Usability Analysis of SmartPaint

Nadia Röning
Abstract

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Image segmentation is the process of identifying and separating relevant objects and structures in an image. The purpose of segmentation is to simplify and/or change the representation of an image into something that is easier to analyze. SmartPaint is a software for semi-automatic segmentation of medical volume images, developed by Filip Malmberg. This thesis investigates whether SmartPaint is useful on several levels, such as usability, functionality and instructional effectiveness. The developer’s ambition is that SmartPaint should be accessible to users without a background in computer science. Hence a formative usability study (Cooperative evaluation) was conducted, involving testing and interviewing participants. Given the result from the study and feedback from the participants, design proposals are given. Furthermore, ideas on how to expand the functionality, the instructional effectiveness and the learnability of SmartPaint are given.
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1 Introduction

1.1 Background

Image segmentation is the process of identifying and separating relevant objects and structures in an image. The purpose of segmentation is to simplify and/or change the representation of an image into something that is easier to analyze. Figure 1 illustrates a segmentation result of a liver. The segmentation process can be divided into two tasks, recognition and delineation. Recognition is the task of roughly determining where in the image an object is located, and delineation consists of determining the exact extent of the object. Humans are able to outperform computers in most recognition tasks, while computers are better at delineation. A successful semi-automatic method combines human and computer abilities, by letting the human perform the recognition and letting the computer perform the delineation. This minimizes the user interaction time, while maintaining tight user control to guarantee the correctness of the result [1].

Figure 1: Illustration of segmentation result of a liver. (Left) A slice from a magnetic resonance volume image of a human abdomen. (Right) Segmentation of the image into liver and background.
1.2 SmartPaint

SmartPaint is software for semi-automatic segmentation of medical volume images, developed by Filip Malmberg at CBA\(^1\). In SmartPaint, the users are allowed to segment an object in an image display by painting them with a brush tool. SmartPaint gives the user the same level of control as fully manual segmentation, but requires less time and gives more accurate results [2]. A detailed explanation of how SmartPaint works can be found in Appendix A.

1.3 Purpose

The purpose of this thesis is to study the SmartPaint software, and investigate its usefulness on several levels, such as usability, functionality and instructional effectiveness. The developer’s ambition is that SmartPaint should be accessible to users without a background in computer science, and therefore the study will evaluate the usability from the perspective of such users.

1.4 Research questions

The thesis will focus on following research questions:

- How efficiently do the users perform tasks within the software?
- How does the software meet the users’ needs?
- How easy is the software to learn?
- How can the usability of the software be improved?

\(^{1}\)CBA: “Centre for Image Analysis is a collaboration between Uppsala University and the Swedish University of Agricultural Sciences.” They are a part of the Division of Visual Information and Interaction at the Department of Information Technology, Uppsala University, and works with conducting research and education in computerized image analysis and perceptualization. (www.cb.uu.se/)
2 Theory

This chapter is divided into three sections. The first section describes the concept of usability and outline aspects when designing for usability. The second section highlights important aspects of selection criteria for measuring usability. The last section gives a brief description of the selected method that will serve as a reference when conducting usability tests.

2.1 What is usability?

Usability refers to "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (ISO 9241-11) [3].

According to Löwgren’s interpretation of usability, usability is a result of relevance, efficiency, attitude and learnability (REAL), where these four elements determines whether a system is useful or not. Relevance is a measure for how well a system meets the users’ needs. Efficiency represents how effectively users can perform their tasks using the system. Attitude is the users’ subjective perception of the system, and learnability is how easy it is to learn the system for the first time and then later remember how the system worked [4].

Usability is deeply affected by every decision in design and development and is not a surface gloss that can be applied at the last minute. And therefore usability has to be built in from the beginning. Involving the user throughout the design process, testing products for usability but also integrating usability can ensure usability [5].

2.1.1 Designing for usability

The following descriptions in this subchapter are based on Normans’ book, *The design of Everyday Things* (2002) [6].

When designing to achieve usability of a system, one should first decide for whom to design the system. It is important to recognize that people with different backgrounds, skills and motives will behave in different ways. And therefore it is a big challenge to make a design that suits everyone. Norman
gives a number of guidelines that helps to create useful systems, as listed and described below:

**Visibility**
The more visible functions are, the more obvious it is for the user to know what it is used for. When functions are hidden, it makes them more difficult to find and know how to use. The functions in a system should be placed where the users would expect them to be.

**Feedback**
The principle of feedback means that the user is given confirmation that an action has been performed successfully (or unsuccessfully). When immediate feedback is given, the result of the actions become more clear, allowing the user to continue with their activity within a system.

**Constraints**
It is important that a system has constraints or restrictions implemented. An interface must never enter into an invalid state, and with constraints this can be avoided if invalid action cannot be performed.

**Mapping**
Mapping is the relationship between controls, such as buttons on a remote control and the result of pressing the keys. Ideally, this relationship should be obvious to the viewer. The mappings should be clear and explicit as possible.

**Consistency**
Consistent interfaces follow rules. People learn when they discover patterns and consistency is the key to help the user recognize and apply patterns. When a system is inconsistent it causes confusion, because things do not work the way the user expect them to.

**Affordance**
Affordance is a visual attribute of an object or a control that allows the user to know how to use them. One way to illustrate affordance to the user of a system is when "pop-up" text appears when the mouse cursor hovers over a control.
2.2 Usability tests

There are several methods for measuring usability. Different methods are suitable for evaluating different parts of the usability concept. The purpose of testing is to make sure that the product meet its requirements gathered during the requirement phase [7]. This section describes what to take into consideration before selecting the final method.

2.2.1 Formative and summative methods

Formative evaluations are methods that provide feedback on various design ideas and are applicable during the development of an information system. The aim is to provide information that can be used in an iterative design process. Formative evaluation allows the developer to assess the program during development. The developer may elect to test an early version of the program with users to identify weaknesses in the user interface or other areas. The formative evaluations contributes most to enhance the usability of a system when applied many times, this is because it is possible to test different design proposals and then choose the one that seems best [4].

Summative assessments is applicable early in or midway into the development cycle, ”usually after the fundamental or high-level design of the product has been established” [5]. Summative assessments are used to measure how an existing system is designed [4]. Unlike formative testing, summative assessments provides quantitative measurements and the user will always perform tasks rather than simply walking through and commenting upon the user interface [5].

2.3 More on formative testing

Due to the purpose of this study, formative evaluation was deemed as a suitable testing method. The first thing to decide is what to measure. Some methods gives specific results and should therefore be selected if it provides the answer to the corresponding question. Secondly, it is important to have in mind what resources that are available. Some methods require access to a number of usability experts while others require services of volunteers. If
it is not possible to access necessary recourses, it may be necessary to look for other methods that are better suited for the available resources [8]. One especially interesting method in light of this is cooperative evaluation.

