

# Research and Implementation of A Digital Image Processing Education Platform

JIA Tong, WU Cheng-Dong, Chen Dong-Yue

School of Information Science & Engineering  
Northeastern University  
Shenyang, China  
jiatong@ise.neu.edu.cn

**Abstract**—Digital image processing is an important course, which has strong theoretical and practical needs for students. This paper proposes a digital image processing education platform (DIPEP) based on C# and .NET framework. It has the image processing, analyzing and visualization function. Students can develop and integrate algorithms into the platform quickly and easily. Moreover, algorithm flow application and algorithm management can be applied by students in DIPEP based on workflow technology. Tested by experiments, DIPEP meets the requirement of interface flexibility, information sharing, algorithms safety and efficiency. (*Abstract*)

**Keywords**—digital image processing; education platform; workflow technology; algorithm management (*Keywords*)

## I. INTRODUCTION

With the development of computer and image processing algorithms, digital image processing have access to a wide range of applications in radio and communication systems, radar signal processing, medical image processing, network security, industrial automation and other fields, so the digital image processing course have attracted extensive attentions. The course has strong theoretical and practical and the combination of them is relatively close, therefore on the one hand, need to display algorithms to improve students' intuitive feeling to theory, on the other hand, need to meet the students' practical requirements after class[1-5].

Digital image processing algorithms usually include image enhancement, image segmentation, image registration, image feature extraction and classification etc. In recent years, many digital image processing toolkits and platform are emerging in the world, which have accumulated many mature algorithms, such as Matlab, VTK(Visualization Toolkit), ITK(Insight Segmentation and Registration Toolkit) etc.

Matlab is a high-level technical computing language and interactive environment for algorithm development, data visualization, data analysis, and numeric computation. Using the MATLAB image processing toolbox, students can solve technical computing problems faster than with traditional programming languages, such as C, C++, and Fortran. VTK is data visualization develop toolkit, which can provide more than 300 C++ function and broad field of digital image applications. ITK is another package, which can provide to

researchers a segmentation and registration image algorithms platform [6-8].

The above mentioned platforms are function-oriented platform, aren't student-oriented. Most of them have some problems to education as following.

- (1) Their architecture is very complex and they are not suitable for beginners to learn.
- (2) They are less portable and must be run in specific circumstance.
- (3) Their fixed algorithm process cannot satisfy the learning needs of students.
- (4) It is very difficult to realize a new image processing algorithm.

Thus, a digital image processing education platform (DIPEP) is proposed in this paper. DIPEP has the following main features.

- (1) There are many typical image processing algorithms are integrated into DIPEP and the image processing results can be displayed to students.
- (2) Students may set algorithm parameters, file name, function name and function parameters etc, and more new algorithms can be integrated easily.
- (3) Because workflow technique is adopted in DIPEP, the algorithm process can be defined and managed by students.
- (4) In DIPEP, the operation is very simple and is very easy to learn for students.

## II. DIPEP FRAMEWORK DESIGN

The Platform uses workflow technology, building component [9] module and framework. The algorithm on the platform meet interface flexibility, information sharing, and safety and efficiency requirements.

Workflow [10-12] means that work is done by different components in a fixed sequence. It stems from the concept of office automation field. With the development of Web technology, a number of standardization organizations develop workflow which is related Web standards, such as XLANG, WSFL. Currently, the workflow technology has been widely

applied in the various fields, such as government offices, approval processes and enterprise content management processes etc.

#### A. DIPEP Architecture

Platform architecture is shown in Fig.1 including: system platform layer, support service layer, data service layer, core service layer and system application layer.

(1) System platform layer: include operating system, database and data management module, and support distributed computing capacity;

(2) Support services layer: provide a unified service and support interface, including framework flow management, visualization control parameters management, and platform management, and application framework algorithms module;

(3) Core service layer: provide core services to support image processing and analyzing, including image pre-processing, image segmentation, image visualization and image registration etc;

(4) System application layer: according users personalized needs to provide corresponding services, such as image processing application, image analyzing application, image visualization applications and image feature extraction application etc.

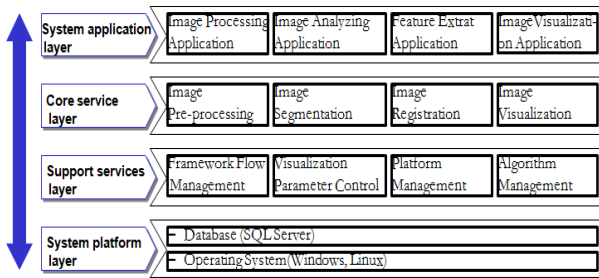


Figure 1. DIPEP architecture

#### B. DIPEP Functions

DIPEP provide the following functions.

(1) Image processing, analyzing and visualization: students adopt the algorithms which are provided in DIPEP to process and analysis image, similar to the image workstations function.

