Lecture Notes in Electrical Engineering 791

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Innovative Computing

Proceedings of the 4th International Conference on Innovative Computing (IC 2021)

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Preface

This LNEE volume contains the papers presented at the International Conference on Innovative Computing (IC 2021) which was held in Taiwan, Taichung City, during 1–3 February 2020. This event is the fourth event of the conference series, in which fruitful results can be found in IC 2015 (Xiamen, China), IC 2016 (Taichung, Taiwan), and IC 2020 (Ho Chi Minh, Vietnam). This conference series aims at providing an open forum to reach a comprehensive understanding of the recent advances and emergence in information technology, science, and engineering. There are two international workshop and international conference are jointly operated with IC 2021 at the same time and place, i.e. The International Workshop on Future Technology (FUTECH 2021), and The 5th International Conference on Big-data, IoT, Cloud computing Technologies and Applications (BICTA 2021), which are organized by FC conference group and Korean Institute of Information Technology, Korea Institute of information technology and innovation (KIITI), and SIEC Korea Chapter.

The papers accepted for inclusion in the conference proceedings primarily cover the topics: database and data mining, networking and communications, web and Internet of Things, embedded system, soft computing, social network analysis, security and privacy, optics communication, and ubiquitous and pervasive computing. Many papers have shown their academic potential and value and indicate promising directions of research in the focused realm of this conference. We believe that the presentations of these accepted papers will be more exciting than the papers themselves and lead to creative and innovative applications. We hope that the attendees and readers will find these results useful and inspiring to your field of specialization and future research.

On behalf of the organizing committee, we would like to thank the members of the organizing and the program committees, the authors, and the speakers for their dedication and contributions that make this conference possible. We appreciate the contributions from these experts and scholars to enrich our IC 2021. Also, we would like to thank and welcome all participants to IC 2021. We also sincerely hope that

all participants from overseas and from Taiwan enjoy the technical discussions at the conference, build a strong friendship, and establish ties for future collaborations.

Taichung, Taiwan — Jason C. Hung
Taichung, Taiwan — Jia-Wei Chang
Fukushima, Japan — Yan Pei
Taichung, Taiwan — Wei-Chen Wu

Contents

Detection of Region-of-Interest Based on Noise Filtering in High-Speed Images

Seok-Woo Jang

Abstract Relatively inexpensive cameras have become common that can film even minute movements of moving objects at high speeds. This paper introduces a method of removing noise pixels abnormally generated from the ultra-high-speed images entered, and then detecting the skin color area of a person, the area of interest that represents personal information from the images of noise removed. The proposed algorithm eliminates noises by applying bilateral filters from the high-speed images that are first accepted. Then, using color models created through learning, the human skin area, which is an area of interest, is accurately extracted from the image of noise removed. The experimental results show that the proposed algorithm effectively removes noises from the high-speed images entered and then robustly detects the area of interest, the skin color area. The method introduced in this study is expected to be useful in many applications related to pattern recognition, such as image analysis and understanding, video pre-processing, noise removal, etc.

Keywords High-speed image analysis · Human skin area · Noise filtering

1 Introduction

Ultra-high-speed cameras, which can accurately capture even the slightest movement that human eyes cannot identify, have been relatively expensive and not very common [1]. Therefore, practical research using ultra-high-speed cameras has been conducted only within a very limited scope of a particular academic field, such as modeling physical or dynamic phenomena [2].

In particular, relatively inexpensive ultra-high-speed cameras, such as the camera installed on Samsung's Galaxy S9, capable of shooting ultra-high-speed video at 960 fps, have just begun to appear. Therefore, it is difficult to find studies for blocking target objects containing personal information, such as a human face area, in a generalized color image photographed with a high-speed camera.

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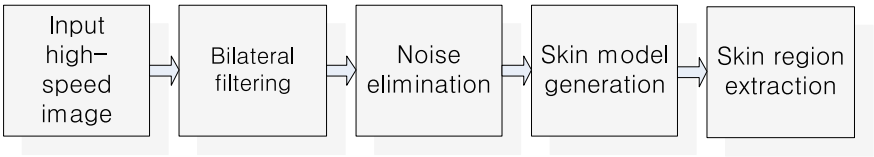

Fig. 1 Overall flow of the suggested algorithm

Therefore, a study is needed to effectively detect the area of interest as a preliminary step to extract the part containing private information from various types of high-speed images that are inputted very quickly [3]. The area of interest referred to in this paper is set as the area of skin color that best represents a person's privacy information.