### 2.3.1 Cooperative evaluation

The following descriptions are based on Monk et al, *Improving your human-computer interface: A practical guide* (1993) [9].

Cooperative evaluation is a technique for identifying usability problems in prototype products and processes. It is a formative evolution method that is applicable in the early phases of the design cycle, once a prototype is available for evaluation or at a later stage when an existing product is to receive further development. Cooperative evaluation methods allow the users to explain what they are doing by talking or thinking-aloud, while users are being observed for unexpected user behavior and for users comments regarding the system. This provides qualitative information concerning any difficulties that the user experience in the features or interface elements. Because this method is so informal, both parts have the opportunity to ask questions about the system and therefore it does not require large recourses like other methods. Because of the qualitative information this method provides concerning any difficulties that the user experience within the system, it is well suited for the system that ought to be investigated in this thesis. Therefore, this method will serve as a reference when conducting usability tests. The cooperative evaluation method consists of four steps:

- **Recruiting users**
- **Preparing tasks**
- **Interact and record**
- **Summarizing observations**

**Recruiting users**

The first step is to identify the typical user. Defining the right target group can do this. How easy that will be depends on what type of system that is
supposed to be tested. If the system is intended for a specific work area, it will be easier to point out the typical user. It is harder if the system covers a larger market since the user can be virtually anyone. The next step is to decide how many users that should test the system and how much time that are needed with each one of them. If it is possible to conduct a test with several users, it is relevant to choose users with a different background.

It is often possible to recruit users among the intended target group. The advantage is that the users will accept the system when they are introduced to it because they feel involved in the work. The danger is that they can oppose the recent changes in the system when they are no longer involved. To avoid that, the users should be tested with a very simple prototype of the system. If it is difficult to recruit users among the intended target group, it is better to test a few rather than no one at all. It is also important to not underestimate the time it takes to recruit users. That work usually takes as long as the test itself.

Preparing tasks
The tasks the users will perform should be specific and the instructions should be representative of the tasks the system will support. The method requires that the pre-work is done. It can be good to estimate how long it will take for the users to perform each task. An idea is to test the data on a colleague or friend to see if the instructions are easy to understand. The selected data should fit into following limitations:

- Written in such language that the users understand them.
- Ensure that the users investigates relevant parts of the system.
- Adapted to the step in the design that is being evaluated. An earlier state in the process requires more specific information.
- Adapted to the time available for the test.

Interact and record
The recruited users should feel comfortable and understand what is expected of them, and this can be the hardest part of the test. In most cases, the users
are more concerned that it is their knowledge that will be tested rather than the product or service. The users should be encouraged to see themselves as co-developers and not as subjects. Some preparations should be done before the users arrive. It is important to make sure that the system can be tested in a quiet environment. Instructions should be available and what the users say or do should be recorded in some way.

When the users arrives, they should receive a brief introduction about what is going to happen and some information about the method. It is important to encourage the users to think-aloud and the observer should be ready to note unexpected events and/or comments. The users should not be interrupted if they make a mistake, instead use that information that causes that mistake in the system. When the test is done, the users should be prepared to answer some questions regarding the system, it is in this stage the most interesting comments shows up.

**Summarizing observations**

The notes will be helpful when summarizing the data and there are two different types of data:

- *Unexpected behavior:* When the user does something that the developer did not have in mind. This type of data is very important as it points out the differences in how the system is supposed to be used and how it really is being used.

- *Comments:* Users’ thoughts about the system could be both positive and negative. The comments are important data as it reflects back on the users’ experience of the system. Even if the users performed the tasks correctly they can still think that the system have unnecessarily complicated sequences.

The developer starts to think almost immediately of a design change when the user experience problems within a system. This can contribute to that the developer see the first design solution as the only possible one. Therefore, the design solution should not be planned until all the problems with the system have been outlined.
3 Method

This chapter gives a brief description of how the test plan was conducted, cooperative evaluation employed to the part of the test plan. The test plan consists of a test session that is followed by an interview. The purpose of the test plan was to investigate following research questions:

- How efficiently do the users perform tasks within the software?
- How does the software meet the users’ needs?
- How easy is the software to learn?
- How can the usability of the software be improved?

3.1 Scenarios and Tasks

The test consisted of 2 warm up tasks and 10 scenarios, written in Swedish to ensure that all of the participants would understand them.

Warm up tasks
The purpose of the warm up tasks was to make the participants feel comfortable using the computer and cards. No measurements were done for the warm up tasks. The participants were also received no information that this were the warm up tasks.

<table>
<thead>
<tr>
<th>Warm Up 1</th>
<th>Open a web browser</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task description</td>
<td>Öppna den webbläsaren du normalt använder.</td>
</tr>
<tr>
<td>Scenario</td>
<td>Säg &quot;klar&quot; när du är klar.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Warm Up 2</th>
<th>Go to SmartPaint official webpage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task description</td>
<td>Gå nu in på denna hemsida: <a href="http://www.cb.uu.se/filip/SmartPaint/">http://www.cb.uu.se/filip/SmartPaint/</a></td>
</tr>
<tr>
<td>Scenario</td>
<td>Säg &quot;klar&quot; när du är klar.</td>
</tr>
</tbody>
</table>
Scenarios

For each task scenario, the participant picked up a card containing the task. The participants were asked before the test to think-aloud and also to inform when he/she was done with each task. Each task had a time limit that the participants were not allowed to surpass and overall the test took about 20-30 minutes to complete. If the participant would completely fail to solve a task, the participant would be asked to continue with the next card. The purpose of the scenarios was to investigate what the possibilities are to improve the usability of SmartPaint and how efficient the users perform tasks within the system. Each scenario could also be categorized depending on the tasks concern. The task could either be measuring the functionality of SmartPaint, how the user navigates in SmartPaint or how the user understands the tools in SmartPaint.

