

Tablet device interaction with geographical information in time-critical, life-threatening and unstable situations

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Abstract: The introduction of new technologies into specific fields always requires that they are easy to use and well designed to suit the needs of the target group. This requirement is especially important in the case of a **Mass Casualty Incident (MCI)** and in the rescue service in general. In the scope of the SpeedUp project¹ the **Emergency Medical Chief (EMC)**, i.e. the target group, is supposed to use a map application on a ruggedized tablet PC. Therefore, it is necessary to design the **User Interface (UI)** of the map application close to the requirements of the target group and optimize it iteratively. The thorough design and implementation of new user-interfaces would potentially reduce problems related to the usability of the application. In the first step we developed different concepts to move and zoom the map while using just the thumbs. Finally, in order to evaluate these concepts, we conducted a user study to be able to compare and rate them. These alternatives are especially designed for the requirements of an MCI.

1 Introduction

In a **Mass Casualty Incident (MCI)** the medical rescue teams have to deal with heavy organizational challenges. There are more injured people than the rescue units are able to take care of at once. For that reason, the relief units perform a triage algorithm such as the **modified Simple Triage and Rapid Treatment (mSTART)** [KKMS06]. mSTART categorizes the patients into different priorities and the need of each patient to benefit from medical care. This work is based on an ongoing research which digitizes this triage approach using PDAs [NK07]. One important advantage of using PDAs equipped with GPS is that the position of each patient can be tracked. The PDAs are supposed to be used by the relief units in the field. After the digitized triage algorithm is performed the position of the patient and its triage state get transferred from the PDA to a tablet PC. If more information like the name of the patients, the ID or/and the age is available, it will also be transferred to the tablet PC. This information is then visualized on a map on the mobile

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tablet PC. The EMC is supposed to use this device to have an overview of the current MCI situation. The EMC can optimize his/her decisions, because now more recent data than in the traditional way is available. Currently, the EMC collects this information from the rescue units verbally. The number of injured people and their classification are written down by the relief units on paper. This manual collection of data can be incomplete, redundant and/or wrong.

This paper focuses on the design, conception and evaluation of different User Interface's (UI) alternatives for a map application on a tablet PC. In a first step, we explore basic map navigation features: Selecting of items (like patients or relief units), moving the current cutout of the map (scrolling) and zooming in and out. Since the tablet PC is a heavy ruggedized hand-held PC, which is used during an MCI, the UI has to fulfill special requirements. Those requirements are presented in section 2. In order to develop high quality UIs it is essential to develop them close to potential users (the EMC in this case) and evaluate different concepts fulfilling the requirements. Additionally, usability research has an even higher importance in the case of an MCI than for home or office applications, since each gained second can save a life. Consequently, the first goal is to speed up the rescue process. Another significant reason behind the importance of high quality UIs in the scope of the rescue service is the users' tendency to resist or even reject new technologies with inadequate UIs. If the users don't accept the new IT supported procedure because of insufficient usability, then all conceivable improvements are useless. The selection of items is already presented in [CNA⁺10]. Therefore, in this paper we focus on the concepts of scrolling and zooming the map.

2 Requirements

There are several requirements to be taken into account by the developer of the UI. The hardware requirements are not explained here in detail, since they are already detailed in [CNA⁺10]. However, in the following subsection, the software requirements greatly influencing the design of the UI are presented. They are subdivided into touchscreen related, common and special requirements.

