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Alternative User Interface Devices for Improved Navigation of CT Datasets

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The workflow in radiology departments has changed dramatically with the transition to digital PACS, especially with the shift from tile mode to stack mode display of volumetric images. With the increasing number of images in routinely captured datasets, the standard user interface devices (UIDs) become inadequate. One basic approach to improve the navigation of the stack mode datasets is to take advantage of alternative UIDs developed for other domains, such as the computer game industry. We evaluated three UIDs both in clinical practice and in a task-based experiment. After using the devices in the daily image interpretation work, the readers reported that both of the tested alternative UIDs were better in terms of ergonomics compared to the standard mouse and that both alternatives were more efficient when reviewing large CT datasets. In the task-based experiment, one of the tested devices was faster than the standard mouse, while the other alternative was not significantly faster. One of the tested alternative devices showed a larger number of traversed images during the task. The results indicate that alternative user interface devices can improve the navigation of stack mode datasets and that radiologists should consider the potential benefits of alternatives to the standard mouse.

KEY WORDS: Navigation, user interface, PACS, computed tomography

INTRODUCTION

In the last decade, the workflow in radiology departments has changed dramatically from working with film-based examinations at light cabinets to working with digital images on a computer workstation (PACS). The transition to the digital PACS environment has enabled more efficient diagnostic review processes for many reasons. The digital PACS has in particular revolutionized the review process of examinations from volumetric modalities such as computed tomography (CT) and magnetic resonance imaging (MRI) with the shift from tile mode to stack mode display.[1]

Because of the rapidly increasing size of routinely captured datasets, it is now necessary to identify new tools for efficient PACS workflow. In particular, the multi-detector CT modalities contribute to the increase in dataset sizes since they make it possible to produce large image volumes of high spatial resolution while keeping scanning times within a few seconds.[2] The TRIP initiative describes navigation and usability tools as one of six identified concepts to make progress in managing the increasing volumes of data.[3]

Today, the dominating user interface devices (UIDs) in PACS work are the standard qwerty-keyboard and a standard two-button computer mouse with a scroll wheel or a trackball.[4,5] This is a reasonable set of devices for a variety of computer application tasks, even PACS work, but as the radiological datasets increase in size, these UIDs become inadequate for navigation.

In a review of ergonomics in PACS workstations, it is suggested that keyboard shortcuts should be used instead of the mouse, and if possible, one should alternate hands in using the mouse. However, the possibility of using different UIDs other than standard mouse and keyboard was

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not considered.[6] In other domains such as computer game industry and video editing industry, several new UIDs have been developed. In this study, we address the possibility of using alternative off-the-shelf UIDs originally designed for other domains for PACS work.

The performance and reader opinion of different UIDs in PACS work has been investigated in a few studies. Sherbondy compared the performance of different UIDs in identifying anatomical and artificial targets in large CT angiographic datasets.[5] Weiss compared reader opinions after testing different UIDs in the clinical practice.[4] Atkins compared interaction methods for stack mode viewing and introduced a "navigation chart" as a way of illustrating stack mode navigation.[7]

In the present study, we combine the previous three approaches of testing alternative UIDs so that we both evaluate the reader opinion after testing the devices in the everyday PACS work and try to obtain a quantitative performance measure of the UIDs when using the devices to identify a sequence of anatomic targets in large CT datasets. We also use the "navigation chart" as an illustration of the stack mode browsing.

Our focus in this study is in particular the navigation and scrolling of medium to large-size CT datasets as we identified that one of the most common complaints among the staff at our department was the cumbersome and strenuous scrolling with the standard mouse in large CT datasets.

MATERIALS AND METHOD

The UIDs included in our study were tested both during general use in ordinary PACS work and for speed in a task-based target identification experiment. In the first part of the study, readers completed a questionnaire regarding their opinion on the different UIDs after using them in the clinical practice. In the second part of the study, we measured the time readers required for a given task.

Tested User Input Devices

Standard Mouse

The normal set of devices used at our department and many other radiology departments consists of a standard qwerty-keyboard and a two-button mouse with a scroll wheel that also works as a middle button. The scroll wheel is used to traverse CT stacks in the longitudinal direction. At our department, several different brands of standard mouses with similar performance are in use. As the participants used different workstations, we did not separate different makes of standard mouse in the questionnaire.