Previous studies conducted to remove noises from dynamic images or to detect areas of interest can be found in related references. However, existing algorithms mostly target general images rather than ultra-high-speed images, and include a number of shortcomings and constraints. Since studies related to high-speed imaging are just beginning, the number of recent existing methods associated with noise removal and detection of areas of interest in ultra-high-speed imaging is relatively small compared to other methods involved.

Therefore, this study introduces an algorithm that effectively removes noise contained within the image by using bilateral filters from ultra-fast images input at very high speeds, and then uses a skin color distribution model to robustly extract areas of interest from the image of noise removed. The following Fig. 1 shows the overall flow chart of the area-of-interest extraction algorithm through noise elimination in the high-speed image introduced in this study.

As shown in Fig. 1, the method presented in this study effectively removes noises contained within the dynamic color image by first using a bilateral filter from the fast-speed images. The area of human skin color distribution, the area of interest that best represents the personal information exposed from the noise-removed image, is then robustly extracted.

This chapter describes the overall overview and background of this study. Section 2 describes how to remove noises from high-speed images input using bilateral filters. Section 3 describes techniques for extracting areas of interest, which is the previous step for detecting target areas, including personal information. In addition, Sect. 4 describes the results of experiments conducted to compare and evaluate the performance of the region-of-interest extraction method using noise elimination proposed in this study. Finally, Sect. 5 describes the conclusions and future research plans.

2 Filtering-Based Noise Elimination

Using a high-speed camera to shoot a scene can cause unexpected noise in the video. In other words, noise occurs when the intensity of light accepted by sensors in the camera is weaker than that generated by electrical signals. In addition, noise occurs depending on the size and resolution of the image sensor inside the high speed camera, and noise occurs frequently when the size of the sensor is small and the resolution is high.

In this paper, a bilateral filter defined as Eq. (1) is applied to effectively eliminate noises contained within the high-speed image [4].

$$I^{filter}(x) = \frac{1}{W_p} \sum_{x_i \in \Omega} I(x_i) f_r(\|I(x_i) - I(x)\|) g_s(\|x_i - x\|) \tag{1}$$

In Eq. (1), the $I^{filter}(x)$ represents the filtered result image, and I(x) represents the original input image to be filtered. x means the position of the current pixel to be filtered, and Ω is the window centered on x. Therefore, x_i means different pixels. f_r is the range kernel for smoothing the difference in pixel values, and g_s is the space kernel for smoothing the difference in coordinates. In this paper, f_r and g_s use the Gaussian function [5].

$$W_p = \sum_{x_i \in \Omega} f_r(\|I(x_i) - I(x)\|) g_s(\|x_i - x\|) \tag{2}$$

The weight W_p is assigned as shown in Eq. (2) using spatial proximity (space kernel g_s) and pixel value differences (range kernel f_r). Consider a pixel located in (i, j) where noise must be removed from the image using adjacent pixels. In addition, suppose one of the adjacent pixels is located at (k, l). The range and space kernel are then assumed to be Gaussian kernels, and the weights assigned to pixels (k, l) to eliminate noise from pixels (i, j) are defined as in Eq. (3).

$$w(i, j, k, l) = \exp\left(-\frac{(i-k)^2 + (j-l)^2}{2\sigma_d^2} - \frac{\|I(i, j) - I(k, l)\|^2}{2\sigma_r^2} \right) \tag{3}$$

In Eq. (3) σ_d and σ_r are smoothing factors, and I(i, j) and I(k, l) are the intensity values of the pixels in positions (i, j) and (k, l), respectively. In this paper, the intensity value $I_D(x, y)$ of the pixels with noise removed from the position (i, j) can be obtained by calculating weights and then normalizing them, as in Eq. (4).

$$I_D(i, j) = \frac{\sum_{k,l} I(k, l) w(i, j, k, l)}{\sum_{k,l} w(i, j, k, l)} \tag{4}$$

As the range parameter σ_r increases, the range of Gaussian convolution is widened and flattened, so the bilateral filter gradually approaches the Gaussian convolution