Studienarbeit

A Usability Study on Mouse Gestures

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Declaration

I declare that this present paper with the title:

"A Usability Study on Mouse Gestures"

has been completed by myself independently without outside help and only the defined sources and study aids were used. Sections that reflect the thoughts or works of others are made known through the definition of sources.

Janine Denise Paschke

Koblenz, 15.09.2011

Abstract

Most users make use of the mouse, when fulfilling a task in a common graphical user interface. Alternative navigational patterns are represented by keystrokes or mouse gestures, which were invented in the year 2000. The latter are not supported by many software applications and occur mainly in browsers.
This paper describes the application of mouse gestures when fulfilling tasks in a web browser, such as switching tabs, navigating back and forth between web pages and many more.

Therefore a usability study on mouse gestures was conducted with 38 participants. A questionnaire was developed, which was to be filled out by the test participants anonymously. The results were documented by text and captured by video, in order to achieve reliable data on the advantages and disadvantages of mouse gestures.

To gain information on the usability of mouse gestures, they were examined in respect to software ergonomic principles, such as the suitability for learning, controllability, error tolerance and self descriptiveness.

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1. Introduction and Motivation

In common graphical user interfaces, specific tasks, such as navigation, are handled via buttons and hyperlinks. The user is able to choose between the across-the-market known mouse, a pen-based device or other navigation-devices. Nevertheless the main problem remains: buttons or hyperlinks, which are used to fulfill tasks, must be addressed precisely by pointing devices.

Since the early Nineties of the past Century a transformation took place, concerning these navigation-devices. Gestures were developed, for easier human-computer-interaction. For different areas of application, several input-devices were developed to support the recognition of gestures performed by a user based on tracking the user' s movement.
Wired gloves for example can provide input to the computer about the position and rotation of the hands using magnetic or inertial tracking devices. Other input-devices are for example stereo-cameras, which support an approximated 3d-representation and detect gestures with direct motion measurement.

But commonly known and used are controller-based gestures, where controllers act as extensions of the human body. Their motion, measured when a gesture is performed, is captured by software. Mouse gestures are an example for controller-based gestures. The motion of the mouse is hereby correlated to a symbol drawn by a person' s hand.

The development in recent years aimed towards tangible user interfaces for example multi-touch-pads. Gestures can be completed by finger movements on the pad and the user has the advantage of actually grasping something. These finger movements are tracked and converted into a digital simulation.

Still, most users do not own a multi-touch-pad to perform gestures. Within the scope of the usability study realized for this paper, the assumption that most users prefer utilizing a mouse to interact with the computer, was confirmed. 92.11% of the participants stated, that they use a mouse for navigation.

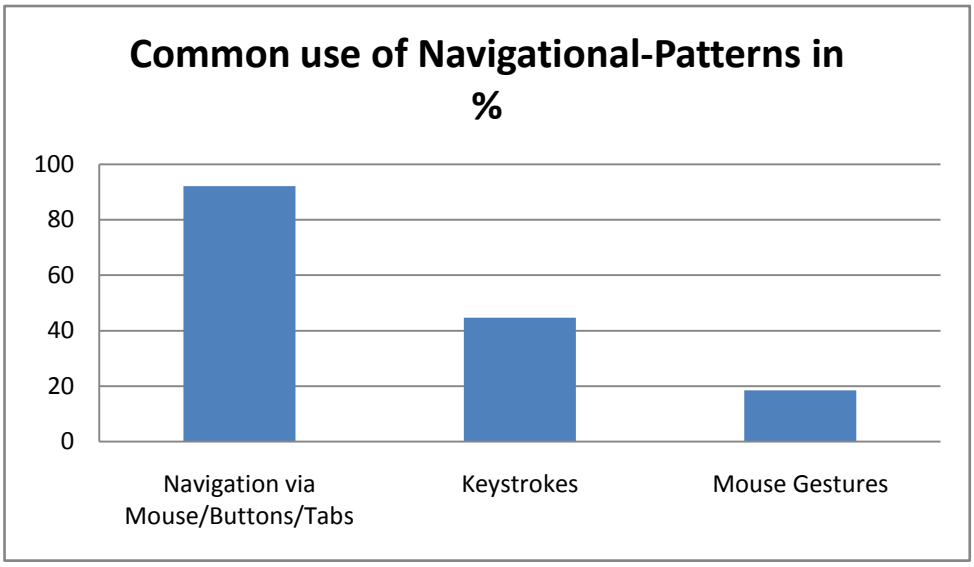

Figure 1. Common Use of Navigational Patterns in %; Multiple Answers Were Allowed

Mouse gestures compose an alternative to common mouse-driven actions or navigating web pages per keystrokes. They are defined as pressing a button of the mouse and simultaneously conducting a motion, for example a circle. Individual motions are tied to specific program functions, such as "open", "close" etc. (Bericht des Ausschusses für Bildung, 2009)

Since gestures are executed unconsciously by humans, the utility of gestures might provide an opportunity to simplify the interaction with a computer on a more natural basis. Out of these considerations the motivation arose to construct a usability study on mouse gestures.

2. Gestures and user friendliness

Gestures need to be chosen and implemented carefully. Justine Cassell explicitly states, that she defines gestures as "hand gestures that co-occur with spoken language ", and explains this constraint with the thought that she does not believe that "everyday human users have any more experience with, or natural affinity for, a "gestural language" than they have for DOS-commands." Hand-gestures accompany speech in most communicative situations and are used automatically. (Cassell, 1998)
Therefore, when creating gestures as an interaction technique, one should be aware of the fact, that these gestures ought to be generated out of the natural behavior of humans, so they can be performed spontaneous and unselfconsciously by users.

Further, Justine Cassell and Caroline Hummels provide two basic approaches for classifying gestures. By means of gesture-classification a better implementation of gestures concerning user friendliness should be ensured. (Cassell, 1998), (Hummels & Stappers, 1998)
On the one hand is the technological approach, which means choosing gestures in a way, that an algorithm can reliably recognize them. On the other hand is the human-based approach, which requires high user friendliness by communicating with the system through an easy to handle interface.
Though the first approach might be easier to implement, the outcome of gestures might not be accessible for some users, specifically users with impairments. (Bericht des Ausschusses für Bildung, 2009)
For especially this group of users, gestures should and could provide a simpler way of interacting with the computer system. When executing a mouse gesture, users with disabilities, such as limited mobility, might be able to interact with their computer without high-cost inventions as for example the eye-tracker.

The second approach displays guidelines for gestures with the highest possible user friendliness with no regard to technical practicability, based on common usability-principles.

Justine Cassell distinguishes between spontaneous gestures, which occur with speech, and conscious gestures independent of speech. Conscious gestures occur in two different ways. (Cassell, 1998)

Emblematic gestures, which are used to facilitate social transactions (e.g. thumbs up indicating "everything is ok"), play an important role in human communication. These symbolic gestures are autonomous, can replace words without loss of meaning, and function as complete utterances in their own right. (Xu, Gannon, Emmorey, Smith, & Braun, 2009)

So-called propositional gestures are often used when fortifying the demonstration of an action. These gestures play an important role in task-oriented talk, for example discussing the displacement of a chair.

The unplanned, spontaneous gestures, emphasized by Justine Cassell, are of four types, which are used more often than conscious gestures. (Cassell, 1998)

The first of these more common gestures are formed by the Iconic gestures, which are characterized by depicting some features of the action or the event being described.

Metaphoric gestures are also of a representative form, but they do not represent anything physical. Instead these gestures rely on a common metaphor.

Deictic gestures support the explanation of spatial relations within a human communication.

The fourth category, Beat gestures, are small baton-like movements, which accompany comments on one' s own linguistic contribution, speech repairs and reported speech. (Cassell, 1998)

Michael Nielsen, Moritz Störring, Thomas B. Moeslund and Eric Granum presented "A Procedure for Developing Intuitive and Ergonomic Gesture Interfaces for HCI", in 2003. Based on the work of Hummels an Cassell, Nielsen et. al developed usability principles for the design of intuitive and ergonomic gesture-based interfaces.

1. The application software must be easy to operate, and must provide controllability concerning interactions of the user. These interactions should be easy to learn and to remember.

2. The application software must be intuitive, meaning that it should be applicable by the user without further instructions.

3. In regard to its controllability, the application software must be pictorially logical in view of underlying functions.

4. The user must be able to operate the software application ergonomically, which means no physical effort should be necessary on the user' s behalf.

Out of these usability principles Nielsen et. al alleged a list of guidelines, which should be noted when generating appropriate gestures. (Nielsen, Störring, Moeslund, & Granum, 2003)

1. Intuitive Mapping of Functionality and Gesture
   This guideline, proceeding the third usability-principle, states that the performed gesture should match the underlying function logically.

2. The Semantic of Gestures
   Regarding the sense of a gesture and the user' s knowledge of it, the gesture should not be defined in another sense in a new application, but be used in the familiar way.

3. Cultural Diversities
   The same gesture might have a completely different meaning, depending on the cultural background.

   For example, Figure 2 displays a gesture, which stands for "Ok" in the North-American or most of the European culture. Japanese people would rather connect "Money" with this particular gesture. Therefore, the main focus should lie on a global understanding of the meaning of gestures, before they are generated.

Figure 2. A Hand Gesture (Payer, 2006)

4. Natural and Unselfconscious Gestures within Human Communication
   Since spontaneous gestures are used naturally and intuitively during human communication, the usage of them as control-elements for interaction may be of advantage when implementing a software application.

5. Physical Effort
   In respect to the fourth usability principle, this guideline is devoted to a low level of physical effort on the user' s behalf, when performing a gesture. The user should not strain himself when fulfilling a task with help of a gesture.

This way barrier-freedom could be ensured, since impaired users might be able to use gestures for task-fulfillment in applications autonomously. Before the implementation of gestures users had to navigate across wide-reaching paths to buttons with added functions with common navigational devices, which were not disability-friendly. Mouse gestures on the other hand allow the user to perform common browsing actions with small, quick mouse movements.

3. Structure of the Usability Study on Mouse Gestures

3.1 The Use of Mouse Gestures in Mozilla Firefox under the Windows Operating System

Mainly web browsers support the use of mouse-gestures. Several surveys during the last year stated, that the "Internet Explorer" (IE) as well as "Mozilla Firefox" are the market-leading browsers.

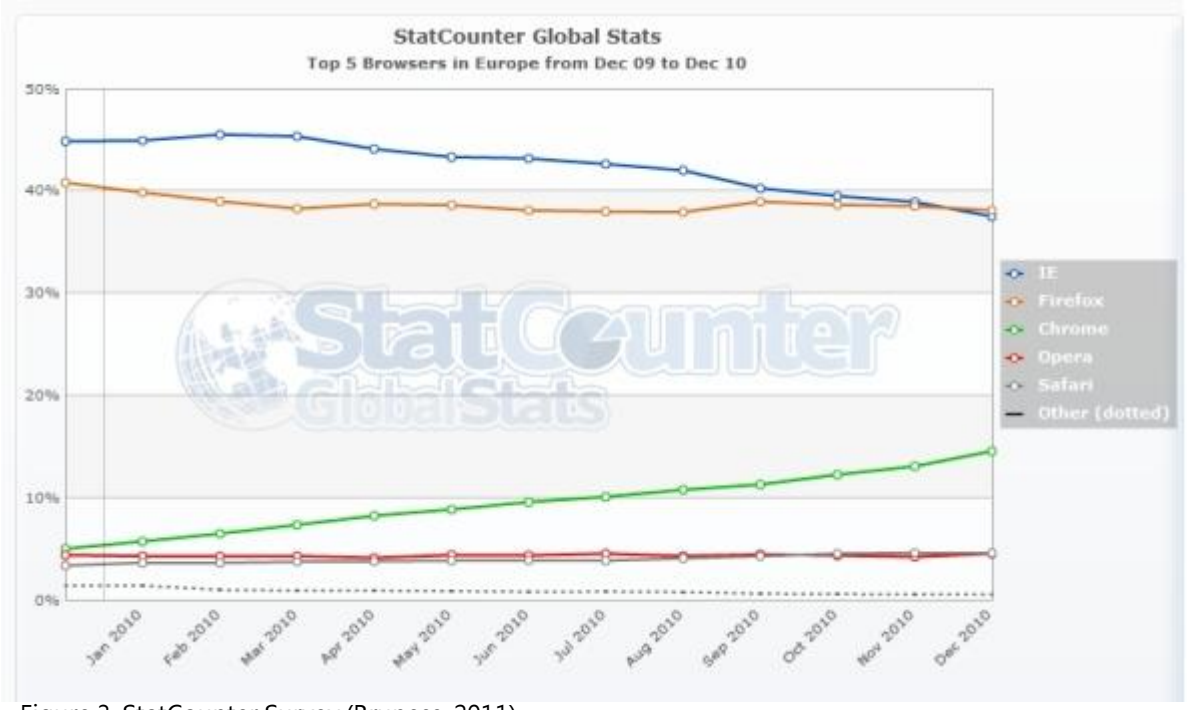

Figure 3. StatCounter Survey (Bruness, 2011)

According to a survey done by "StatCounter" and published by "www.netzwelt.de" on January 5th 2011, Mozilla Firefox was the most popular browser in Europe between December 2009 and 2010. Therefore the browser of choice used for the usability study is Mozilla Firefox. (Bruness, 2011)

Since Mozilla Firefox is installable under the operating systems of Windows, Linux and Macintosh, the question, which operating system to choose as part of the usability study, subsided. Nevertheless the most popular operating system is retrievable under www.webhits.de, data that is updated every day. Figure 4 shows the distribution of operating systems on September 4th 2011.

