Image Processing Tools Package in Medical Imaging in MATLAB

Ching Yee Yong, Kim Mey Chew, Nasrul Humaimi Mahmood and Ismail Ariffin

***Abstract*—**This paper is about 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 to investigate the use of software package in 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; more than 60% of the respondents prefer to use MATLAB for their image processing work. The Microsoft Photo Editor is the second popular software for images editing process. More than 30% of respondents are very likely to use a ready-to-use package for processing image rather than given source code. The result is expected to be beneficial and able to assist users on effective image processing and analysis in a newly develop software package. A preliminary image processing tool prototype was developed as shown in this paper.

***Keywords*—**MATLAB, editor, image processing, software package.

I. 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 wave, not only in the engineering world; but also to the public. Personal computers now are able to handle 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 personal computers. For example, Image Processing Toolbox in MATLAB provides a comprehensive set of reference-standard algorithms and graphical tools for image processing, analysis, visualization, and algorithm development. User can perform image enhancement, image deblurring, feature detection, noise reduction, image segmentation, geometric transformations, and image registration without serious difficulties.

Biomedical Image Processing techniques involve lot of mathematical equations and new learners/ students need to calculate manually in order to analyze such techniques. It is very important to the new learners to understand the fundamentals of Biomedical Image Processing; however, through demonstration the techniques via real application would be extra benefit for new learners to understand such techniques.

This paper is divided into seven sections. The first section introduces the study. It provides the general view of the visualization tools in medical image processing. The second section includes the objectives of the study, which describes the aims that need to be achieved. The third section discusses the background of 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 are 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.

II. Problem Formulation

Imaging has become an essential component in medical research and clinical practice. 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, 2, 3].

This survey focused on identifying specific software packages; and its advantages and disadvantages of using it. On the other hand, this survey also tries to communicate with software vendors in discussing on how technological problems can be resolved. The survey is very important in order to develop the tools (in both hardware and software) to give new learners the ability to analyze biomedical data to support the discovery and advancement of biomedical knowledge.

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:

1) To discover the current visualization practice in

Manuscript received May 23, 2012: Revised version received May 23, 2012. This work was fully supported by the Dana Pembangunan Pengajaran (DPP) and Universiti Teknologi Malaysia (UTM) under Grant Vote 08233.

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biomedical image processing techniques.

2) To relay current general and subject specific technological limitations.

In this paper, an effective medical image processing for image processing is presented through survey result. Several aspects like the speed of the processing and ease of use are considered while the processing is being done. This is to make sure the software package does not only process the raw image for further analysis, but it is also able to manage the image data effectively and provides accurate and reliable scientific information.

III. Literature Review

The rapid development of information technology has directly impacted on the techniques in image processing techniques and the implementation 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.

The research framework and methodology complies with ADDIE model [4, 5]. ADDIE model is the generic process traditionally used by instructional designers and training developers. The five phases including Analysis, Design, Development, Implementation, and Evaluation represent a dynamic, flexible guideline for building effective training and performance support tools. Our work starts with conducting a survey to the new learners/students about their understanding on Biomedical Image Processing course to identify any problems or issues of how difficult to them to understand the Biomedical Image Processing course. To make meaningful to these new learners, we are going to develop user friendly Biomedical Image Processing software package, which new learners can do some Biomedical Image Processing analysis through various methods that have been taught in Biomedical Image Processing course.

Our plan is to use the MATLAB programming software [6] as a tool for developing this Biomedical Image Processing software package [7, 8]. Such techniques (image enhancement, filtering, segmentation and morphological operation) in Biomedical Image Processing that have been taught in the class (or in the syllabus) will be included in the Biomedical Image Processing software package. This software package should capable to display input image, output image and various click button for various image processing techniques as well as description of the techniques so the students will learn effectively the application on how biomedical image is analyzed instead of learning the mathematical algorithm for such techniques.

A number of software packages for the image processing and editing have increased 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 to guarantee the reliability of the data processing.

The famous well-developed software packages for image processing are as follow:

A. Adobe Photoshop

Adobe Photoshop is a graphics editing program and used in teaching and research. It was generally found to be useful and easy to use. It comes with functionality for scanning and scanned image manipulation. It can produce 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. The main function is an image analysis and it is quite easy to use. According to the developer, ImageTool has no guaranteed future development and has 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 a 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

Image Prep is 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

It is a package designed to plan for surface change such as urban development, transport planning and landscape planning. It is very 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

MATLAB is a high-level technical computing language and interactive environment for algorithm development, data visualization, data analysis, and numerical computational. It is easy on customization and able to handle large matrices. It also

uses 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.

