BLOCK MODE DECISION IN H.265 USING PIXEL TOPOLOGY

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Dedicated to my father prof dr sabeeh hmoud altamimi

Beloved mother waiting for my success

My wife, who shares my life difficult

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ABSTRACT

Video compression standards is one of the key contributions of the electrical and electronics engineering discipline. The latest video standard is the High Efficiency Video Coding (HEVC) or H.265 which has a very high computational complexity. This project proposes the pixel topology algorithm which reduces the computation time spent in block mode decision. It is based on the early detection of predictive unit without passing through the fourth depth that is detection way for H.265. This technique is applied in two phases. First, calculate the cost of each frame depending on the eight models of prediction unit. Second, the frame with minimal cost determines the suitable prediction unit which is used for partitioning the current frame. The project produces significant savings in encoding time and reduction of computation complexity in a robust version which maintains high image quality and suitable encoding rate for transfer over networks.

ABSTRAK

Standard pemampatan video adalah satu satu sumbangan besar disiplin kejuruteaan elektrik dan elektronik. Standard video terbaru ialah High Efficiency Video Coding (HEVC) atau H.265 yang mempunyai kekompleksan komputasi amat tinggi/ Project ini mencadangkan algoritma topologi piksel yang mengurangkan masa diperlukan untuk keputusan mod blok, Ia berdasarkan kepada pengesanan awal unit ramalan tanpa melalui kedalaman keempat iaitu cara pengesanan H.265. Teknik ini digunakan dalam dua fasa. Pertama, kiraan kos bagi setiap kerangka bergantung kepada lapan model unit ramalan. Kedua, kerangka dengan kos minima menentukan unit ramalan yang paling sesuai untuk membahagi kerangka semasa. Projek ini menghasilkan penjimatan masa tinggi yang banyak untuk pengekodan dan pengurangan pengiraan kompleks dalam versi teguh sambil mengekalkan kualiti imej yang tinggi serta kadar pengekodan yang sesuai untuk pemindahan melalui rangkaian.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

HEVC	-	High-Efficiency Video Codec
IEC/ISO MPEG	-	International Electro technical Commission/ International Organization for Standardization
ITU-Ts VCEG	-	International Telegraph Union Telecommunication
AVC	-	Advanced Video Coding
MPEG-2	-	Moving Picture Experts Group
k	-	Kilo
CTU	-	Coding Tree Unit
CU	-	Coding Unit
PU	-	Prediction Units
RDO	-	rate distortion optimization
VCEG	-	Video coding experts group
MPEG	-	moving pictures experts group
ISO/IEC	-	International Organization for Standardization /International Electro Technical Commission
DSL	-	Digital subscriber line
LAN	-	Local area network
ISDN	-	Integrated Services for Digital Network
NAL	-	Network Abstraction Layer
VLC	-	Video LAN Client
L	-	Length
CTB	-	coding tree block
CB	-	coding blocks
PBs	-	prediction blocks
ME	-	motion estimation
TSS	-	Three step search

LIST OF SYMBOLS

H.265	-	High-Efficiency Video Codec
x	-	Cross
+	-	Plus
Δ	-	
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CHAPTER 1

INTRODUCTION

1.1 Introduction

High-Efficiency Video Codec (HEVC), which is also called H.265 is the latest nonproprietary compression standard for video. HEVC is going to become the video standard for upcoming years as it was included in final draft sanctioned in January 2013. Just as the earlier technologies of video compression in HEVC the viewer will experience the same or better quality of video than before while, the net cost of video storage and delivery will be reduced.

The organizations in the technological industry (IEC/ISO MPEG) and telecommunications (ITU-Ts VCEG) have standardized HEVC as an open standard to leverage most efficient video compression techniques using market's latest processing platforms. As compared to the standards of AVC/H.264 and MPEG-2 the size of the video file or a bit stream can be decreased up to 50% and 75% respectively. As a result of this the cost of the transmission and video storage is reduced and high definition content is delivered for consumer consumption.

The techniques and algorithms used in HEVC are significantly more complex than those of H.264 and MPEG-2. There are more decisions to make when encoding a given video stream or file and as a result, more calculations need to be made in compressing video assets. This complexity, however, is an excellent fit for video processing solutions that seamlessly evolve from one compression generation to the next as they mitigate the risks that come with any large technological migration.