In the target identification experiment, we used a Dell two-button optical mouse with scroll wheel[8] as the standard mouse.

Contour Design Shuttle Pro v2 (Shuttle Pro)

Shuttle Pro[9] is a UID originally designed for video editing. It combines a number of programmable buttons with a double navigation wheel for scrolling. Shuttle Pro ships with a configuration utility that allows the user to program the buttons and scroll wheels for different behavior in specific applications by mapping keystrokes and scroll wheel behavior to the device. Since Shuttle Pro has no capabilities for moving the mouse cursor, it is necessary to combine this device with a mouse or another device for controlling the mouse cursor. In this study, we combined Shuttle Pro with the standard mouse.

The innermost of the two scroll wheels on the Shuttle Pro device can be rotated. The CT stack advances one image per click. The outer wheel can be rotated 90° to the left or right from its starting position and is forced back to the starting position by a spring when released. The outer wheel was programmed for continuous scrolling in the CT dataset with faster scrolling the more the wheel was rotated from its starting position. The maximum continuous scrolling speed was configured to 45 images per second. Typically, the inner wheel is used for fine control and the outer wheel for speed.

For the questionnaire study, we mapped some common PACS functions to the programmable buttons such as changing window settings in CT datasets.

Logitech VX Revolution Mouse (VX Revolution)

The VX Revolution mouse[10] is a wireless mouse with a scroll wheel that can operate in a free-spin mode and a click-to-click mode. In the free-spin mode, the scroll wheel can spin freely for several seconds with very low friction. When used in a PACS setting, this allows the radiologist to rapidly navigate through a large number of slices in a CT dataset by letting the wheel spin freely. It is possible to change between the free-spin mode and the click-to-click mode with a switch on the bottom of the mouse. In this study, the readers were instructed to keep the mouse in the free-spin mode at all times. The mouse has three extra buttons and a zoom switch that can be programmed. Due to software conflicts between the Logitech SetPoint utility that came with the mouse and existing computer mouses in our department, these extra buttons could not be used. Because of this limitation, the main tested difference between the VX Revolution mouse and the standard mouse in this study was the free-spin mode of the scroll wheel.

Participants

Six readers (two women, four men, three radiology residents with 3, 3, and 4 years experience in PACS work and 3 radiologists, each with 10 years experience in PACS work) participated in both parts of the study. At the beginning of the questionnaire study, one of the radiologists had previous experience from using Shuttle Pro in a PACS setting. One of the residents had previously used another mouse from Logitech with a similar scroll wheel function. The others had no previous experience of the tested devices.

When the second part of our study started, the target identification experiment, all of the readers had several weeks of previous experience from both Shuttle Pro and free-spin scroll wheel mouses in a PACS setting.

Questionnaire Study Design

Participants were instructed to use each of the UIDs for a period of 2 weeks in the daily diagnostic radiological image interpretation in a university hospital radiology department. Based on records in the Radiology Information System at the department the mean number of reviewed studies with each device is estimated to 150–200 per reader. The image interpretation included a majority of plain X-rays (40–50%) and CT datasets (30–40%). To a lesser extent MRI, nuclear scintigraphy and ultrasound images were also reviewed during the test period. All CT studies were read as stack mode datasets, mainly for disease detection and therapy monitoring. The size of the CT datasets varied.

Before the trial period, the experiment leader had a meeting with the participants where information on the tested devices, and the questionnaire was given. Questionnaires were completed and returned after both set of devices were tested. A third questionnaire concerning the standard UIDs in our department (keyboard and standard mouse) was completed at the same time without any separate testing period as all participants used this set of devices regularly. The experiment leader had regular contact with the participants during the testing period to ensure that the UIDs functioned correctly.

In the questionnaire, the UIDs are grouped in sets of devices (standard mouse + keyboard, Shuttle Pro + standard mouse + keyboard, VX Revolution + keyboard). This was done because no device completely replaces the standard keyboard and one of the tested devices, Shuttle Pro, requires a separate mouse to control the mouse pointer. The participants were asked about their opinions on the tested set of UIDs as a whole.