IV. Methodologies

The survey was designed to support the imaging techniques community by fostering inter-institution communication and it is the first step in determining the most effective one. It was also expected that camera and imaging systems developers would benefit by gaining in-depth understanding of the digital image processing. Research laboratories, too, may require the information sought by the survey to guide them in determining if 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.

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

The framework of the questionnaire is very simple and easy to understand. It was divided into 4 sections; part 1 for demographic details, part 2 for quantitative questions, part 3 for qualitative questions and the last part is the open-ended questions. All 19 questions will took about half an hour to complete. Most of the participants are the major undergraduate students who had taken 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 [9]. 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 the 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 [10].

V. Result

We have received over 35 completed questionnaires. Almost 70% of the respondents completed the survey. Around 20-25% of the response rates to the questionnaires are considered good by some relevant literature suggestions [11, 12].

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 followed by C++, C# and Java. Due to the easiness of coding and image processing toolbox available in the platform, MATLAB and LabView are the famous choice for the respondents. On the contrary, all respondents never use Python, R, Lua, Ruby and Perl as their processing tool.

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 followed 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, it is the famous processing tool among all.

When we switch our discussion in rating the usefulness of the software, the respondents seems prefer to choose ready-to-use package software due to the easiness and its user friendly features as in Figure 1. They feel that it is easy for them to edit their photo according to their needs without thinking or writing any code. But, a ready-to-use software might not completely fulfill the user needs. Some respondents had commented that a source code package sometimes may save a lot of time for them especially who are not very familiar with the coding language but they also claimed that understanding the source code written by someone is not an easy task.

Table 3 shows the understanding of importance of Matlab Toolbox features in image processing. The advantages of the processing tool were ease of customization, ability to handle large matrices, and informative error messages. However, the main disadvantage of the tool was the time taken to learn the application and the UNIX version is command-line driven.

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 customized procedures, matrix manipulation, data visualization, graphic image production and editing, and customization of statistical data using language script.

VI. Discussion

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 to the five core

capabilities discussed above.

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 the extent which a processing can be shown to produce scores that are an accurate reflection of the image taken. Reliability concerns the extent to which processing results are stable, consistent and accurate. Impact concerns the effects, beneficial or otherwise. Practically can be defined as the extent to which a processing is practicable in terms of the resources needed to produce and administer it [13, 14, 15].

The advantage of the development of image processing package is to provide an effective and easy handling tools for users. It is important to consider the processing in all aspects like the speed and the quality of the image.

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

This processing tool need to be revised to make them more user-friendly, focusing 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

VII. Conclusion

An ethical issue has 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 them background of the survey so that they can make decision based on their knowledge and finally ensuring respondents of anonymity in the reporting of the project [7].

This survey is attempted to raise interest in MATLAB application in the medical image processing field. In medical imaging field, there are not many visualization tools can be used and most of them are not easy to handle. Hence, a creation of simple computer graphics such as histograms, bar charts and scatter plots by MATLAB package to manipulate and visualize matrices data will help.

In order to minimize the differences between variables, it is very important to standardize the procedures and instruments use in the survey. Solutions and procedures in providing consistent and interpretable results must be suggested, problems of defining observational variables and phrasing questions need to be outlined [7].

A prototype version of image processing tool package was developed for testing as in Figure 2. The tool was divided into two sections with literature learning and interactive learning as in Figure 3. Literature learning is a section that directly pop out with result after select without changing the setting and parameters while in interactive section as in Figure 4-5, users can change the parameters as they like to witness the changing and result performance.

Further developments in each algorithm step are required to improve the overall performance of the computer-aided image processing in medical sciences. A more detailed concept of processing tool package will be more useful in later processing stages. As in image flow algorithm, all the information is need to be incorporated on the direction of processing. Optimization in realization is very important for a optimize solution from the beginning.

Acknowledgment

A project of this magnitude depends on the hard work and commitment of many professionals, and we are pleased to acknowledge their contributions. The authors are deeply indebted and would like to express our gratitude to the Universiti Teknologi Malaysia and Dana Pembangunan Pengajaran for supporting this study under Vote 08233.