The HEVC video compression standard is based on a similar set of coding tools as the H.264/AVC, the major difference is that the pixels in H.264/AVC, the largest coding block called the macro block are 16 × 16 while in HEVC, the largest block supported by the standard is 64 × 64 pixels. Because of the larger coding blocks in HEVC, the standard can support higher resolutions up to 8192 × 4320 pixels-ultra high definition or the 8k [1].

The names of the three profiles in the initial version of HEVC were main, main 10 and main still picture. A profile is a definition of a set of tools necessary to encode videos in a certain mode to produce unique bits streams for that particular profile. HEVC is designed to encode videos at a very high efficiency rate; this means that the HEVC encoder optimizes the bits budgets required to encode each frame and the entire video sequence. HEVC in performance comparison with H.264/AVC, increases the compression of video about 50% of the value obtainable from H.264 along with better quality of visual [2].

As the designs and tool sets of HEVC are complex in all profiles so, the coding efficiency in terms of the encoding time is poor in the sense that real time encoding of video files using this standard poses a strong challenge at present. This delay in encoding observable in this standard is due, mostly, to complex coding tools and motion estimation algorithms built into the standard to enhance the quality of the encoded video. These motion estimation algorithms implemented in the standard will be studied with an aim to propose an improved faster algorithm that would yield higher efficiency in encoder timing at an acceptable psycho-visual quality.

1.2 Problem Statement

The key problems to be examined in this research are to reduce the encoder complexities by reducing the encoder run-time while maintaining the same video quality and compression ratio. The research problems are:

1. Is there a technique to quickly identify the predictive unit?
2. Is the proposed method able to reduce overall computation complexity?
3. Will the proposed algorithm produce videos at an acceptable PSNR and bitrate?

1.3 Research Objectives

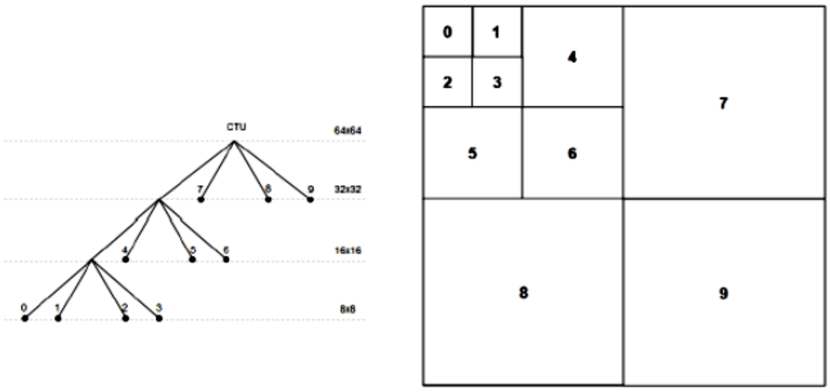
This research seeks to improve encoder run-time by reducing complexities associated with diamond estimation algorithm. To achieve this goal, the following research objectives are pursued:

1. To adopt a novel block partitioning scheme based on the theories of pixel topology
2. To use the Lagrange function to reduce computation complexity
3. To evaluate the enhancement method using standard data set.

1.4 Prediction Modes

HEVC is a block based compression standard that relies heavily on motion estimation as a tool to code video frames. In HEVC, 33% of encode time is allotted to motion estimation which reflects the complexities of the encode process due to motion estimation. The core of coding standards prior to HEVC was based on a unit called macro block. A macro block is a group of 16×16 pixels which provides the basics to do structure coding of a larger frame. This concept is translated into

Coding Tree Unit (CTU) with HEVC standard, this structure is flexible compared to macroblock. A CTU could be of size 64 × 64, 32 × 32, or 16 × 16 pixels.
Each CTU is organized in a quad-tree form for further partitioning to smaller sizes called Coding Unit (CU). An example of partitioning a CTU into CUs is given in Figure 1.



1.1 HEVC Coding Tree Unit

The tree is traversed in depth first order and the corresponding nodes of the tree are visible on the CTU structure in Figure 1.1.