2.1 Touchscreen Related Requirements

Every UI which runs on a touchscreen device like the tablet PC has to fulfill some requirements inherited from the nature of a touchscreen interface. The most obvious fact of a touchscreen based UI, is that the touched area by the finger is occluded. Thus, if a softbutton² for example is pressed with a finger, it will not be visible anymore. The requirement here is to overcome this occlusion. Another touchscreen related requirement comes from the low resolution of a finger tip [AZ03]. As described in section 2.3 the user may only use the thumbs to interact with the whole application. An adult man's thumb's

²A virtual button is called softbutton

size is in average 18.2 mm wide [Til02]. The design of the UI has to pay special attention to the problem of the low precision of the user, because the thumb has the lowest precision among all hand fingers. Anyway, according to literature an accuracy of 99% can still be reached if the button size is larger than 22 mm [Lew93], [LP98]. This is especially problematic on devices with little screen size. Potter et al. introduced a strategy called take-off which can increase the accuracy of the user by placing a cursor 0.5 inch above the finger's tip [PWS88]. With this technique the size of a soft button can be reduced to 6.8mm without reducing accuracy. Sears et al. compared different design concepts to introduce new pointing strategies to touchscreens with a comparable performance of a real mouse [SS91].

2.2 Usability And MCI Related Software Requirements

The first common requirement is the intuitiveness of the UI. In fact, this requirement is very important for all UIs, and it is especially important in the case of an MCI situation. The reason behind that is the fact that a special training for every EMC would cost effort and time. Another reason is that the user should be able to immediately understand the information presented by the UI. The user should also be able to perform the basic interaction with the application when using it the first time. Furthermore, the target group; the EMC in our case will not accept a new application if they have to spend too much time to learn how to use it. The second common requirement is the attractiveness of the interface. If the users do not like the appearance of the interface, then there is a higher risk for rejection [AGGS04], [HBB01]. Last but not least, the next two requirements are especially important in the case of an MCI: Efficiency and accuracy. The efficiency is particularly important since adding IT in the scope of the rescue service intends to speed up the rescue process. However, developing efficient UI elements should not lead to inaccurate processes.

2.3 Special Software Requirements

Nowadays, the information in an MCI situation is mainly captured on paper. Since this method provides an easy, familiar, intuitive and flexible way to realize the information capture task, the first requirement is to achieve a comparable performance with the tablet PC UI. Another special requirement from the fire department of the Technische Universität München (Feuerwehr TUM) is **to use just the thumbs for all interaction tasks while holding the tablet PC in both hands**. The fire department staff is using a heavy ruggedized tablet PC during their daily work (xplore iX104). The staff complained about the fact that holding it with one arm during interacting with the free hand causes their arm fatigue. Our solution to hold the tablet PC with two hands constrains the user to use only the thumbs to reach the screen. As a consequence, the application must provide all interaction elements on the left and/or the right edge of the tablet PC screen as shown in figure 1.

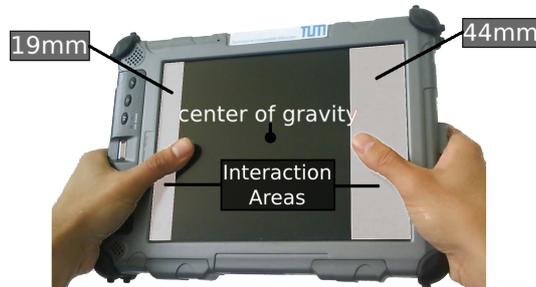


Figure 1: Tablet PC xplore iX104 holding in both hands

3 Concepts

The UI for the tablet PC application which should be used by the EMC is developed step by step to increase the acceptance by the users. Thus, we will focus on the essential features of map navigation, which comply with the requirement of interacting with the interface just with the thumbs, holding the tablet in both hands. We want to answer the following questions:

1. How can we move the map (scrolling)?
2. How can we zoom in/out the map (zooming)?

It is necessary to take a closer look on different alternatives which fulfill all of the mentioned requirements and answer the previous questions. We evaluate our concepts in a formative user study and compare the results. This allows us to find the best solution for the target group. These concepts are described in the following.