The questionnaire was based on ordinal scaled data where the participants were instructed to assess whether they agreed or disagreed with a number of statements concerning the tested set of UIDs. For each statement, a five-point scale was used (Strongly disagree, Disagree, Neutral, Agree, Strongly agree). One single answer per question was allowed. The first five questions in the questionnaire were modified from Weiss' questionnaire study.[4]

Statistical Analysis

Statistical analysis on the ordinal scaled data were performed with Friedman test and where this test showed a statistical significant difference ($p<0.05$) pairwise comparisons between the different sets of UIDs were performed with two-tailed Wilcoxon Signed rank test. The null hypothesis of equal medians among the tested devices was tested against the alternative hypothesis of unequal medians.

Target Identification Experiment Design

Design

The target identification experiment was designed as a repeated measure comparison of the same task in six different CT datasets using three different UIDs.

Task

Readers were instructed to identify a number of normal anatomic vascular targets in thoraco-abdominal CT datasets in a given order. Readers were informed of the purpose of the experiment and that the navigation and the total time of completing the task were recorded. The targets in order were: origin of right renal artery, aortic bifurcation, origin of brachiocephalic artery, origin of coeliac trunk, bifurcation of pulmonary trunk, origin of superior mesenteric artery, and origin of left profunda femoris artery. The navigation started at the most cranial slice of the CT dataset. Each identification of a target was marked by the reader with a keystroke.

During the target identification experiment the readers were instructed to use only the scrolling possibilities of the tested devices. No scrolling using keyboard shortcuts was allowed.

Protocol

Each reader performed the same target identification task on six CT datasets using all three UIDs. The trial was divided into three trial sessions, separated by at least 1 week of time to reduce case memory. Each trial session started with three practice datasets, one with each UID, followed by six recorded trials, two with each UID. The order of UIDs was rotated within and between readers to achieve counterbalance. The starting device for each reader was randomized.

The regional Research Ethics Board approved the study protocol.

CT Datasets

Nine thoraco-abdominal CT datasets from the normal clinical production were included in the study. Three of the datasets were used as training and six datasets were used in the study. Before inclusion in the study, all patient specific data were removed from the CT datasets. We used a 3-mm non-overlapping reconstruction interval for the CT datasets. The number of slices in the datasets ranged from 196 to 211 (mean 205).

PACS Workstation

We used a Sectra IDS7 PACS workstation (Sectra AB, Linköping, Sweden) with the addition of a logging feature specially designed for the study. The logging feature recorded the time for each displayed image in a log file. The IDS7 workstation was running on a standard radiological workstation at our department (HP Compaq dc7700, Intel Core 2 CPU, 2.4 GHz, 3.5 GB RAM, Hewlett–Packard, CA, USA) with three EIZO RadiForce R22, 54 cm (21.3 in.) Color LCD Monitors (1,600 × 1,200 pixels), Eizo Nanao Corporation, Ishikawa, Japan. All three UIDs were simultaneously connected to the workstation.

Dependent Measures

The total time for completing the task for each CT dataset was extracted from the log files. The navigation time was measured as the time between the first movement from the most cranial slice in the CT stack to the marking of the last target with a keystroke. After the completion of the three reading sessions, the outcome variable mean task time for the reader was computed for each of the three UIDs.

The correct slices for each target were defined by the experiment leader as an ideal slice number ±2 slices. The number of incorrectly identified targets was counted by comparing the slice number of each marked target in every trial with the documented slice number. The total number of incorrectly identified targets was computed for each UID.

As a secondary measure to indicate the accuracy of the tested UIDs, we also analyzed the mean number of traversed images for each UID. The number of traversed images is the total number of steps in the navigation path between the start of the navigation and the identification of the last target. This measure is introduced under the assumption that a better accuracy of a UID would be reflected as fewer steps required to complete the task.