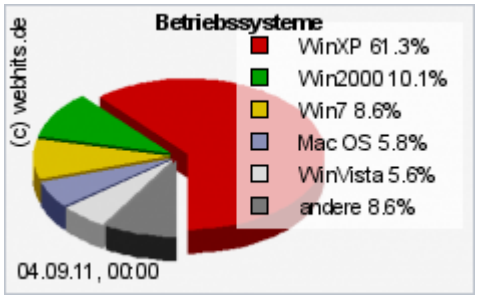

Figure 4. Distribution of Operating Systems (WebHits - Hit Counter und Live-Statistiken)

3.2 FireGestures 1.6.6

Mouse gestures are not automatically available when using Firefox. For this usability study the Add-on "FireGestures 1.6.6" was installed, an application with the possibility of defining mouse gestures individually. Besides the following five types of gestures installed, own scripts can be made to add own functions (Figure 5):

- Mouse Gestures (Move mouse with holding right-click)
- Wheel Gestures (Scroll wheel with holding right-click)
- Rocker Gestures (Left-click with holding right-click and vice versa)
- Keypress Gestures (Mouse Gesture with holding Ctrl/Shift key)
- Tab wheel Gestures (Scrolling wheel on Tab bar)

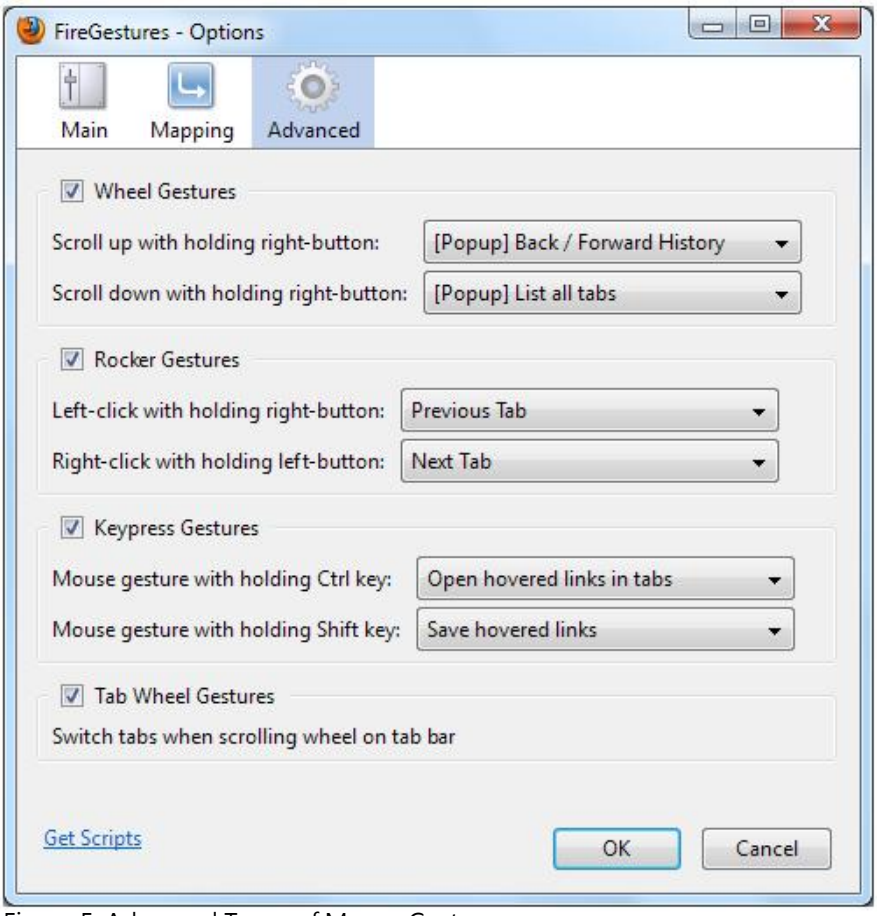

Figure 5. Advanced Types of Mouse Gestures

The first three gesture types were used in this particular usability study. Since mouse gestures are activated upon pressing a mouse button, the user is able to appoint a trigger button, which is by default set to "Right."

Aside of determining gestures, one may also define with FireGestures 1.6.6 whether or not the trail drawing should be activated, and if so, may choose the design. (Figure 6)

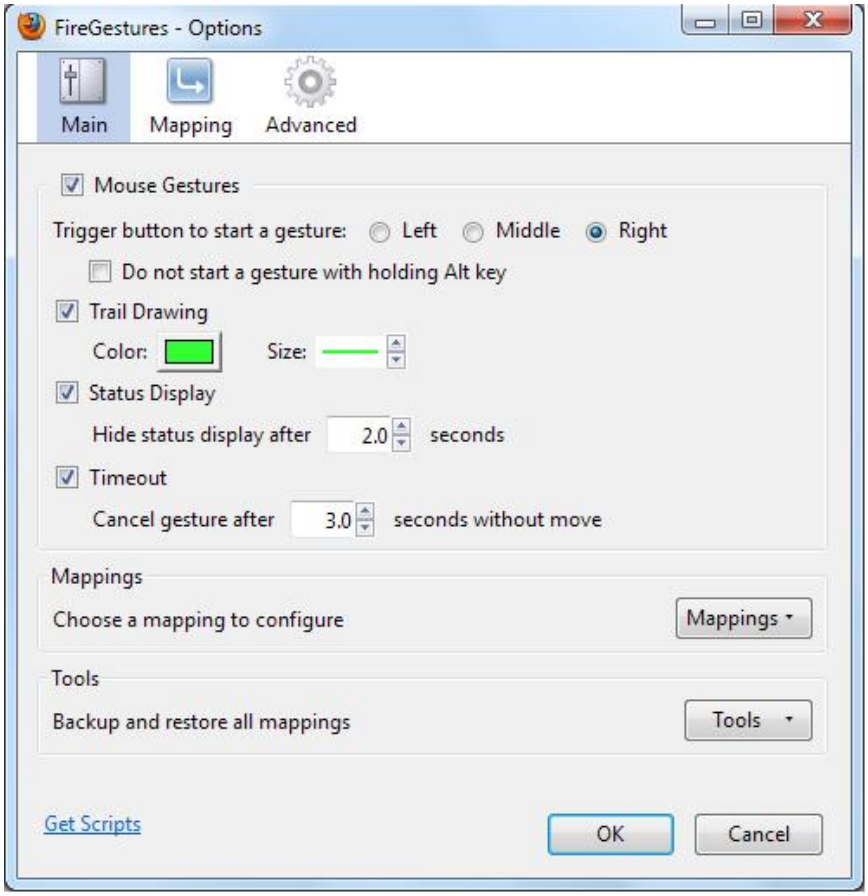

Figure 6. Main Functions of FireGestures 1.6.6

The Status Display, as seen in Figure 6, may be used as visual guidance. If the checkbox is marked, the user will see a small pop-up in the bottom left corner of the browser window.

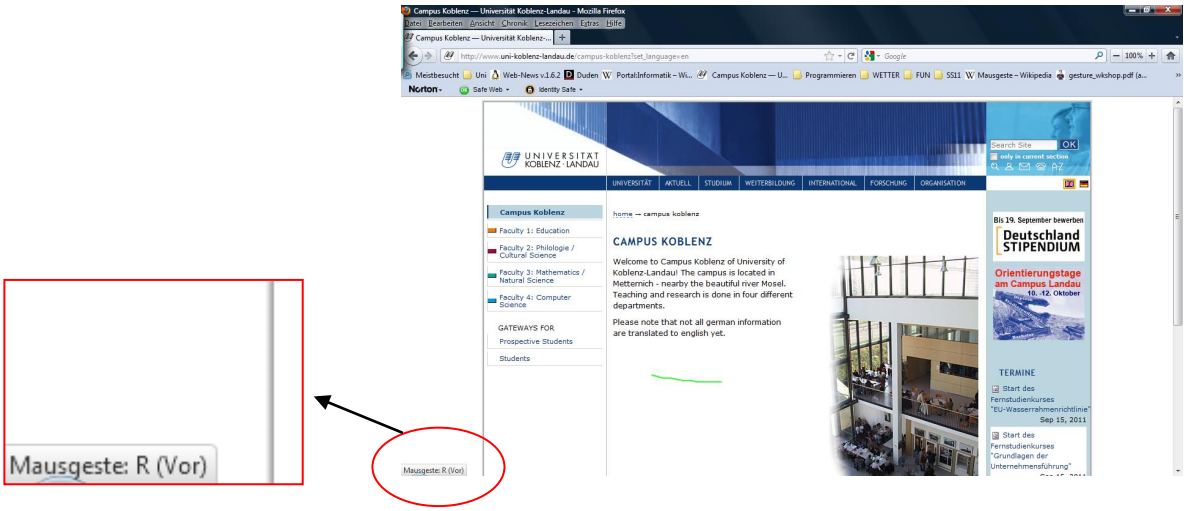

Figure 7. Visual Assistance

By clicking the "Mapping" Tab of the FireGestures 1.6.6 setting, the user has the possibility to generate gestures of his personal liking. Within the prior named Add-on, gestures are recognized and identified upon direction. The user can only appoint the directions right(R), left (L), up (U) and/or down (D) choosing the initial letter of the direction desired and typing it next to the designated function. Hereby, an arbitrary order of the initial letters is possible and they can recur in any constellation. (Figure 8)

