NEW FAST BLOCK MATCHING ALGORITHM USING NEW HYBRID SEARCH PATTERN AND STRATEGY TO IMPROVE MOTION ESTIMATION PROCESS IN VIDEO CODING TECHNIQUE

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DECLARATION

I declare that this thesis entitled "New Fast Block Matching Algorithm Using New Hybrid Search Pattern and Strategy to Improve Motion Estimation Process in Video Coding Technique" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

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APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Science in Electronic Engineering.

Signature	: …………………………………...
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DEDICATION

Dedicated to ALLAH Almighty, my loving family members for your infinite and unfading love, sacrifice, patience, encouragement and best wishes.

ABSTRACT

Up until today, video compression algorithm has been applied in various video applications ranging from video conferencing to video telephony. Motion Estimation or ME is deemed as one of the effective and popular techniques in video compression. As one of its techniques, the Block Matching Algorithm or BMA is widely employed in majority of well-known video codes due to its simplicity and high compression efficiency. As such, it is crucial to find different approaches of fast BMAs as the simplest and straightforward BMA is not a good fit for implementation of real-time video coding because of its high computational complexity. The aims for this study is to develop and design a new hybrid search pattern and strategy for new fast BMAs that can further improve the ME process in terms of estimation accuracy and video image quality, searching speed and computational complexity. There are 6 main designs that the algorithms proposed namely the Orthogonal-Diamond Search Algorithm with Small Diamond Search Pattern (ODS-SDSP), the Orthogonal-Diamond Search Algorithm with Large Diamond Search Pattern (ODS-LDSP), the Diamond-Orthogonal Search Algorithm with Small Diamond Pattern (DOS-SDSP), the Diamond-Orthogonal Search Algorithm with Large Diamond Pattern (DOS-LDSP), the Modified Diamond-Orthogonal Search Algorithm with Small Diamond Pattern (MDOS-SDSP), and the Modified Diamond-Orthogonal Search Algorithm with Large Diamond Pattern (MDOS-LDSP). These 6 algorithms are divided into 3 main methods namely Method A, Method B, and Method C depending on their search patterns and strategies. The first method involves the manipulation of the diamond pattern in the process, the second method includes the manipulation of the orthogonal steps, and lastly, the third method is the modified version of the second method to improve the performances of the algorithms. Evaluation is based on the algorithm performances in terms of the search points needed to find the final motion vector, the Peak-Signal to Noise Ratio (PSNR) of the algorithms, and the runtime performance of algorithm simulations. The result shows that the DOS-SDSP algorithm has the lowest search points with only 1.7341, 4.9059 and 4.0230 for each motion's content respectively; meanwhile all the algorithms acquired similar and close PSNR values for all types of motion contents. As for simulation runtime, the results show that Method B has the least simulation runtime and Method C has the highest simulation runtime compared to others for all video sequences. The finding suggests that an early termination technique should be implemented at the early stage of the process, and mixing the selection of the mode is able to improve the algorithm performances. Therefore, it can be concluded that Method B gives the best performance in terms of search points reduction and simulation runtime while Method C yields the best for PSNR values for all types of motion contents.

ABSTRAK

Sehingga hari ini, algoritma pemampatan video telah digunakan dalam pelbagai aplikasi video yang terdiri dari persidangan video untuk telefoni video. Anggaran Gerakan atau ME dianggap sebagai salah satu teknik berkesan dan popular dalam mampatan video. Sebagai salah satu teknik ini, Blok Sepadan Algoritma atau BMAs secara meluas digunakan dalam majoriti kod video terkenal kerana kesederhanaan dan kecekapan mampatan yang tinggi. Oleh itu, adalah penting untuk mencari pendekatan yang berbeza untuk BMAs cepat yang paling mudah disebabkan kerana BMA cepat tidak sesuai untuk perlaksanaan video pengekodan di masa nyata kerana kerumitan pengiraan yang tinggi. Tujuan kajian ini adalah untuk membangunkan dan mereka bentuk pola carian dan strategi hibrid baru untuk BMAs cepat baru untuk memperbaiki lagi proses ME dari segi ketepatan anggaran dan kualiti imej video, kecepatan pencarian dan kerumitan pengiraan. Terdapat 6 reka bentuk utama algoritma yang dicadangkan iaitu Ortogon-Diamond Search Algoritma dengan Diamond Carian Corak Kecil (ODS-SDSP), Ortogon-Diamond Search Algoritma dengan Diamond Carian Corak Besar (ODS-LDSP), Diamond-Ortogon Cari Algoritma dengan Diamond Carian Corak Kecil (DOS-SDSP), Diamond-ortogon Cari Algoritma dengan Diamond Carian Corak Besar (DOS-LDSP), Diamond-Ortogon Cari Algoritma dengan Diamond Carian Corak Kecil (MDO-SDSP) dan Diamond-ortogon Cari Algoritma Ubah Suai dengan Diamond Carian Corak Besar (MDO-LDSP). 6 algoritma ini dibahagikan kepada 3 kaedah utama iaitu Kaedah A, Kaedah B dan Kaedah C yang bergantung kepada pola dan strategi carian. Kaedah pertama melibatkan corak berlian yang dimanipulasi semasa proses, kaedah kedua pula melibatkan langkah-langkah ortogon yang dimanipulasi dan akhir sekali, kaedah ketiga adalah versi dari kaedah kedua yang diubahsuai untuk meningkatkan prestasi algoritma. Penilaian adalah berdasarkan kepada prestasi algoritma dari segi titik pencarian yang diperlukan untuk mencari vektor gerakan akhir, Puncak-isyarat kepada nisbah bunyi (PSNR) algoritma dan prestasi runtime simulasi algoritma. Hasil kajian menunjukkan bahawa algoritma DOS-SDSP mempunyai titik pencarian terendah dengan hanya 1,7341, 4,9059 dan 4,0230 bagi setiap kandungan gerakan masing-masing;sementara itu, semua algoritma memperoleh nilai PSNR lebih kurang sama untuk semua jenis kandungan gerakan. Untuk kecepatan simulasi, keputusan menunjukkan bahawa Kaedah B mempunyai kecepatan simulasi paling rendah dan Kaedah C mempunyai kecepatan simulasi yang paling tinggi berbanding dengan yang lain untuk semua video. Dapatan kajian menunjukkan bahawa teknik penamatan awal perlu dilaksanakan pada peringkat awal proses dan juga membenarkan pemilihan mod untuk meningkatkan prestasi algoritma. Oleh itu, dapat disimpulkan bahawa Kaedah B memberikan prestasi yang terbaik dari segi pengurangan titik pencarian dan simulasi runtime, sementara Kaedah C adalah yang terbaik untuk nilai PSNR untuk semua jenis kandungan gerakan.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATION

