

Ministry of Education of the Republic of Belarus
Educational institution
Belarusian State University of
Informatics and Radioelectronics

UDC 621.391

CHEN
JIKE

ALGORITHM FOR ANALYSIS AND SYNTHESIS OF TEXTURE IMAGES

Abstract
for a Master's Degree
in the Specialty 1-45 80 01 Infocommunication Systems and Networks

Supervisor
Tsviatkou Viktor
Doctor of Sciences, Full professor
Head of the Department of
Infocommunication technologies

Minsk 2023

INTRODUCTION

There is often more than one type of information in an image, but people may be interested in only one of them. For example, in a chest CT image of a cardiac patient, a cardiologist focuses only on the heart area to study it and determine treatment options. Therefore, image segmentation techniques have been developed to isolate the part of interest from the image. Image segmentation is a key technique in image processing, where different image descriptors and image segmentation models are used to divide the image into several non-overlapping regions and determine the boundaries of the regions, which is the main problem to be solved by image segmentation techniques.

And image, as a visual description of things, has many attributes. Such as chromaticity, brightness, saturation, etc., among which texture is an important attribute of an image. Texture feature is an important visual cue, which is a pervasive and difficult to describe feature in an image.

Texture, as a fundamental property of the surface of an object, is widely found in nature and is an extremely important feature for describing and identifying objects. Texture analysis techniques have been an important application in computer vision, image processing, image analysis, image retrieval, etc. The research content of texture analysis mainly includes: texture classification and segmentation, texture synthesis, texture retrieval and shape recovery from texture. One of the most fundamental problems of these research contents is image segmentation based on texture features. Image segmentation is the basis of image feature extraction and recognition, image analysis, and is a long-term research hot spot in the field of image processing. A large number of images belong to texture images, which have texture features such as complex structure and random variety, etc. If texture features are neglected, it will lead to inaccurate texture image segmentation or even segmentation errors, so texture image segmentation has been a difficult point in image processing. Because the accurate segmentation of texture images is closely related to the quality of extracted texture features, so extracting good texture features is the key and difficult part of texture image segmentation.

Texture synthesis techniques are very widely used in the field of computer graphics. For example, image restoration, image stitching, etc. Textures can be obtained in many different ways, such as scanning a photo, or drawing a picture by hand. However, this is very time consuming to obtain textures in both ways. It is inefficient because of the need to deal with luminance differences at the borders of the texture. Therefore, texture synthesis techniques have been developed in the last two decades. Using texture synthesis algorithms it is possible to extract texture samples and generate an unlimited number of texture data to achieve a synthetic similar texture within the range of human perception.

In this work, for the segmentation and synthesis algorithm of texture images, author has done the following work:

1 Summarized and analyzed several commonly texture image segmentation methods and proposed an improvement scheme.

2 Proposed a using active contour model segmentation method for texture segmentation, and designed experiments to verify its segmentation effect.

3 Described a very simple algorithm which was proposed to solve the texture synthesis problem, implemented optimized neural network texture synthesis algorithm, their applicability and advantages and disadvantages were analyzed through texture synthesis experiments.

GENERAL DESCRIPTION OF WORK

Relevance of the subject

The work corresponds to paragraph 1 «Digital information and communication and interdisciplinary technologies, production based on them» of the State Program of innovative development of the Republic of Belarus for 2021–2025.

The work was carried out in the educational institution Belarusian State University of Informatics and Radioelectronics within the framework of research work 21-2033 "Processing, coding and transmission of information in network-centric systems".

The aim and tasks of the work

The aim of the work is to research on the segmentation and synthesis of texture images.

To achieve this aim, the following tasks were solved in the dissertation:

1 Implementation of texture image segmentation algorithm and texture synthesis algorithm.

2 Designing experiments to evaluate algorithms.

3 Analyze and summarize the performance of each algorithm.

Personal contribution of the author

The content of the dissertation reflects the personal contribution of the author.

1 Proposed a texture segmentation method based on active contour.

2 Experiments of texture image segmentation were designed and conducted using Matlab (2019a). By analyzing the texture segmentation results, the effectiveness of the texture segmentation method based on active contour was

evaluated. Finally, it is concluded that the algorithm in this dissertation can better extract the second-order texture.

3 Experiments in Matlab (2019a) were designed and three texture synthesis algorithms were implemented: Image Quilting, texture synthesis using CNN, improved synthesis base on CNN. By analyzing the texture synthesis results, it is concluded that: most textures processed using the Image Quilting algorithm are acceptable, but there is a risk of compromising the originality of the texture and the synthesis is not efficient; images synthesized using CNN suffer from color imbalance and unstable texture structure; the improved texture synthesis algorithm base on CNN can solve the instability problem and improve the image quality and synthesis efficiency.

Task setting and discussion of the results were carried out together with the supervisor Tsviatkou Viktor, Doctor of Sciences, full professor, head of the Department of Infocommunication technologies.