3.1 Scrolling

We assume, that our users are used to different kinds of browsing through a digital map. A paradigm for touch screens is to allow the users to drag the map by sticking the finger on the map. An advantage is that this paradigm is a very intuitive and direct interaction, since the map sticks to the user's finger like a real paper-based map. Additionally, the user has the full control of the speed and the direction of the movement. Thus, the user is able to move the map slow and smooth as well as fast and rough by moving the finger accordingly. However, this widely used method does not satisfy the requirement of interacting with the application only from the screen's edge. In fact, the limited space at the edge would lead to several thumb repeated short horizontal movements to move the map horizontally. This would take too much time and will not only exhaust the users' thumb, but would also lead to frustration after a while. Therefore, we invented three other promising techniques, which are appropriate for the thumb interaction.

Minimap Scrolling (SC1) The first approach to browse the map is to put a miniature version of the map on the edge of the screen. This is called minimap and is shown in figure 2. Tracked patients that are not inside the visible area of the map are indicated visually by a sign displayed on the corresponding side of the screen. This way, the user is immediately informed about the existence and the direction of these patients. However, the distance to each patient is not displayed on the real map to avoid information overload. For this reason, we make it possible to indirectly extract this distance from the minimap.

On the one hand the minimap is visually comprehensive. The minimap shows the whole area of interest and all patients. This way the user is automatically aware of the following information: The geographical position of each patient, the disposition of all patients, their triage states and the number of red, green, yellow and black categorized patients. Furthermore, the part of the real map which is currently rendered on the display is highlighted with a small square on the minimap. The square helps for the orientation.

On the other hand the minimap is interactive. The user is able to jump to different positions with just one tap on the minimap. Hence, a fast and rough positioning is possible. Moreover, the user is also able to move the map continuously while sliding the thumb inside the minimap. Another advantage is the direct mapping of the finger's position on the minimap and the position on the real map which makes it more intuitive. So there is a high chance that the users will feel comfortable with this approach. Finally, the minimap needs less space on the screen and is compactly placed on the edge of the screen. But this approach has a disadvantage: Depending on the ratio between the minimap and the real map, the sliding feature will not allow fine movements. We will learn during the evaluation if the users are able to deal with the coarse movement or not.

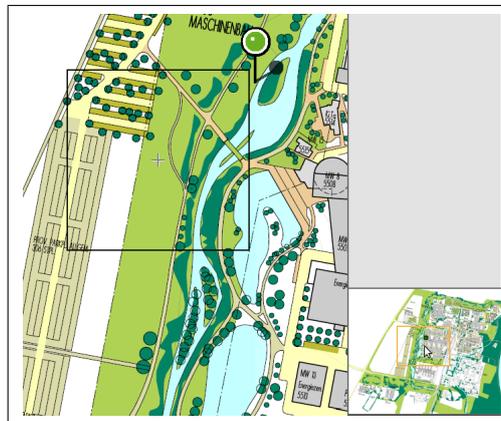


Figure 2: Minimap Scrolling (SC1)

Arrow Scrolling (SC2) The next approach is a straightforward one. A button with an arrow is placed on each corner of the screen. The upper buttons are shown in figure 3. The arrow simply points to the direction in which the map moves if the user presses the button and holds it down. The map will then move to the appropriate direction with a constant

speed. Even though the users will understand this method immediately, there are some disadvantages with this approach. The constant speed means that the user is not able to specify the speed of the movement and will not be able to move the map in every possible direction. There are four corners. Thus, there are four possible directions to move: upper-left, upper-right, lower-left and lower-right. Since these concepts are designed for the use with a single-touch screen it is not possible to press two of the buttons at the same time to merge directions. Unfortunately, more than the four buttons would reduce the intuitiveness of this approach. Consequently, a button which moves the map to the north has to be placed on the middle of the upper edge on the screen. This is contradictory to the requirement that every UI element has to be reachable with the thumbs. Furthermore, the four buttons consume already a lot of space of the marginal interaction area, so adding more simple buttons to the corners is not an option.