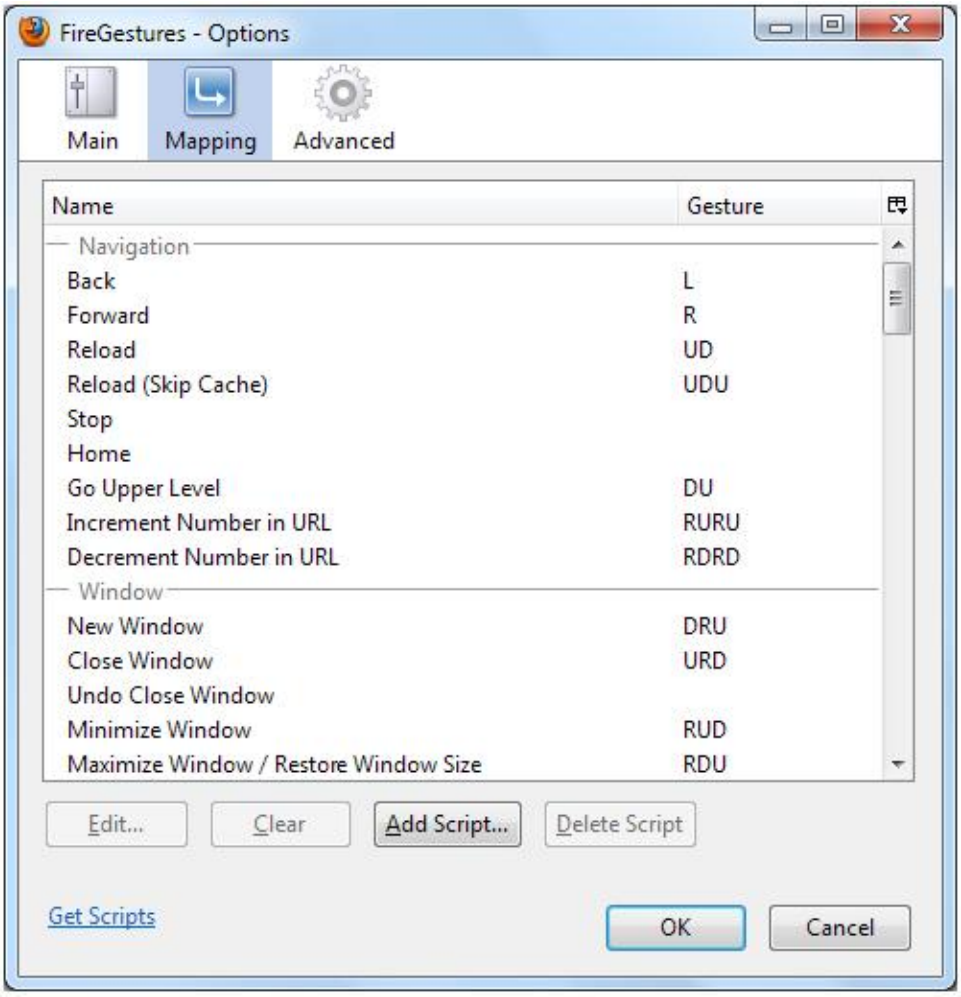

Figure 8. Appointing Gestures

4. The Questionnaire

The usability study on mouse gestures was divided into four sections, beginning with part A, which consisted of personal questions regarding the utility of an operating system and browser. Furthermore, the participants answered questions concerning their navigational behavior when browsing through websites and if they used a magic mouse once before. The last fact, which seemed interesting, was whether the participants were left-handed, right-handed or ambidextrous and if this fact influenced the execution of mouse gestures.

Part B of the questionnaire was structured in open questions. Hereby the participants were encouraged to conceive individual mouse gestures for given functions. They were presented an example of how to generate a new mouse gesture, consisting of pressing a mouse-button and drawing a path into the adjacent box as seen in Figure 9.

Figure 9. Example for Mouse Gesture

This action was to be conducted for the following sixteen items divided into navigational gestures, link gestures and wheel gestures, all concerning the navigational behavior in a browser.

Navigation gestures:

These gestures help the user to navigate faster by clicking and holding for example the right mouse button, and moving the mouse in the indicated direction. After performing this action, the right mouse button may be released. An overview of the examined functions and their concurring gestures is given:

- Back
- Forward
- Open a New Tab
- Open a New Tab in the Background
- Reload Page
- Close Tab
- Previous Tab
- Next Tab
- Go to Parent Directory
- Open a New Window
- Close Window

Link Gestures

These gestures are performed by pointing the mouse to a link, then clicking and holding the right mouse button. With moving the mouse in the indicated direction and releasing the right mouse button, the gesture is completed.

- Open a New Link in the Foreground
- Open a New Link in the Background

Wheel Gestures

- Zoom in
- Zoom out
- Reset Zoom-Factor to 100%

Within part C of the questionnaire the participants were asked to perform given mouse gestures and evaluate them based on ergonomic features, such as suitability for learning, self descriptiveness, controllability and error tolerance.

For answering, the study participants were able to judge the given mouse gestures by means of a five-stepped rating-scale, ranging from 1=very good to 5=very poor. The rating-scale was developed in reference to Rohrmann (1978), who delivered several proposals for classifying rating-scales (Bühner, 2011). The advantage of this evaluation-technique lies in the receipt of differentiated information concerning a specific feature.

The questionnaire was completed by section D, in which the study participants answered questions relating to mouse gestures in general. Since the participants executed mouse gestures in the previous test-sections, it was presumable that they were able to indicate the liking of mouse gestures and whether they would use them on a more frequent basis. Further, the participants were encouraged to evaluate the visual assistance (Figure 7) regarding mouse gestures and the timeout of the activated mouse trail drawing (Figure10).

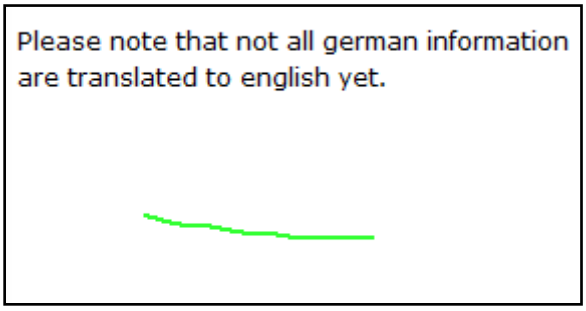

Figure 10. Trail Drawing

One of the most interesting items was the approval of mouse gestures concerning the association of a gesture with, for example, the initial letter of the concurring function (eg. "D" for "delete"). This question was formed in regard to a study done by Feng Tian et. al, who investigated the features a good gesture should have, for example Iconicness. (Tian, Cheng, Wang, & Dai, 2006)

Finally the study participants were asked which gestures they preferred: single-stroke gestures or multiple-stroke gestures.

5. Participants and Usability Study Setup

The usability study comprised of 38 participants, of whom 33 have been or still are students of computer science at the University of Koblenz-Landau in Koblenz. The other 5 participants have different occupations, such as teacher or physical therapist.

The usability study was realized in an observation laboratory at the University of Koblenz-Landau in Koblenz. Besides computers, several devices for monitoring actions of the user are provided by the University of Koblenz (Figure 11).

Figure 11. The Observation Laboratory at the University Koblenz; here: The Observation Room (Abert, 2005)

The questionnaire was handed to the participants in the test room (Figure 12), which lies behind a mirrored glass panel. One participant at a time was seated at a desk, with a laptop in front of him, at which he was asked to perform the tasks of section C. These actions were captured via the 30-day-trial-version of the screen-recording software Camtasia 7. (TechSmith)

Figure 12. Testroom (Abert, 2005)

To ask questions or to communicate, the study participants could make use of a two-way intercom system, interconnecting the test room with the observation room. Observing the usability study from a separate room was supposed to ensure that the participants could fill out the questionnaire and perform the tasks without further interruption or feeling too closely monitored, which might have led to hesitation during task-fulfillment.

6. Evaluation

In line of this usability study there will be no differentiation between computer scientists and non-computer scientists, since there were no conspicuities to record between the two evaluated participant groups. The returned results in percent relate to all 38 study participants.

6.1 Section A

The questionnaire, which was filled out in line of the usability study, returned the anticipated result in regard to the favored browser and therefore confirmed that Mozilla Firefox is the most used Internet Browser. 76.32 % of the participants stated, that they mainly use Mozilla Firefox when browsing (Figure13).

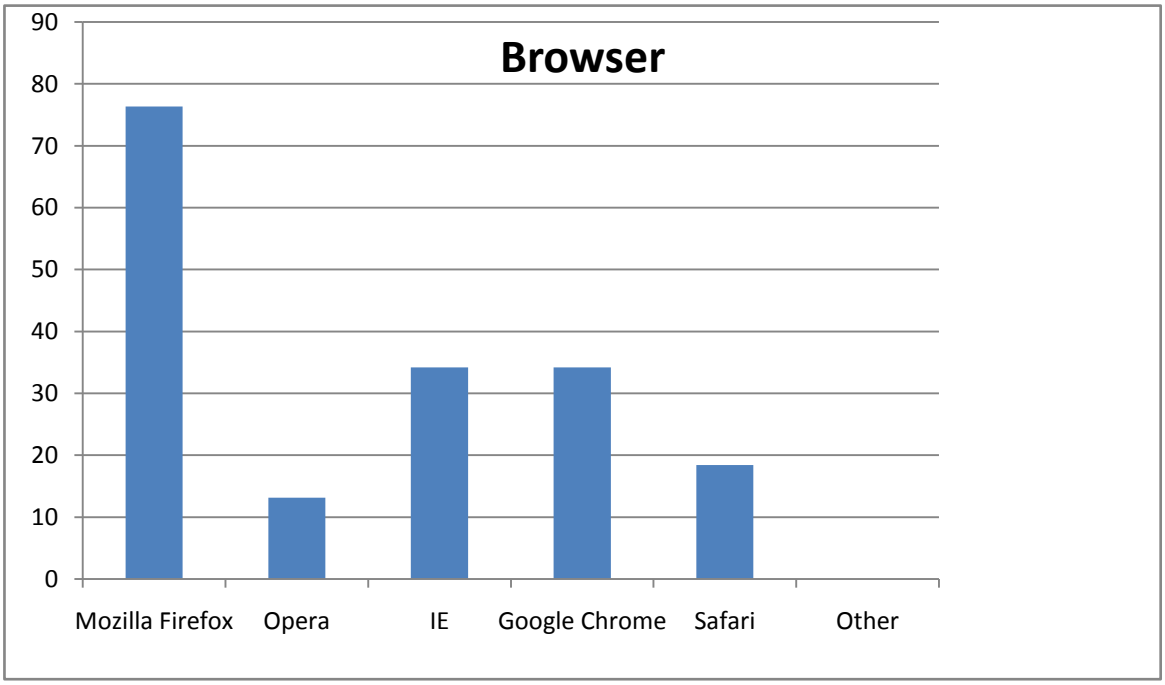

Figure 13. The Use of Web Browser in %

Also, the values of the survey on the most popular operating system were confirmed in the realized usability study (Figure 14). 94.74 % stated that they used the Windows operating system, with no regard to the system version.

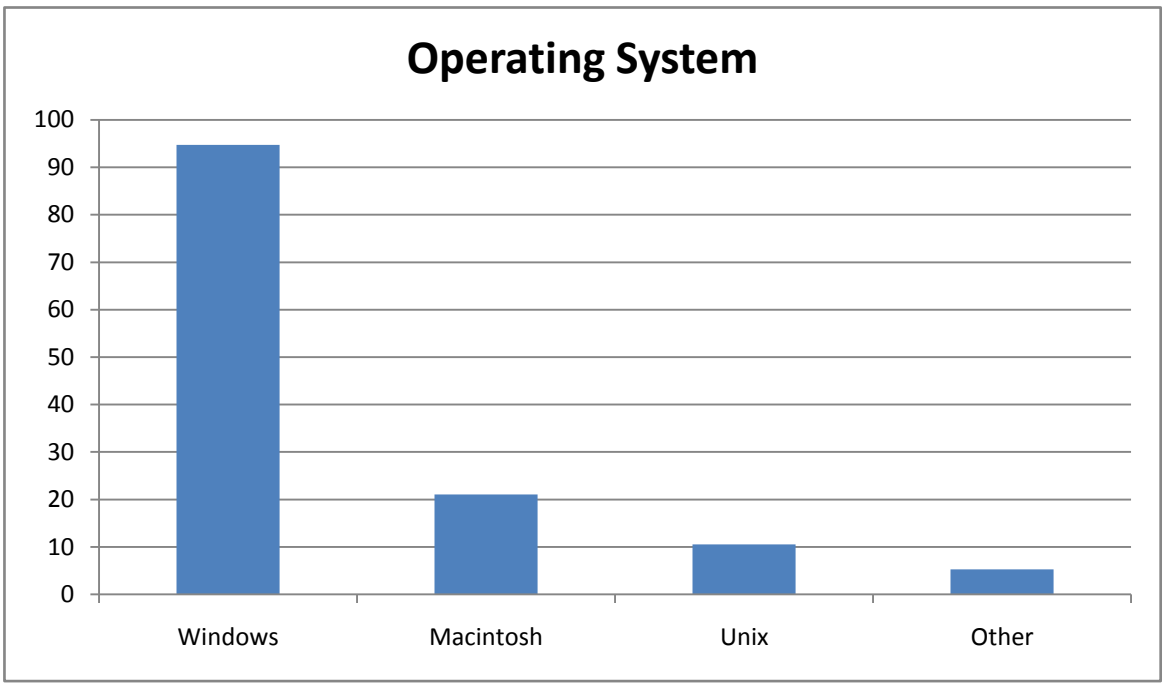

Figure 14. Use of Operating System in %; Multiple Answers Were Possible

Further, when asked to specify their handedness, 94.74% of the participants indicated, that they were right-handed, and only 5.26 % stated to be left-handed. This question was formed to retrieve possible data in respect to difficulties when executing gestures associated with handedness, such as settings of the mouse or moving the mouse in a certain way to form a gesture. Analyzing the test results, no knowledge is extractable, that left-handed participants, in contrast to right-handed ones, do not come to terms with the predetermined mouse gestures. All study participants had their difficulties with a few of the same gestures, for example opening a link in a new tab.

