Image Processing Software Package in Medical Imaging: A review

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Abstract— MATLAB is at present among the best available technique for image processing. Medical images after digitalized processed can help reducing the number of false positives and they assist medical officers in deciding between follow-up and biopsy. This paper gives a survey of image processing algorithms that have been developed for detection of masses and segmentation techniques. 35 students from university campus participated in the Development of Biomedical Image Processing Software Package for New Learners Survey investigating the use of software package for processing and editing image. Composed of 19 questions, the survey built a comprehensive picture of the software package, programming language, workflow of the tool and captured the attitudes of the respondents. The result of this study shows that MATLAB is among the famous software package and this result is expected to be beneficial and able to assist users on effective image processing and analysis in a newly developed software package.

Keywords- MATLAB; image processing; image editting; software package.

1. Introduction

This paper details a project jointly funded by the *Dana Pembangunan Pengajaran (DPP)* and *Universiti Teknologi Malaysia* (UTM) to produce a survey of computer graphics and visualization tools in use in the medical image processing.

Image processing has moved into the mainstream, not only for the engineering world but also the society of general. Nowadays, personal computers are now able to handle a large amount of graphics and images with ease. The fast network system and modem transfer rate are able to transfer images just in a fraction of time. Image manipulation software becomes a general and common item on PC. As a result of this growth, image processing package had become a standard tool in the repertoire of the engineer.

This paper is divided into seven sections. The first section mainly introduces the whole study. It provides the general overview of the visualization tools in medical image processing. The second section includes the objectives of this study, which describes the aims that needed to be achieved. The third section discusses the background studies, literature review and the study implementation. A specification list of the computer environment and thorough discussion on the developmental tool or processing and analysis on various medical images will be explained in section 4 and 5. Finally, the last two sections contain the results, conclusions, future developments and possible enhancement and improvement on this study.

2. Problem Formulation

The hypothesized function of newly developed image processing software package is to provide the users with information about the ease of image processing of an image in order to deliver useful information through the analysis with connection to the theory of image information through processing. In this study, the practice item of image processing software package was focused on MATLAB application.

Several imperatives were identified to be addressed by the survey:
- To identify specific software packages in use together with the advantages and disadvantages of using these packages.
- To attempt to establish a dialog with software vendors to discuss how technological problems might be resolved.

Validity of measurement is very important as this argument need to be valid to the extent that conclusions and results drawn from the data collected do logically follow from them.

A wide variety of image processing techniques have been used in medical field for image analysis. This employs a large number of visual and physiological features, a fact which usually impedes the training process [1]. In this paper, an effective medical image processing for image processing is presented through survey result. Several aspects for example the speed of the processing and ease of use are considered while the processing is being done. This software package does not process only raw image for analysis, but also important in managing the image data effectively and providing scientific information about image characteristics.

3. Literature Review

Due to the rapid development of information technology, in turn, impacted significantly on the techniques for image processing techniques and implementing of survey processing systems. This main development has been shifted from mainframe system to PC platform. User now can easily perform all kind operations and processing techniques ranging from small scale to large scale statistical operations.

A number of software packages for the image processing and editing have emerged over the years. The different steps of image processing make each of the software packages differ with different relative strengths. Having the right software and appropriate processing techniques is necessary for guarantee for the successful processing of data.

In principle, all the data run through the same kind of cycle and the typical famous well-developed software packages for image processing are as follow:

A. *Adobe Photoshop*
 A software used in teaching and research and was generally found to be useful and easy to use. Functionality for scanning and scanned image manipulation. Simple integration with other Adobe products.

B. *Adobe Illustrator*
 It is the industrial standard software and works well with other graphics software. Not easily compatible with WORD and Windows PC users cannot easily send images to a non-graphics PC user.

C. *ImageTool*
 ImageTool is a free package with powerful image processing capabilities. Its main use is image analysis and it is quite easy to use. Developed by UTHCSA, as will all freeware, *ImageTool* has no guaranteed future development and no direct support.

D. *LabView*
 Its main use is to convert from one image file format to another. A large number of image formats are supported. Images can be increased or reduced in size. Image resolution may be altered in the preparation of images for importation into word-processing or desktop publishing packages.

E. *Paint Shop Pro*
 It is used both in teaching and research. It is regarded as easy to use and useful. It is robust, good documentation and capable in conversion between different image file formats.

F. *ImageJ*
 ImageJ is freeware. It is a free package with powerful image processing capabilities. The most used features of the software are image editing, processing, and enhancement.

G. *Image Prep*
 A specialist graphics manipulation package which has proved to be very useful for converting and enhancing graphics images. Used for manipulation of scanned photographic images for research software generation.

H. *ERDAS Imaging*
 A GIS package designed to plan for surface change such as urban development, transport planning and landscape planning. Useful but fairly difficult to use. Very hard to start off with, but once you have conquered the initial problems it becomes a lot easier.

I. *MATLAB*
 Ease of customization and able to handle large matrices. Use of the language script to customize statistical tests and matrix manipulation.