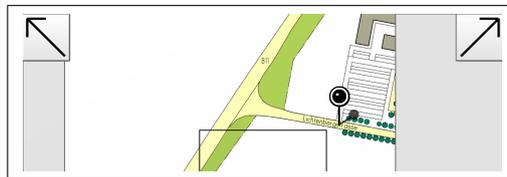


Figure 3: Arrow Scrolling (SC2)

Joystick Scrolling (SC3) Our third approach to browse through the map is called *Joystick Scrolling (SC3)*. A graphical joystick is used to control the movement of the map. Its functionality is basically the same like a real analogue joystick with some intrinsic touch differences. Visually, the graphical joystick looks like a real joystick from a bird's eye view. There is also a graphical representation of the stick to give the user a visual feedback of the stick's current position. The head of the stick will be occluded by the user's finger, while the stick itself will be visible. The functionality of the soft-joystick is the same like the functionality of a real joystick and will automatically influence the movement of the map. If the users' thumb is on the upper-left side of the joystick's center the map is moved to the upper-left too. The speed is correlated to the distance between the thumb's position and the center of the joystick. The radius of the joystick determines the maximum speed. This alternative provides the full control to the user to change both speed and direction. This functionality makes the user able to move the map fast or slow in a specific direction to gain more control over fine movements. The previously mentioned differences to real joysticks leads to the following problem. Like real joysticks, the stick moves always back to the center if it is not held in the desired position. Indeed, the user is automatically aware of this fact due to the tactile feedback coming with real joysticks since there is always a tangible force which presses the stick back to the center. The graphical stick does not provide this tactile feedback. The evaluation will demonstrate whether this difference causes a problem or not.

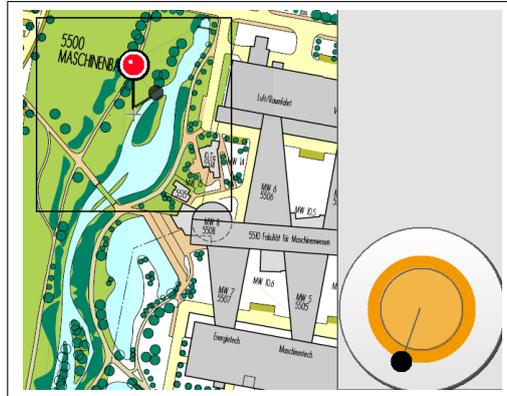


Figure 4: Joystick Scrolling (SC2)

3.2 Zooming

In general several map applications like google maps use the mouse wheel in order to zoom in and out. Since most tablets do not have a mouse wheel the user interface has to offer a graphical interaction element to zoom the map in and out. There are well known graphical elements which can be placed at the edge. We finally decided to test two different well known paradigms: zooming with buttons and zooming with a slider.

Button Zooming (Z1) The most simple method is just to put two large buttons on the edge of the screen, one (plus sign) to zoom in and the other to zoom out (minus sign). The graphical representation of the buttons is shown in figure 5 (a). If the user presses a button and holds it down the map will continuously zoom in or out until the user releases the button. Zooming just with buttons lacks the option to jump to a specific zoom factor and to determine the speed of the zooming process. However, considering that these elements have to be used during an MCI a large button is a promising alternative.

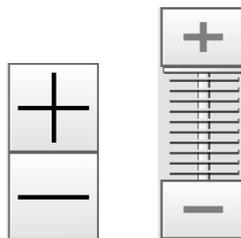


Figure 5: (a) Button Zooming (Z1) and (b) Slider Zooming (Z2)

Slider Zooming (Z2) In opposition to zoom with buttons the user can jump to specific zoom factors and change it by sliding the slider up or down with the thumb. It is shown in figure 5 (b). While sliding the thumb the user is also able to determine the speed of the zooming process. The next advantage of using a slider is that the current zoom factor is visualized. For instance, if the value of the slider is on the highest part of the slider, the map has already reached its maximum zooming capability and the user is immediately aware of this. But it is possible that using the same space of the display for large buttons could be the better choice in case of an MCI because of its convenience. Another point is that the events in the user's environment have a much higher priority than the application itself. Therefore, the slider may not consume too much the user's attention.