Scenario 1

<table>
<thead>
<tr>
<th>Task description</th>
<th>Download and install SmartPaint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>Functionality, Navigation</td>
</tr>
<tr>
<td>Concern</td>
<td>How does the user downloads and installs SmartPaint. How easy it is to download and understand the installation script.</td>
</tr>
<tr>
<td>Research question</td>
<td>How can the usability of the software be improved?</td>
</tr>
<tr>
<td>Scenario</td>
<td>Ladda ner och installera SmartPaint, öppna sedan programmet.</td>
</tr>
<tr>
<td></td>
<td>Säg &quot;klar&quot; när du är klar.</td>
</tr>
<tr>
<td>Starting point</td>
<td><a href="http://www.cb.uu.se/">http://www.cb.uu.se/</a> filip/SmartPaint/</td>
</tr>
<tr>
<td>Time limit</td>
<td>None</td>
</tr>
</tbody>
</table>

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### Scenario 2

<table>
<thead>
<tr>
<th>Task description</th>
<th>Load a volume image</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>Navigation</td>
</tr>
<tr>
<td>Concern</td>
<td>How does the user interact with SmartPaint when loading a volume image.</td>
</tr>
<tr>
<td>Research question</td>
<td>How can the usability of the software be improved? How efficiently do the users perform tasks within the software?</td>
</tr>
<tr>
<td>Scenario</td>
<td>Ladda in volymbilder från fil &lt;liver.vtk&gt;. Såg &quot;klar&quot; när du är klar.</td>
</tr>
<tr>
<td>Starting point</td>
<td>SmartPaint user interface</td>
</tr>
<tr>
<td>Time limit</td>
<td>1 min</td>
</tr>
</tbody>
</table>

### Scenario 3

<table>
<thead>
<tr>
<th>Task description</th>
<th>Move and adjust the views</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>Functionality</td>
</tr>
<tr>
<td>Concern</td>
<td>How does the user interact with the interface by adjusting the views in SmartPaint</td>
</tr>
<tr>
<td>Research question</td>
<td>How can the usability of the software be improved? How efficiently do the users perform tasks within the software?</td>
</tr>
<tr>
<td>Scenario</td>
<td>Flytta och justera fönstren så du får en bra och överskådlig blick. Såg &quot;klar&quot; när du är klar.</td>
</tr>
<tr>
<td>Time limit</td>
<td>2 min</td>
</tr>
</tbody>
</table>
### Scenario 4

<table>
<thead>
<tr>
<th>Task description</th>
<th>Adjust brightness and contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>Navigation</td>
</tr>
<tr>
<td>Concern</td>
<td>How does the user interact with SmartPaint to adjust the brightness and contrast.</td>
</tr>
<tr>
<td>Research questions</td>
<td>How can the usability of the software be improved? How efficiently do the users perform tasks within the software?</td>
</tr>
<tr>
<td>Scenario</td>
<td>Justera ljus och kontrast tills du känner dig nöjd. Säg &quot;klar&quot; när du är klar.</td>
</tr>
<tr>
<td>Time limit</td>
<td>2 min</td>
</tr>
</tbody>
</table>

### Scenario 5

<table>
<thead>
<tr>
<th>Task description</th>
<th>Use SmartPaints tools to paint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>Tools</td>
</tr>
<tr>
<td>Concern</td>
<td>How does the user understand how the different tools work by looking at them and by using them.</td>
</tr>
<tr>
<td>Research question</td>
<td>How can the usability of the software be improved? How efficiently do the users perform tasks within the software?</td>
</tr>
<tr>
<td>Scenario</td>
<td>Testa de olika verktygen för att måla levern i valfritt fönster. Säg &quot;klar&quot; när du är klar.</td>
</tr>
<tr>
<td>Time limit</td>
<td>5 min</td>
</tr>
</tbody>
</table>
### Scenario 6

<table>
<thead>
<tr>
<th>Task description</th>
<th>Adjust the radius and sensitivity.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>Functionality</td>
</tr>
<tr>
<td>Concern</td>
<td>How does the user interact with the system to adjust the radius and sensitivity of the tools in SmartPaint.</td>
</tr>
<tr>
<td>Research question</td>
<td>How can the usability of the software be improved? How efficiently do the users perform tasks within the software?</td>
</tr>
<tr>
<td>Scenario</td>
<td>Lek med radien samt styrka på penseln tills du hittar ett läge som känns bra. Säg &quot;klar&quot; när du är klar.</td>
</tr>
<tr>
<td>Time limit</td>
<td>2 min</td>
</tr>
</tbody>
</table>

### Scenario 7

<table>
<thead>
<tr>
<th>Task description</th>
<th>Save a segmentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>Navigation</td>
</tr>
<tr>
<td>Concern</td>
<td>How does the user interact with SmartPaint to save a segmentation.</td>
</tr>
<tr>
<td>Research question</td>
<td>How can the usability of the software be improved? How efficiently do the users perform tasks within the software?</td>
</tr>
<tr>
<td>Scenario</td>
<td>Spara det du målat som fil &lt;test_liver.vtk&gt;. Säg &quot;klar&quot; när du är klar.</td>
</tr>
<tr>
<td>Time limit</td>
<td>1 min</td>
</tr>
</tbody>
</table>
### Scenario 8

<table>
<thead>
<tr>
<th>Task description</th>
<th>Clear all painting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>Navigation</td>
</tr>
<tr>
<td>Concern</td>
<td>How does the user interact with the interface to clear all painting in SmartPaint.</td>
</tr>
<tr>
<td>Research question</td>
<td>How can the usability of the software be improved? How efficiently do the users perform tasks within the software?</td>
</tr>
<tr>
<td>Scenario</td>
<td>Rensa all målning.</td>
</tr>
<tr>
<td></td>
<td>Säg &quot;klar&quot; när du är klar.</td>
</tr>
<tr>
<td>Time limit</td>
<td>1 min</td>
</tr>
</tbody>
</table>

### Scenario 9

<table>
<thead>
<tr>
<th>Task description</th>
<th>Control a segmentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>Functionality</td>
</tr>
<tr>
<td>Concern</td>
<td>How does the user interact with the interface when controlling and adjusting an earlier segmentation.</td>
</tr>
<tr>
<td>Research question</td>
<td>How can the usability of the software be improved? How efficiently do the users perform tasks within the software?</td>
</tr>
<tr>
<td>Time limit</td>
<td>5 min</td>
</tr>
</tbody>
</table>
### Scenario 10

<table>
<thead>
<tr>
<th>Task description</th>
<th>Quit SmartPaint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>Navigation</td>
</tr>
<tr>
<td>Concern</td>
<td>How does the user interact with the interface to quit SmartPaint.</td>
</tr>
<tr>
<td>Research question</td>
<td>How can the usability of the software be improved? How efficiently do the users perform tasks within the software?</td>
</tr>
<tr>
<td>Scenario</td>
<td>Avsluta SmartPaint utan att spara. Såg &quot;klar&quot; när du är klar.</td>
</tr>
<tr>
<td>Time limit</td>
<td>1 min</td>
</tr>
</tbody>
</table>

**Interview**

After the test session an interview was conducted to get feedback from the participant’s experience using SmartPaint. The purpose of the interviews was to investigate how the software met the users’ needs when they interacted with the system. The participants were also asked if they had some requests on how SmartPaint could be improved.

