MOSAICKING OF TORN IMAGE USING GRAPH ALGORITHM AND COLOR PIXEL MATCHING

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ABSTRACT

Mosaicking of torn image is a challenge for the investigators while reconstructing image from nonlinear torn images. Numerous researches were conducted in the past few decades to develop accurate algorithms to reconstruct images from torn image. Due to several factors, torn image reconstruction is not matured. In past researches, researchers focused on only image contour matching. The challenge in the contour matching technique is that extracting exact contour of the image fragment. Therefore, in this project, a new technique has been proposed to address the torn image reconstruction based on contour matching and contour pixel color matching. This project discussed the existing techniques used for torn image reconstruction and the advantages and disadvantages of those techniques. In this study, the proposed solution was evaluated based on the performance of the system in terms of accuracy and computational speed of the image reconstruction. The simulation indicates that the proposed technique performs better than existing technique in terms of accuracy. While simulating the system, 15 images were fragmented out of which 60% of the images were reconstructed fully, 33.33% of images reconstructed ¾ of the image fragments and 6.7% of images reconstructed half of the image. Most surprisingly, none of the images failed to reconstruct, at least 50% of image fragments reconstructed in the worst reconstruction while performing simulations. In terms of computational speed, it takes unacceptable time to reconstruct which is worse than traditional methods. Therefore, researcher classified the area's to refine which will be helpful for the future researchers, those who are attentive in the field of image reconstruction field.

ABSTRAK

Membina semula imej yang pecah menjadi satu cabaran bagi para penyelidik bagi menyusun semula imej daripada serpihan - serpihan imej yang tak linear. Kerja penyelidikan ini telah dijalankan dalam beberapa dekad yang lalu untuk membangunkan algoritma yang tepat lagi jitu. Atas beberapa faktor, kerja-kerja cantuman menjadi kurang praktikal. Dalam kajian lepas, penyelidik memberi tumpuan hanya kepada padanan kontur imej. Teknik ini mendapat cabaran dalam mengekstrak kontur yang tepat bagi serpihan imej. Atas faktor tersebut, projek ini mencadangkan satu teknik baru untuk menangani pembinaan semula imej yang pecah berdasarkan padanan kontur dan kontur piksel warna yang sepadan. Projek ini membincangkan teknik-teknik yang sedia ada; kelebihan dan kekurangan bagi pembinaan semula imej yang pecah. Dalam kajian ini, penyelesaian yang dicadangkan telah dinilai berdasarkan prestasi sistem dari segi ketepatan dan kelajuan pengiraan pembinaan semula imej. Simulasi menunjukkan bahawa teknik yang dicadangkan memberi prestasi yang lebih baik daripada teknik yang sedia ada dari segi ketepatan. Keputusan menunjukkan 15 imej adalah terpecah dan 60% daripadanya berjaya dibina semula, 33.33% imej berjaya dibina semula dari ¾ serpihan imej dan 6.7% imej terbina dari sebahagian imej yang ada. Paling mengujakan tiada imej yang gagal untuk dibina semula, sekurang-kurangnya 50% daripada serpihan imej berjaya dibina. Dari segi kelajuan pengkonputeran, ia mengambil masa yang lebih lama berbanding teknik konvensional. Oleh yang demikian, penyelidik cuba memberi penekanan yang lanjut terhadap bidang ini selain membantu generasi penyelidik untuk meneroka bidang ini dengan lebih khusus dan mendalam.

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LIST OF ABBREVIATIONS

BMU	:	Best Matching Unit
DP	:	Douglus-Pucker
Dpi	:	dots per inch
GA	:	Graph Algorithmic
GB	:	Giga Byte
GDR	:	German democratic Republic
GHz	:	Giga Hartz
ICP	:	Iterative Closest Point
IPAN	:	Image and Pattern Analysis group
KNN	:	Kohenon Neural Network
La*b*	:	Lab Color space
RAM	:	Random Access Memory
RGB	:	Red, Green, Blue
SOM	:	Self-Organizing Map

