Rate
SVC	Scalable Video Coding
Tcl	Tool Command Language
TCP	Transmission Control Protocol

TEAR	TCP Emulation At Receiver
TES	Transform Expand Sample
TFRC	TCP-Friendly Rate Control
UDP	User Datagram Protocol
VBR	Variable Bit Rate
VBV	video buffer verifier
VoD	Video on Demand
VQM	Video Quality Measurement
Y	luma/luminance

CHAPTER ONE

INTRODUCTION

This thesis is about enhancing rate control or rate adaptation for video transmission, which plays an important role in delivering video traffic over the Internet. This is due to the fact that video data is highly bursty and the Internet bandwidth fluctuates. The aim of this chapter is to place the thesis in its context by initially covering a brief introduction to video rate control issues. Later, the description of the research properties are stated, which includes the motivation, scope, objectives, key research steps, and the contributions of the work done in this thesis. In the last section, the whole thesis organization is presented.

1.1 Video Transmission and Rate Control Issues

Recent years have witnessed an explosive growth of the Internet and increasing demand for multimedia information services. Multimedia based applications via the Internet have received tremendous attention. The surge of video media applications over the Internet are attributed to the increasing capacity of the Internet and its cost-effectiveness. In spite of the growing networking capabilities of the modern Internet and sophisticated techniques used by today's video coding, transmitting video over the Internet is still a great challenging task, as stated in [4]. In order

The contents of the thesis is for internal user only

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