4 Formative User Study

An essential part in order to develop high quality user interfaces is to work together with potential users of the system. We arranged a user study to be able to rate the different alternatives and compare their usability to each other. The first goal was to find out which of the presented alternatives is the most intuitive, efficient, attractive and accurate one. Another goal was to find out potential usability issues, lacks of understanding and potential problems. With that gained knowledge we are able to enhance the elements and maybe filter them out. This way, we can focus on the remaining elements in future work. The users themselves need something to get a realistic imagination and feeling for the application and its tasks. Therefore, the first step is to talk with them and get some basic requirements. We talked with the people from the fire department TUM (Feuerwehr TUM) and we found out some additional special requirements which are described in 2.3. After these discussions, we were able to develop different UI-alternatives which satisfy those requirements. Afterwards, the user is able to try the different alternatives out.

4.1 Participants

According to literature, the developer learns the most from the first few test users. It is recommended to have between three and five participants, since more users will not particularly increase the benefits of the evaluation [Nie94]. Therefore, we evaluate the system with five test users, two females and three males. All of the participants were between 25 and 28 years old. In this first approach these people are not from the rescue service. This is to avoid dissipating our resources (rescue units) in this early step. This decision is reasonable since the basic usability issues in an early development state are the same for most of the people, no matter if they are from the rescue service or not. The even more important part is to choose people who have low experience in the field of human computer interaction. For that reason, we took people from different fields: Two biologists, a jurist, a political scientist and a sociologist. All of the five test users have low to average experience with computer interaction in general according to their own judgment. Additionally, they all mentioned that they have low to average experience with

touch screens. The optimized elements will then be evaluated with people from the rescue service in future work.

4.2 Procedure

The users have to use all UI elements to get an impression of their functionality and to be able to point out usability issues and rate the different alternatives. Therefore, it makes sense to define some tasks which the users have to solve using these alternatives. Thus, we defined a task for each map navigation feature. The users are asked to solve the task with each element (three elements for scrolling, two for zooming). The tasks are all written down on paper and a picture of each important state of the tasks is attached to it. The users read the instructions carefully and start as soon as they understand the task. None of the elements is introduced to the participants. This way, we are able to see if the elements can be understood without further explanation or help instructions. The application logs the time each user needs to fulfill the task. Additionally, the accuracy will be measured in the case of the scrolling task. For each of the interface elements the users are asked to fill out two questionnaires: SUS (System Usability Scale) [Bro96] and AttrakDiff [HBK03]. Finally, a short interview follows.

As already described, we focus on the two basic map interaction features presented in this paper: Scrolling, and zooming. During the execution of each task the participant is observed to determine difficulties of the usability and to clarify to the user if there are some ambiguities. To avoid learning effects, we use a within-subject design. Thus, the sequence of the different alternatives is randomized. After finishing a task with one of the provided alternatives, users fill out two questionnaires: AttrakDiff and SUS. Afterwards, the subject may note some comments on each of the alternatives. After working with all elements users are asked to choose their favorite. The task of the users are described in detail in the following.

Scrolling One thing we want to know is which of the introduced methods to move the map is the fastest one and which is the one with the highest accuracy. A square is drawn at the center of the screen and the goal is to move the map in a way that the currently shown patient is exactly in the middle of this square like shown in figure 6.

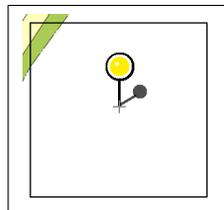


Figure 6: Scrolling, perfect hit

The first priority of this task is to move the patient as fast as possible anywhere inside

the black square. The second priority is to place it exactly in the middle. The application records the time the user needs for each patient and the achieved accuracy as well. Seven patients appear one after another in a predefined order. The position and the order of the patients will be the same for all alternatives and for all users to avoid differences in the results because of different positioning of the patients.

