DISTRIBUTED PROCESSING OF MPEG-2 VIDEO ENCODING ON MICROSOFT WINDOWS PLATFORM

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For my beloved mum, sister and late father

DEDICATION

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ABSTRACT

MPEG-2 Video standard is a high resolution digital video format developed by the Moving Picture Experts Group (MPEG) that specifies the coded bit stream for high quality digital video. MPEG-2 Video encoding is a heavy-duty task that needs a lot of processing power. The video encoding time depends mostly on the computer's CPU clock speed. To make the encoding process faster and better on existing Microsoft Windows (MS) platform (98/Me/2000/XP), distributed processing of MPEG-2 Video encoding (DPMVE) system can be implemented using TCP/IP with existing PCs on a 10/100 Mbps Local Area Network (LAN). The video encoding process can be distributed to all connected computers that are idle and fully utilize them. When each computer finishes the encoding process, the result will be returned and combined at the main computer that originated the job. Instead of doing the MPEG-2 Video encoding job alone, distribution of the MPEG-2 Video encoding process is better and faster by utilizing idle PCs. It also saves a lot of time over doing such heavy-duty processing with just one computer. Multiple experiments were carried out from one to fifteen PCs in the computer lab of Masters of Education, KUiTTHO. The results obtained from this research prove that the DPMVE system has met the DP feature, which is, the combination of a numbers of PCs to do MPEG-2 Video encoding at the speed of a super computer on MS Windows platform.

ABSTRAK

Kepiawaian video MPEG-2 merupakan sejenis video digital resolusi tinggi yang dibangunkan oleh *Moving Picture Experts Group* (MPEG). Kepiawaian MPEG-2 ini juga menentukan taraf bait yang berkod untuk video digital yang berkualiti tinggi. Pengekodan video MPEG-2 adalah kerja berat yang memerlukan banyak kuasa pemprosesan komputer. Masa yang digunakan untuk pengekodan video kebanyakannya bergantung kepada kelajuan jam pemproses (CPU) sesebuah komputer. Untuk mempercepat dan memperbaiki lagi proses pengekodan di dalam sistem operasi *Microsoft Windows* (MS 98/Me/2000/XP), pengekodan video MPEG-2 (*DPMVE*) boleh dilaksanakan dengan menggunakan kaedah pengagihan kuasa pemproses. Proses ini dilaksanakan dengan menggunakan *TCP/IP* dan rangkaian tempatan (*LAN*) berkelajuan 10/100 Mbps yang sedia ada. Proses pengekodan video boleh dibahagikan kepada setiap komputer yang sentiasa berada dalam keadaan lega dan menggunakan semua masa lega ini dengan sepenuhnya. Apabila setiap komputer ini telah menghabiskan proses pengekodan video, hasilnya akan dikembalikan kepada komputer utama dan digabungkan di situ untuk menghasilkan video MPEG-2. Kaedah ini dapat menjimatkan masa yang digunakan untuk proses pengekodan video di mana ia merupakan sejenis proses yang amat beban mengambil masa yang lama pada sesebuah komputer. Pelbagai eksperimen untuk satu hingga 15 buah komputer telah dijalankan di Makmal Komputer Sarjana Pendidikan, KUiTTHO. Keputusan yang diperolehi daripada penyelidikan ini membuktikan bahawa sistem *DPMVE* telah memenuhi ciri-ciri pengedaran kuasa pemproses, iaitu kombinasi beberapa buah komputer untuk melaksanakan kerja pengekodan video MPEG-2 pada kelajuan yang tinggi dalam sistem operasi *Microsoft Windows*.

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LIST OF ABBREVIATIONS

AAC	-	Advanced Audio Coding
AAL	-	ATM Adaptation Layer
API	-	Application Programming Interface
ARPANET	-	Advanced Research Projects Agency Network
ATA	-	Advanced Technology Attachment
ATM	-	Asynchronous Transfer Mode
ATS	-	Academic Technology Services
AVI	-	Audio-Video Interleave
CCIR	-	Consultative Committee for International Radio
CPU	-	Central Processing Unit
DC	-	Discrete Cosine
DCT	-	DC Transformation
DDR RAM	-	Double Data Rate Random Access Memory
DP	-	Distributed processing
DPMVE	-	DP of MPEG-2 Video Encoding
DVD	-	Digital Versatile Disc
DVI	-	Digital Video Interactive
e.g.	-	As an example
EBU	-	European Broadcast Union
etc.	-	etcetera
GoM	-	Group of Macroslices
GOP	-	Group of Pictures
GUI	-	Graphical User Interface
HDD	-	Hard Disk Drive
HDTV	-	High Definition Television
i.e.	-	Id est (that is).

