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Method for the Development of Software Tool for Face Recognition

Abstract to master degree thesis

Specialty 1-98 80 01 Information Security

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GENERAL DESCRIPTION OF WORK

The Research Aim and Objectives

The aim of the research is to analyze the existing face recognition algorithms and develop, based on this analysis results, an improved software tool for face recognition.

To achieve the aim, it is necessary to solve the following objectives:

1) to analyze the methods and means of face feature extraction and feature recognition in face recognition;

2) to discuss the advantages of using MATLAB as the development platform;

3) to study a variety of commonly used face image preprocessing techniques, including face images for geometric correction, histogram equalization and filter denoising methods;

4) to study the theoretical basis and specific implementation process of PCA algorithm and SVM are studied in depth;

5) to implemented face recognition system on MATLAB platform on the base of the framework of PCA algorithm and SVM method;

6) to conduct static tests through ORL, Yale and IMM standard face databases as well as dynamic environment tests through self-built face databases.

Work Connection with Priority Areas of Scientific Research

The topic of the thesis corresponds to paragraph 6 Ensuring the security of humans, society and the state (means of technical and cryptographic information protection, cryptology and cybersecurity) of the list of priority areas of scientific, scientific-technical and innovative activities for 2021–2025, approved by the Decree of the President of the Republic of Belarus dated 07.05. 2020 No. 156.

Thesis Results Approbation

The main results of the dissertation were reported and discussed at the 59th Scientific conference of Graduate Students, Master Students and Students of BSUIR (Minsk, April 17–21, 2023), 16th International Conference “Pattern Recognition and Information Processing” (Minsk, October 17–19, 2023), X Belarusian-Chinese Youth Innovation Forum “New Horizons – 2023” (Minsk, November 9, 2023), the 60th Scientific conference of Graduate Students, Master Students and Students of BSUIR (Minsk, April 22–26, 2024).

INTRODUCTION

Face recognition technology has been developed for a long time, especially nowadays, in economic life, military, security and so on have great development. Horizontally, face recognition has obvious advantages in many pattern recognition methods, with naturalness, non-intrusiveness, low acquisition cost and strong human-computer interaction natural advantages, the application scene is broader. Vertical analysis, major listed companies continue to launch a large number of commercial face recognition products, face recognition will show explosive growth in the future. Thus, the study of face recognition has great practical significance.

This paper focuses on three major contents: face preprocessing, face feature extraction and face recognition. Especially, the Principal Component Analysis (PCA) and Support Vector Machine (SVM) algorithms are thoroughly studied, and a real-time face recognition system based on PCA and SVM is realized. The main objectives of this paper are:

- to analyze the methods and means of face feature extraction and feature recognition in face recognition;
- to discuss the advantages of using MATLAB as the development platform;
- to study a variety of commonly used face image preprocessing techniques, including face images for geometric correction, histogram equalization and filter denoising methods;
- to study the theoretical basis and specific implementation process of PCA algorithm and SVM are studied in depth;
- to implemented face recognition system on MATLAB platform on the base of the framework of PCA algorithm and SVM method;
- to conduct static tests through ORL, Yale and IMM standard face databases as well as dynamic environment tests through self-built face databases.

The face recognition system is tested with a general recognition rate of 97 % on standard face databases and is capable of real-time face recognition in dynamic environments.

MAIN PART

The first chapter provides a detailed introduction to modern contemporary face recognition methods and the basic functions of MATLAB as well as its application in face recognition, and briefly describes the advantages of using the PCA algorithm and SVM classifier for face recognition [1–A].

The second chapter presents the development sequence of a face recognition system using PCA and SVM. It detailed the principles of these methods, their implementation in MATLAB, GUI development and execution of various functions. Highlights include pre-processing of face images to improve recognition accuracy, principles and implementation of face feature extraction via PCA, SVM-based face classification using the LibSVM toolbox, and the implementation of the PCA and SVM-based face recognition system in MATLAB, including the training, testing, and recognition processes, as well as the GUI development of the system [2–A – 4–A].