### 3.2 Evaluation of learnability

In an attempt to evaluate the learnability of the software, users were recruited and divided into three groups, depending on the users’ earlier experience with the SmartPaint software (Advanced, Intermediate, Beginner). A comparison was then made between these groups.

### 3.3 Recruited users

The test was conducted with six participants. The different types of participants were:

- Three image analysis experts with experience in computer science. One of them had been involved in developing the SmartPaint software (Ad-
vanced) and two of them had tested the software once before (Intermediate).

- One physician working with medical volume images and had tested the SmartPaint software once before (Intermediate).

- Two students that had no experience in the medical field or with the SmartPaint software (Beginners).

Recruitment of possible participants
The developer of SmartPaint, Filip Malmberg, had a list of possible participants for the test. This saved a lot of time in the recruitment process. A recruitment email was sent to possible participants. A detailed description of the recruitment email can be found in Appendix B. The interested users that replied to the recruitment email were sent a confirmation e-mail of time and place for the test session. A detailed description of the confirmation e-mail can be found in Appendix C.

3.4 Procedure
The test plan was tested on Mats Lind, professor at Uppsala University, to estimate how long it would take for the users to perform each task. This helped to discover possible problems prior to the test session and to see if the instructions were easy to understand.

In the start of the test session the participants were given the consent forms, tasks and a brief introduction about what was going to happen. The consent form informed the participants about the study and the participants rights to withdraw etc. If the participants declined to sign the paper, he/she could not take part in the study. A detailed description of the consent form can be found in Appendix D. The participants were clearly informed that it were not their knowledge that ought to be tested, and were encouraged to explain what they were doing by thinking-aloud. The exact words the participants were introduced with can be found in Appendix E. During the test session the participants were also being observed for unexpected user behavior and for comments regarding the system.
3.5 **Interact and record**

The test was conducted in a seminar room at Polacksbacken. Polacksbacken is located at Uppsala University in Uppsala. It was important that the test was conducted in a quiet environment, in order to ensure that unexpected distractions would not affect the result.

The users performed the test using a laptop connected to a 17” screen. With the user’s approval, the entire session was video recorded using Morae 1.3². A detailed description of the approval form can be found in Appendix F. Morae collected data about what functions and tools the participants clicked on and event sequences like mouse clicks and keyboard strokes. This was all synced with a screen-captured video. The participants voice and face were also video recorded through Morae.

3.6 **Summarizing the observations**

After the test sections the result was summarized for each person. The purpose of summarizing the results individually was to see if there were any differences in their behaviors, opinions and comments. All the individual results were then summarized to deduce general trends.

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²Morae 1.3 is an analysis program that gives the possibility to record, observe and analyze usability studies and other similar field researches. (www.techsmith.com/morae.html)
4 Result

This chapter represents the results gathered from the test plan. The test plan consisted of a test session and a following interview.

4.1 Results of the test session

The result for each scenario in the test session:

**Scenario 1: Download and install SmartPaint**

<table>
<thead>
<tr>
<th>Beginner (2/6)</th>
<th>Intermediate (3/6)</th>
<th>Advanced (1/6)</th>
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<tbody>
<tr>
<td>Succeeded</td>
<td>2/6</td>
<td>3/6</td>
</tr>
<tr>
<td>Failed</td>
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</table>

Observations: All of the participants found it easy to follow the installation script.

**Scenario 2: Load a volume image**

<table>
<thead>
<tr>
<th>Beginner (2/6)</th>
<th>Intermediate (3/6)</th>
<th>Advanced (1/6)</th>
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<tr>
<td>Succeeded</td>
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<td>3/6</td>
</tr>
<tr>
<td>Failed</td>
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</table>

Observations: All participants clicked "Load volume" tag under File menu in the Menu bar.

**Scenario 3: Move and adjust the views**

*Move the views*

<table>
<thead>
<tr>
<th>Beginner (2/6)</th>
<th>Intermediate (3/6)</th>
<th>Advanced (1/6)</th>
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<tr>
<td>Succeeded</td>
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<td>3/6</td>
</tr>
<tr>
<td>Failed</td>
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</table>

Observations: The two participants that failed to perform this task did not recognize from the first sight that the views landed on top of each other.
Adjust the views

<table>
<thead>
<tr>
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<th>Beginner (2/6)</th>
<th>Intermediate (3/6)</th>
<th>Advanced (1/6)</th>
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<tr>
<td>Failed</td>
<td>2/6</td>
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<td>-</td>
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</table>

Observations: Two participants rescaled the views by dragging the x-axis and then the y-axis. Four participants tried to rescale the views in xy-axis by dragging the edge on the view, these participants failed to perform this task.

Scenario 4: Adjust brightness and contrast

<table>
<thead>
<tr>
<th></th>
<th>Beginner (2/6)</th>
<th>Intermediate (3/6)</th>
<th>Advanced (1/6)</th>
</tr>
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<tbody>
<tr>
<td>Succeeded</td>
<td>2/6</td>
<td>3/6</td>
<td>1/6</td>
</tr>
<tr>
<td>Failed</td>
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</table>

Observations: All participants clicked on the "Brightness-Contrast" tag under Display menu in the Menu bar to open a dialog for adjusting the brightness and contrast.

Scenario 5: Use SmartPaints tools to paint

<table>
<thead>
<tr>
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<th>Beginner (2/6)</th>
<th>Intermediate (3/6)</th>
<th>Advanced (1/6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Succeeded</td>
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<td>-</td>
<td>1/6</td>
</tr>
<tr>
<td>Failed</td>
<td>2/6</td>
<td>3/6</td>
<td>-</td>
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</tbody>
</table>

Observations: Five participants did not understand how to use all of the tools. How to use the tools became clear to them after reading the user’s guide.

Scenario 6: Adjust the radius and sensitivity

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<tr>
<th></th>
<th>Beginner (2/6)</th>
<th>Intermediate (3/6)</th>
<th>Advanced (1/6)</th>
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<tr>
<td>Succeeded</td>
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</tr>
<tr>
<td>Failed</td>
<td>2/6</td>
<td>3/6</td>
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</table>

Observations: Five participants did not understand how to adjust the radius and sensitivity of the tools in SmartPaint. How adjust them became clear after reading the user’s guide.
Scenario 7: Save a segmentation

<table>
<thead>
<tr>
<th></th>
<th>Beginner (2/6)</th>
<th>Intermediate (3/6)</th>
<th>Advanced (1/6)</th>
</tr>
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<tbody>
<tr>
<td>Succeeded</td>
<td>2/6</td>
<td>3/6</td>
<td>1/6</td>
</tr>
<tr>
<td>Failed</td>
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</tbody>
</table>

Observations: All participants clicked on the ”Save segmentation” tag under File menu in the Menu bar.