IBM	-	International Business Machines
ICMP	-	Internet Control Message Protocol
IDCT	-	Inverse DCT
IDE	-	Integrated Device Electronics
IEC	-	International Electrotechnical Commission
IP	-	Internet Protocol
IS	-	International Standard
ISDN	-	Integrated Services Digital Network
ISO	-	International Organization for Standardization
ITU	-	International Telecommunications Union
ITU-RS	-	ITU-Radiocommunication Sector
ITU-TS	-	ITU-Telecommunications Standardization
JTC1	-	Joint Technical Committee 1
LAN	-	Local Area Network
MAC	-	Media Access Control
MB/s	-	Megabyte per second
Mbps	-	Megabit per second
MIMD	-	Multiple Instruction Multiple Data
MPEG	-	Moving Picture Experts Group
MPI	-	Message Passing Interface
MS	-	Microsoft
MS-DOS	-	Microsoft Disk Operating System
NTSC	-	National Television System Committee
OS	-	Operating System
PAL	-	Phase Alternating Line
PC	-	Personal Computer
RFCs	-	Requests for Comments
SATA	-	Serial ATA
SC29	-	Sub-committee 29
SDTV	-	Standard Definition Television
SECAM	-	SEquential Couleur Avec Memoire
SIF	-	Source Input Format
SIMD	-	Single Instruction Multiple Data
SMP	-	Symmetric Multiprocessor

SMPTE	-	Society of Motion Picture and Television Engineers
SPMD	-	Single Program Multiple Data
SVCD	-	Super VCD
TCP/IP	-	Transmission Control Protocol/Internet Protocol
TMC	-	Thinking Machines Corporation
TTL	-	time-to-live
UDP	-	User Datagram Protocol
US	-	United States
USD	-	United States Dollar
VB	-	Visual Basic
VCD	-	Video Compact Disc
VHS	-	Video Home System
WG11	-	Working Group 11

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CHAPTER I

INTRODUCTION

1.1 An Introduction to Distributed Processing and MPEG-2

This chapter gives a brief preview of distributed processing, MPEG-2 Video and MPEG-2 Video encoding. The research objectives, scope of research, problem statement and overall architecture of DPMVE are also discussed in this chapter.

1.1.1 Distributed Processing

Since computers existed, some people have dreamt of combining the power of more than one processor. When this is done with several processors physically linked together in one box, it's called a parallel processor. When it is done with several boxes closely linked together, usually in the same room, it is called a cluster. When it is done using several computers in widely separated locations, it is called distributed processing (DP) or distributed computing.

DP computer systems are clusters of low-end personal computers dedicated to distributing computation and running software that allows the system to be viewed as a unified computer system or a high-end computer.

When a big and complicated task is split into many smaller tasks to distribute the workload, a network of typical home computers or lab computers can be used to

process the original task. The power of these networks such as LAN can rival larger and more expensive supercomputers at a fraction of the cost and time. Typical participation in a DP project involves downloading and installing a client program on the user's computer. This client then fetches an operation unit from a server. Once the client machine processes the operation, the result is returned to the server in exchange for a new operation unit.

1.1.2 MPEG-2

MPEG (pronounced M-peg), which stands for Moving Picture Coding Experts Group, is the acronym given to a family of international standards used for coding audio-visual information in a digital compressed format. The MPEG family of standards includes MPEG-1, MPEG-2, MPEG-7 and MPEG-21, formally known as ISO/IEC-11172, ISO/IEC-13818, ISO/IEC-14496, ISO/IEC-15938 and ISO/IEC-21000.

Established in 1988, the MPEG group has produced MPEG-1, the standard on which such products as Video CD and MP3 are based, MPEG-2, the standard on which such products as Digital Television set top boxes and DVD are based, MPEG-4, the standard for multimedia for the fixed and mobile web and MPEG-7, the standard for description and search of audio and visual content. The group is now working on the new standard MPEG-21 "Multimedia Framework" that started in June 2000.