Zooming At the beginning, the participant sees one patient while the zoom is set to maximum. When the user starts the task the goal is to zoom out the map to the minimum. At this point all patients which are drawn at the map are visible and a message appears which informs the user that the first part of the task is finished successfully. The user moves to the next step of this experiment by pressing a button with the label “continue”. The second part of the task is simply to zoom the map back to the maximum. This way, the user will get an initial feeling and is able to share that experience with us. Beside that, the time needed for each user to zoom back the map is recorded. But more important for us is to note down the user’s opinion and suggestions as well as our observation to improve the interface elements for zooming. This observation will provide answers to some questions, for example whether the subjects are using the slider or if they are just pressing the small buttons attached to the slider.

4.3 Results

The results of SUS for all alternatives are presented in figure 7 as a box-plot, whereas the mean values are given in figure 8. The results for AttrakDiff are shown in figure 9. The results for the scrolling and for the zooming task are presented and discussed in the following. The automatic collected data for the speed and the accuracy in case of the scrolling task are not mentioned here. The reason is that the users tried to place the patient in the square by scrolling the map as perfect as possible. Therefore, they didn’t try to solve the task as fast as possible which in fact was more important. Unfortunately, this misunderstanding falsified the results for speed and accuracy. We will consider that and perform a further test in future.

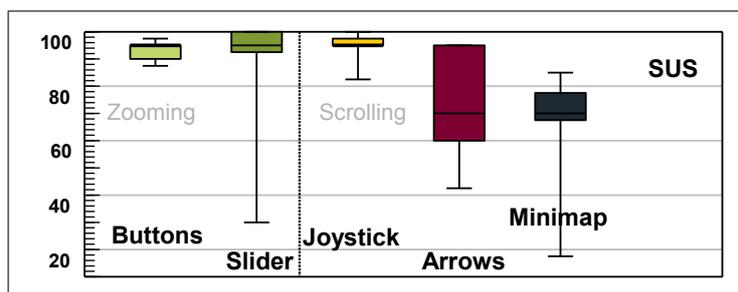


Figure 7: System Usability Scale (SUS) - Boxplot

Scrolling If we compare the results of the SUS questionnaire regarding the three elements *Minimap (SC1)*, *Arrows (SC2)* and the *Joystick (SC3)* we see that there is a real tendency for the joystick alternative. The outcome of SUS ranges from 0 to 100, where 100 is the best score. Four out of the five participants rate the joystick alternative above 90 and the fifth rating is still above 80. Consequently, the mean value of the joystick is very high with a score of 94. The results for the *Arrows (SC2)* and the *Minimap (SC1)* are more scattered even though most of them are still high. The mean values are 72.5 and 63.5 respectively.

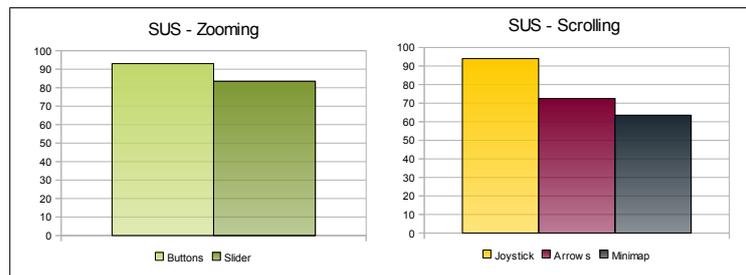


Figure 8: SUS mean values

The AttrakDiff results range from 1 to 7, where 7 is the best score. The attractiveness and the pragmatic quality of the joystick are also rated very high (both above 6). The hedonistic quality is subdivided into a stimulation and an identification part. For both parts the joystick has the highest score, too. Last but not least, four out of the five test users would prefer the joystick to scroll the map. One participant would prefer the arrows. Although none of the participants has chosen the minimap, all five test users mentioned, that they would like to use it if they could be more accurate with it.