(2) Algorithms develop: DIPEP provides 2D and 3D view interface, students can develop new algorithms and run it on the platform, such as using Visual Studio .NET framework to compile c++/c# language as dynamic link library (DLL).

(3) Algorithm flow application: according to the requirement of students, they can edit and management various algorithms, such as set algorithm parameters, file name, function name and function parameters etc.

(4) Algorithms management: including management control to the various algorithm flow, such as begin, suspension, end and delete operation etc. The algorithm processes also can be saved to facilitate students to run the algorithm flow for next image.

#### C. Algorithm Flow Application

Each algorithm in CADAP is an independent implementation unit and has the corresponding node, as shown in Fig.2.

In Fig.2, the above dotted line is image processing process, the below dotted line is data conversion process. Each data conversion is through a logical processing unit to finish, and we will regard this logic unit as the workflow nodes.

Because algorithm implement parameters are automatically or manually inserted, algorithm flow node can be divided into several types, which have different node types as following.

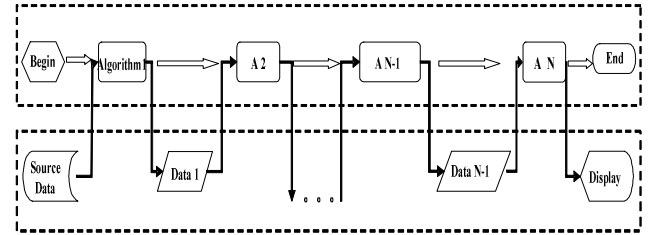


Figure 2. Algorithm flow Simulation

(1) Parameter node: parameter node is used to input or output parameter of algorithm node, these parameter types are Integer, Double, Boolean or String type etc.

(2) Image node: the image data is saved in image node and the data is either input image or output image.

(3) Algorithm node: algorithm node not only is the image processing logic unit, but also is the core process of the entire algorithm flow simulation. Algorithm node is divided into automatic processing node and manual processing node. To automatic processing node, it does not require user's interactive operation. But to manual processing node, it must require students' interactive operation.

### III. THE KEY ALGORITHM OF DIMEP

The current key algorithms of DIMEP mainly include image enhancement, image segmentation, image registration and image visualization etc. According to the requirement of students, the new algorithms can be added into the algorithm list constantly.

#### A. Image Enhancement

Image enhancement is the improvement of digital image quality, without knowledge about the source of degradation. The integrated image enhancement algorithms include direct intensity adjustment, histogram transformation, image arithmetic and image filter etc.

#### B. Image Segmentation

Image segmentation is to distinguish objects from background. For digital images, four popular approaches are integrated. They are threshold methods, edge-based methods, region-based methods, and connectivity-preserving relaxation methods.

### C. Image registration

Image registration is the process of aligning two or more images of the same scene. Typically, one image (base image) is considered the reference to which the other images (input images) are compared. The object of image registration is to bring the input image into alignment with the base image by applying a spatial transformation to the input image. The integrated algorithms include cross-correlation, mutual information, sum of squared intensity differences, and ratio image uniformity. Mutual information and normalized mutual information are the most popular image similarity measures for registration of multimodality images. Cross-correlation, sum of squared intensity differences and ratio image uniformity are commonly used for registration of images in the same modality.

### D. Image Visualization

Image visualization has been used to explore large amount of abstract data. It involves selecting, transforming and representing abstract data in a form that facilitates human interaction for exploration and understanding. There are some common 3D visualization algorithms in DIPEP. Such as max intensity rendering, min intensity rendering, surface shadow rendering, volume rendering etc.

## IV. APPLICATION

In this paper, we take the algorithm list as an example to explain the platform application. After DIPEP running, algorithm management component automatically communicates with server, based on the students' authority to download the corresponding algorithms list, and display all of the algorithms which have developed and integrated in the main interface. Students can also easily add their own algorithm in the algorithms list and through mouse double-click the algorithm list to run the corresponding algorithms. For example, Fig.3 shows the algorithm management list and Fig.4-Fig.6 show the corresponding algorithm result. In Fig.4, (a) is the original image; (b) is the enhanced result. In Fig.5, (a) is the original lung CT image; (b) is the lung parenchyma segmentation result. In Fig.6, (a) is the orthophoto; (b) is the aerial image; (c) is the registered image.

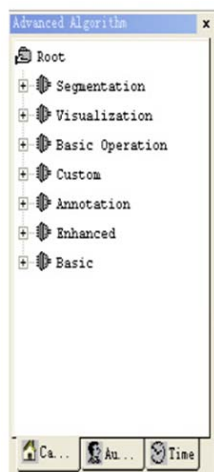


Figure 3. Algorithm management list

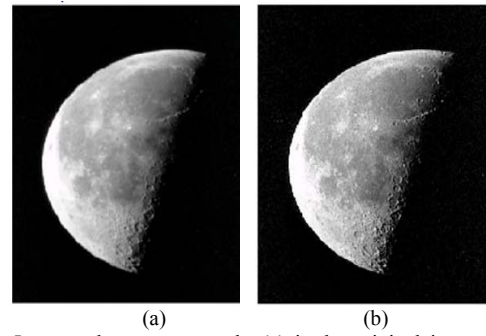


Figure 4. Image enhancement result. (a) is the original image; (b) is the enhanced result.