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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. IMPORTANCE OF MATLAB FEATURES IN IMAGE PROCESSING

Rate questions on a scale of 1 to 4.	Don't need it	Low priority	High priority	Essential	Response	Total	Mean	Std Deviation
Please rate the importance of the following features of Matlab in Image Processing (%)	1	2	3	4				
Ease of installation of the software	0	13	**47**	41	32	10	3.20	0.797
Completeness and accuracy of installation instructions	0	9	**47**	44	32	10	3.26	0.780
Ability of the initially delivered software to function without errors or problems	0	13	**63**	25	32	10	3.03	0.707
Ability of the user to easily perform required tasks using the software	0	3	**66**	31	32	10	3.20	0.677
User friendliness of the software	0	0	**50**	**50**	32	10	3.37	0.690
Availability of the technical support	0	9	**53**	38	32	10	3.20	0.759
Complete suite of processing, analysis, and reporting tools	0	6	**63**	31	32	10	3.17	0.707
Database module management	0	13	**66**	22	32	10	3.00	0.686
An Intuitive, Easy-to-Use Interface	0	6	**56**	38	32	10	3.20	0.719
Presentation Quality Output	0	3	**56**	41	32	10	3.29	0.710

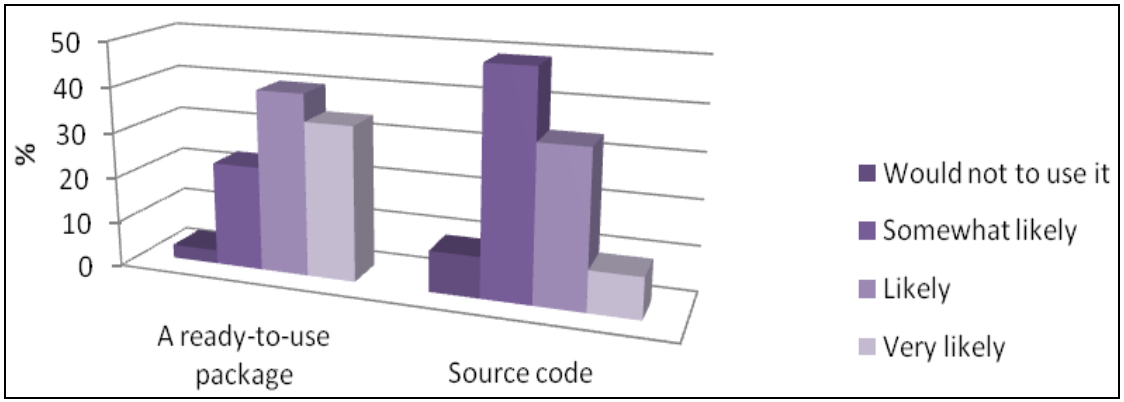

Fig. 1 comparison between a ready-to-use package and source code

TABLE III. 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

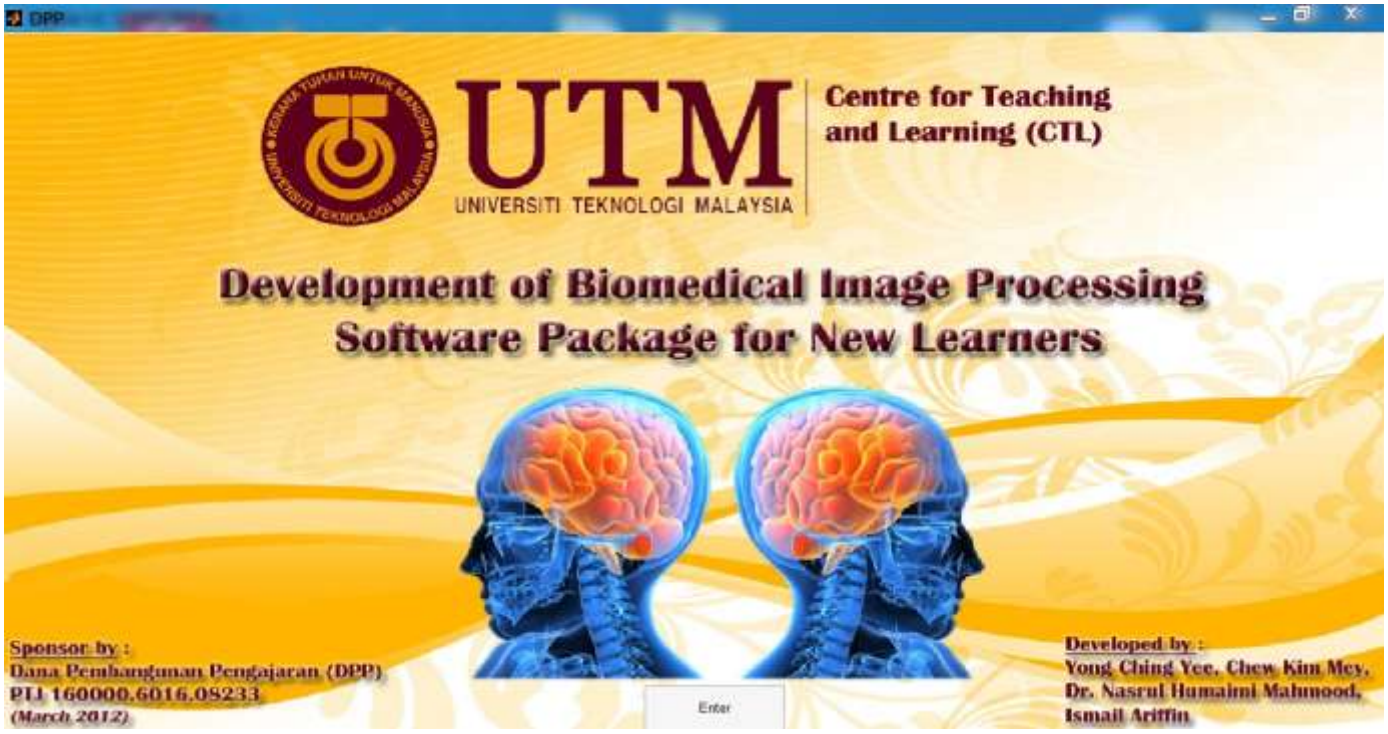

Fig. 2 Main interface of image processing tool prototype.

Fig. 3 Literature learning and interactive learning of the prototype.