Mouse Gestures are a fast way to execute commands without using the keyboard, menus or toolbars. Instead, the user holds down a mouse button (usually by default the right one), moves the mouse in a certain way to form a gesture and afterwards releases the mouse button. Although this seems as such an easy way to navigate when browsing, only 18.42% of the study participants have availed themselves of mouse gestures. 44.74% use keystrokes as control functions and 92.11 % choose common mouse-driven actions, such as clicking buttons and using the menu or toolbar for interaction with the software application (Figure 1). Multiple answers were allowed for this question, because most users utilize more than one navigation technique.

The last question of the first section comprised of usage of the Magic Mouse. Since one-hand and two-hand gestures are possible with the Magic Mouse, it was interesting to see, whether or not the use of this item has any effect on the enhancement of comprehension of mouse gestures with a common USB-mouse. 13.16% of the study participants have already handled a Magic Mouse.
The usage of the Magic Mouse had no effect on the task-management during the usability study on mouse gestures, though. Participants, who used a Magic Mouse, had no better understanding of mouse gestures, than those, who stated to have never utilized a Magic Mouse. Therefore, the argumentation is permissible, that mouse gestures, as examined in this usability study, do not show any similarity to conventional hand-gestures, which may be used, when performing actions with a multi-touch pad, such as the multi-touch feasible Magic Mouse.

6.2 Section B

During Section B, the study participants were prompted to generate their own mouse gestures for prespecified browsing functions. They were allowed to move the mouse in any direction, instead of the four usable directions predefined by FireGestures 1.6.6. Further, the participants should distinguish which mouse button they wanted to use for activating their mouse gesture, thus by marking the position on the mouse (Figure 9).

This part was formed as an open question, so as to gain as much insight on the needs of every single participant concerning the composition of a mouse gesture (Changing Minds.org). This way the respondents were encouraged to think and reflect and to offer their opinions and wishes. They were allowed to repeatedly assign the same gesture to a different function, as well as to skip an association of a gesture to a function, if a particular function was in no need for a gesture according to the participant' s opinion.

This section was analyzed using the factor analysis, a statistic method that proposes that each observed response is influenced partially by underlying common factors and partially by underlying unique factors. (DeCoster, 1998)

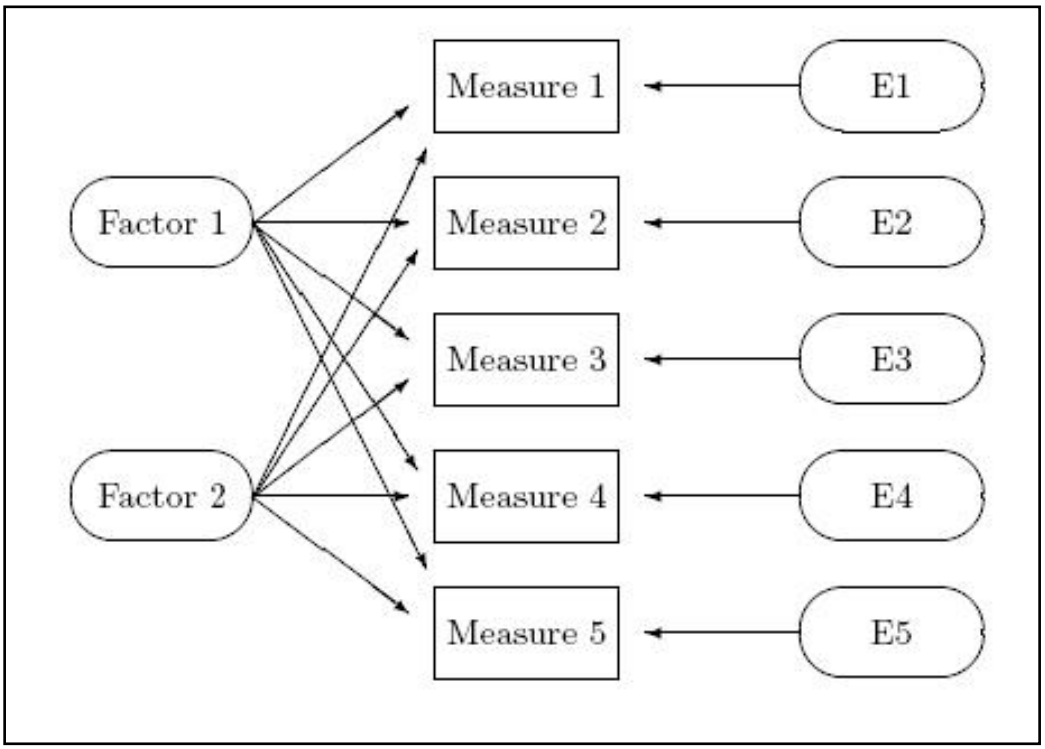

Figure 15. The Common Factor Model (DeCoster, 1998)

Factor analysis is performed by evaluating the pattern of correlations (or covariances) between the observed measures (Figure 15). Measures that are highly correlated (either positively or negatively) are likely influenced by the same factors, while those that are relatively uncorrelated are likely influenced by different factors. (DeCoster, 1998)

Because the, for this study, utilized Add-on FireGestures 1.6.6 recognizes direction, the criteria for evaluating the participant-generated gestures (Chapters 6.2.1-6.2.3) was found in order to gain homogenous results. Therefore, common factors are gathered by examining the direction towards which the participants moved the mouse, when assigning a gesture to a given function. The unique factors are represented by the pressing of a mouse button.

If pressing a mouse button would also affect the evaluation, then no more than two matching gestures, at most, would be to record. Considering only the possibilities of pressing either the left mouse button or the right one or the wheel to activate a gesture, let alone the option of defining the mouse-movement out of a multitude of variations regarding the combination of direction, delivers an infinite amount of gestures constructed for one and the same function.

6.2.1 Navigational Gestures

In respect to merely the direction of a developed gesture, 34.21 % of the study participants moved the mouse upwards, when wanting to open a new tab.

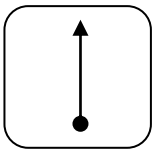

Figure 16. Open a New Tab

For opening a Tab in the background 31.58% chose a straight downward gesture.

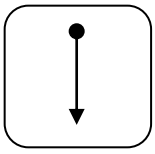

Figure 17. Open New Tab in Background

Switching to the previous tab delivered a strong result: 55.26% stated they would use a movement to the left for fulfilling this task.

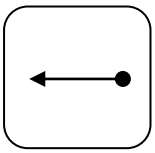

Figure 18. Switch to Previous Tab

Even more uniform was the result on switching to the next tab. The majority of 60.53% would associate a movement of the mouse to the right with this function.

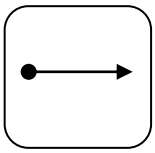

Figure 19. Switch to Next Tab

Being asked for a gesture concerning the reloading of a webpage 44.74 % of the study participants displayed a tendency towards a circular movement, probably in regard to the Iconicness of the broadly existing reload-button in every web browser (Figure 21). This relation towards Iconicness will be investigated further in section D.

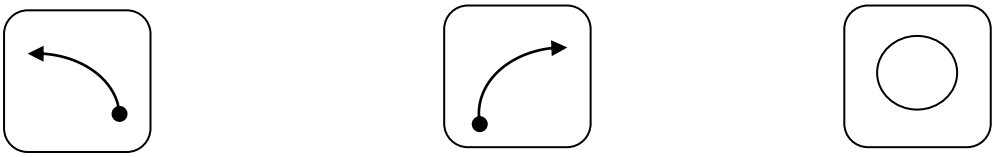

Figure 20 a-c: a) Represents a Circular Movement to the Left, b) a Circular Movement to the Right and c) Displays a Circle Without Further Knowledge of the Starting Point and Moving Direction.

Figure 21 a-c: Represent the Reload Buttons of Common Browsers. A) Mozilla Firefox, b) Internet Explorer, c) Opera

Attaining the parent directory delivered various answers on behalf of the participants. Interesting though was the number of participants who stated to not need a gesture for this function. 26.32% declared that they would not use this function very often and did not describe a gesture for this action. At least 15.79% agreed on a similar gesture, a movement upward.

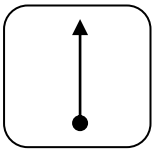

Figure 22. Parent Directory

In style of the common known back-button in every web browser (Figure 24) and also referring to Iconicness, 44.74% of the study participants chose a left-warded movement for navigating to the previous viewed webpage.

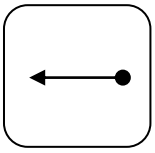

Figure 23. Back

Figure 24 a-c: Back-Buttons in Common Browsers. a) Mozilla Firefox, b) Internet Explorer, c) Google Chrome

Analogue to the foregoing function and the existing forward-button in web browsers 44.74% of the study participants chose a right-warded movement for navigating to the following webpage.

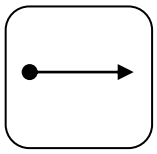

Figure 25. Forward

The following three examined functions deliver relatively inconsistent results and low percentage for the same created gesture.

15.79% of the study participants would close a tab by drawing an "X" (Figure 26) with the mouse, a commonly used item representing closure in software applications. (Figure 27) 13.16% on the other hand would choose a downward orientation as seen in Figure 28.

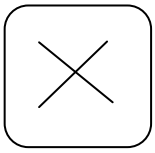

Figure 26. Close Tab

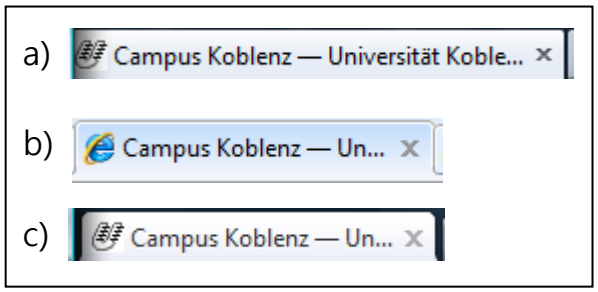

Figure 27 a-c: Symbol for Closure in Common Web Browsers. a) Mozilla Firefox, b) Internet Explorer, c) Opera

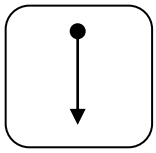

Figure 28. Close Tab

The opening of a new browser window supplied another function, which 18.42% of the study participants thought in no need of compensation by a gesture. Combining all participant-created gestures for this function with an upward movement of the mouse, whether straight or diagonal, yields 31.56% (Figure 29). Since this usability study is based on the detection of mouse gestures by the Add-on FireGestures 1.6.6, where gestures are only recognized by their alignment, and this feature supplies the common factor of the hereby used factor analysis, the joining of all gestures with the same or similar orientation appears to be reasonable to obtain homogenous results.

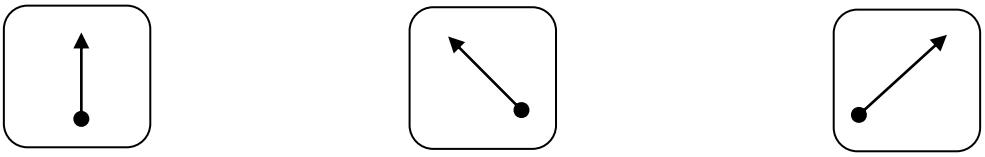

Figure 29 a-c: where a) Represents a Straight Upward Movement of the Mouse, Whereas b) as well as c) Diagonal Upward Movements

As well as the opening of a new browser window, the closing of one holds results, which diverge strongly from one another. Again, 18.42% do not prefer the utilization of a mouse gesture for this function. 21.04% associate the closing of a browser window with a downward oriented movement of the mouse, hereby again combining the straight and the diagonal ones, for the above stated reasons. The third amount of data, which was also interesting, was the one

featuring the "X" as a symbol for closure, as already seen for tab-closing (Figure 30). Here, as stated before, the "X" representing closure in software applications, obviously was associated to already known notation. (Figure 31)

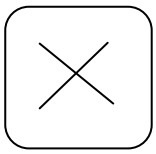

Figure 30. Close Browsing Window

Figure 31. Symbol for Closing a Browsing Window in Common Web Browsers

6.2.2 Link Gestures

The function "open a link in a new tab (foreground)" did supply two gestures that were designed almost equally often. 23.68% appointed a movement of the mouse upwards to the predefined function. 18.42 % drew an arrow to the right.

