Design and Implementation of Image Processing System Based on MATLAB

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Abstract—Digital Image Processing can be mentioned as computer image processing. It refers to a process within which image signals are transformed into digital ones and computers will be applied to the process of transformation so as to generate images that should be received by human vision or receiving devices of other types. Mathematics serves as the base of digital image processing and its primary missions include algorithm design and realization of the algorithm. By utilization of computers, a multitude of image data can be processed [1].

MATLAB has already gained its reputation as one of the most excellent mathematical application software with high competence for scientific calculation. The software assists image processing engineers and scientific researchers by offering a more visible and reliable development tool, which is named Image Processing Toolbox [2].

To design an image processing system, and to discourse the image display, this paper conducts image drawing and picture processing through the system on the basis of digital image processing environment of MATLAB.

Keywords- Digital Image Processing; Matlab; Graphical User Interface; Image Processing Ssystem; Image Processing Functions

I. INTRODUCTION

With the continuous development of information technology, the digital image processing technology is extensively applied to various fields, such as aerospace, biomedical engineering, industrial inspection, robot vision, military guidance and culture and the arts [3]. Image processing is becoming a remarkable and promising science. MATLAB language is the most influential and most dynamic software in the world of science, especially in the field of automatic control, because of the powerful scientific computing, flexible program design process, high quality graphics and visual interface design, convenient interface functions with other procedures and language [4]. MATLAB, also known as matrix laboratory and its powerful matrix operation ability is unmatched by other languages, and matrix operation count is the essence of image processing [5]. Therefore, this paper tries to develop and design the image processing system based on MATLAB.

II. SYSTEM IMPLEMENTATION

A. The main characteristics of the system

- Practicability and expansibility.
- Friendly interface
- Generality

B. System Design Procedure

The system determines the general steps of the design based on the software development and design principles. Specific steps are as follows:

- Analyse the main functions of the interface requirements and Clear design task.
- Draw the sketch interface in the manuscript and review.
- Produce the static interface in accordance with the idea of the sketch and examine.
- Write the program of the interface dynamic function and check the function item by item.

C. Implementation

- System Frame Design

According to the main functions of the system, the system can be divided into six modules, which is the basic operation of the file, image type conversion, the basic operation of the image, image enhancement, image transform and two value image operation, etc. Some of these modules also include sub modules, in order to make the system frame diagram clear, some sub modules are not

described here. The frame diagram of whole system structure is shown in Figure 1.

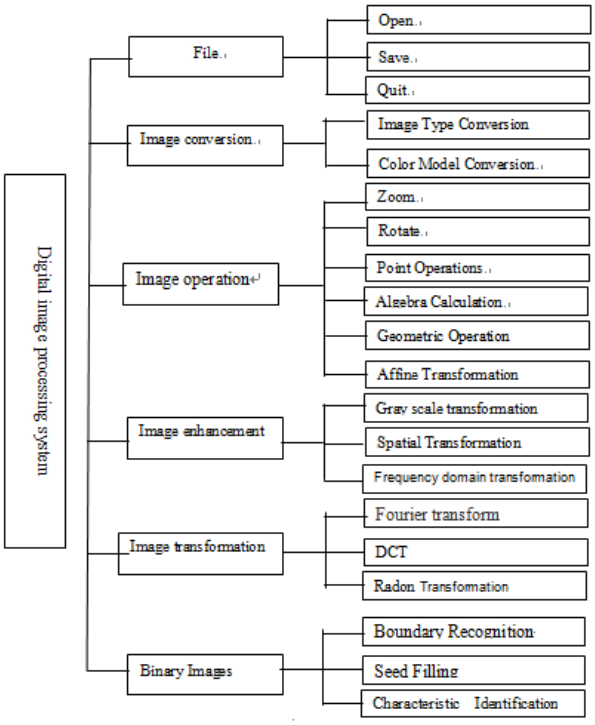

Figure 1. The frame diagram of system structure

- Interface Design

According to the design procedure of the system, the static interface of the system is designed by using the MATLAB graphical user interface (GUI), as shown in Figure. 2

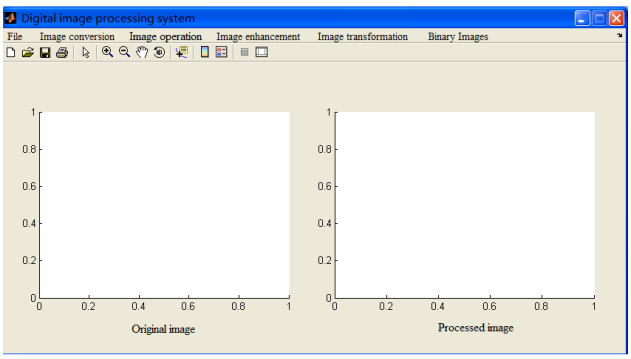

Figure 2. Static system graphics interface

In order to facilitate the presentation and operation, the image type conversion and color space transform will be carried out in a platform in the system. Image conversion interface is as shown in Figure 3.

