Development and Realization of System of Digital Image Processing Based on MATLAB Platform

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ABSTRACT: *This paper established a set of complete visual digital image processing system under the design environment of graphical user interface (GUI) of MATLAB aiming at the characteristics of digital image processing. This system can achieve visual abstract conception, visual GUI and visual processing result, and highlight explaining theory by vision and speaking by example. This paper fully displayed strong human-computer interaction ability and image processing ability of the image processing system through demonstrating two spatial filtering recovery and wavelet decomposition.*

Categories and Subject Descriptors
H. 5.2 [User Interfaces]: Graphical user interfaces; I.4.10 [Image Representation]

General Terms: Filtering Recovery, Image Processing

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1. Introduction

Digital image processing is processing methods and technologies such as eliminating noise, strengthening, recovery, segmentation, extracting characteristics [1-3]. With the development of computer and information technology and the expansion of application field, digital image processing technology has achieved great progress; digital image processing is easy to realize nonlinear processing with variable processing program and processing parameter. Therefore, it is a kind of image processing technology with strong universality, high accuracy, flexible processing method, easy storage and reliable transmission. It is widely applied in various industry fields such as remote sensing, universe observation, medical imaging, communication, criminal investigation, etc.

It is particularly important for people who engage in image and relative field to master knowledge and principle of digital image processing, since digital image processing technology has strong theoretical property, practicalness as well as rich and vivid content. Although the popular commercial image processing software such as Photoshop, 3DMAX, Maya, etc has friendly interface, the content aiming at understanding and mastering basic knowledge of image processing is rare and can not reveal knowledge connotation of digital image processing technology.

In recent years, some development platforms for image processing appear abroad [4], such as CVIptools [5] software developed by American Southern Illinois University, CVB [6] image processing platform developed by Germany, etc. The former is aiming at UNIX platform and has not yet transplanted into windows platform. The latter supports for windows platform, but it are mainly applied in industry production with high price and complex operation. Some image processing teaching system interface developed by some university at home also exists disadvantages such as unfriendly interface, poor interaction

and single function. In view of the development requirement of current digital image processing technology, this paper developed the image processing system based on MATLAB that is suitable for teaching and project development of digital image processing.

2. Design and Realization of Image Processing System

2.1 Introduction of matlab gui

MATLAB is a set of high-powered software used for numerical calculation and visualization proposed by American MathWorks Corporation. As the emerging programming language and visual tool, it has the advantages that other programming languages can not match. It is widely applied in scientific calculation, system control, analysis of information and image processing, simulation and design. MATLAB GUI [7] is a user interface composed of window, cursor, key, menu and literal statement. We can and deign a beautiful and convenient human-computer interaction interface with menu and control with GUI design tool of MATLAB.

Composition of System Module

The image processing system includes image transformation, image enhancement, image restoration, color image processing, image coding, wavelet transformation, image segmentation and image analysis. It covers the most content of digital image processing field. Besides the basic image processing content, we also add some new algorithm for image processing proposed at home and abroad in time, such as Lucy-Richardson interactive filtering and wavelet transform. Compared to the image processing teaching system appeared at home, function and interaction of these algorithms improves greatly. The overall framework of image processing system is as shown in Figure 1.

3. Design of Subfunction Interface Module

Image restoration is always the important content of digital image processing. Wavelet transformation is the difficulty of digital image processing field and also one of the hotspot of current research. The following introduced the function design of subfunction module with the example of spatial filtering restoration in image restoration module and subfunction module of wavelet multistage decomposition in wavelet transformation module.

3.1 Spatial filtering restoration

Noise is one of the important factors that cause image degradation. The noise of digital image mainly comes from image acquisition and transmission. The common noise includes gaussian noise, index noise, uniform noise and impulse noise. For a degraded image, we can express it by $g(x, y)$:

$$g(x, y) = f(x, y) + n(x, y) \quad (1)$$

Where $f(x, y)$ is original image and $n(x, y)$ is noise. Minus $n(x, y)$ in $g(x, y)$ is unpractical because of the unknown noise. At this moment, we can restore the image and reduce noise by spatial filtering. Common spatial filter includes mean filter, statistical filter, median filter and adaptive filter.

3.2 Wavelet decomposition and multiresolution analysis

Wavelet transformation is characterized by multiresolution analysis. It can decompose signal with different scale, thus to obtain different levels of outline information and detail information of target image.

Suppose 2D image signal is $f(x, y)$. $\Phi(x)$ and $\Psi(x)$ express one dimensional scale function and wavelet function, respectively. Then 2D separable scale function is:

$$\phi(x, y) = \phi(x)\,\phi(y) \quad (2)$$

Core can be expressed by three separable 2 D wavelet:

$$\psi^H(x, y) = \psi(x)\,\psi(y) \quad (3)$$

$$\psi^V(x, y) = \phi(x)\,\psi(y) \quad (4)$$

$$\psi^D(x, y) = \psi(x)\,\psi(y) \quad (5)$$

Where $\psi^H(x, y)$, $\psi^V(x, y)$ and $\psi^D(x, y)$ is termed as horizontal, vertical and diagonal wavelet and expresses variation along column, row and diagonal, respectively.

3.3 Experimental result demonstration

Figure 2 is the spatial filtering restoration demonstration. Add different noise on original image and set mean value and variance to make original image degrade into a noise image, then select relative spatial filter, for example, restore mean filter and obtain final restoration image. The experiment proves that median filter and adaptive filter have good denoising effect. B in Figure 2 is the subinterface of two dimensional wavelet decomposition. Left is original image for decomposition and selects setting of parameters. Right displays two dimensional wavelet decomposition result figure. It can be seen from the figure that, in every level, the wavelet decomposition is divided into three sub-bands, that is, low frequency component, high frequency detail of horizontal edge, high frequency detail of vertical edge, high frequency detail of diagonal. We select Haar wavelet basis and make Level 3 wavelet decomposition on Lena image.