In the third chapter, the face recognition system constructed based on PCA algorithm and SVM method is tested using MATLAB software and ORL, Yale and IMM standard face database, and the results show that the system can successfully realize the face recognition function, and the human-computer interaction interface can reflect the recognition results of the system in real time. At the same time, I also built my own face database to verify the recognition effect of the system and display the results through the recognition interface, and the experimental results proved that the system has fast recognition speed and high accuracy, and can meet the requirements of face recognition. This chapter finally analyzes the test results, the main factors affecting the recognition rate of the algorithm are the number of eigenvalues and the size of the test face dataset, as the number of eigenvalues rises, the recognition is the first to rise and then there is a downward trend; the size of the training set affects the recognition rate of the test set, at any time the number of the training set increases, the recognition rate of the test set will be improved. For the training set the training set speed will be longer as the number of feature values increases.

CONCLUSION

Face recognition is an important means of identification in people's daily life, and also has a wide range of applications in military and criminal investigation. The current face recognition algorithm is also one of the popular research in today's society, and many scholars have put forward a lot of constructive methods in the research of face recognition. Nowadays, the most important technical methods in face recognition are as follows: geometric feature-based methods, local feature analysis methods, feature face methods, neural network methods and so on.

In this thesis, a face recognition method combining PCA algorithm and SVM method is proposed, and a face recognition system is realized by using this method through MATLAB platform, which has the following main functions:

- training and testing of face database;
- real-time acquisition of face images for face recognition.

By testing the system statically and dynamically using three standard face databases ORL, Yale, IMM and self-built face databases, the average recognition rate of the system in the three standard databases is at 97 % and it can acquire face images for face recognition in real time.

The face recognition system based on PCA algorithm and SVM method realized in this paper has achieved good results, and the application environment of the face recognition system is complex and varied, but there are still unresolved issues that need to be further improved. They mainly include the following aspects.

1. As the face recognition system in the actual application, many are dynamic a recognition process. Therefore, it is a huge pressure on the accuracy of face detection. How to improve the accuracy of face detection in complex environments will greatly improve the practicality of face recognition.

2. Face recognition is still very sensitive to the influence of light, so how to eliminate the influence of light on face recognition will be a major research problem.

3. At present, most of the research on face recognition is on two-dimensional face images, and the recognition of two-dimensional face images is very sensitive to light, shade, posture and age. Compared with 2D face images, 3D face images will carry more information and provide a more accurate description of a person's face. It is worthwhile to investigate how to use 3D face images for recognition or how to combine them with 3D face images.

LIST OF OWN PUBLICATIONS

1–A. Wang, K. Urgent Problems of the Development of Software for Face Recognition / Kaiyu W. // Information Security : Collection of Materials of the 59th Scientific Conference of Graduate Students, Undergraduates and Students of BSUIR, Minsk, April 17–21, 2023 / Belarusian State University of Informatics and Radioelectronics. – Minsk, 2023. – P. 56.

2–A. Novel Fall Detection Algorithm based on Multi-Threshold Fall Model / L. Hao, M. Jun, X. Ren, K. Wang // Pattern Recognition and Information Processing (PRIP'2023) : Proceedings of the 16th International Conference, October 17–19, 2023, Minsk, Belarus / United Institute of Informatics Problems of the National Academy of Sciences of Belarus. – Minsk, 2023. – P. 169–175.

3–A. Wang, K. Y. An Improved LBP Algorithm in Face Recognition / K. Y. Wang, H. Li // Belarusian-Chinese Youth Innovation Forum “New Horizons – 2023”, November 9, 2023, Minsk, Belarus / Belarusian National Technical University. – Minsk, 2023. – T. 1. – P. 134–135.

4–A. Wang, K. Face Recognition System Based on Principal Component Analysis and Support Vector Machine Classification / Kaiyu W. // Information Security : Collection of Materials of the 60th Scientific Conference of Graduate Students, Undergraduates and Students of BSUIR, Minsk, April 22–26, 2024 / Belarusian State University of Informatics and Radioelectronics. – Minsk, 2024. – P. 42–45.