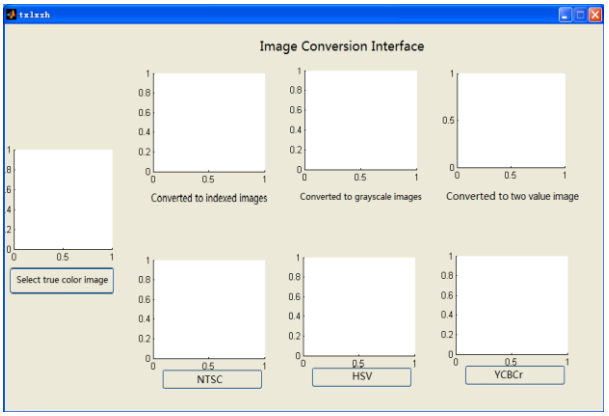

Figure 3. Image conversion interface

The effect of Image conversion function is shown in Figure. 4

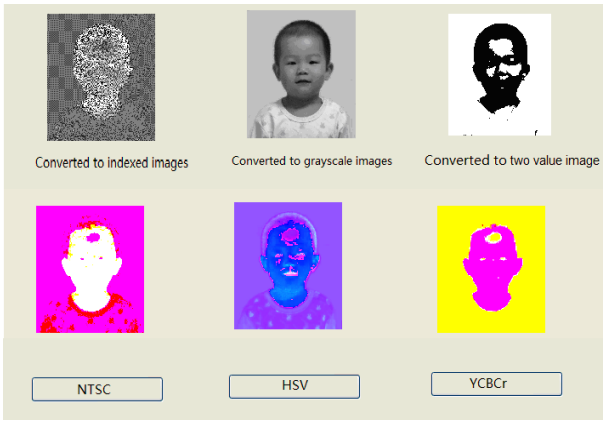

Figure 4. The effect of Image conversion function

- Write Dynamic Callback Procedures

After the completion of the static interface design, GUI will automatically generate .fig file and .m file, which .fig file save the attribute values of all objects on the static window interface [6]. .M file is mainly used for various features of control GUI by control functions and user control callback function [7]. This .M file can be divided into two parts, GUI initialization and callback function. The callback function for user controls is called separately according to the user's specific interaction with GUI.

The object responds to callback function the when it is called [8]. Therefore, how to write the callback function of the object is a difficult problem in the system. When you write a callback function, the handle of the function is the key to achieve the function of the object. Actually, the handle is digital ID assigned for each object. Whenever you want to create an object, MATLAB automatically creates a unique handle for it, so that if we can find the handle, we can operate on the object [9].

In MATLAB, the graphics object is a unique part of the picture, which can be operated alone. Each item produced by a graphics command is a graphic object, including a graphical window or merely a graphics, and a coordinate axis, line, surface, text, etc.

These objects form a hierarchical structure, including the parent object and the child object. The computer screen is the root object, and it is the father of all other objects. The graphics window is a child of the root object. The

coordinate axis and the user interface are the children of the graphics window; Lines, text, surfaces, patch and image objects are the sub objects of a coordinate axis [10]. This hierarchy is given in Figure 5.

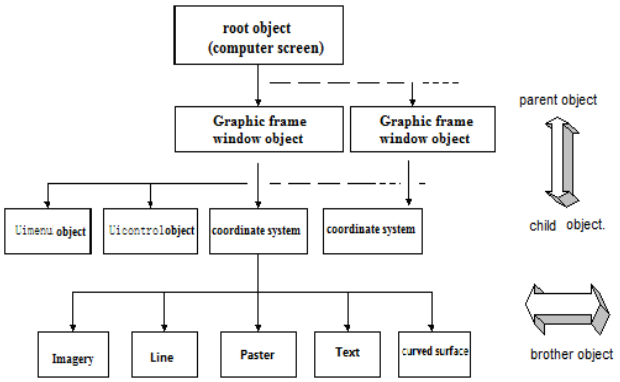

Figure 5. MATLAB graphics window hierarchy

The functions used to obtain a handle in MATLAB are the following:

gcf: to get the handle for current graphics window.

gca: to get the handle for current axis.

gco: to get the handle for current object.

gcbo: to get the handle for current object being called.

gcbf: to get the handle for the graph of current object being called.