The MPEG-1 standard, established in 1992, is designed to produce reasonable quality images and sound at low bit rates. It was designed to reproduce VHS/VCR quality in a digital format such as 352x240 images with VHS quality at 1.5 Mbits/sec [1]. The MPEG-2 standard, established in 1994, is a generic method for compressed representation of video sequences using a common coding syntax defined in the document ISO/IEC 13818 Part 2 by the ISO and the IEC, in collaboration with the ITU as Recommendation H.262. The MPEG-2 standard, is designed to produce higher quality images at higher bit rates. The MPEG-2 concept,

similar to MPEG-1, is intended to cover a wider range of applications including DVD quality and its primary goal of an all-digital transmission of broadcast TV at coded bitrates between 4 and 15 Mbps. For example, 720x485 studio quality CCIR-601 images at up to 15 Mbits/sec [2].

The following are summary of currently available image/video compression standards [3] – [6]:

(a) CCITT G3/G4 – Binary images (non-adaptive)

(b) JBIG – Binary images

(c) JPEG – Still gray scale and color images

(d) JPEG2000 – Still images

(e) H.261 – ISDN applications (p×64 kbps).

(f) H.263 – PSTN applications (less than 64 kbps).

(g) H.263+ – Low bit rate PSTN applications.

(h) MPEG-1 – Optical storage media (1.5 Mbps).

(i) MPEG-2 – Genetic coding (4-15 Mbps).

(j) MPEG-4 – Object-based functionality.

(k) MPEG-7 – Construct metadata for multimedia contents.

(l) MPEG-21 – Multimedia contents delivery and use.

1.1.3 MPEG-2 Video Encoding

MPEG-2 Video encoding is a task that lends itself easily to parallel/distributed processing. The main problem of creating a DP of MPEG-2 Video encoder is the movement of raw data. Cook and Delp wrote that "the greatest difficulty lies not with the compression algorithm inherently, but with the parallel architecture" [7]. The solution to this problem lies mainly in expensive high-end hardware type real time encoder.

There are two types of MPEG-2 encoder, software-based and hardware-based. A software-based MPEG-2 Video encoding is considerably CPU-intensive while a

hardware-based MPEG-2 encoder (such as encoder card/box) is a costly independent device and not CPU-intensive. The latter also cannot be upgraded directly after new types of video encoding techniques are introduced.

The software based MPEG-2 Video encoder is far cheaper than hardware based video encoder card, and some software video encoders are even available as freeware. MPEG-2 Video encoding mainly involves three main parameters: bit rate, encoding performance and quality. Normally, an increase in one of the three parameters produces degradation in either or both of the other two. Each potential application for the coded video has different constraints and each of these applications implies different policies as to which parameters are important [7] - [21].

1.1.4 Microsoft Windows

MS Windows is a type of operating system by Microsoft Corporation. For home user type operating system, there is MS Windows 95, MS Windows 98, MS Windows Me and the latest release MS Windows XP Home Edition. While for advance system such as networking and server type, there is MS Windows NT, MS Windows 2000, MS Windows XP Professional and MS Windows Server 2003.

1.2 Research Objectives

The objectives of this research are:

(a) To implement the MPEG-2 Video encoding system on MS Windows platform (MS Windows 98, MS Windows Me, MS Windows 2000 and MS Windows XP) in a distributed processing environment.

(b) To develop a graphical user interface (GUI) that can be used for DP of MPEG-2 Video encoding (DPMVE) system on MS Windows

platform (MS Windows 98, MS Windows Me, MS Windows 2000 and MS Windows XP).

1.3 Scope of Research

This research covers the study of currently available software based MPEG-2 Video encoding in both standard and distributed methods. The MPEG-2 Video encoder will encode raw video data into MPEG-2 Video format.

Besides MPEG-2 Video encoding, the study of other DP system software will be carried out also on both MS Windows and Non-MS Windows's operating system. With the most suitable video encoding method being used, a DPMVE GUI combine with video cutting and video encoding shareware on 100Mbps LAN Ethernet can be designed within MS Windows 98, MS Windows Me, MS Windows 2000 and MS Windows XP platforms. The DPMVE GUI can be used for other heavy-duty processing purposes on MS Windows platform.

The whole distributed encoding process that ran continuously, was carried out in the computer lab of Masters of Education which was equipped with 100Mbps LAN Ethernet infrastructure located at Kolej Universiti Teknology Tun Hussein Onn (KUiTTHO). All PCs used for the DPMVE were normal PCs equipped with the same CPU clock speed, ATA133 IDE hard disk drive and 100 Mbps network interface card.

1.4 Stages of Research Work

The stages of research involved in the MPEG-2 encoding with distributed computer on MS Windows platform are as follow:

a) Literature survey and understanding of MPEG video encoding method.

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