Zooming Both results for the two zooming alternatives regarding the mean SUS scores are above 80 (figure 8). The boxplot in figure 8 shows that most of the test users rated both alternatives above 90. The results from the AttrakDiff questionnaire confirm that we are not able to decide which alternative is better if we just regard the values (figure 9). The stimulation part of the hedonistic quality of the slider is rated with a value of 4.94 while the buttons are close to it with a value of 4.46. The scores for the identification part is similar. The slider achieves a value of 5.11 and the buttons have a value of 4.97. Thus, the hedonistic quality of the slider is rated better than the hedonistic quality of the buttons. But the difference is too low to be relevant. The values for the pragmatic quality and the attractiveness are similar. The differences between the slider and the buttons are still low but the buttons are somehow rated better in the latter qualities. The pragmatic quality of the slider and the buttons were rated with 5.83 and 6.11 respectively. The attractiveness was rated with 5.51 and 5.56. Thus, the buttons-alternative has a better score in this case. Anyway, this is not that relevant too, because the differences between the scores of the alternatives are low again. The individual favorites of the users do not lead to a clear decision either two of the five subjects preferred the slider while three preferred the buttons. Nevertheless, the observation of the users while solving the tasks with both alternatives

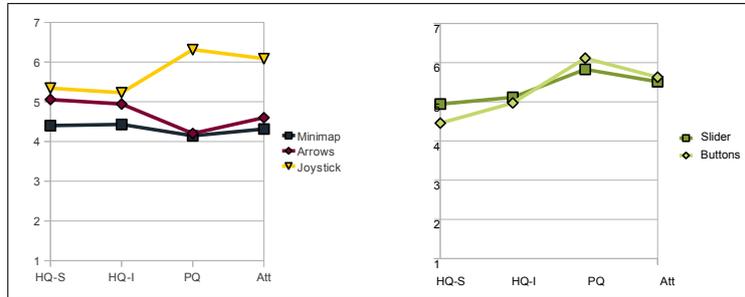


Figure 9: AttrakDiff results

and the interview which was held with them lead to interesting insights. These insights are discussed in section 5.

5 Discussion

We evaluated the different UI alternatives with 5 participants that are not from the rescue service. This decision seems to be significant because the low number of participants and because they are not from the target group. Anyway, the results of this evaluation proves that this decision is right and correct. We identified the weak points as well as the capabilities of all the introduced UI elements and hence we are ready to enhance all of them. The results of this work can be useful for other applications and purposes. For instance, every UI element introduced here can also be used for touch screen input devices in future.

As shown in section 4.3 the joystick was rated the best alternative to scroll the map. There are traceable reasons for this rating which are discussed in the next paragraph. In contrast to the scrolling part, there is no possible clear decision in the case of the zooming part. Actually, we are able to improve the zooming method if we take a closer look at the interview part of the evaluation. This is discussed in the second paragraph in this section.

Scrolling The interview with the users reveals the reason for the results shown in section 4.3. The users were asked to place the map in a way that the displayed patient will be exactly in the middle of the visualized square as fast as possible. The goal was to investigate two things: The accuracy and the efficiency of each alternative. A picture of a perfect hit was shown to the users to help them to understand the task (figure 6). Because of this picture the users payed more attention to the accuracy as to the efficiency. This fact made them try their best to move the map as perfect as shown in the instructions. In a next step, this tutorial picture will be changed. In the new version of this picture the patient will not be exactly in the middle. Moreover, the participants will be explicitly informed that the first priority is to execute the task as fast as possible. Since the resolution of the minimap depends on the ratio between the size of the real map and the minimap it is not