We can use these functions to obtain a handle of the object. For example, you can use the get function and combine several functions mentioned above to obtain the digital identity of the object to be operated. Once you get the handle to the object, the next job is to design and implement the system function.

- Determination of System Function

Theoretically, the image is a two-dimensional continuous function. However, when the image is digitally processed on a computer, it is necessary to make a digital image in space and brightness, which is the process of sampling and quantization of the image [9]. A 2D image is uniformly sampled, you can get a digital image, which is discredited into M×N samples, the digital image is an integer array, So using matrix to describe the digital image is the most intuitive and simple method [10]. The advantage of MATLAB is that it is good at processing matrix operation. So it is very convenient to process the digital image with MATLAB [11].

The system supports five types of image, which are index image, gray image, binary image, RGB image and multi frame image array. It allows reading, writing and displaying the operation on the GIF, JPEG, TIFF, BMP and other image file formats. It has powerful image processing functions, for example, Image type conversion function can realize the conversion in the color image, the index image and the two value image; Editing functions can realize the geometric operation on the image; The image module can realize the function of gray scale processing, expansion, corrosion, boundary map extraction; The orthogonal transformation module can realize the function of image compression and reconstruction.

These functions are realized by written program code in M file based on MATLAB language. As an example, the functions of the gray menu in image module are realized by the design of piecewise linear transformation algorithm, and using mat2gray( ) gray enhancement function provided by MATLAB to achieve gray degree transformation of the selected region. The main code as follows:

```
x1= getimage(gco);
 figure
imshow(x1)
f0=0;g0=0;
f1=20;g1=10
f2=180;g2=230;
f3=255;g3=255;
figure,plot([f0,f1,f2,f3],[g0,g1,g2,g3])
r1=(g1-g0)/(f1-f0);
b1=g0-r1*f0;
r2=(g2-g1)/(f2-f1);
b2=g1-r2*f1;
r3=(g3-g2)/(f3-f2);
b3=g2-r3*f2;
[m,n]=size(x1);
x2=double(x1);
for i=1:m
   for j=1:n
   f=x2(i,j);
   g(i,j)=0;
   if(f>=f1)&(f<=f2)
       g(i,j)=r1*f+b2;
elseif(f>=f2)&(f<=f3)
       g(i,j)=r3*f+b3;
      end
   end
end
figure
imshow(mat2gray(g))
```

The effect of the gray scale image processing is shown in Figure 6.

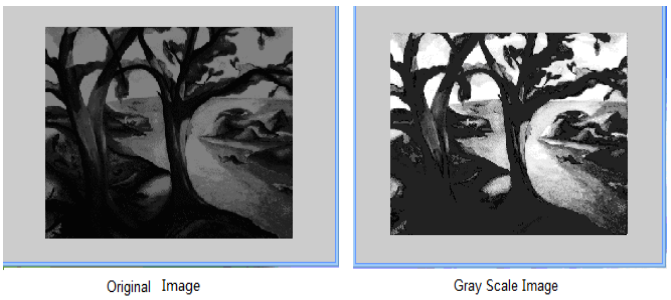

Figure 6. The effect of the gray scale image processing

After running the program, we get the image is transformed by piecewise linear transformation algorithm. It will be seen that the dynamic range in original image between (0~20) and (180~255) is reduced, and the dynamic range in original image between 180 and 255 is increased. Image contrast in this area has been enhanced. The specific change in the image is that brightness increased significantly in the upper half of the picture.

III. CONCLUSIONS

In this system, some classical and practical functions of the image processing technology are realized. The reason for choosing these functions is that the techniques have a strong application value for the real life. For example, image enhancement technology and orthogonal transformation have a very high application value in the field of medical imaging. CT scanning technology used commonly in medicine is based on the X - ray attenuation coefficient of different substances [12]. If we can determine the distribution of the human body's attenuation coefficient, researchers can reconstruct the fault or three-dimensional image.

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