Scenario 8: Clear all painting

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<tr>
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<th>Beginner (2/6)</th>
<th>Intermediate (3/6)</th>
<th>Advanced (1/6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Succeeded</td>
<td>1/6</td>
<td>2/6</td>
<td>1/6</td>
</tr>
<tr>
<td>Failed</td>
<td>1/6</td>
<td>1/6</td>
<td>-</td>
</tr>
</tbody>
</table>

Observations: From the four participants that succeed to perform this task, three participants clicked on the ”Clear all” tag under Edit menu in the Menu bar and one participant used the brush tool to wipe of the painting. From the two participants that failed to perform this task, both clicked several times on the undo tag under Edit menu in the Menu bar before clicking the ”Clear all” tag.

Scenario 9: Control a segmentation

Scroll between slides

<table>
<thead>
<tr>
<th></th>
<th>Beginner (2/6)</th>
<th>Intermediate (3/6)</th>
<th>Advanced (1/6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Succeeded</td>
<td>2/6</td>
<td>3/6</td>
<td>1/6</td>
</tr>
<tr>
<td>Failed</td>
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</tbody>
</table>

Observations: All of the participants used the mouse wheel to scroll through the segmentation.

Toggle segmentation

<table>
<thead>
<tr>
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<th>Beginner (2/6)</th>
<th>Intermediate (3/6)</th>
<th>Advanced (1/6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Succeeded</td>
<td>2/6</td>
<td>2/6</td>
<td>-</td>
</tr>
<tr>
<td>Failed</td>
<td>-</td>
<td>1/6</td>
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</tr>
</tbody>
</table>

Observations: Two participants did not toggle the segmentation. From the four participants that succeeded with this task, two of them clicked on the
toggle tag under Display menu in the Menu bar. The other two clicked first on the Display menu in the menu bar to notice that they could use the space key to toggle the segmentation.

Scenario 10: Quit SmartPaint

<table>
<thead>
<tr>
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<th>Beginner (2/6)</th>
<th>Intermediate (3/6)</th>
<th>Advanced (1/6)</th>
</tr>
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<tbody>
<tr>
<td>Succeeded</td>
<td>2/6</td>
<td>3/6</td>
<td>1/6</td>
</tr>
<tr>
<td>Failed</td>
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</tr>
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</table>

Observations: Five participants clicked the "Quit" tag under File menu in the Menu bar. One participant closed SmartPaint by pressing the close symbol in the interface.

4.2 Results of the interviews

The results from the interviews are listed below:

Feedback

- All of the participants found that the design was simple, as the program did not contain a lot of unnecessary features. It was also hard to make mistakes just by clicking their way through the program.

- All of the participants found the software very intuitive since it implements real-time segmentation.

- All of the participants would use SmartPaint if they were in need of segmenting a medical image.

- All of the participants found that everything they needed for perform a segmentation was available in the user interface.

- Two of the participants liked that SmartPaint offered an installation script when installing the software. It was easy to follow the instructions in the script and therefore it was easy to install the software.
Functionality

- All of the participants found it hard to rescale the views in SmartPaint because the mouse cursor jumped over to another view if it was nearby.

- Five of the participants mentioned that it was exhausting to scroll between many slides using the mouse wheel.

- Three of the participants mentioned that it was confusing whether the brightness-contrast dialog appeared, since it automatically disappears behind the views if the mouse cursor is hovering over one of the views.

- Two of the participants appreciated the toggle function in SmartPaint and told that it gave a clearer understanding of where the object has been painted or not.

- One participant found it confusing that the sensitivity circle became larger when increasing the sensitivity of a certain tool in SmartPaint, and that it should get larger when decreasing the sensitivity.

Navigation

- All of the participants thought that it was easy to navigate through the interface to find certain tools and functions.

Tools

- Four of the participants found that the Reference brush tool and the Navigation tool were hard to understand just by looking at them, two of them thought that the Reference brush tool looked like a brush with a ”jaeger sight” and thought that it would select something, but did not know what. All of the four participants that did not understand the Navigation tool and were confused whether it would add something, since it looked like a plus sign.
Other Requests
The participants had some requests of how SmartPaint could be improved:

- Explanatory text for the symbols when hovering over them.
- A scrollbar next to the view for easier and faster scrolling.
- Being able to adjust the brightness and contrast for each orthogonal view.
- Being able to zoom in the views.
- Being able to undo several segmentation operations.
- Being able to see how the segmentation would look like in a three-dimensional view.
- Being able to paint different objects with different colors.
- Being able to rescale the view in xy-axis by dragging the view on the edge.
- That SmartPaint could handle more file formats.
- That SmartPaint could calculate volumes automatically.
5 Analysis

This chapter gives an analysis of the result gathered from the test session. Given the result from the study and feedback from the participants, design proposals are given in this chapter. Note that these proposals are just mock-ups and not real implementations. Furthermore, ideas on how to expand the functionality, the instructional effectiveness and the learnability of Smart-Paint are given.

5.1 Analysis of results

The results from the test session showed that there are possibilities to improve the usability of the software, since it seemed like the users experienced some functionality problems with the software. Figure 2 illustrates the user interface of SmartPaint that the participants were interacting with throughout the test session.

![Figure 2: Screenshot of the SmartPaint user interface.](image-url)
**Functionality**

None of the participants had trouble with downloading and installing SmartPaint. SmartPaint offers an installation script when installing the program and this gave a positive response since it was easy to follow the installation instructions to get set with the software immediately.

All participants agreed that the design was simple, as the program did not contain a lot of unnecessary features. They found that everything they needed was there and it was hard to make mistakes by simply clicking their way through the program.

When loading a volume to SmartPaint, all the pictures land on top of each other. This seemed a bit confusing to the participants regarding how many views that really where there. SmartPaint shows the image data in three orthogonal views that can be moved and resized freely. The views can only be resized in either x-axis or y-axis but not in xy-axis. The participants told that it would simplify the rescaling if they were able to do so in xy-axis by dragging the view on the edge. It seemed also hard for the users to spot the edge of the view when rescaling. This was because the mouse cursor automatically jumped to the next view if another view were lying next to it.

The majority of the participants failed to adjust the radius and sensitivity of certain tools in SmartPaint. However, how to perform this task became clear after reading the user’s guide. SmartPaint has no shortcut for a user’s guide in the interface. And that is something that should be accessible, since it would increase the understanding of certain tools and functions in SmartPaint.