LIST OF SYMBOLS

C	-	Cluster
E	-	*Edge*
F, f	-	Fragment
G	-	Weight graph
H	-	(n x m) matrix
N_p	-	Number of pixel
P	-	Data points
S_p^i, S_q^j	-	Support points
S	-	Score
T	-	Transformation
t	-	Iteration
V	-	Vertex
w	-	Weight vector
X	-	Vector
Φ	-	Mapping function
a	-	Alignment
y	-	Closest point
γ	-	Learning parameter
δ	-	Delta
θ	-	Angle
σ	-	Best matching unit of neighborhood
$\neq$	-	Not equal

CHAPTER 1

INTRODUCTION

1.1 Introduction

Image processing plays a significant role in investigation to identify the crime related activities and to construct evidence. Images have been used as an evidence for most of the criminal related activities. Though constructing a picture from a torn image is still a challenge for the forensic investigators, there are numerous approaches to reconstruct torn documents. However, these techniques are much focused on extracting the text on a document. As a result, these techniques are not sufficient enough to construct an appropriate image from the torn image as most of the pictures do not have texts and the torn images are in nonlinear arrangement. Therefore shredded document reconstruction mechanism is not suitable for image reconstruction.

Most of the researchers focus on reconstructing an image from a torn single image, which means the pieces, are belong to one image. The purpose of this project is to develop a technique, which can reconstruct a picture from the torn picture collected in a crime environment, which is nonlinear. In real world scenarios, investigators do not know whether the collected pieces of a torn image belong to one image or not. Therefore, this research focus on how to reconstruct the image based on the image pieces using image boundaries and the color matching.

1.2 Problem Background

Image processing plays a substantial role in the investigation. Forensic experts encounter several issues when they discover several questionable fragmented documents in a crime scene or a suspected environment. Therefore, in forensic document examination, reconstructing images from ripped-up and shredded images and document is the hardest job forensic examiners face (Lin and Fan-Chiang, 2012). This may have been done by the criminal to destroy the evidence intentionally or unintentionally. Until today, there is no reliable mechanism to sort the torn image (Chanda, Franke and Pal, 2012). Secret police of German Democratic Republic (GDR) is still working with researchers to reassemble millions of files, which were destroyed before the socialist regime of the GDR in 1989. Some of these files are shredded and some are torn (Richter et al., 2013; Bstu.bund.de, 2014). Due to the huge amount of files, it is impossible to reconstruct the documents using human power.

Image processing and pattern recognition techniques have been in existence for a long time **(**Vendrell-Vidal and S\'anchez-Belenguer, 2014). Several researches have been conducted to address image reconstruction and these researchers have proposed various techniques, but still there is no reliable and dependable technique to reconstruct images from pieces of a torn image. Due to the immatureness of the algorithms used to identify the shape or dimension and quality of the picture, it is hard to recognize the patterns.

The challenges behind the reconstruction of an image from torn image pieces are mainly due to variations of the fragment size. Moreover, the complexity of the color of the image is another problematic issue. As a result, it takes long time to reconstruct the image. Researchers have proposed image reconstruction techniques by recognizing the fragment shape and recognizing fragment based on its contour color.

Reconstruction of image from fragments by recognizing boundary is not sufficient as the fragments might have similar fragments in terms of size and shape due to the way image was ripped, there might be gaps between the correctly matching fragments. In addition it is possible to match two fragments of different image, which has same characteristics in terms of shape and size (Biswas, Bhowmick and Bhattacharya, 2005; Kesarkar, Prasad and Tade, 2013).

The challenges in reconstructing image fragments by recognizing color is not an effective technique. Because in an image there might be the same level of color in several areas, therefore, fragments share same color in its contour then there is a high probability to miss match fragments. In addition, in a mixture of several fragments, which belongs to two or more images, then there are chances that fragments share same color in more than one fragment. However, if a fragment is missing, then the rest of the image might not resemble or mismatch occurs **(**Chakravarti and Meng, 2009).