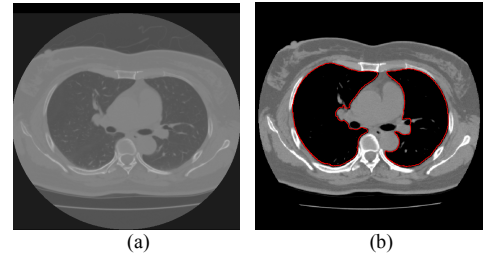


Figure 5. Image segmentation result. (a) is the original lung CT image; (b) is the lung parenchyma segmentation result.

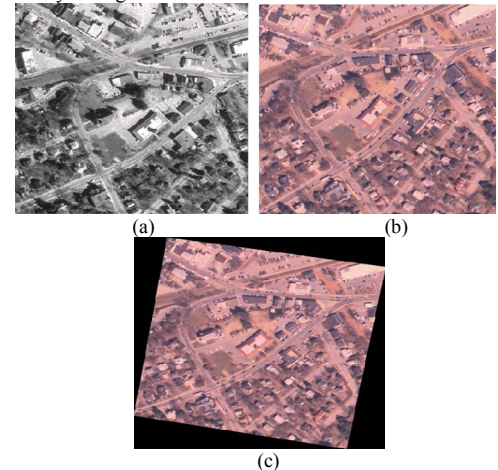


Figure 6. Image registration result. (a) is the orthophoto; (b) is the aerial image; (c) is the registered image.

## V. CONCLUSION

In this paper, using *c#* and .NET framework, we research a digital image processing education platform, which can implement image processing, analyzing and visualization, algorithm flow application and algorithm management. Based on experiments, DIPEP meets interface flexibility, information sharing, algorithms safety and efficiency.

## ACKNOWLEDGMENT

This paper was supported by Fundamental Research Funds for the Central Universities of China, Grant No. N090304001.

## REFERENCES

- [1] Zhao Haifeng, Tang Jin, Luo Bin, "Teaching Reform and Innovation of the Course - Digital Image Processing Experiments," Proceeding of 5th International Conference on Computer Science and Education, pp.1599-1600, 2010.

- [2] Fan, Hong<sup>1</sup>, Li De-Min<sup>1</sup>, Liu Tang You, Cui Feng, "Using Interesting Examples for Teaching Digital Image Processing Course," Proceedings of 2009 4th International Conference on Computer Science and Education, pp. 1729-1732, 2009.
- [3] Huang Ying, "Implementation of Open Teaching Platform on Digital Image Processing," Journal of Electrical & Electronic Education, vol.28, pp.95-98, 2006.
- [4] Simon, Alejandro<sup>1</sup>, Adjouadi, Malek, "A programming tool for enhancing the teaching of image processing," Comput. Educ. J, vol.17, pp.85-94, 2007.
- [5] Ning Yuan, Huang Runlin, Tan, Xin, Wei, Xuejun, "Research on the teaching reform of digital image processing course," Proceeding of International Conference on Educational and Information Technology, pp.2457-2459, 2010.
- [6] Varga, Matija<sup>1</sup>, Varga, Zdravko, "Utilizing Matlab in secondary technical education," Proceeding of 33rd International Convention on Information and Communication Technology, Electronics and Microelectronics, pp.970-974, 2010.
- [7] Martin-Villalba, Urquia A, Dormido, "Visualization and interactive simulation of Modelica models for control education," Proceeding of Control and Decision Conference, pp.3076-3081, 2009.
- [8] Tsai, Chia-Ling, Stewart, Charles V, "A correspondence-based software toolkit for image registration," Proceeding of IEEE International Conference on Systems, Man and Cybernetics, pp. 3972-3977, 2007.
- [9] M. Brian Blake, "Component-based design and development for robust medical applications," <http://www.cis.upenn.edu/hcmdss/papers/sub/missions>.
- [10] A.S.Parrish, "Automated flow graph-based testing of object-oriented software modules," Journal of Systems and Software, vol.23, pp.95-109, 2002.
- [11] J.Weissenfels, D.Wodtke, "The mentor architecture for enterprise wide workflow management," <http://paris.cs.uni2sb.de/public2html/papers>.
- [12] P.K.Chrysanthos, K.Ramamritham, "Synthesis of extended transaction models using ACTAM," Database Systems, vol.19, pp. 450 – 491, 1994.