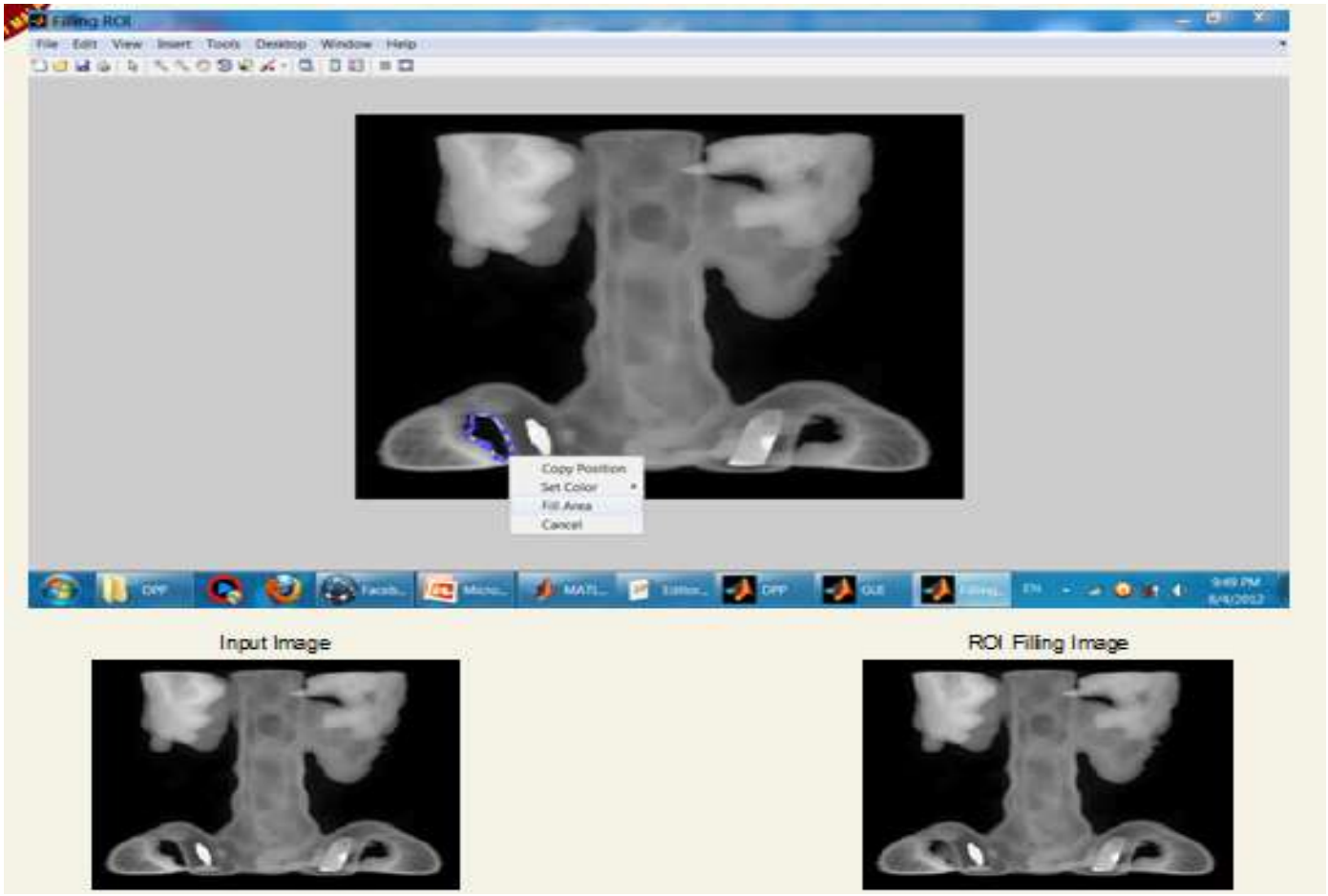

Fig. 4 One of the interactive learning – Filling region of interest.