CD	: Compact Disk
DVD	: Digital Video Disc
ME	: Motion Estimation
BMA	: Block Matching Algorithm
FSA	: Full Search Algorithm
PSNR	: Peak Signal-to-Noise Ratio
RDO	: Rate-Distortion Optimization
MC	: Motion Compensation
ISDN	: Integrated Services for Digital Network
PSTN	: Public Switched Telephone Network
CD-ROM	: Compact Disc, read-only-memory
HDTV	: High Definition Television
CIF	: Common Intermediate Format
QCIF	: Quarter Common Intermediate Format
CCIR	: Consultative Committee for International Radio
VLC	: Variable Length Coder
DCT	: Discrete Cosine Transform
MPEG-1	: Moving Picture Experts Group 1
MPEG-2	: Moving Picture Experts Group 2

MPEG-4	: Moving Picture Experts Group 4
ITU-T	: ITU Telecommunication Standardization Sector
H.26x	: ITU-T video compression standard
2D-MV	: Two-Dimensional Motion Vector
MV	: Motion Vector
AVC	: Advanced Video Coding
MCF	: Matching cost function
SAD	: Sum of Absolute Difference
MSE	: Mean Squared Error
MSD	: Mean Squared Difference
MAD	: Mean Absolute Difference
ITU-R	: ITU Radiocommunication Sector
2D	: Two-dimensional
3D	: Three-dimensional
fps	: frame per second
MB	: Macro-block
Cb	: Chrominance
Cr	: Chrominance
GOB	: Group of Block
TDL	: 2-D Logarithmic Search
TSS	: Three-Step Search
CS	: Cross Search
NTSS	: New Three-Step Search
4SS	: Four-Step Search

DS	: Diamond Search
CDS	: Cross-Diamond Search
NCDS	: New Cross-Diamond Search
KCDHS	: Kite-Cross Diamond Hexagonal Search
HDS	: Hexagon-Diamond Search
OS/OSA	: Orthogonal Search
MOS	: Modified Orthogonal Search
EMOS	: Enhanced Modified Orthogonal Search
ARPS	: Adaptive Rood Pattern Search
MPBM	: Mean Predictive Block Matching
HBMA	: Hierarchical Block Matching Algorithm
OLS	: Orthogonal Logarithmic Search
LDSP	: Large Diamond Search Pattern
SDSP	: Small Diamond Search Pattern
HEXBS	: Hexagon-Based Search
HSP	: hexagonal pattern
FSB	: Fixed Size Block
VSB	: Variable Size Block
VBSME	: Variable Block Size Motion Estimation
ODS-SDSP	:Orthogonal-Diamond Search Algorithm with Small Diamond Search Pattern
ODS-LDSP	: Orthogonal-Diamond Search Algorithm with Large Diamond Search Pattern
DOS-SDSP	: Diamond-Orthogonal Search Algorithm with Small Diamond Pattern

DOS-LDSP : Diamond-Orthogonal Search Algorithm with Large Diamond Pattern

MDOS-SDSP : Modified Diamond-Orthogonal Search Algorithm with Small Diamond Pattern

MDOS-LDSP : Modified Diamond-Orthogonal Search Algorithm with Large Diamond Pattern

dB : Decibel

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CHAPTER 1

INTRODUCTION

This chapter presents an overview on the research background of the project and covers the problem statements, objectives and scopes of the research. This chapter briefly describes the flow of this research. The organization of this thesis is also briefly described at the end of this chapter.

1.1 Project Overview

Telecommunication technology has made significant advancement especially in multimedia communication where a wide range of emerging applications has been developed such as video conferencing through wired and wireless medium, data storages like CDs, DVDs, and so on. Technology nowadays has reached its state of maturity but the research is still ongoing in order to achieve further improvements. Metkar and Talbar (2013) stated that the amount of uncompressed video data is too large for limited bandwidth or storage capacities thus it is also crucial to minimize the data size by utilising the video compression.

In video compression, Motion Estimation (ME) is considered as one of the popular and effective methods of reducing the temporal redundancy between successive frames of a video sequence. ME estimates the motion by finding the motion vectors of the objects in an image sequence. ME consists of two basic approaches namely, the pixel-based ME and block-based ME. The former is to determine the motion vectors for every pixel in the