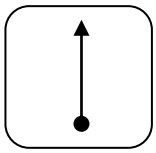

Figure 32. Open a New Link (Foreground)

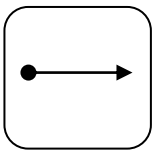

Figure 33. Open a New Link (Foreground)

23.68% of the study participants would open a link in a new tab (background) with a down-pointed movement of the mouse.

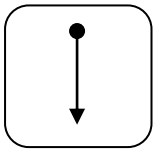

Figure 34. Open a New Link (Background)

6.2.3 Wheel Gestures

Contrary to developing navigation gestures referring to closure, it became clear that the participants had broadly the same opinion on the gesture development in regard to zooming. 36.84% would use the mouse wheel and scroll upwards for zooming in. Even more had the same idea for zooming out of a webpage: 44.74% proposed the mouse wheel and a scroll-movement downwards.

Nevertheless, when encouraged to develop a mouse gesture for setting the zoom on 100%, the opinions were divided so extreme, that the only homogenous data acquirable was a rotating movement of the mouse leaning towards a circular gesture as seen for the reload function (Figure 20c). 13.16% associated this gesture with the above mentioned function.

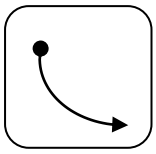

Figure 35. Reset Zoom Factor to 100%

What seems noticeable is the obvious preference of one-stroke gestures, a fact that will be examined during the evaluation of part D.

6.3 Section C

This part of the questionnaire consisted of the execution of given gestures, which were developed for this usability study, some of them in regard to already existing mouse gestures used in popular browsers. This way new and individual gestures can be evaluated as well as gestures commonly used.

The participants were asked to evaluate them based on ergonomic features, such as suitability for learning, self descriptiveness, controllability and error tolerance. During this section one gesture after another will be examined with respect to the named software ergonomic principles.

6.3.1 Navigational Gestures

Opening a New Tab

This function was implemented in regard to the metaphor of opening a file cabinet and pulling out a folder, which is represented by a tab, with an upward movement (Figure 36). The associated gesture may be seen in Figure 37.

Activating the gesture is achieved by pressing the right mouse button, a characteristic used for all of the following navigation gestures in order to attain a simplified homogenous feature. Therefore this set of gestures does not require rethinking in respect to the activation of a gesture since all of them are activated with the same trigger-event.

Figure 36. Metaphor for Opening a New Tab (Oservo - Büro- und Projektservice)

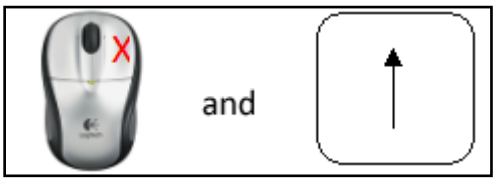

Figure 37. Opening a New Tab

The participants were asked if the gesture appeals to them in respect to naturalness, or expressed as an ergonomic principle, in respect to self-decriptiveness. 52.63% thought this gesture good and 21.05% judged it as even very good. 2.63% stated, that this gesture did not appeal at all to them.

In regard to the suitability for learning, the majority of participants, namely 52.63% stated to be able to memorize this mouse gesture very good. 42.10% agreed that this particular gesture was good to memorize.

60.52% thought the controllability concerning the tab-opening gesture very good. 26.31% seconded this opinion by stating that the execution of the mentioned gesture was easy to handle and therefore good.

When asked to evaluate the error rate by indicating the number of repetitions, 89.47% were able to perform this action within the first attempt. 2.63% tried five or more times to execute this gesture, before completing the task successfully.

Previous Tab

Switching between tabs with mouse gestures enables the user to manage navigational tasks easier and without precise mouse-driven events on the desired tab. Therefore the following gesture for turning to the previous tab on the basis of a click-event was generated (Figure 38). The participants had to press and hold the right mouse button while clicking the left mouse button in order to execute this gesture.

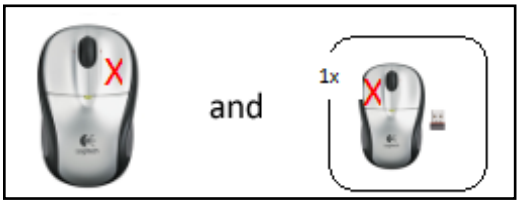

Figure 38. Switch to Previous Tab

The majority of answers on behalf of the study participants ranged between very good to moderate (very good = 36.84%, good=28.95%, moderate= 21.05%).

Almost the same results were obtained when evaluating the suitability for learning. Hereby also 36.84% stated that the mouse gesture was easily memorable regarding the function. 34.21% marked the checkbox “good” and 21.05% chose to judge this mouse gesture with “moderate”.

The controllability was rated very good by 52.63%, followed by 21.05% each who thought the controllability was good and moderate.

Surprisingly though, in regard to the previous results on this mouse gesture was the fact that 13.16% needed five or more tries to perform this gesture. Being a complex and not so easy to handle gesture, the participants needed to obtain a feel for this particular click-event. Once the concept was understood, the gesture was judged as "ingenious". Besides participants who had trouble at the beginning, 39.47% tried once and 21.05% twice to complete the gesture successfully.

Next Tab

This gesture functions the opposite way of the previous-tab-gesture. For reaching the next tab, the participants had to press and hold the left mouse button while clicking the right one. Since the tasks of switching to the previous tab and switching to the next tab were consecutive, one could see a training success during the execution of this mouse gesture. Some study participants already anticipated the mouse gesture while reading the name of the associated function (Figure 39).

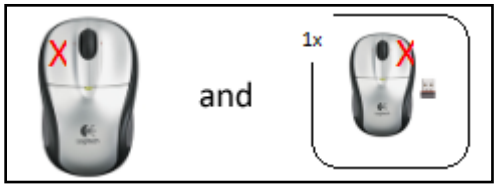

Figure 39. Switch to Next Tab

Again the majorities of 47.36% (=good) and 34.21% (=very good) stated that this particular gesture seems to be of natural behavior. According to the

foregoing examined mouse gesture 36.84% announced the gesture was very easy to learn, which was supported by the statement of 39.47% who thought this gesture was good to memorize, followed by 21.05% who judged the suitability for learning with "moderate". 55.26% experienced this gesture as being very easy and 31.58% as being easy to accomplish.

Compared with the previous mouse gesture a training success can be registered. Whereas merely 39.47% could perform the previous gesture within the first attempt, this gesture was executed by 73.68% at once.

Back

With help of the back-button placed next to the address bar in most common browsers, users may retrieve the previous viewed web page. A mouse gesture (Figure 40) enables performing this action without a possible mouse-driven event across the browser window, depending on the cursor's resting location. Here the mouse gesture was developed in regard to the existing back-button in common software applications, namely a movement to the left.

Figure 40. Back

This mouse-gesture was rated overall "very good". In view of the self-descriptiveness 78.95% valued this gesture as very good, the remaining 21.05%

as good. The same tendency can be observed for the three other ergonomic principles.

18.42% classified the suitability for learning as good and 81.58% as very good. The percentage rose even more when asked for evaluating the controllability. Hereby, 89.47% indicated that this gesture is very good. Due to the inference to the back-button, 97.37% could perform the given mouse gesture within the first attempt.

Forward

The forwarding-function is represented by a mouse-gesture (Figure 41), which was generated according to the corresponding forward-button in common web browsers.

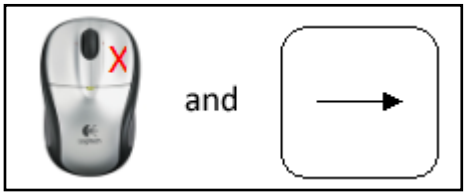

Figure 41. Forward

When prompted for their opinion, the participants inclined the same values in regard of the examination of the ergonomic principles as recorded for the previous mouse gesture (back).

Evaluating the self-descriptiveness of the proposed gesture led to 81.58% who thought this gesture is very good. 94.74% rated this mouse-gesture as being very easy to learn and remember.

Because of the foregoing similar gesture, a training success could also be registered. 97.37% thought that this action was very good in respect to the controllability. The same percentage of study participants also stated to have been able to execute this gesture trying once.

Reload Page

Although this gesture (Figure 42) was generated in respect to the page-reload-button noticeable in every common browser (Figure 21), this task did not appeal to many study participants. Only 44.74% were evocative of the Iconicness of this gesture among which 13.16% evaluated it as being very good and 31.58% as being good. 47.36% however thought this gesture of rather being mediocre.

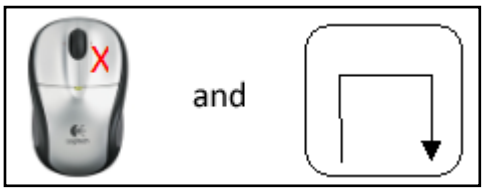

Figure 42. Reload Page

Concerning the suitability for learning the opinions diverged (very good= 23.68%, good= 39.47%, moderate= 28.95%, poor= 7.89%). Also controllability was rated to be only middling.

When asked to indicate the number of tries used to accomplish this gesture, 73.68% marked "one attempt". Nevertheless, it was noticeable when observing the participants' behavior that they concentrated on only copying the properties of this particular mouse gesture upon execution, without drawing the line to the popular reload-button in browsers. This might be the reason for

obtaining the mediocre results in regard to self-decriptiveness, suitability for learning and controllability, in contrast to other mouse gestures that were also developed in respect to existing buttons representing functions (e.g. back and forward).

Parent Directory

The parent-directory-gesture should enable users to reach the next higher level of a menu or navigation structure without constantly using the back-button or typing the URL in the address bar without the extensions leading to a more complex level (Figure 43).

Figure 43. Addressing Parent Directory by Typing with Marked More Complex Level

Figure 44. Parent Directory

The results received for this particular mouse gesture (Figure 44) during evaluation are diverse. The rating of self-descriptiveness leaned towards "moderate" by 44.74%, followed by 31.58% who thought this gesture was appropriate for the named function and rated it "good".

Investigating the suitability for learning yields following percentage: very good= 10.53%, good= 42.10%, moderate= 34.21%, poor= 13.16%, very poor= 0%.

The same tendency can be observed in respect to the controllability: very good= 13.16%, good= 36.84%, moderate= 39.47%, poor= 7.89%, very poor= 2.63%.

As already experienced when evaluating the page-reload gesture the majority of participants executed this task within the first attempt. 32 of 38 study participants were able to accomplish this action without multiple attempts. This again, might be to ascribe to the fact that the study participants mainly just copied the predefined mouse gesture.

Close Tab

In popular web browsers, such as Opera or when using the default settings of FireGestures 1.6.6 in Mozilla Firefox, closing a tab is accomplished by a two-stroke mouse gesture pointing down and then right. Multiple-stroke gestures did not seem user-friendly in regard to the software ergonomic principles, a thought that was affirmed during this usability study and which is discussed in section D.

In line of this study closing a tab is accomplished by a one-stroke mouse gesture pointing down (Figure 45). The metaphor behind this action, analogue to opening a new tab (Figure 36), is putting a folder (here represented by a tab) back into the file cabinet (Figure 46) with a downward movement.