Statistical Analysis

The outcome variables mean task time and mean number of traversed images was analyzed one by one with repeated measure ANOVA implemented as a mixed model with unstructured covariance structure for the three UIDs on the null hypothesis of equal means. Pairwise post hoc tests and confidence intervals between the UIDs were adjusted by the Scheffe method. The ANOVA was performed using SAS for Windows v 9.2 (SAS Institute Inc, Cary, NC, USA).

The total number of incorrectly identified targets was analyzed with Chi-squared test with the null hypothesis of equal frequency of incorrectly identified targets between the tested devices. The statistical analysis for the questionnaire and for the Chi-squared test in the target identification experiment was performed using SPSS for Windows v15.0.1.1 (SPSS Inc, Chicago, IL, USA).

RESULTS

Questionnaire Data

As Shuttle Pro requires a separate mouse to control the mouse cursor, the UIDs are grouped into sets of devices in the questionnaire (Standard mouse + keyboard, Shuttle Pro + standard mouse + keyboard, VX Revolution mouse + keyboard). Table 1 shows the distribution of the answers in the questionnaire. Where Friedman test showed a significant difference in medians between the UIDs, additional Wilcoxon Signed rank test between each pair of devices was performed.

Target Identification Experiment

Table 2 summarizes average performance measurements for the different UIDs. Pairwise comparisons (Table 3) show that the VX Revolution mouse was faster than both the standard mouse (p=0.003) and Shuttle Pro (p=0.010). The mean number of traversed images during the task was significantly higher for VX Revolution compared to Shuttle Pro (p=0.014).

No statistically significant differences, analyzed with Chi-squared test, in the number of incorrectly identified targets were observed.

DISCUSSION

In the present study, we evaluated three sets of UIDs for PACS work both in clinical day-to-day image interpretation and in a task-based performance test in CT datasets. In the questionnaire study, the participants considered both of the alternative sets of UIDs better in terms of ergonomics (question 4) and in terms of efficiency in navigating large CT datasets (questions 9, 10), compared to the standard mouse. In the experimental study, the VX Revolution mouse was faster than the standard mouse and Shuttle Pro. However, when using VX Revolution, a larger number of images were traversed to complete the task compared to Shuttle Pro, which may indicate a better accuracy with Shuttle Pro. Correspondingly, in the questionnaire Shuttle Pro was considered better for fine control than the other UIDs (question 11).

Our study has a number of limitations. The task in our study, to identify a sequence of normal anatomical targets, was designed with a lot of longitudinal scrolling in the CT datasets. The outcome variable, time to complete the task, is not necessarily the best way to measure if a UID is well suited for PACS work. The task in our study cannot replicate the normal use of UIDs in the complex image interpretation process. In contrast, in the questionnaire part of our study, the UIDs were used in the normal day-to-day clinical work. The measurements in the task-based study are also sensitive to changes in the configurations, such as the maximum navigation rate of the Shuttle Pro, and to the design of the task. We also included only two alternative UIDs, and there may be other UIDs, not tested by us, that are better suited for radiological work.

Furthermore, only a small number of readers, all working in the same radiology department, participated in the study. Their opinions in the questionnaire study may not reflect the opinion of radiologists in general. There was no independent observation of the readers' compliance to the tested devices. However, the experiment leader, working in the same department, had regular contact with the readers to ensure that the UIDs worked as supposed. No indication of lack of compliance was noted during the testing period. Some of the questions regarding the devices can be seen as vague and can be interpreted slightly different by different readers. Even though we had no detailed definitions of the terms in the questionnaire, we tried to reduce this effect by giving common information to the readers before the testing periods and by the paired study design where all readers assessed all three UIDs.

