IMAGES INFORMATION RETRIEVAL USING GUSTAFSON-KESSEL RELEVANCE FEEDBACK

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"To my beloved family, thanks for your loves and support in every effort I did. To all my friends, thanks for your encouragement and for willing to lend your hands in this journey of dreams and hope..."

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ABSTRACT

The goal of CBIR is to retrieve images that are visually similar to the query image. Relevance feedback retrieval systems ask the user for feedback on retrieval results and then use this feedback on later retrievals with the goal of increasing retrieval performance. The objectives of this research are to compare CBIR based with Gustafson-Kessel (GK) clustering and relevant feedback approach and to evaluate the effectiveness of GK relevance feedback for images retrieval. The research requires a better understanding of GK clustering and probabilistic relevance feedback method in turn to figure out different methods that can be used in solving similar problems. This project will give better insights in the usage of relevance feedback learning in order to reduce the gap between low-level features and high-level human concepts. The research will evaluate Gustafson-Kessel clustering and probabilistic relevance feedback method to improve the retrieval performance.

ABSTRAK

Matlamat utama pencarian imej berdasarkan kandungan imej adalah untuk mencari imej yang serupa secara visual dengan imej yang berkenaan di dalam pengkalan data. Selepas mendapat hasil pencapaian, sistem pencapaian imej dengan maklum balas releven *"Relevance Feedback"* akan menyoal pengguna tentang maklum balas mereka terhadap imej untuk meningkatkan tahap pencapaian imej oleh sistem. Objektif kajian ini untuk membandingkan pencarian imej berdasarkan kandungan imej dan mengaplikasikan teknik *"Gustafson-Kessel Clustering"* dan *"Relevance Feedback"* untuk pencapaian imej. Kajian ini memerlukan pemahaman yang mendalam ke atas kedua-dua teknik untuk digunakan bagi menyelesaikan masalah yang serupa. Kajian ini akan membuka pandangan umum tentang kegunaaan teknik *"Relevance Feedback"* untuk mengurangkan jarak di antara *"low-level features*" dan *"high-level human concepts"*. Kajian ini seterusnya akan menilai keberkesanan kedua-dua teknik untuk meningkatkan tahap pencapaian imej oleh sistem.

TABLE OF CONTENT

CHAPTER	TITLE	PAGE
	TITLE	i
	DECLARATION	ii
	DEDICATION	iii
	ACKNOWLEDGEMENT	iv
	ABSTRACT	v
	ABSTRAK	vi
	TABLE OF CONTENT	vii
	LIST OF TABLES	x
	LIST OF FIGURES	xii
	LIST OF SYMBOLS	xiv
	LIST OF ABBREVIATION	xv
	LIST OF APPENDICES	xvi
1	**INTRODUCTION**	**1**
	1.1 Introduction	1
	1.2 Problem Background	2
	1.3 Problem Statement	4
	1.4 Project Objectives	5
	1.5 Project Scopes	5
	1.6 Significance of The Project	6
	1.7 Project Plan	6
	1.8 Organization of the Report	7

2	**LITERATURE REVIEW**		**8**
	2.1	Introduction	8
	2.2	Overview of Content-Based Image Retrieval	9
	2.3	Overview Of Relevance Feedback	11
	2.3.1	Feedback strategies	12
	2.4	Preprocessing	14
	2.4.1	Image Pre-processing	14
	2.4.2	Median filtering	15
	2.4.3	Edge detection	15
	2.5	Features Extraction	17
	2.5.1	Geometrical Moments	17
	2.6	Distance Measure	18
	2.7	Clustering	19
	2.7.1	Fuzzy Clustering	22
	2.7.2	Fuzzy C-Means	28
	2.7.3	Gustafson-Kessel Clustering	30
	2.7.4	Comparison between Fuzzy C Means and Gustafson-Kessel Algorithm.	32
	2.8	Evaluation Metric for Image Clustering	35
	2.9	Summary	38
3	**METHODOLOGY**		**39**
	3.1	Introduction	39
	3.2	Analyze Previous Research	40
	3.3	Tourism Images Data Collection	41
	3.4	Images Pre-processing	41
	3.4.1	Median filter	41
	3.4.2	Edge Detection	42
	3.5	Features Extraction	48
	3.5.1	Geometrical Moments	48
	3.6	Clustering	51
	3.6.1	Determining Weight Features	51