Scrolling through the segmentation and “toggle” it is one way to control a segmentation. Toggle the segmentation can be done by pressing space on the keyboard or by pressing the ”toggle segmentation” tag under Display menu in the Menu bar. Toggling the segmentation gives the user a clearer understanding of were the object has been painted or not, since it turns the segmentation on/off. Some of the participant felt no need for toggling the segmentation while some of the participants tried this feature. The feedback from that feature was very appreciated since it gave the users clearer understanding of where adjustments were needed. The participants that did not use the toggle functions had prior experience with segmentation and therefore
found it easier to distinguish where adjustment were needed.

Another feature that was appreciated was that the user could scroll between slices in any of the views using either the mouse wheel or the up/down arrow keys. However, if the user was in need of scrolling through many slides, the scrolling seemed a bit exhausting using the mouse wheel. The participants suggested that it would be easier if there were a scrollbar next to the view for easier and faster scrolling.

The users are able to adjust the brightness and contrast of the image displays by open a dialog, as shown in figure 3. When the user open a dialog for adjusting the brightness and contrast of an image display, the dialog disappears in the background if the mouse cursor is hovering over another view in SmartPaint. The dialog should pop-up at the front regardless of where the mouse is pointing. Under the interview, two of the participants mentioned that it would be a good idea to implement an adjustment bar for each view in SmartPaint, so they could select a certain view for adjusting the brightness and contrast.

![Figure 3: Dialog for adjusting the brightness and contrast of the image display.](image)

**Navigation**

All participants agreed that it was easy to navigate through the program. Using the left mouse-click to paint and the right mouse-click to wipe seemed as a natural performance when segmenting without any pre instructions on how to use the program.

The participants had no trouble with loading a volume or saving segmentation. This is probably because the Menu bar follows the regular standard of how a Menu bar usually looks like. And therefore, it was also easy to find different functions in the Menu bar, like open a dialog for adjusting the
brightness and contrast of the image display.

The test result showed however that some of the participants had trouble with the scenario that told the user to clear all segmentation. The main problem was not in how to clear an entire segmentation but in how to undo the last segmentation operation worked. The regular standard for how an undo button works is that it can undo several operations if the user is in need of doing so. To improve SmartPaint, the system should be able to undo several segmentation operations instead of just one.

Tools
SmartPaint implements a number of tools for performing segmentation. These are the Brush tool, Reference brush tool, Bucket tool, Smoothing tool and the Navigation tool, as shown in figure 4. From the test session it clearly showed that the Brush tool, Bucket tool and Smoothing tool were easy to understand and use but almost everyone had trouble with understanding how the Reference brush tool and the Navigation tool worked just by looking at their symbols. The participants though that the Reference brush tool looked like a brush with a “jaeger sight”, they found it hard to understand how it worked just by looking at it. The Navigation tool was hard to understand since the symbol looks like a plus sign. The participants were confused whether that tool would add something in the program. However, how to use these tools became clear after reading the user’s guide.

![SmartPaint interface](image)

Figure 4: Tools for performing segmentation.

Feedback
SmartPaint seemed to meet the users’ needs. The users found the software very intuitive as it allows the user to segment in real-time. They found that all the tools needed for segmentation were accessible in the user interface.
All of the participants also told that they would use SmartPaint if they were in need of segmenting medical images.

One of the participants told that it would give great feedback if the user were able to see how the segmentation would look like in a three-dimensional (3D) view. It would then be easier to recognize if the segmentation were good or bad. This may feel natural for physicians that work with magnetic resonance imaging, since they are used to generate high-resolution volume images of the human body. But it would also give great feedback for users with no experience in the medical field.

Another participant with prior experience of segmentation had a suggestion that it would give great feedback if SmartPaint were able to automatically calculate the volume of a segmented object.

SmartPaint can load volume images in the following formats: VTK and MetaImage. The segmentation results are saved in the VTK format. One participant suggested that SmartPaint would give a greater demand if it could handle more file formats.

5.2 Learnability

The users that had prior experience with SmartPaint seemed to perform tasks more efficient compared to the users that had less experience with SmartPaint. The less experienced users needed more clarification on how to use the Reference brush tool and the Navigation tool. It seemed also hard with recognizing how to move and adjust the views.

To increase the learnability of SmartPaint, an implemented user’s guide should be accessible from the user interface if more explanation is needed. And by adding explanatory text that hovers over the symbols can give the users a hint on how the tools might work. Also a good idea would be to offer a beginner tutorial the first time the software are installed. This could increase the learnability of SmartPaint and make the users get ready to use the software faster.
5.3 Design proposals

The result from the test session showed that SmartPaint have some functionality problems. The participants had trouble with rescaling the views if another view were next to it, since it automatically jumped to the next view. Figure 5 illustrates how this problem can be solved. The users should be able to choose what view they want to work with. Being able to minimize the views in SmartPaint, the users do not need to worry about another view being in the way. That the pointer jumps to the next view when rendering over it is however a good feature since the user do not need to click on the view, risking painting a part of object that was not meant to be painted.

Figure 5: Design proposal of new added features fixed from the participants requests and problems with the functionality.
Another feature that was appreciated was that the user could scroll between slices in any of the views using either the mouse wheel or the up/down arrow keys. However, if the user was in need of scrolling through many slides, the scrolling seemed a bit exhausting and the participants requested that if would be easier to scroll if there existed a scrollbar next to the view, as seen in figure 5. With a scrollbar the user could also jump faster to another slide of the volume, and then use the mouse wheel to tune up.

Several of the participants had trouble with understanding how the Reference brush tool and the Navigation tool worked just by looking at their symbols. How to use these tools became clear after reading the user’s guide. Figure 6 illustrates how this problem could be solved, by being able to the see the name of the tool when hovering over it would give a clearer understanding of how the tool might work. A shortcut to an implemented user’s guide in SmartPaint should be accessible in the pop-up text when clearer understanding is needed, by clicking the question mark. The user can then read about that tool and do not need to visit the webpage or printing out the user’s guide when a situation of confusion appears.

![SmartPaint - liver](Image)

**Figure 6:** Explaining text when hovering over the symbols.

As figure 7 illustrates, a Help menu should be added in the Menu bar. From here the user is able to contact the developer when bugs or similar things are detected, SmartPaint will then be easier to keep under maintenance. From here the user’s guide can be accessible by clicking the help tag. Under the "SmartPaint 1.0" tag the user is able too read about SmartPaint, and for example get information about what kind of image file formats SmartPaint supports etc.
The users are able to adjust the brightness and contrast of the image display in SmartPaint. Some of the participants mentioned that it would be a good idea to implement an adjustment bar for each orthogonal view in SmartPaint, so they could select a certain view for adjusting the brightness and contrast. Figure 8 illustrates how this could be implemented in SmartPaint. With this solution the users can adjust the brightness and contrast directly in the interface for respectively view. As figure 9 illustrates it would also be good to save the original dialog, if the user are in need of adjusting the brightness and contrast for all of the views in SmartPaint. A good idea could be to add text labels so the user is able to enter an exact value for a more specific result.