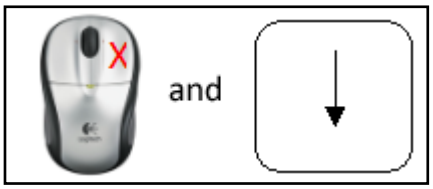

Figure 45. Close Tab

Figure 46. Metaphor for Closing a Tab (Oservo - Büro- und Projektservice)

This particular mouse gesture should enable users to close a tab with a small movement at whatever position the mouse cursor rests and not having to possibly cross the whole browsing window to close the tab with the designated button at the top of the browser. (Figure 47)

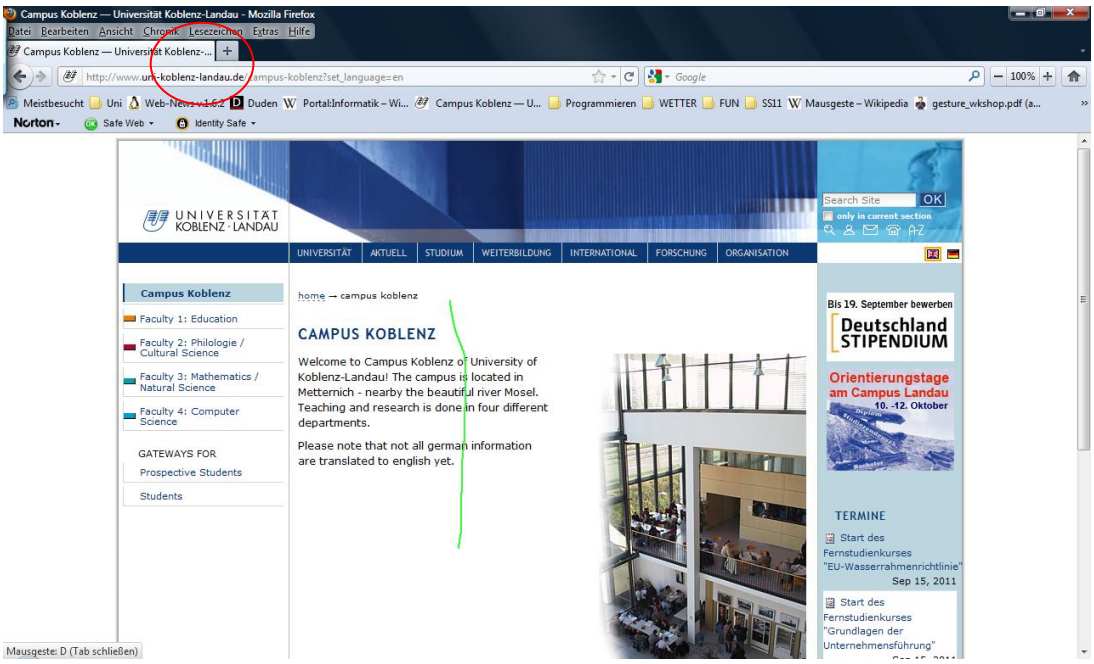

Figure 47. Close-Tab Gesture (Green Line) in Web Browser and Position of Closing-Symbol (Red Circle)

The generated gesture seemed to appeal to the study participants, of whom 60.52% rated this gesture as "very good" and 23.68% as "good" with regard to its self-descriptiveness.

The evaluation of the suitability for learning clarified this attitude further. 71.05% of the study participants elucidated that this examined mouse gesture was very good memorable, a mindset which was seconded by 26.31% who stated to remember this mouse gesture "good". Some even anticipated the adequate mouse gesture for the given function on the basis of the previous tab-opening-gesture. This again is an example for the training success which was achieved during this usability study.

Further the majority of participants (97.37%) expressed that the controllability was appropriate to the given task (very good= 84.21%, good= 13.16%). The

exact same percentage stated to have executed this gesture only trying once. Only one participant had to perform this gesture twice before succeeding.

Opening a New Browsing Window

This mentioned function is normally executed when clicking the provided icon (Figure 48). If a browsing window is already open the user must first minimize this one before clicking the web browser icon so as to fulfill the action of opening a new window. With mouse gestures this action can be performed unheeding all open software applications and browsing windows.

Figure 48. Icons for Web Browsers on Desktop

Previous mouse gestures mainly consisted of a single stroke performed with the mouse. Behind generating a multi-stroke gesture lies the idea to test if the study participants are able to discern an iconic gesture, which depicts some features of the action being described, as characterized by Justine Cassell. (Cassell, 1998) In this case a mouse gesture was developed depicting the contour of a window (Figure 49 and Figure 50).

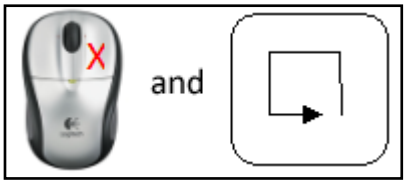

Figure 49. Open a New Window

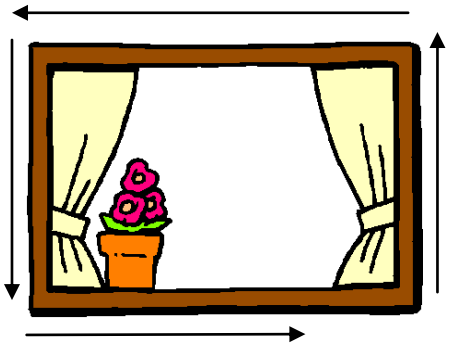

Figure 50. Metaphor for Gesture in Figure 49 (Eso1960's Blog, 2011)

The majority of 71.05% classified this described mouse gesture between good and moderate (good= 39.47%, moderate= 31.58%) with respect to its naturalness resulting out of its self-description. The same proportions were attained when examining the suitability for learning. 44.74% thought this gesture was good and 31.58% that it was moderate.

44.74% judged this mouse gesture "moderate" with regard to its controllability. Observing the participants' behavior yielded that they executed the gesture regardless of the prespecified sequence of direction, which is, as defined before, the main criteria for FireGestures 1.6.6 to recognize a gesture. Therefore about a quarter of the study participants rated this gesture as being too complicated. Nevertheless, 68.42% stated to have completed this task within the first attempt, followed by 21.05% who needed two tries.

Closing a Browsing Window

As mentioned before, closing an application is usually done by a mouse-driven action to the upper part of the screen and possibly contains wide-reaching paths. Utilizing mouse gestures enables the user to close a browsing window at the local position of the cursor. The closing-tab-metaphor is revisited. Thereby the action performed was a single downward stroke with the mouse (Figure 45).

To distinguish the closing of a browsing window, this function is accomplished by the associated two-stroke gesture (Figure 51). First, incorporating the closing-tab gesture a downward movement should be performed followed by a movement towards the right while pressing the right mouse button. This generated gesture implies wiping the browsing window from the computer screen (Figure 52).

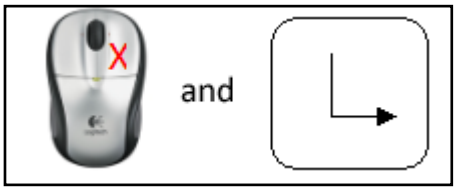

Figure 51. Close a Web Browser Window

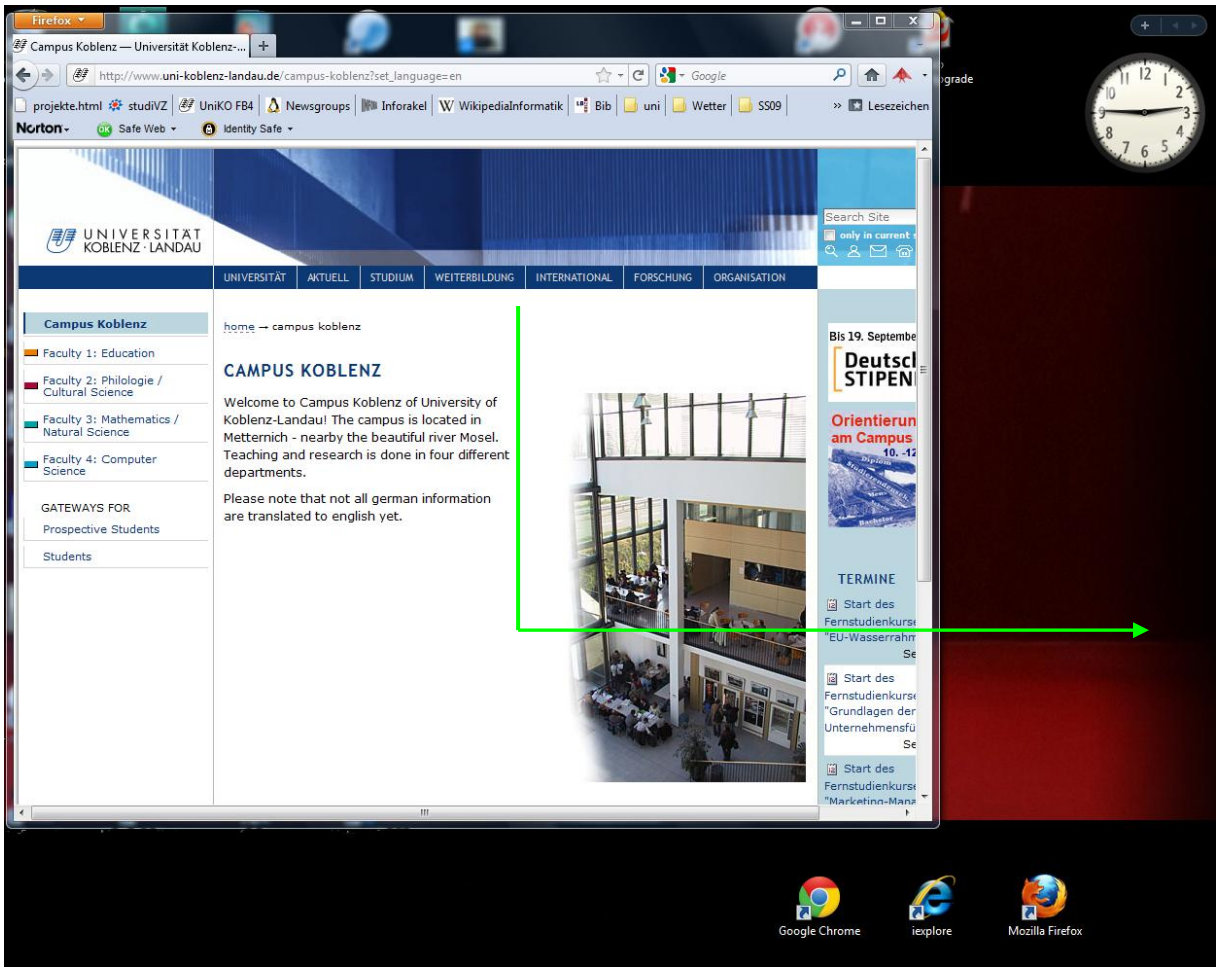

Figure 52. Wiping Metaphor

31.58% stated this mouse gesture supported the underlying function very good. 42.10% agreed by rating this action as good in regard to its self-descriptiveness.

Observing evaluation results concerning the suitability for learning, the participants' opinions converged (very good= 52.63%, good= 31.58%, moderate= 15.78%). The same tendency could be perceived while examining the distributions concerning the controllability of this particular gesture (very good= 47.36%, good= 39.47%, moderate= 7.89%). The majority of 92.11% were able to

complete the task by executing this mouse gesture once, which implies that it is easy to handle.

6.3.2 Link Gestures

Open a Link in a New Tab (Background)

FireGestures 1.6.6 recognizes the mouse gesture regarding the above mentioned function only if the action is performed exactly on the link to be opened. This attempt to open links is also used by common browsers supporting mouse gestures, like Opera. Within this usability study the function is accessible through the gesture seen in Figure 53.

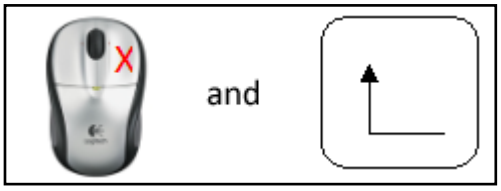

Figure 53. Open a New Link

63.16 % were confronted with problems when trying to open a new link, mainly because they did not perform the gesture on a link. After several tries and demanding help, they were able to complete the action. This execution-problem is reflected in the participants' judgment. Exactly 50% state that this gesture is only moderately natural. 7.89% even think this gesture is not suitable for the corresponding function. The minority of participants with no problems during the performance of the task evaluated this mouse gesture accordingly.

Nevertheless, after a successful completion of the action, 55.26% stated that this mouse gesture was easy to remember. 18.42% even thought that the gesture was very good memorable.