very precise. The results of the minimap are not as good as expected. But the users mentioned that they like the overview feature of the minimap. The arrows are declared to be very easy and intuitive to use. However, the lack of the possibility to determine the speed of the map's movement and the missing arrows to some of the directions were frustrating for four out of the five test users. The other one has not noticed that there are only the four diagonal directions to move the map. Since the joystick was the only element which provides the possibility to move the map fast and rough as well as slow and precise, the required task could be solved in a satisfactory way by using the joystick. The high value of the pragmatic quality (PQ) of the joystick in the AttrakDiff results confirms this assumption. These results have to be regarded carefully, since the results are strongly bounded to the specific task which might not be representative for all possible tasks in the case of a real MCI. Thus, we have to conduct more user studies with different tasks. Although these results depend on the underlying tasks, this user study demonstrated that the users are able to understand the functionality of the joystick quite well, and that they are all willing to continue the scrolling task using the joystick to improve their results. In the following some of the users' comments concerning the joystick are given:

- “good control and selection possible”
- “I had a lot of fun!”
- “Most comfortable of the used alternatives”

Even though the fun factor using the UI is not a primary goal of our usability research, it helps to increase the acceptance of the users, and therefore the use of the underlying system as well.

Zooming Like described in section 4.3, the results of the used questionnaires do not lead to a conclusive decision. Thus, it is not possible to choose one of the presented alternatives by comparing the scores of these questionnaires. Both alternatives are rated high with both questionnaires. The reason is that the task was easy to solve with both alternatives. Since the users are both observed while solving the tasks and individually interviewed, we are able to improve the zooming method. Only two out of the five participants used the sliding feature of the slider. The others just tabbed the buttons of the slider (*Z1*) stepwise in order to accomplish the task. On the other hand, it is possible to hold the big buttons (*Z2*) down until the desired zoom factor is reached. Therefore, the two users which used the sliding feature of the slider prefer the slider (*Z1*) while the remaining three prefer the big buttons (*Z2*). We found out during the interview that the users like the big size of the buttons and the possibility to hold the button down. But one of them mentioned that there is no way to find out the current zoom factor if there are just two buttons. Thus, we plan to combine the two elements in future work. The new element will have two big buttons. Additionally, a visual feedback about the current, the maximum and the minimum zoom factor will be added.

6 Conclusion and Future Work

This work explores some user interface elements for the typical map manipulation features: scrolling and zooming. Three alternatives to scroll the map while holding the tablet PC in both hands (*Minimap (SC1)*, *Arrows (SC2)* and *Joystick (SC3)*) and two for zooming (*Buttons (Z1)* and *Slider(Z2)*) the map are presented. All of them fulfill common user interface and touchscreen requirements as well as special requirements which appear in the special environment of an MCI. In this user study the joystick is clearly rated as the best scrolling method, because it is the most appropriate alternative to solve the given task. Therefore, another user study is necessary with new tasks and improved interface elements. In this next user study the test users will be explicitly informed that they are not supposed to adjust their scrolling quality. Furthermore, figure 6 which shows a perfect hit will be changed. The new figure will show the patient anywhere in the black square. Since the main problem of the minimap is its low precision a possible solution to improve that is to integrate the take-off feature mentioned in section 2. Another way to handle the low precision of the minimap is to combine the functionality of the minimap and the joystick. Concerning the zooming: The evaluation of the two zooming alternatives did not lead to conclusive results. But the interview with the participants show, that they like the big buttons but they are missing the feedback about the current, maximum and minimum zoom factor. That feedback however is provided by the slider. Thus, the next step is to provide both: Big buttons to zoom the map in or out and a visual feedback, which displays these informations. Additionally, we want to integrate the enhanced elements for scrolling, zooming and selecting (discussed in [CNA⁺10]) into one system and evaluate it again. The participants will be from the rescue service in the next user study. Additionally, we want to explore features, which are possible with more powerful hardware. For instance, if the hardware includes a gyroscope, the tilting of the tablet PC to interact with the map application would be possible. This can be used to scroll the map like it has been done by Rekimoto [Rek96]. Finally, using a multi-touch instead of single-touch device in future work would also lead to new capabilities of the user interface.

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