	3.6.2	Problem Formulation	55
	3.6.3	Gustafson-Kessel Clustering	55
	3.6.4	Proposed Strategy For Relevance Feedback With Gustafson-Kessel Clustering	59
	3.7	Comparisons and Evaluation	60
	3.8	Summary	62
4	**EXPERIMENT AND ANALYSIS RESULTS**		**63**
	4.1	Real data	63
	4.1.1	The Images Dataset	63
	4.2	The Data Used	66
	4.2.1	Dataset I	67
	4.2.2	Dataset II	71
	4.2.3	Dataset III	74
	4.2.4	Dataset IV	80
	4.3	Detail System Diagram	83
	4.4	Web Design	83
	4.4.1	Web Design Interfaces	85
	4.5	Testing Analysis	91
	4.6	Summary	96
5	**CONCLUSION AND FUTURE WORK**		**97**
	5.1 Introduction		97
	5.2 Summary of Work		98
	5.3 Conclusion		98
	5.4 Suggestion for Future Works		100
	REFERENCES		**101**
	APPENDIX A		**107**
	APPENDIX B		**110**
	APPENDIX C		**114**

LIST OF TABLES

TABLE NO	TITLE	PAGE
2.1	Researches by (Ruofei Zhang *et al.,* 2002).	23
2.2	Researches by (F. Masulli *et al.,* 2000).	24
2.3	Researches by (D.A. Karras *et al.,* 2000).	25
2.4	Past researches on relevance feedback for image retrieval.	26
2.5	Past researches on relevance feedback for image retrieval.	27
2.6	Past researches on relevance feedback for image retrieval.	28
2.7	Shows the Advantages between FCM and GK Algorithm	32
2.8	Shows the Disadvantages between FCM and GK Algorithm	33
3.1	A sample partition matrix $U_{c\times N}$ resulting from relationship between moment invariant value and weight features for the images.	58
4.1	Sample of geometrical moments values.	66
4.2	Sample from Database I	67
4.3	Sample from Databases II.	71
4.4	Sample from Databases III.	74
4.5	Cluster 1 with highest weight of value.	76
4.6	Cluster II	76
4.7	Cluster III with lowest weight of value.	77
4.8	Cluster IV.	78
4.9	Cluster V.	78
4.10	Cluster VI.	79
4.11	Sample from Databases IV.	80
4.12	Cluster I result.	81
4.13	Cluster II result.	82

4.14	Shows major concept with the total number of images, positive cluster (Relevant) and negative cluster (Not Relevant).	91
4.15	Shows major concept with the total number of positive cluster (Relevant) *precision* and *recall*.	92

LIST OF FIGURES

FIGURE NO	TITLE	PAGE
2.1	*Sobel* Operator.	17
2.2	Two-dimensional example.	34
2.3	Outcome of the Fuzzy C-means algorithm.	34
2.4	Outcome of the Gustafson-Kessel algorithm.	35
3.1	A General Framework of the Study.	40
3.2	Sobel convolution kernels.	45
3.3	Pseudo-convolution kernels used to quickly compute approximate gradient magnitude.	46
3.4	Samples Original Images.	46
3.5	These are the results of edge detection by using *Sobel* operator.	47
3.6	A flowchart procedure for S*obel* operator implementation.	47
3.7	A set of seven {RST}-invariant features, φ_1 to φ_7	49
3.8	A flowchart procedure to generate moment invariants value based on the formulation.	50
3.9	A flow chart of the procedure used in this work.	61
4.1	Sample tourism images.	64
4.2	Sample tourism images after *Sobel* operator.	65
4.3	Cluster result for database I.	70
4.4	Cluster result for database II.	72
4.5	Cluster result for database III.	75
4.6	Cluster result for database IV.	81
4.7	Detailed System Diagram	84

4.8	Main Page.	85
4.9	Search Results Top of Page.	86
4.10	Search Results Bottom of Page.	86
4.11	User Click for Detail Search.	87
4.12	Detail Search Results Top of Page.	87
4.13	Detail Search Results Bottom of Page.	88
4.14	Detail Search Results within Cluster on Top of Page.	89
4.15	Detail Search Results within Cluster on Bottom of Page.	89
4.16	Weight Update from User Feedback.	90
4.17	Original Size of the Image.	90
4.18	Precisions graph for each destination.	92
4.19	Recall graph for each destination.	93
4.20	Retrieval Precision for different experience.	94
4.21	Retrieval Recall for different experience.	95

LIST OF SYMBOLS

$c_l^{(i)}$	-	cluster prototypes (means)
$F^{(i)}$	-	cluster covariance matrices
$d^2_{F^{(i)}}$	-	distances
$u_{ij}^{(l)}$	-	partition matrix
W_{ij}	-	weight
φ_1	-	first value of {RST}-invariant features

LIST OF ABBREVIATION

CBIR	-	Content-Based Image Retrieval
RF	-	Relevance Feedback
PFRL	-	Probabilistic Feature Relevance Learning
GK	-	Gustafson-Kessel algorithm
FCM	-	Fuzzy C Means
QBIC	-	Query By Image Content
CBVIR	-	Content-Based Visual Information Retrieval