42.10% classified this gesture as being easy to accomplish, when judging the controllability. 39.47% stumbled across the above mentioned difficulties and stated this gesture to be mediocre.

In reference to the execution-problems 13.16% tried five or more times to complete the action, while 47.36% stated to have needed one attempt. This high percentage results out of the fact that many participants made a consultation call via the intercom before gesture-execution, because they did not understand the task.

6.3.3 Wheel Gestures

Zooming

The gesture, appointed to this function, is composed of the single functions zooming in and zooming out. It seemed appropriate to use the scrolling function of the mouse wheel to generate this gesture. By pressing and holding the right mouse button the gesture is activated and by scrolling upwards the action of zooming in is performed. Contrary to the zooming in action, when wanting to zoom out the user must press and hold the right mouse button and scroll downwards (Figure 54). These zooming-actions were generated due to the zooming demeanor in popular software applications.

Figure 54. Zooming

This mouse gesture led to split opinions. Regarding the self-descriptiveness the whole range from very good to very poor was exhausted (very good= 36.84%, good= 28.95%, moderate= 13.16%, poor= 15.78%, very poor= 5.26%).

The suitability for learning was rated very good by 34.21% and good by 47.36%. This tendency was also viewable in reference to the controllability of this mouse gesture. 36.84 % approved this gesture stating it was good and 34.21% saying it was very good.

The execution of this gesture led to various attempts on behalf of 52.64% of the study participants, needing two or more tries for completing the task successfully. The other 47.36% handled the execution effectively within the first try.

Zoom reset (100%)

During browsing web pages a user has the possibility to zoom into attractive looking text elements or pictures of interest. If the zoom factor differs from 100% the user should be provided with a function for resetting the zoom factor.

Resetting the zoom factor to 100% is achieved in line of this study by pressing and holding the right mouse button and at the same time performing first an upward movement then a downward movement of the mouse (Figure 55).

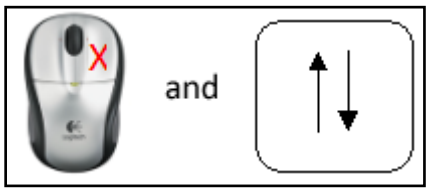

Figure 55. Reset Zoom Factor to 100%

The generated mouse gesture splits the group of participants into proponents and opponents. 42.11% stated that the action fulfills the ergonomic principle of self-descriptiveness (very good= 13.16%, good= 28.95%). 31.57% on the other hand did not agree and rated this gesture concerning the named ergonomic principle poorly (poor= 23.68%, very poor= 7.89%).

This mouse gesture fulfills the standards for the suitability of learning exclaimed the majority of 55.26%. The remaining 44.74% rated this gesture from moderate to very poor (moderate= 21.05%, poor= 18.42%, very poor= 5.26%). The same percentage distribution was noticeable when examining the controllability.

In respect to the error rate most participants were content with the presented mouse gesture. "One attempt" and "two attempts" were marked in the questionnaire by 31.58% and 28.95%. Nevertheless 28.95% had to execute this gesture five or more times to complete it. This proceeds from the fact that these users released the right mouse button between the actually coherent upward and downward movement of the mouse.

On the other hand, the study participants did not have to execute the gesture by drawing a straight line up and then down as seen in the example of Figure 56. FireGestures 1.6.6 allows the execution of gestures in several ways, as long as the sequence is strictly adhered to direction (Figure 57 and Figure 58).

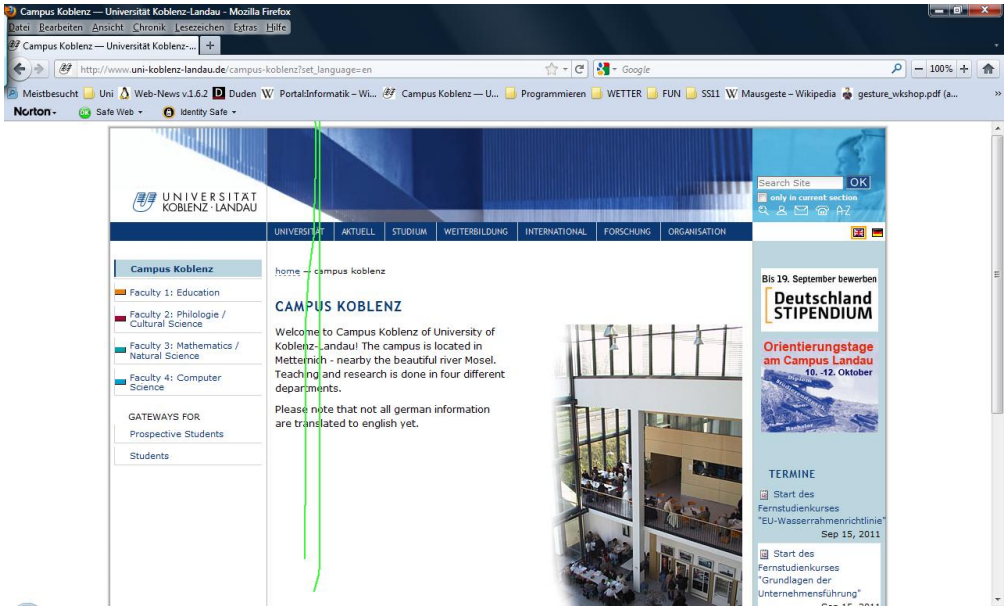

Figure 56. Resetting the Zoom Factor to 100% by an Up-Down Movement

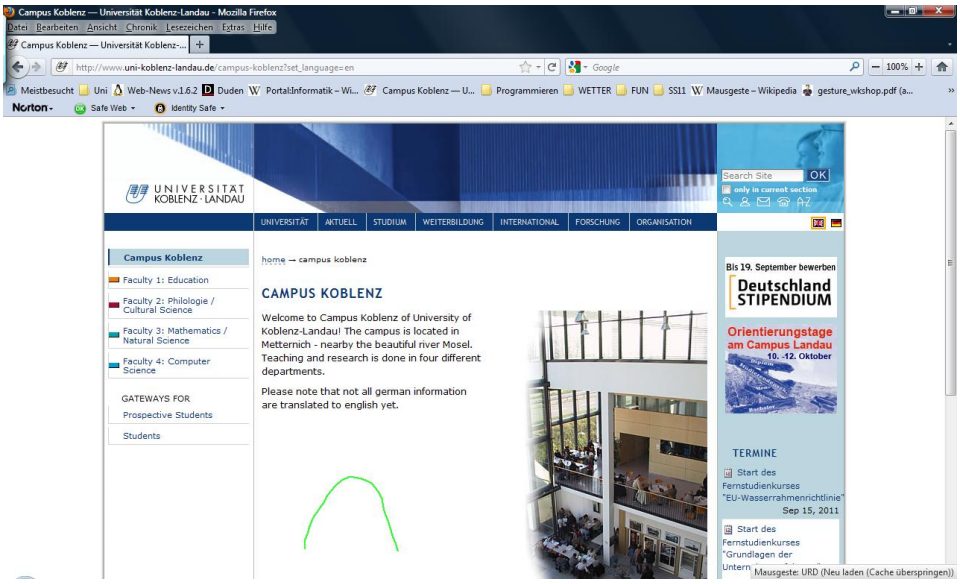

Figure 57. Resetting the Zoom Factor to 100% by a Different Up-Down-Movement

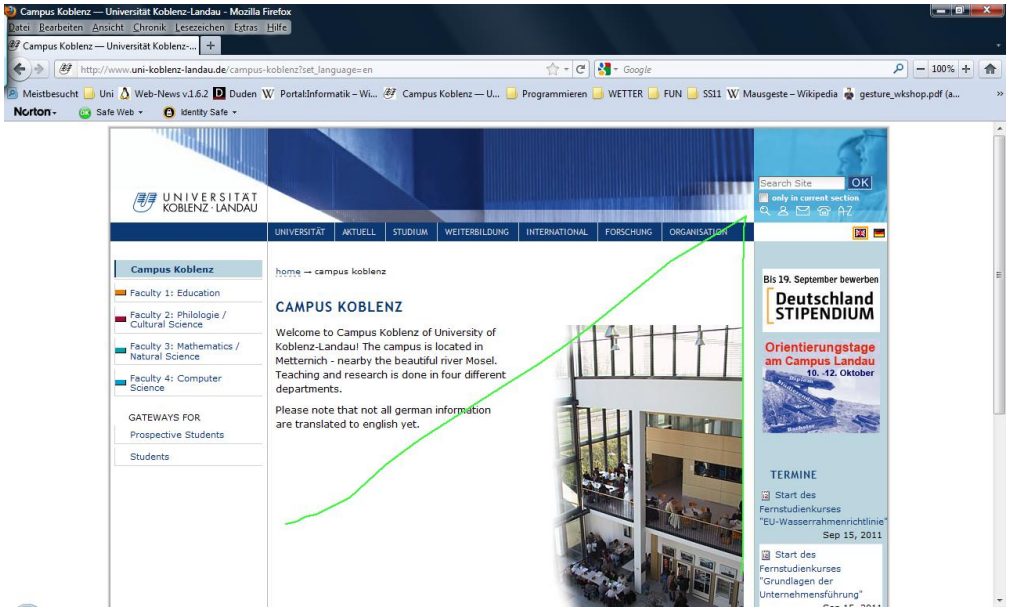

Figure 58. Resetting the Zoom Factor to 100% by a Different Up-Down Movement

Figure 59 seems as if the sequence of movement was strictly adhered to direction, but the sensible setting of FireGestures 1.6.6 recognized a direction-change (Figure 60). This was a problem the participants struggled with, because minor irritations according to the movement, which might occur from the mouse-controlling, led to the recognition of invalid gestures.

During this section of the questionnaire and the rating of all gestures it became obvious that the feedback on behalf of the participants was consistently positive. This aspect will be elucidated thoroughly in the following section.

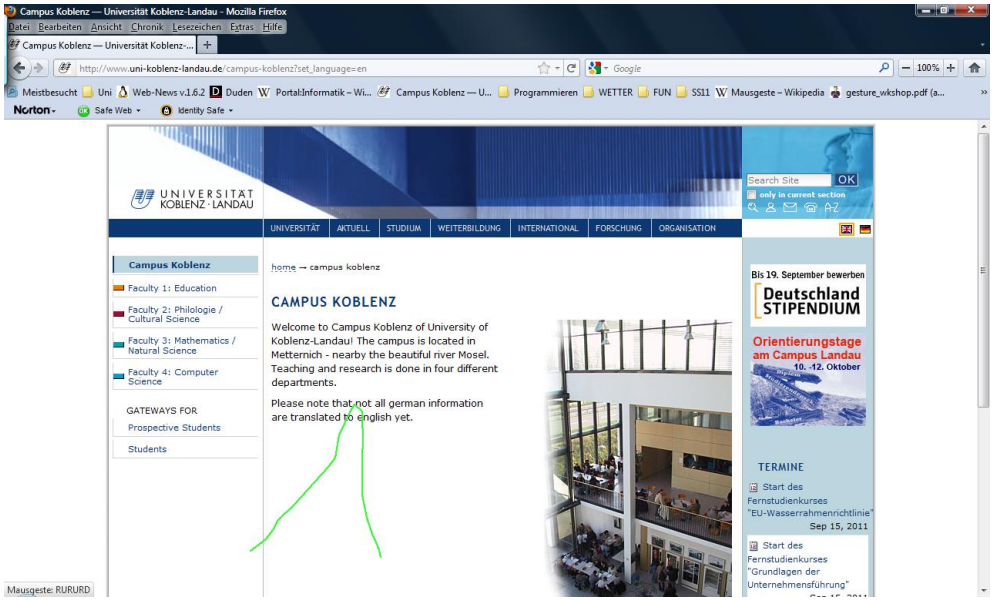

Figure 59. An Apparent Up-Down Movement, But FireGestures 1.6.6 Also Recognizes Different Directions