With those limitations in mind, we note that both VX Revolution and Shuttle Pro were consid-

Table 1. Questionnaire Results

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Friedman p value	Wilcoxon p value: Standard vs St + Shuttle Pro	Wilcoxon p value: Standard vs VX Revolution	Wilcoxon p value: St + Shuttle Pro vs VX Revolution
1. The use of this set of devices is intuitive	Standard			1	2	**3**	n/s			
	St + Shuttle Pro		1		**5**					
	VX Revolution				**4**	2				
2. The learning curve for this set of devices is rapid	Standard			1	2	**3**				
	St + Shuttle Pro		2		**4**					
	VX Revolution				**4**	2	0.032	n/s	n/s	n/s
3. I would like to use this set of devices on a daily basis in my regular work	Standard	1	**3**	1	1					
	St + Shuttle Pro		1	1	**3**	1				
	VX Revolution		1	2	**1**	2	n/s			
4. The use of this set of devices is ergonomical	Standard	3	**3**							
	St + Shuttle Pro		1	2	**3**					
	VX Revolution		2	1	**2**	1	0.027	0.041	0.042	n/s
5. The use of this set of devices is not a distraction from image viewing	Standard		2		**4**					
	St + Shuttle Pro		3	**0**	3					
	VX Revolution			1	**4**	1	n/s			
6. This set of devices is efficient for PACS overall workflow	Standard		3	**2**	1					
	St + Shuttle Pro	1		1	**4**					
	VX Revolution		1	1	**3**	1	n/s			
7. This set of devices is efficient for reviewing plain X-rays in PACS	Standard			1	**5**					
	St + Shuttle Pro	1	1	1	**3**					
	VX Revolution			2	**3**	1	n/s			
8. This set of devices is efficient for reviewing CT/MR datasets in general in PACS	Standard		2	**2**	2					
	St + Shuttle Pro		1		**4**	1				
	VX Revolution			1	**4**	1	n/s			
9. This set of devices is efficient for reviewing large (>100–150 slices) CT/MR datasets in PACS	Standard	1	**5**							
	St + Shuttle Pro				2	**4**				
	VX Revolution		1		1	**4**	0.010	0.026	0.025	n/s
10. This set of devices is efficient for traversing large longitudinal distances (scrolling) in CT/MR datasets in PACS	Standard	2	**3**	1						
	St + Shuttle Pro				3	**3**				
	VX Revolution		1		1	**4**	0.013	0.023	0.039	n/s
11. This set of devices gives a feeling of control when performing fine longitudinal movements in CT/MR datasets in PACS	Standard			2	**3**	1				
	St + Shuttle Pro				1	**5**				
	VX Revolution		3	**1**	1	1	0.018	0.034	n/s	0.041
12. This set of devices is efficient for administrative tasks	Standard		1	2	**3**					
	St + Shuttle Pro	2		**2**	2					
	VX Revolution			2	**3**	1	n/s			

Distribution of questionnaire answers reported as number of answers for each category. Boldfaced values indicate median (ambiguous medians are rounded up). Where Friedman test showed statistically significant differences between UIDs (p<0.05), pairwise comparisons with Wilcoxon signed rank test were performed

n/s not significant

Table 2. Performance Measurements for UIDs

Device	Total trial time (SD) seconds	Number of traversed images (SD)	Overall incorrectly identified targets
Standard Mouse	54 (3.6)	603 (40)	19
Shuttle Pro	50 (8.2)	600 (22)	21
VX Revolution mouse	41 (7.0)	630 (19)	22
Repeated measure ANOVA p value	0.001	0.012	

Data for total trial time and number of displayed images are means. Numbers of incorrectly identified targets are total for all readers. A total of 252 targets were identified per device. One reader consequently misinterpreted one target corresponding to six incorrectly identified targets per device. Differences in number of incorrectly identified targets, analyzed with Chi-squared test, are not statistically significant

ered more efficient for reviewing large CT datasets compared to the standard mouse, whereas the participants reported better control in fine longitudinal movements with Shuttle Pro compared to the other UIDs. In the task-based study, these results are partially reflected. VX Revolution was faster in the task-based part compared to the standard mouse. Shuttle Pro, however, was considered more efficient for reviewing large CT datasets than the standard mouse in the questionnaire study but was not faster than the standard mouse as measured by our task-based study. On the other hand, more images were traversed when using VX Revolution compared to Shuttle Pro. This may reflect the better fine control for Shuttle Pro compared to VX Revolution reported in question 11 in the questionnaire.

Where the navigation rate of the standard mouse is limited by the biomechanics of the repetitive movement of the index finger on the scroll wheel, Shuttle Pro was in our study limited by the configuration of the device, where we configured the maximum navigation rate to 45 images per second. The free spin scroll wheel of the VX Revolution mouse allowed a faster navigation rate than the other devices, which is reflected in the results of the task-based study.