J. *Microsoft Photo Editor*
 A fairly easy and useful drawing package for drawing graphs within WORD documents used in preparation of teaching materials. Straight forward intuitive mouse-driven actions and the ease with which images could be embedded within WORD documents.

4. Methodologies

The survey was designed to support the imaging techniques community by fostering inter-institution communication and as an important first step toward determining effective 'best practice'. It was also expected that camera and imaging systems developers would benefit by gaining in-depth understanding of the digital image processing needs of the imaging heritage

niche. Research laboratories, too, require the information sought by the survey to help guide them in determining where improvements are needed.

A number of steps were taken in order to realize these objectives and these including the design of a questionnaires framework, construction of the project web pages, the use of on-line social activity platform like facebook messaging, e-mail discussion groups, face-to-face interview and the development of a dedicated project discussion list.

A. Sample Size

Sample size and the method of collecting data from the respondents needed to be considered for this survey. 35 participants with a total sample size n=35 would have sufficient statistical power for statistical significance.

B. Data Collection Framework

The framework of the questionnaire is very simple and easy to understand. It was divided into 4 sections which are part 1 for demographic details, part 2 for quantitative questions, part 3 for qualitative questions and last part for open-ended questions.

The 19 questions of the survey took about half an hour to complete. That so many took the time to respond to the questions is testimony to a strong need and interest by imaging service providers for a better understanding of digital image processing. Participants included many of the major undergraduate students who had taken their image processing subject credit.

The full merits and limitations of particular software could only be fully established through the use of the software with real data, involving real questions and real problems. The design and size of the question within a subjective survey must be limited to promote respondents completion of the survey [2]. The survey was conducted through questionnaires distribution, World Wide Web Service online filling, email and facebook online activity platform. Subjects were also invited to make general observations and perspectives on the use and potential use of the image processing software tool techniques in their work. The result is mainly relies on human perception and is subjective by nature [3].

5. Results

The response rate to the questionnaires is mild and has been limited but not very disappointingly so. We have received over 35 completed questionnaires. Of these, almost 70% were completed the survey. Around 20-25% of the response rate to the questionnaires is considered good by some relevant literature suggestions [4].

Table 1 shows the frequency of coding with various types of programming languages. Result had recorded that most of the time, MATLAB and LabView are the main tools or languages for processing image then follow by C++, C# and Java. Due to the easiness of coding and image processing toolbox available in the platform, hence MATLAB and LabView are the famous choices for respondents. On opposition, all respondents definitely never use Python, R, Lua, Ruby and Perl as their processing tool for image processing.

When the respondents discussed about the use of MATLAB software in image processing, the software was described as being neither particularly easy nor difficult to use and it was viewed in high regard however. Descriptions were included that the software was specifically used for data analysis with customised procedures, matrix manipulation, data visualization, graphic image production and editing, and customization of statistical data using language script.

Nowadays, there are many types of different software products in the market that we can use to process images. Most of the products are well-developed and user may produce desired images within a few clicks. Table 2 shows the frequency of respondents of using these types of software products. In medical images wise, respondents still choosing MATLAB as their first choice following by Microsoft Photo Editor, Adobe Photoshop, LabView and ImageTool.

Although, MATLAB is not a well-developed image processing tool package like Adobe Photoshop and Microsoft Photo Editor, and also user need to code a few lines for processing process, but MATLAB still remain as the famous processing tool among all.

When we switch our discussion to rating an interesting piece of software if it were distributed as a ready-to-use package or source code as in Figure 1, respondents seems feeling likely on a ready-to-use package software due to the easiness and simple handling. They feel that it is easy for them to edit their photo according their needs without thinking or writing any code. But somehow, a ready-to-use software might not completely fulfil the user needs. Some respondents had commented that a source code package sometimes may save a lot of time for us especially who are not very familiar with the coding language but they also commented that understanding of the source code written by someone is not an easy task.

6. Discussions

A good image processing tool package is determined through five core capabilities: image utilities, image filtering and transformation, image compression, image analysis and programming and data analysis environment. User can easily rate any software package according the five core capabilities discussed above.

Besides, it is very important for a software package during the designing step. It should cover around four essential qualities: validity, reliability, impact and practicality. Validity is normally taken to be extent to which a processing can be shown to produce scores which are an accurate reflection of the image taken true level. Reliability concerns the extent to which processing results are stable, consistent and accurate, and therefore the extent to which they can be depended on for making decisions about the image processing. Impact concerns the effects, beneficial or otherwise, which an examination has on the processing using the package. Practically can be defined as the extent to which a processing is practicable in terms of the resources needed to produce and administer it [5].

The advantage of the development of image processing package over other is the ability of this processing tool to provide an effective and easy method for user. It is important to consider the processing in all the aspects including speed and quality.

Due to the speed and ease of use, MATLAB is highly recommended as the software for image processing. Users can rate a software package using above five major core capabilities.

MATLAB is a general numerical analysis and visualization environment. The underlying data structure in MATLAB is the matrices, and this structure lends itself well for image processing.