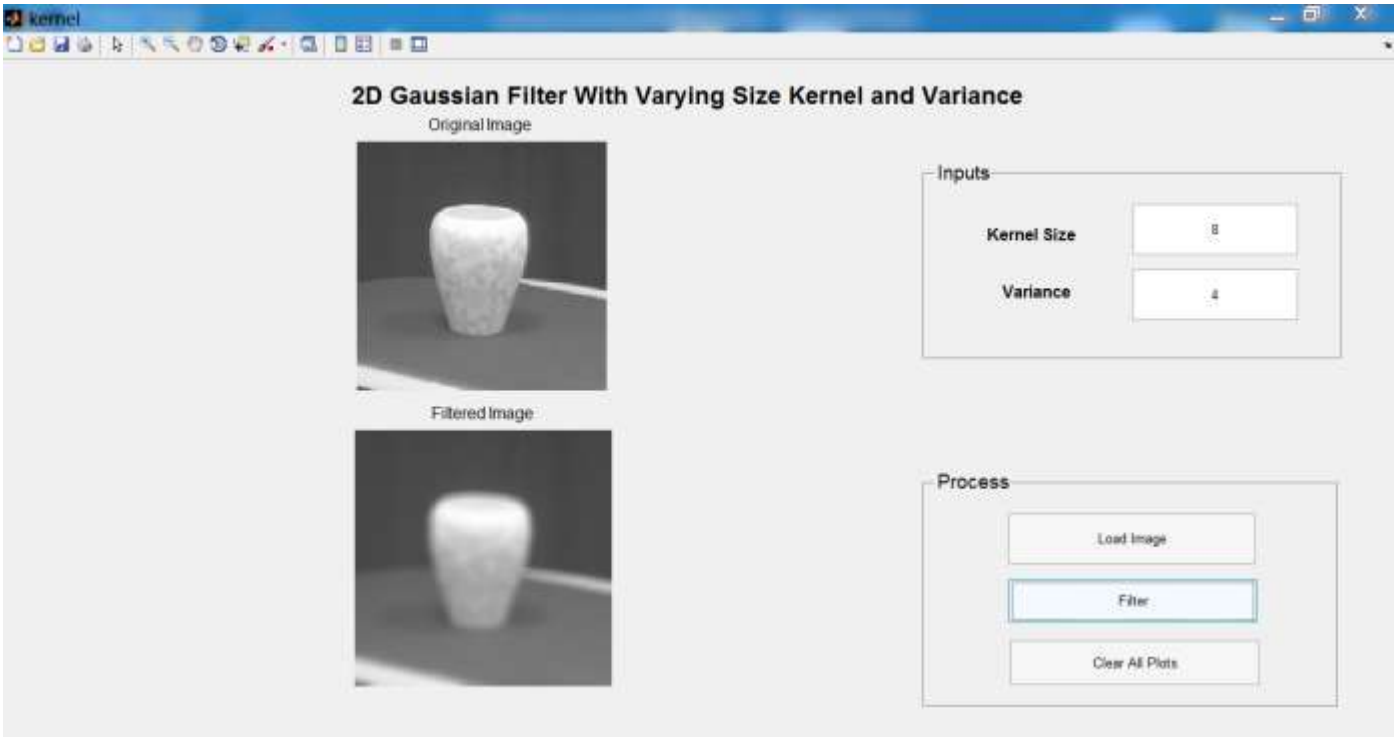

Fig. 5 One of the interactive learning – 2D Gaussian filter with varying size kernel and variance.