Testing and implementation of results

The main provisions and results of the dissertation work were reported and discussed at: 59th scientific conference of postgraduates, undergraduates and students, (Minsk, April 18–22, 2023.) and International scientific and technical seminar "Technologies of information transmission and processing" (Minsk, March - April 2023)

Author's publications

According to the results of the research presented in the dissertation, 3 author's works was published, including: 3 articles and abstracts in conference proceedings.

Structure and size of the work

The dissertation work consists of introduction, general description of the work, four chapters with conclusions for each chapter, conclusion, bibliography, eight appendixes.

The total amount of the thesis is 62 pages, of which 40 pages of text, 25 figures on 9 pages, 2 tables on 1 pages, a list of used bibliographic sources (36 titles on 3 pages), a list of the author's publications on the subject of the thesis (3 titles on 1 pages), 1 appendixes on 2 pages, graphic material on 8 pages.

Plagiarism

An examination of the dissertation «Algorithm for analysis and synthesis of texture images» by Chen Jike was carried out for the correctness of the use of

borrowed materials using the network resource «Dayainfo» (access address: <https://dsa.dayainfo.com>) in the online mode 05.31.2023. As a result of the verification, the correctness of the use of borrowed materials was established (the originality of the thesis is 95.8 %)

SUMMARY OF WORK

The **introduction** addresses the problems of the difficulty of texture image analysis and synthesis techniques.

The **general description of work** shows the connection between the work and the priority areas of scientific research, the aim and tasks of the research, the personal contribution of the applicant for a scientific degree, the approbation of the dissertation results.

In the first chapter the background of texture image segmentation is introduced, the author summarizes and analyzes the texture image segmentation algorithm, and proposes the direction of optimization.

In the second chapter a texture image segmentation method using active contour lines is proposed, and experiments are designed to verify and analyze his effectiveness. And the experiment results show that the algorithm proposed in this chapter can segment the second-order texture relatively well.

In the third chapter different texture synthesis algorithms are introduced, and the applicability and advantages of texture synthesis algorithms are analyzed through comparative experiments.

CONCLUSION

With the continuous development of computer graphics, more and more researchers are devoted to the feature analysis of images. And texture is a very important part of image feature information, and texture analysis techniques have become a hot spot for research.

The research object of this paper is texture images. The research in this paper is about the segmentation algorithm and texture synthesis algorithm of texture images.

The author introduced the texture features of images, and summarized and studies the segmentation methods applicable to texture images. The basic principles of the current stage of texture image segmentation methods were described, and the applicability, advantages and disadvantages of each method were analyzed.

In the process of designing texture image segmentation experiments, the author proposed a segmentation method based on active contours. Firstly, a method

to compute local spectral histogram to obtain texture features was introduced, based on which active contours are driven to extract textures. Secondly the author performed segmentation tests on standard texture datasets, synthetic textures and real time texture images. By comparing with the segmentation results derived from other filtering methods, finally the author verified the accuracy and practicality of the proposed method.

What's more, the author also designed texture synthesis experiments in order to study better texture synthesis algorithms. At first, the Image Quilting algorithm for Texture Synthesis is studied and the principle and implementation of the algorithm are described. Then briefly introduced the texture synthesis algorithm using neural networks and proposed an optimized neural network synthesis algorithm. Finally, the author tested the texture synthesis results of each method with a large amount of texture data and evaluated the applicability and efficiency of the algorithms.

Image segmentation techniques have been developed for many years, and texture feature segmentation has been a difficult problem in image segmentation algorithms, and an efficient and general texture segmentation method has yet to be proposed. Texture synthesis using neural networks is still immature, and although good synthesis results can be achieved, the synthesis efficiency is not high and pre-trained models are required; in order to get the best synthesis results, researchers often manually tune parameters on a per-image basis, and it is still a challenge to automate parameter settings.

LIST OF AUTHOR'S PUBLICATIONS

Conference abstracts

1–A. Chen, J.K. Texture feature extraction method based on grayscale recognition / J.K. Chen // *Инфокоммуникации : сборник тезисов докладов 59-ой научной конференции аспирантов, магистрантов и студентов, Минск, 18–22 апреля 2023 г.* – Minsk : BSUIR, 2023. – С. 156–157.

2–A. Chen, J.K. Research on texture image feature extraction method / J.K. Chen, J.X. Fu, V.yu. Tsviatkou // *Технологии передачи и обработки информации (Technologies of information transmission and processing): материалы Международного научно-технического семинара, Минск, март – апрель 2023 г.* – Minsk : BSUIR, 2023. – С. 149–153.

3–A. Chen, J.K. High dynamic range image processing technology / J.X. Fu, J.K. Chen // *Технологии передачи и обработки информации: материалы Международного научно-технического семинара, Минск, март – апрель 2023 г.* – Minsk : BSUIR, 2023. – С. 163–166.