Although some progress has been made in developing semi-automatic methods for reducing mathematical complexity of reconstruction and reassembly problems using digital image scans of the fragments. These techniques are not sufficient to depend. Hence, in practice, forensic examiners depend on manual reconstruction procedures (De Smet, 2008; Richter et al., 2013; Biswas, Bhowmick and Bhattacharya, 2005; Kesarkar, Prasad and Tade, 2013; Vendrell-Vidal and S\'anchez-Belenguer, 2014). While relying on manual methods, if the forensic examiners identified several hundred of image fragments, they might not know whether those image fragments belong to one image or not, and some part of the piece might be missing. For that reason, they should spend lots of time on analyzing the fragment and need additional workforce. Thus, it is important to find the computer-based solution to solve this problem. So while considering the solution, many methods are modeled to find out automatically reassembling the fragments along with the reduction in computation in order to speed up the operation (Kesarkar, Prasad and Tade, 2013).

Mosaicking of torn image can be solved by combining fragment boundary feature extraction using the graph algorithmic framework and matching boundary color of each fragment. Because the fragments shares same characteristics in terms of shape and color of their contour. Therefore, in this study, graph algorithmic framework and color pixel matching techniques will be explored.

1.3 Problem Statement

Challenges exist for extracting features from the image pieces and even reconstructing pictures from torn pieces includes recognizing the variation of the fragment shape, dimension and color, therefore these features need to be addressed to find a better solution.

Therefore, this research will focus on a technique to reconstruct image from collected fragments of image using contour color of the image pieces and the shape of the fragments. However to propose a proper solution, it is essential to answer the following questions;

1. How to extract the pattern and dimension of the fragments using Graph Algorithm.
2. How to rearrange fragments based on the edges and boundaries of the fragment.
3. How to rearrange the fragments based on its background color and dimension.

1.4 Aim of the Project

The aim of the research is to propose torn image reconstructing solution based on the graph algorithm and contour pixel color matching technique.

1.5 Objectives of the Project

The aim of this research is to enhance current image reconstruction techniques using existing techniques to reorganize or reconstruct image from torn image using hybrid method, which will be an efficient mechanism as it considers the dimension, and color of the image. This mechanism will provide the forensic investigators with a much more reliable result.

To achieve this goal the following objectives have been set;

1. To implement the Graph Algorithmic Framework to determine the dimension of fragments.
2. To reconstruct the image using background color matching techniques and dimension.
3. To evaluate the misplacement, inaccurate matching and performance computing speed.

1.6 Scopes of the Project

The scope of the research is mainly focused on the following items:

1. The suggested technique will identify the shapes and dimension of image fragments.
2. The suggested technique will use contour pixel color matching technique that will be determined by processing pixel of all the image fragments.
3. To experiment the result researcher is going to use four and eight fragments of an image as a dataset.
4. This solution will be evaluated based on the reconstruction accuracy and the reconstruction computing speed.

1.7 Significance of the project

The proposed approach will give better accuracy compared to existing technique, which will assist the forensic investigator to speed up their work while working with a bulk of torn pieces of an image. This research will be helpful and beneficial to the future researchers who work in the field of recognition and construction of images and texture.

1.8 Expected Contribution of the research

To enhance the existing technique by reconstructing algorithm with better accuracy compare to existing Graphic Algorithm Framework.

1.9 Organization of the research

This research is divided into six chapters. The first chapter of the research includes an introduction, problem background, problem statement, aim of the study, objectives of the research, the scope of the research, the significance of the research and the contribution of the research. In general, this chapter is an enhancement of the research proposal.

The second chapter focuses on a literature review, which talks about the related work done by other researchers and the techniques used in previous works to reconstruct the image. It will give a clear idea of the dataset and the techniques used by the previous researchers to evaluate their work. Finally, limitation of each work will be discussed.

Chapter three will be focused on research methodology which explains the steps included in this research and the framework that is going to be used in this

research study. It will cover detailed information of the dataset and the evaluation matrix.

Chapter four will be focused on the design of image reconstructing algorithm, which will discuss about the process of implementing the algorithm and explanation of the formula's used in the algorithm.

Chapter five will be an evaluation of the proposed technique. This chapter discuss on the result of the proposed technique. The results are presented in the form of tables and graphs.

Chapter six is the conclusion. This chapter will be more focused on the achievement of the research and its impact. It will highlight the future works to be carried out in the field of image construction.

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