Especially for the VX Revolution mouse, but also during the bursts of the scroll wheel on the standard mouse, the navigation rate displayed in the navigation chart (Fig. 1) exceeds the screen refresh rate of 60 Hz. This results in a tearing of the displayed images so that the actual displayed image on the screen is composed of parts of two adjacent slices in the navigation chart, which can be noted as a horizontal break in the image. This is considered to be of low relevance in our study as these high navigation rates are seen only in locating phases where the approximate location of a target is identified. The detailed reading, when a target is identified, is performed in much lower navigation rates. Even in normal clinical diagnostic reading, it is reasonable to assume that navigation rates higher than the screen refresh rate only occurs as transportation between different parts of the dataset and that the tearing of images in high navigation rates is of low relevance for the outcome of the reading.

Even though we saw no significant differences in the number of incorrectly identified targets between the UIDs in our task-based study, it is an interesting question whether a change in navigation path that comes from a change of UID can affect not only the workplace ergonomics for the radiologist but also the diagnostic quality of the clinical reading.

As a task-based study may not reflect the everyday PACS work, we conducted this study as a combination of a questionnaire part and a task based part. In the task-based study, we saw an approximate difference of 10–15 s between the UIDs for a task where the standard mouse required slightly less than 60 s. This difference cannot easily be translated to time savings in clinical reading as a

Table 3. Pairwise Comparisons for UIDs

Devices	Difference in total trial time, seconds (95% CI)	Difference in number of traversed images (95% CI)
Standard mouse–Shuttle Pro	4 (−5–12) n/s	3 (−25–31) n/s
Standard mouse–VX Revolution	13 (6–19) $p = 0.003$	−28 (−67–11) n/s
Shuttle Pro–VX Revolution	9 (3–15) $p = 0.010$	−31 (−53 to −9) $p = 0.014$

Values are mean differences between devices with Scheffe-adjusted p-values and 95% confidence interval for the differences

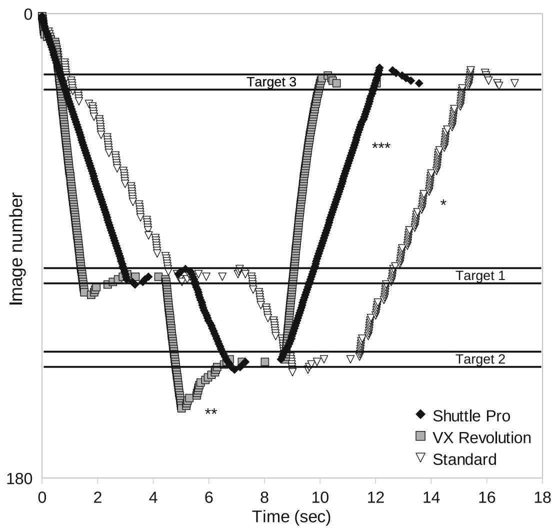

Fig. 1. Navigation chart. Detail from navigation chart showing identification of the first three targets by one reader on the same dataset with the three tested UIDs. Note the bursty navigation with the standard mouse (*), the overshoot with VX Revolution (**), and the constant navigation rate with Shuttle Pro (***).

task-based study cannot replicate the complex image interpretation process. In addition, the results of our task-based study did not entirely correspond to the results in the questionnaire part. This indicates that the explanation to why the alternative UIDs were appreciated by the participants may be the possibility to traverse large longitudinal distances without the cumbersome repetitive movement of the scroll wheel, rather than just a question of time savings or speed. As the number of images in the volumetric datasets increases, this feature becomes even more important, reflected in question 9 in our questionnaire study.

In a previous task-based study, Sherbondy showed that a trackball is slower than tablet-stylus device and marginally slower than Shuttle Pro.[5] Probably due to different radiological cultures, the standard mouse was not included. Instead, a trackball was included as the standard UID for PACS work. A limitation of Sherbondy's study is that the study design did not include the use of the UIDs in the everyday routine at the radiology department.