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
A	Profile Users	101
B	Gustafson-Kessel Algorithm Codes	104
C	Results Of Gustafson-Kessel Algorithm Using Different Gamma Value And Index Number For Different Dataset	

CHAPTER 1

INTRODUCTION

1.1 Introduction

A variety of content-based retrieval methods and systems for image database have gone through the development during this past several years. Since early 90's content-based image retrieval has become a very active research area. Many image retrieval systems such as QBIC, MARS, Virage, FIDS etc have been built. (Robert *et al.,* 1999; Berman and Shapiro, 1999; Huang, *et al.,* 2000). The CBIR systems can be classified broadly into two categories, which are low level feature based system, and high level/semantic feature based system. Low-level features are general features and computed from pixel values. The images generally represented by numeric features or attributes, such as texture, color and shape. (Flickner *et al.,* 1995). On the other hand, high level features are abstract attributes involving a major amount of reasoning. (Sanjoy *et al.,* 2004).

The goal of CBIR is to retrieve images that are visually similar to the query image. Similarity to the query is computed using either a default or a user-defined similarity metric. The notion of "similar" in the mind of the user may vary depending on the query, the history of retrievals observed, and the user. If there is a significant difference between the similarity as calculated by the system and the notion of similarity in the user's mind, the results are meant to be unsatisfactory (Peng *et al.,* 1999) This problem has become for what is known as relevance feedback. (Sean *et al.,* 2002)

Relevance feedback retrieval systems ask the user for feedback on retrieval results and then use this feedback on later retrievals with the goal of increasing retrieval performance. (Sean *et al.,* 2002). Human high-level concepts are what user desires. The task of relevance feedback learning is to reduce the gap between low-level visual features and high-level human concepts. (Rui *et al.,* 1998; Bhanu and Dong, 2002; Jing *et al.,* 2003).

For this purpose, this research presents a tourism images information retrieval using Gustafson-Kessel(GK) clustering and relevance feedback. It attempts on improving the performance on future queries by using GK clustering and relevance feedback. This method can give better results rather than using low-level features. It is because of extra knowledge of high-level classification.

1.2 Problem Background

The traditional image retrieval paradigm is by keyword annotation. In this approach, the images are first annotated manually by keywords. They can then be retrieved by their corresponding annotations. However, there are three main difficulties with this approach; (for instances,) the large amount of manual effort required in developing the annotations, the differences in interpretation of image contents and inconsistency of the keyword assignments among different indexers. As the size of image repositories increases, the keyword annotation approach becomes infeasible. (Rui *et al.,* 1998).

To overcome the difficulties of the annotation based approach, a content-based image retrieval (CBIR) has been proposed as alternative mechanism in early 1990s. CBIR systems also use visual content of images such as color, texture, and shape features as the image index as well as using human assigned keywords. (Rui *et al.,* 1998).

Most of the early researches on content -based image retrieval (CBIR) was focused on developing effective global features (Stricker and Orengo, 1995; Huang *et al.,* 1997) While these researches establish the basis of CBIR, the retrieval performance is still far off user's expectations. The main reason is to be the gap between low-level features and high-level concepts. (Rui *et al.,* 1998; Bhanu and Dong, 2002; Jing *et al.,* 2003). One of the interactive learning techniques is "relevance feedback" (RF). It was initially developed to narrow down this semantic gap. Relevance feedback was introduced into CBIR during mid 1990's and had been proved to upgrade performance in retrieval systems (Huang *et al.,* 2002). The main idea is to let users handling the control system. During retrieval process, the user interacts with the system and rates the relevance of the retrieved images, according to his or her subjective judgment. With this additional information, the system dynamically learns the user's intention, and progressively presents better results. (Jing *et al.,* 2003).

(Bhanu and Dong, 2002) described the most important thing to be learned in relevance feedback learning is the weights of different features. The feedback, provided by different users in the form of "similar"(positive) images and 'dissimilar" (negative) images, is an important part of the experience.

(Sean *et al.,* 2002) presented a relevance feedback technique that uses decision trees to learn a common thread among instances marked relevant. They applied the technique in preexisting content-based image retrieval (CBIR) system that was used to access high-resolution computed tomography images of the human lung. The results show that their approach achieves better retrieval as measured in off-line experiments and as judged by a radiologist who is a lung specialist. (Peng *et al.,* 1999) presented a novel probabilistic method that enables image retrieval procedures to automatically capture feature relevance based on user's feedback and that is highly adaptive to query locations. Experimental results demonstrated the efficacy of technique using both simulated and real world data.