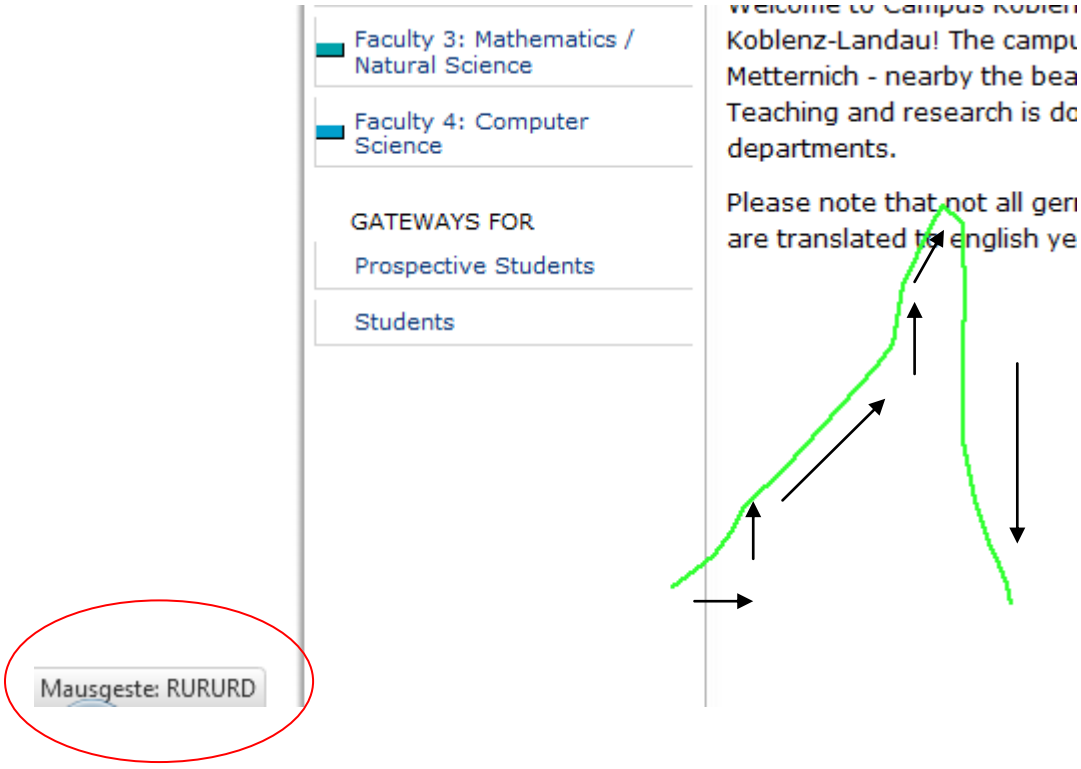

Figure 60. Close-up of Figure 59

6.4 Section D

As stated above the questionnaire was completed by section D, in which the study participants answered questions relating to mouse gestures in general.

The first aspect of interest was devoted to the liking of a gesture-type regarding the path-drawing. The study participants were able to choose between single-stroke mouse gestures, multi-stroke ones or had the possibility to state that they had no preference. As seen during the evaluation of the parts B and C, a vast number of study participants (89.47%) favored single-stroke mouse gestures, which seemed easier to remember and execute. Section B elucidates this assumption, as gestures generated on behalf of the majority of the participants were single-stroke ones. The remaining 10.53% stated that they had no preference concerning the execution path of a mouse gesture, which is also displayed in part B, where some multiple-stroke gestures are recordable.

The next interesting item was the approval of mouse gestures concerning the association of a gesture with, for example, the Iconicness, a feature that was examined in line of a study done by Feng Tian et.al (Tian, Cheng, Wang, & Dai, 2006). 55.26% stated that Iconicness is a feature a mouse gesture should posess mainly. During the evaluation of this usability study, this statement can be validated by means of sections B and C. For example navigating forth and back between viewed web pages was associated to the forward and back buttons next to the address bar in most common web browsers, which are depicted as arrows. The most developed mouse gestures are therefore a leftward movement implying navigating to the previous viewed webpage (back-function) and a mouse movement to the right for navigating forward.

7.89% associated given functions with the initials of the functions name, e.g. "R" for reload (Figure 61). The majority of 86.84% appreciated the fact that a mouse gesture was easy to execute, an assertion, which was enhanced by the preference of easy to handle single-stroke mouse gestures as evaluated above.

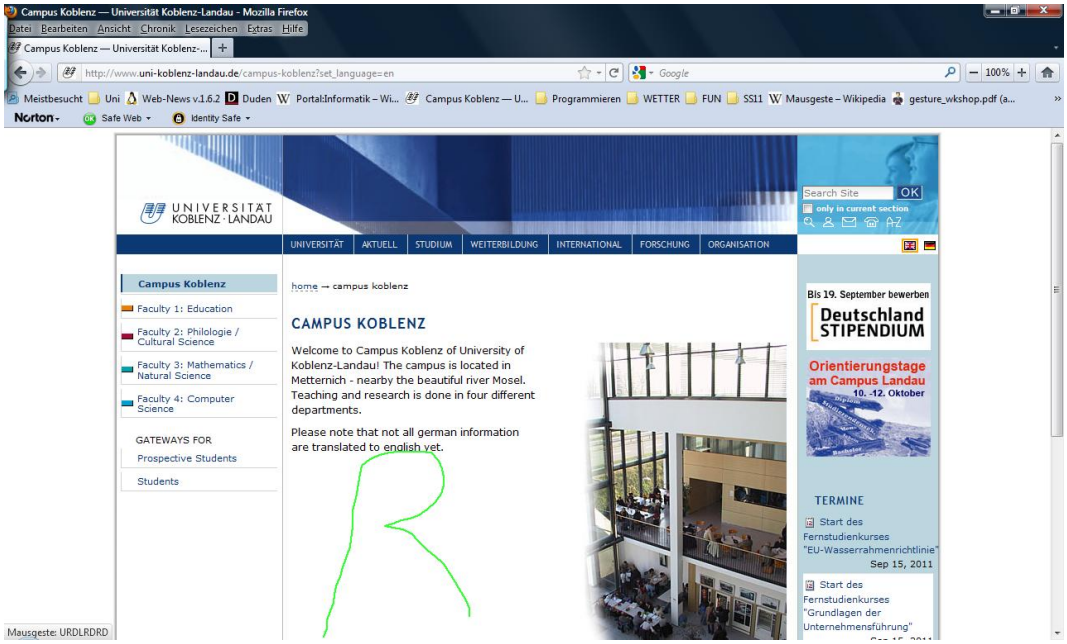

Figure 61. Drawing a "R" as a Reload Page Gesture

When encouraged to evaluate the activated mouse trail drawing, 89.47% stated that they experienced this feature as being very helpful. Also the question concerning the timeout of this mentioned trail drawing yielded positive results. 76.32% said they did not notice a timeout, which led them to conclude that the time set by default was perfectly adequate. 18.42% experienced the timeout set to 3 seconds as too long.

Asked about the visual assistance 76.32% stated it as being sufficient. Because the participants were not disturbed during the filling out of the questionnaire

they were asked afterwards what visual assistance they recognized. All of those who said the visual guide was satisfactory based their statement on the images describing a mouse gesture in part C of the questionnaire.

23.68% understood this question as a reference to visual assistance actually in the web browser. They declared that the guidance was not sufficient, since only a small, almost unnoticeable, box appears in the lower left corner of the web browser exclaiming whether the mouse gesture was completed successfully or not (Figure 62).

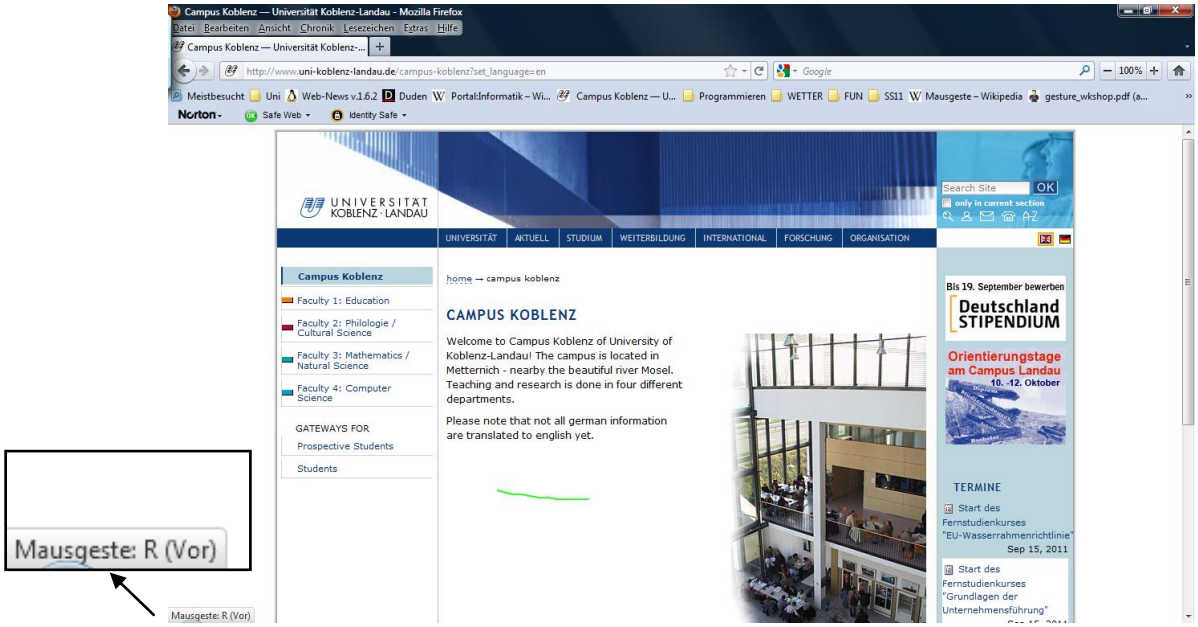

Figure 62. Successful Performed Gesture

The last question the participants were encouraged to answer was in regard to the liking of mouse gestures and if they would use them more frequently. 30% thought mouse gestures were too complicated to remember let alone to execute. The most frequent objection towards mouse gestures was the

commitment of learning all these new gestures, which would not lead to saving of time, being one of the main arguments for the utility of mouse gestures.

About two thirds of the study participants stated they would use mouse gestures for navigation as an alternative to their customary navigation patterns. They commented that they were surprised how convenient mouse gestures could be used for addressing specific functions without actually selecting them precisely by a mouse-over or click-event. This distribution was equally measurable on side of computer scientists and non computer scientists.

7. Conclusion

The conducted usability study on mouse gestures yielded positive resonance in respect to this navigation pattern. Participants who had not experienced this pattern when browsing the Internet before were altogether impressed by the possibilities, which mouse gestures offer. Besides the four previous viewed and in detail examined ergonomic principles, mouse gestures are also mostly suitable for the task. Merely the minority of study participants thought these gestures were too complicated for the task to be fulfilled. Some stated that they moved their pointing device faster towards the therefore provided locations (e.g. buttons) than having to struggle with the problems occurring while executing a gesture.

Others complained that the gesture did not match the conformity with user expectations. For example opening a link did not work the way many study participants expected. Having to perform the gesture upon a link was not evident at once but became clear during task performance.

The advantage of mouse gestures lies in their high individuality, since users may generate own gestures or even change existing ones in Add-ons like the here examined FireGestures 1.6.6. A user may hereby adjust any gesture according to a function, matching the own personal needs, which leads to the mentioned high individuality.

FireGestures 1.6.6 provides an easy way to adjust gestures by simply appointing directions. The user may determine the sequence of orientation to fit his individual preferences. On the other hand appointing only the direction may seem simple but leads to difficulties because only a limited number of composed gestures are possible.

In line of this problem FireGestures 1.6.6 recognizes these movements (Figures 56 , 57 and 58) as one gesture according to the sequence of orientation. The diversity of utilizing gestures is restricted by the constraint of direction, with a triangle signifying the same function as an upward curved arch. Otherwise these gestures could stand for different functions.

If the mentioned movements would be accounted as different mouse gestures, more possibilities to obtain a gesture would exist. More gestures in respect to popular imageries could be developed, simplifying the process of remembering these patterns and encouraging self-descriptiveness.

Making some adjustments in regard to the predetermined gestures, they might provide a suitable way for navigation. The results obtained in line of the evaluation of the questionnaire support that statement in clarifying that users have a general interest in utilizing new navigation patterns, such as mouse gestures.

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