Each CU could be predicted using three prediction modes: 1) Intra-predicted CU; 2) Inter-predicted CU; 3) and Skipped CU. Intra-prediction uses pixel information available in the current picture as prediction reference, and a prediction direction is extracted. Inter-prediction uses pixel information available in the past or future frames as prediction reference, and for that purpose motion vectors are extracted as the offset between the matching CUs. A skipped CU is similar to an inter-predicted CU, however there is no motion information; hence skipped CUs ignore motion information already available from previous or future frames.

In contrast to eight possible directional prediction of intra blocks in AVC, HEVC supports 34 intra prediction modes with 33 distinct directions, and knowing that intra prediction block sizes could range from 4 × 4 to 32 × 32, the combinations of size of the block and prediction direction defined for HEVC bit streams are 132.

A leaf CU in the Coding Tree Units CTU can be farther split into regions of homogeneous prediction called Prediction Units (PU). One CU can be divided upto four PUs. The modes possible in PU depend on the prediction mode. For intra-prediction there is can be two possible modes, whereas inter-prediction can be done using one of eight possible modes. Figure 1.2 presents all possible PU modes available in HEVC whereas in the block the numbers of pixels are determined by N , N is pixel .

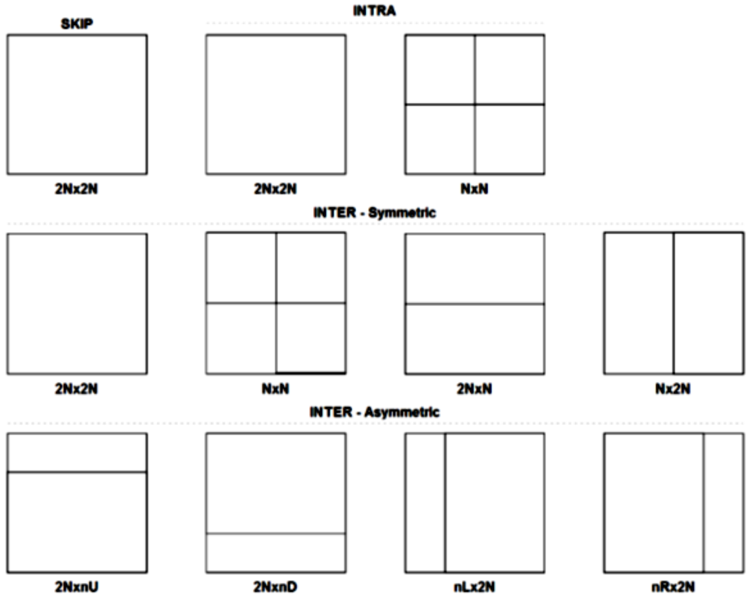


Figure 1.2 Prediction Unit partitioning modes

To code a particular CU, the encoder must perform a rate distortion optimization (RDO) decisions to determine which of the intra or inter-prediction blocks offers the least coding cost; that would be the chosen mode to code the CU.

Due to this multitude of evaluations that the encoder has to make to optimize the bits budgets, this lead to complexities of the encoding process and for this reason, real time encoding becomes quite challenging.

Because mode decision in block video coding takes many decisions, for this reasons it consumption so match time 33% of encoder time, one becomes necessary to reduce the decision loop to one based on simple computation of pixel line topology. This give the required block mode base on the features of the target block.

1.5 Scope of the Research

The data used in this study classified into five classes from A to E depending on dimensions of the image where they give varying dimension and different resolution as shown in Figure 1.3

1.6 Significance of the Study

This study would develop and introduce a novel fast motion vector search algorithms into the HEVC literature; also the concepts of mode decisions based on pixels topology shall also be introduced.

Class A 2650 x 1600 –people on street

Class B 1920 x 1080 – kimono1

Class B 1920 x 1080 – park scene

Class C 832 x 480 – party scene

Class C 832 x 480 BQ mall

Class D 416 x 240 –Basketball Pass

Class D 416 x 240 –blowing

Class D 416 x 240 –race horses

Class E 1280 x 720 –city

Class E 1280 x 720 –mobile calendar

Figure 1.3 Ten standard video sequence using in this research

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