This processing tool also need be revised to make them more user-friendly, with a focus on issues such as layout, illustrations, message, information, and cultural appropriateness. It should provide full functionality for the entire processing cycle: authoring, scheduling, administering and rating. It is a premier and affordable personal computer-based image processing package for academia, government and business users.

7. Conclusion

Ethical issues had to be considered since the proposed survey required the involvement of human respondents. Ethical considerations are required during surveying human for their opinions and such considerations include: seeking permission of potential respondents for their involvement, explaining their level of involvement and responsibilities in the survey, providing some background so that they can make an informed decision based on their knowledge background and finally ensuring respondents of anonymity in the reporting of the project [2].

This survey attempted to raise an interest in MATLAB application in the medical image processing field. The survey results are fairly depressing and there is plenty of work to be done. In medical image field, not many visualization tools can be used and most of them are not easy being used. Hence, a creation of simple computer graphics such as histograms, bar charts and scatter plots by MATLAB package to manipulate and visualize matrices data is a need.

The project's web pages will continue beyond the completion of the survey, as will visualization tools.

In order to minimize the differences between variables, it is very important to standardize the procedures and instruments used in the survey due to variations in the way the research was carried out. Hence, solutions and procedures for providing consistent and interpretable results must be suggested, problems of defining observational variables and phrasing questions need to be outlined [2].

Further developments in each algorithm step are required to improve the overall performance of the computer-aided image processing in medical sciences.

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TABLE I. FREQUENCY OF USING FOLLOWING PROGRAMMING LANGUAGES

Rate questions on a scale of 1 to 4.	Never	Occasionally	Frequently	Most of the time	Responses	Total	Mean	Standard deviation
How often do you use the following programming languages (%)	1	2	3	4				
C++	23	**57**	20	0	35	10	1.9714	0.6636
Python	**100**	0	0	0	35	10	1	0
Java	**86**	9	6	0	35	10	1.2	0.5314
C#	**63**	31	6	0	35	10	1.4286	0.6081
R	**100**	**0**	**0**	0	35	10	1	0
Lua	**100**	**0**	0	0	35	10	1	0
Ruby	**100**	**0**	0	0	35	10	1	0
Perl	**100**	0	0	0	35	10	1	0
MATLAB	9	20	**37**	34	35	10	2.9714	0.9544
LabView	29	**34**	29	6	35	10	2.1714	0.9544

TABLE II. FREQUENCY OF USING THE FOLLOWING SOFTWARE PRODUCTS

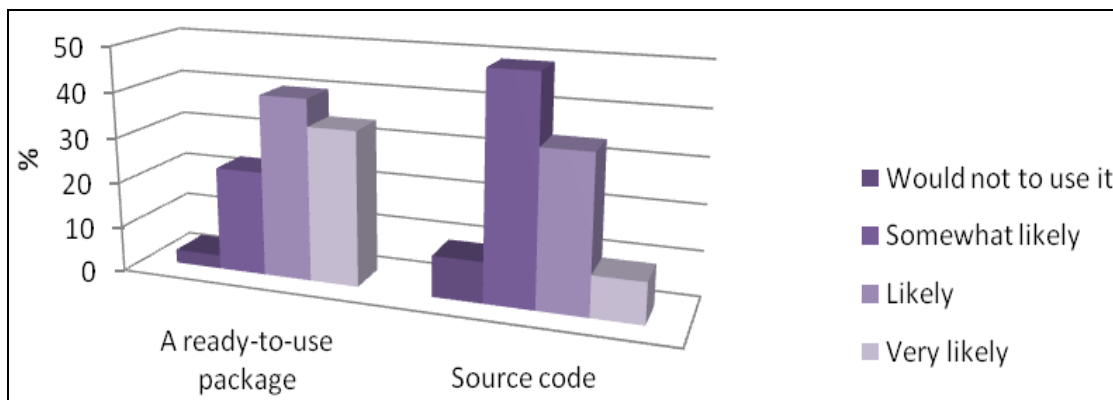| Rate questions on a scale of 1 to 4.	Never	Occasionally	Frequently	Most of the time	Response	Total	Mean	Standard deviation
How often do you use the following software products (%)	1	2	3	4				
Adobe Photoshop	14	**40**	29	17	35	8	2.4857	0.9509
Adobe Illustrator	**74**	17	6	3	35	8	1.3714	0.7311
Image Tool	**54**	20	26	0	35	8	1.7143	0.8599
LabView	31	29	**37**	3	35	8	1.2857	0.7101
Paint Shop Pro	**83**	9	6	3	35	8	2.1714	0.7470
Image J	11	**69**	11	9	35	8	1.0571	0.3381
Image Prep	**97**	0	3	0	35	8	1.0857	0.3735
ERDAS Imaging	**94**	3	3	0	35	8	2.6286	1.2623
MATLAB	9	17	**37**	**37**	35	8	1.0857	0.2840
Microsoft Photo Editor	29	17	17	**37**	35	8	1.0286	0.1690
OpenCV	**91**	9	0	0	35	8	3.0571	0.8382
VTK	**97**	3	0	0	35	8	2.4285	0.7778

Figure 1. Comparison between a ready-to-use package and source code.