4. Conclusion

This paper discussed development and realization of digital image processing system based on MATLAB. The system can not only visualize image processing but also have friendly interface and adjustable parameter, which can meet the requirement of most image processing algorithm. In subsequent work, we will continuously perfect the function of image processing system, increase the latest demonstration interface of image processing algorithm and make it into image processing software for convenient and practical use.

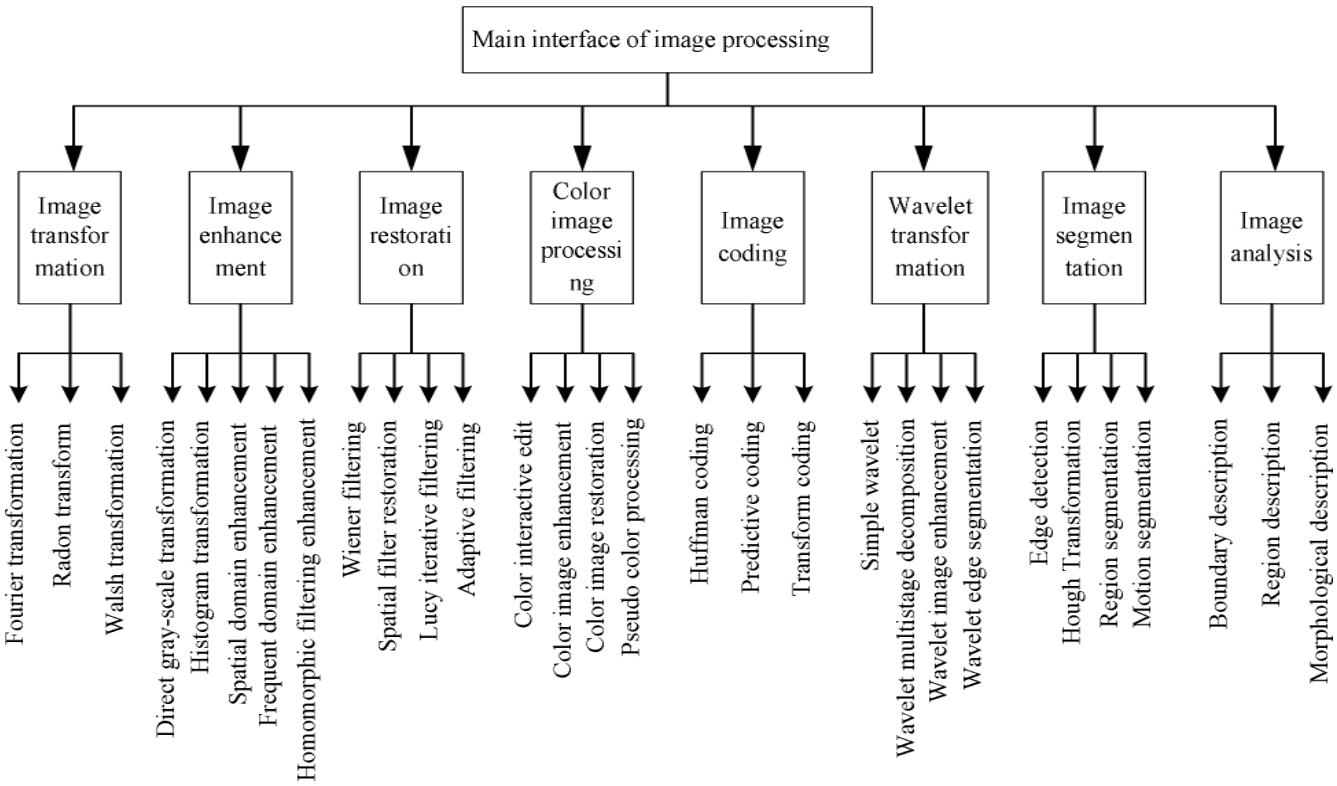

Figure 1. Overall structure of digital image processing system

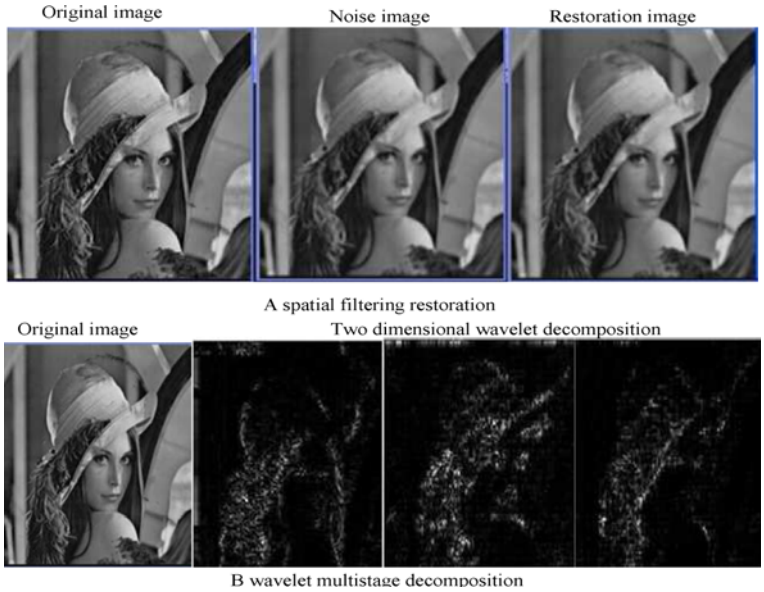

Figure 2. Experiment Demonstration

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