(Jing *et al.,* 2003) proposed two relevance feedback methods. One is the query point movement (QPM) algorithm with speedup techniques. The other is

introducing three SVM schemes based on a new kernel. The main purpose is to integrate region-based representations and learning techniques.

Another research by (Ruofei and Zhongfei 2004) was presenting Stretching Bayesian Learning in the Relevance Feedback of Image Retrieval. They developed a novel approach to stretch Bayesian learning to solve this problem by explicitly exploiting two unique characteristics, which is the methodology of "BAyesian Learning in Asymmetric and Small sample collections" (BALAS). They also developed an integrated ranking scheme in "BALAS", which complementarily combines the subjective relevancy confidence and the objective feature-based distance measure to capture the overall retrieval semantics. The experiments demonstrated that BALAS is superior than existing relevance feedback method in the current literature in capturing the overall retrieval semantics.

This research tries to bring up a new approach based on GK clustering and relevance feedback to improve image retrieval performance. It attempts to adapt GK clustering method, which is extended of fuzzy C-means so that it can learn human desires by using a variety of knowledge extracted from prior experience of the system (meta knowledge).

1.3 Problem Statement

There are several fundamental problems associated with the retrieval by text and by simple content-based image retrieval scheme:

1. Keyword annotation approach becomes infeasible.
2. Features are unequal in their differential relevance for computing the similarity between images. Feature relevance may change from one image to another and from location to the location.

3. The user understands more about the query whereas the database system can only guess what the user is looking for during the retrieval process.
4. Different persons or the same person under different situations may see the same visual content differently.
5. The gap between high-level concepts and low level features.

1.4 Project Objectives

The following are the objectives of this research:

1. To study on CBIR, Gustafson-Kessel (GK) clustering method and relevant feedback approach for image retrieval.
2. To compare CBIR based with Gustafson-Kessel (GK) clustering and relevant feedback approach.
3. To evaluate the effectiveness of GK clustering and relevance feedback for images retrieval.

1.5 Project Scopes

The project scopes are defined as follows:

1. 180 tourism images are used as a sample dataset, which is from Malaysian's famous tourism destinations in a JPEG and BMP format.
2. Gustafson Kessel clustering and probabilistic relevance feedback methods are the main tools for this purpose.
3. The threshold value for the experiment was get from user experiences during image retrieval process to see the overall performance.

4. *Precision* and *recall* concept will be used to test the effectiveness of the result.
5. Image preprocessing and feature extraction was not being done in this project but the data captured from previous dissertation by (Teh Jian Ting, 2005).

1.6 Significance of the Project

This project will give better insights in the usage of relevance feedback learning in order to reduce the gap between low-level features and high-level human concepts. The research will evaluate Gustafson-Kessel clustering and probabilistic relevance feedback method to improve the retrieval performance.

1.7 Project Plan

This project is carried out within two semesters. The first part of the project focuses on understanding the general view of Gustafson-Kessel (GK) clustering problem in image retrieval and also the relevance feedback tool. Then it focuses on understanding the past approaches that have been applied by other researches. This approach will be used as a methodology through out this project. Most of the time in the first semester is used to explore and gather relevant information from textbooks and published journals. Total understanding in Gustafson-Kessel (GK) clustering and relevance methods is important in order to comprehend different methods that can be used in solving similar problems. The research requires a better understanding of Gustafson-Kessel (GK) clustering and probabilistic relevance feedback method to improve the retrieval performance.

The second part of the project involves implementing Gustafson Kessel for clustering in classification of images. This technique will be used to learn human

desires from retrieval experience. The experience will include classification of images into various classes (clusters), relevance (weights) of features and the number of times these images are selected as a query and marked as positive or negative. It integrates the meta knowledge into a probabilistic relevance feedback method to improve the retrieval performance. Comparison will be carried out to see the performance of Gustafson-Kessel clustering and relevant feedback approach. Finally, the report will include experimental result and conclusion.

1.8 Organization of the Report

Several chapters are laid out to arrange the contents of the report. The content of each chapter are as follows:

- Chapter 1 gives a general introduction of this thesis, which includes the introduction, problem background, problem statement, project objectives, scope, significance of the project; project plan as well as project expected contribution.

- Chapter 2 presents a review of relevant and related literature on content-based image retrieval (CBIR). It also gives an overview of Gustafson-Kessel (GK) clustering in classification of images and relevance feedback method to improve retrieval performance. This chapter also presents how these approaches are being applied in CBIR. Besides that, preprocessing approaches applied in CBIR domain are also being clarified.

- Chapter 3 discusses about methodology used in this research.

- Chapter 4 presents the experiment and analysis result of this project.

- Chapter 5 presents the conclusion as well as suggestion for future research.