Figure 8: Design proposal for the Brightness-Contrast in the user interface.

Figure 9: Design proposal for the original Brightness-Contrast dialog.
6 Conclusions

It is effective to use usability testing in the development cycle. This thesis describes one way to do so, but there are other ways to achieve similar results. It is desirable to identify any usability problems in an early stage as possible. Otherwise, much of the effort in the realization of a system would be meaningless, since the design has to be revised in order to be useful. The users’ desire to use a system will likely increase if it is simple to perform tasks within a system. The introduction of usability testing is a quality aspect that can be used in order to improve the results achieved within the development cycle [7]. It could be a competitive advantage if you can secure the usability of a system at the development stage.

In this case the use of usability test has been very useful when addressing problems with the SmartPaint software. The study resulted in qualitative information concerning any difficulties that the users experienced in the features or interface elements. And from the result it seemed like SmartPaint met the users’ needs, since the software was easy to use and did not contain a lot of unnecessary features. SmartPaint had thus a number of functionality problems. By fixing those problems, SmartPaint will become more attractive on the market for those who are in need of a semi-automatic segmentation of medical images. SmartPaint is a software that has already gone far in the research of creating an effective segmentation program, since the user is allowed to segment in real-time.

The users that had less experience with SmartPaint needed clarification on how to use certain tools. A good design should not need clarification of instructions. If instructions are necessary the design is flawed from the beginning [10]. Adding explanatory text that hovers over the symbols can solve those problems and give the users a hint on how the tools might work. An implemented user’s guide should also be accessible from the user interface if more explanation is needed. Also a good idea would be to offer the user a beginner tutorial the first time they install the software. This could increase the learnability of SmartPaint and make the users get ready to use the software faster. It could also increase the market of users since it can be seen as a learning program for new users.
6.1 Future work

One of the participants told that it would give great feedback if the user were able to see how the segmentation would look like in a three-dimensional (3D) view, to recognize if the segmentation were good or bad. One way to visualize a volume image is to extract slices from the data along one of the principal axes (x, y, or z) and display the slices as 2D images on the screen. This gives a direct view of the data but it may be hard to perceive how different structures relate to each other in the volume. A slightly more sophisticated version of this technique is multi-planar reformatting (MPR), where arbitrarily positioned and oriented planes are used to visualize multiple cross-sections of the 3D data-set. "A common application of MPR is to display three planes, each one orthogonal to one of the principal axes, next to each other along with a user interface that allows for translation of the planes" [1], as seen in figure 9. This would give a great feedback in how the segmentation would look like when working in a multi-planar view.

Figure 10: A computed tomography volume image of human abdomen, visualized using multi-planar reformatting [1].
6.2 Discussion

Usability definitions, for instance the one adopted by ISO, all stress the importance of finding representative users when evaluating. Also, for methodological reasons, a larger number of participants give more reliable results. The present study had deficiencies in both these respects. The participants were not all sampled from the group of intended users and the number of participants in each subgroup was very small. The results presented here, therefore, need to be validated in a larger study. However, the results provide a good starting point for such an investigation pinpointing issues that needs to be investigated in more detail.
References


7 Appendices

7.1 Appendix A: SmartPaint 1.0 User’s Guide

1. Introduction
Welcome to the SmartPaint user’s guide. SmartPaint is a freely available software tool for interactive segmentation of medical 3D images, e.g., MRI or CT images. SmartPaint can be downloaded from http://www.cb.uu.se/filip/SmartPaint/.

2. Requirements
SmartPaint requires a 64-bit version of the Windows operating system.

3. User Interface

The above picture shows a screenshot of the SmartPaint user interface. SmartPaint shows the image data in three orthogonal views. The segmen-
tation tools can be used in any of the views, and the results are updated globally. The three views can be moved and resized freely. The user can scroll between slices in any of the views using either the mouse wheel or the up/down arrow keys. SmartPaint implements a number of tools for segmentation, and these can be selected from the toolbar at the top of the window. The segmentation is displayed as semi-transparent yellow overlay. The display of the segmentation can be turned on/off by pressing the space bar. Toggling the segmentation display on and off is often useful for judging the correctness of the current segmentation.

**File menu**

- **Load volume.** Loads a volume image to be segmented. Supported file formats are listed here.

- **Save segmentation.** Save the current segmentation to a VTK file. To understand the contents of this file, we must first say a few words about how SmartPaint represents the current segmentation internally. Rather than representing the segmentation state of a voxel as a binary value (object or background), SmartPaint assigns to each voxel a real value between 0 and 1. Voxels whose value is greater than 0.5 are belong to the object, and all other voxels belong to the background. There are two reasons for why we choose to represent the segmentation in this way. Firstly, it allows information about previous user actions to be retained between interaction events - A voxel whose value is very close to 0.5 is more likely to change its label during subsequent interaction events than a voxel whose value is close to 0 or 1. This behavior has a subtle, but important, effect on the user experience. Secondly, this type of representation can be used to extract geometrical features, e.g., volume or surface area, from the segmented object with sub voxel precision. In the saved segmentation file, the segmentation state of each voxel is stored as an 8 bit unsigned integer value. Thus, each voxel is assigned a value between 0 and 255. Voxels whose value is greater than 255/2 belong the object, and all other voxels belong to the background.
• **Load segmentation.** Load a previously created segmentation from a file. Supported file formats are listed here. The loaded segmentation must have the same size as the currently loaded volume.

• **Preferences.** Open a dialog for editing user interface preferences.

• **Quit.** Quit SmartPaint.

**Edit menu**

• **Undo.** Undo the last segmentation operation.

• **Clear all.** Reset the current segmentation.

• **Toggle 3D paint mode.** By default, all segmentation tools available in SmartPaint operate in 3D, i.e., painting in one slice also affects voxels in nearby slices. For additional control, it is also possible to switch to a 2D mode, where the effect of the tool is restricted to the active slice. This menu toggles between 2D and 3D mode.

**Display menu**

• **Brightness-Contrast.** Open a dialog for adjusting the brightness and contrast of the image display.

• **Change display interpolation.** Toggles the interpolation method used for image display between nearest neighbor interpolation and trilinear interpolation.

• **Toggle segmentation.** Turns the display of the current segmentation on/off.
Preprocessing menu

- **Reduce noise.** Applies one iteration of an edge-preserving smoothing filter to the currently loaded volume image.

4. Tools

SmartPaint implements a number of tools for performing segmentation, these tools are listed below.