Atkins compared interaction methods for stack mode viewing and introduced a "navigation chart" as a way of illustrating stack mode navigation. No significant differences in total trial time were observed between the three tested interaction techniques (mouse scroll wheel, mouse click, and drag and jog wheel technique).[7]

Figure 1 illustrates the nature of the navigation with the different devices in our study in a navigation chart. As described by Atkins,[7] the navigation chart reveals the bursty scrolling with the standard mouse (marked with asterisk in the figure). The bursty behavior is produced by the repetitive movement of the index finger on the scroll wheel. VX Revolution shows the fastest navigation rate and a considerable overshoot distance (marked with two asterisks). Compared to Shuttle Pro, the number of traversed images is significantly higher for the VX Revolution mouse (p=0.014). There is also a tendency, although not statistically significant, towards a higher number of traversed images for the VX Revolution mouse compared to the standard mouse. This finding can at least in part be explained by the overshoot noted in the navigation charts for the VX Revolution mouse. Shuttle Pro typically shows a constant image navigation rate for traversing long distances (marked with three asterisks).

The task in our experimental study was designed to include a lot of longitudinal scrolling in the CT datasets. This, in combination with the repeated measure design and the possibility to achieve a fast navigation rate with the free spin scroll wheel of the VX Revolution mouse included in our study, may explain why we see a significant difference in the total trial time for VX Revolution compared to the other UIDs. The VX Revolution mouse has not, to our knowledge, been tested before in a radiological context.

In a questionnaire study by Weiss, a number of different UIDs were tested by radiologists in clinical practice.[4] Weiss' study concluded that no single device could replace mouse and keyboard. Among the tested devices in Weiss' study was Shuttle Pro, which was appreciated by the readers. The result concerning Shuttle Pro was confirmed in the questionnaire part of our study.

In our opinion, the most important conclusion from the previously discussed studies and from the present study is that the standard UID, whether it is a trackball or a standard mouse, may not be optimal for PACS work. As pointed out by Krupinski,[11] the type of UID for radiological work is for the most part a matter of personal preference based on the type of reviewed studies. However, up until today, the keyboard and the standard mouse remain the dominating UIDs and few radiologists seem to have made a real choice based on personal preference. Our study confirms that alternative UIDs can provide more efficient navigation and suggests that the choice of UID becomes even more important as the number of images in radiological datasets increases.

Off-the-shelf UIDs designed for other domains provide a large selection of UIDs to choose between. However, one drawback of using off-the-shelf UIDs is that there is a limitation of the mapping possibilities of PACS functions to the device. Another drawback is that with the installation of configuration utilities comes a risk of software and hardware conflicts with the workstation. In our study, we experienced software conflicts between the Logitech SetPoint program for the VX Revolution mouse and existing standard mouses. We also had to exclude one device (a gamepad) that we planned to include in our study because of hardware conflicts with the workstations.

CONCLUSION

Radiology departments are facing a data explosion in particular due to the widespread use of multi-detector CT modalities.[2] There is a need for new tools to be developed and adopted by the radiology community in order to manage the increasing dataset sizes.[3] One basic approach to facilitate the review process and to improve the ergonomics for radiologists in PACS work is to take advantage from UIDs developed in other domains such as the video game and video editing industry.

Our results confirm the previous findings that alternative UIDs can provide more efficient navigation of the increasing dataset sizes. Participants in our questionnaire study reported that both tested alternative UIDs in our study were better than the standard mouse when reviewing large CT datasets. Even though a task-based target identification experiment may not be ideal for evaluating alternative UIDs, one of the tested alternatives in our study, the VX Revolution mouse, was faster than the standard mouse, but on the other hand, more images were traversed compared to Shuttle Pro, which could indicate less accuracy. Our results suggest that off-the-shelf UIDs can improve the stack mode browsing of volumetric datasets.

We cannot point out a single UID that is ideal for radiological work, and we only tested two alternatives to the standard mouse. For the most part, the choice of UID is a matter of personal preference. Nevertheless, it is important for radiologists to consider the potential benefits of alternative UIDs in PACS work.

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