4.1 Brush tool

This is the default tool of the software, intended for general purpose creation and editing of a segmentation. The tool allows the user to paint the segmentation by sweeping the mouse cursor in the image while holding a mouse button. The left mouse button is used to add to the object, while the right mouse button is used to remove parts of the object. The key feature of the brush tool is that the amount of ”paint” applied to a voxel during painting depends on both the spatial distance and range distance (difference in image intensity values) between the voxel and the mouse cursor. The effect, from a user perspective, is that the brush seems to “understand” where the user wants to apply it, selectively sticking to objects of interest while avoiding other structures.

**Parameters:**

- **Radius.** The radius of the brush can be adjusted using ctrl-mouse wheel.

- **Sensitivity.** This parameter determines how much the brush adapts to the image content. When this value is zero, the image content is not taken into account at all when painting. With higher values, the brush adapts more to the image content. The sensitivity can be set using shift-mouse wheel.
4.2 Reference brush tool

The brush tool described above requires the user to drag the mouse cursor inside the object that is to be segmented. For very small objects this might require high precision movement, slowing down the segmentation process. For these situations, we have developed an alternative tool that we call the reference brush. This tool works just like the brush tool, with one exception: the range distance is not calculated with respect to the center of the brush, but relative to the intensity of a reference point, specified by the user by alt-clicking once in a representative area of the image. By specifying a reference point, the user indicates to the software that he/she wants to segment objects with intensity similar to the reference point. The reference point can be changed by the user at any time during segmentation.

Parameters:

- **Radius.** The radius of the brush can be adjusted using ctrl-mouse wheel.

- **Sensitivity.** This parameter determines how much the brush adapts to the image content. When this value is zero, the image content is not taken into account at all when painting. With higher values, the brush adapts more to the image content. The sensitivity can be set using shift-mouse wheel.

4.3 Bucket tool

This tool allows the user to fill large areas in the image with either foreground or background labels, and is very useful for quickly initializing a segmentation. A single click in the image affects the labels of all the voxels within a
user specified radius. Again, the effect of the tool is adapted to the image content. The left mouse button is used to add to the object, while the right mouse button is used to remove parts of the object.

Parameters:

- **Radius.** The radius of the brush can be adjusted using ctrl-mouse wheel.

- **Sensitivity.** This parameter determines how much the tool adapts to the image content. When this value is zero, the image content is not taken into account at all when painting. With higher values, the brush adapts more to the image content. The sensitivity can be set using shift-mouse wheel.

### 4.4 Smoothing tool

![Smoothing tool icon]

When segmenting noisy images, using the tools described above tends to produce segmentation results with noisy and jagged boundaries. Therefore, we additionally provide a smoothing tool, that can be used to locally regularize the boundary of the segmentation. A single click with the smoothing tool affects all voxels within the tool radius adaptively, giving a smoother segmentation boundary in homogeneous image regions while preserving the segmentation in regions where the segmentation boundary coincides with high contrast edges in the image.

Parameters:

- **Radius.** The radius of the brush can be adjusted using ctrl-mouse wheel.

- **Sensitivity.** This parameter determines how much the smoothing procedure should preserve the segmentation in regions where the segmentation boundary coincides with high contrast edges in the image. When
this value is zero, the smoothing is uniform and does not the take the image content into account. With higher values, the smoothing adapts more to the image content. The sensitivity can be set using shift-mouse wheel.

4.5 Navigation tool

When clicking with this tool in one of the three image view, the other view scroll to that point. This is useful for navigating within the volume image. The tool does not alter the segmentation in any way.

Parameters:
None.

5. Supported Image File Formats

Smart paint can load volume images in the following formats:

MetaImage: http://www.cmake.org/Wiki/MetaIO/Documentation

Segmentation results are saved in the VTK format.
7.2 Appendix B: Recruitment e-mail

Hej!

Vi söker nu ett antal testpersoner som vill vara med att medverka till att förbättra SmartPaint.

SmartPaint är ett verktyg för interaktiv segmentering av medicinska volymbilder. Mer information om programmet finns att hitta på hemsidan: http://www.cb.uu.se/~filip/SmartPaint/

Hur går det till?

Resultatet

Är du intresserad av att bli en av våra testpersoner? Maila då dina kontaktuppgifter till: XXX@XXX.com

När du har anmält ditt intresse kommer du inom en vecka att bli kontaktad av mig och du får då mer information samt möjlighet att ställa frågor.

Väl mött!
Hej!

Vad kul att du vill vara med och testa SmartPaint.


Om det är något du undrar över så är du välkommen med att ställa frågor. Jag kommer att svara på dem så gott det går utan att det påverkar testet.

Mvh Nadia Röning
Tel: XXX-XXXXXXX
7.4 Appendix D: Consent form

Välkommen till den här undersökningen!

Vi är mycket tacksamma över att du vill ställa upp och hjälpa oss. Som testdeltagare har du ett antal rättigheter som du bör känna till.

- De data som genereras sparas på ett helt avpersonifierat sätt så att det inte går att förknippa dig med några enskilda resultat.
- Du har rätt att när som helst och utan några förklaringar avbryta testet.
- Du har rätt att få hela försöket förklarat för dig om du så önskar, dess syfte, metod etc. Testledaren kommer att svara på sådana frågor så långt det går utan att resultatet av försöket påverkas, så snart du frågar. Vissa förklaringar måste dock ibland ges först efteråt för att resultaten ska vara tillförlitliga.
- Testledaren får inte ge falska eller vilseledande uppgifter.

Jag har tagit del av dessa upplysningar:

________________________________________
Ort och datum

________________________________________
Namn

________________________________________
Namnförtydligande
7.5 Appendix E: Introduction to the participants

Hej och välkommen!

Vad kul att du vill vara med och testa SmartPaint. Du kan slå dig ner här.


Innan vi kan börja testet, måste du skriva på två papper.

[Skriver under papper]

Det är viktigt att du är medveten om att det inte är dina kunskaper som testas, om du stöter på något som hindrar dig från att utföra någon uppgift i SmartPaint så är det fel på något i SmartPaint.

Och kom ihåg att hela tiden berätta vad du tänker. Du kan nu börja med att dra första kortet i högen.
7.6 Appendix F: Approval form

Godkännande av videoinspelning

Var vänlig notera att allt ditt arbete vid datorn kommer att bli videoinspelat. När du skriver under den här sidan så ger du din tillåtelse att vi använder din röst, kommentarer, och videoinspelad bild, men inte ditt namn för att kunna utvärdera sidan.

Jag har tagit del av denna upplysning:

________________________________________________________________________

Ort och datum

________________________________________________________________________

Namn

________________________________________________________________________

Namnförtydligande