Personalized Mobile Health Monitoring for Elderly

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ABSTRACT
The key for successfully deploy mobile applications is the ability to understand the specific needs of its customers. In the field of mobile health monitoring, the currently most important user group is the group of persons of the age 50+. In our project senSAVE® we developed a user interface for monitoring personal vital parameters that is specifically adapted to the needs of this group. The paper illustrates our work to ensure usability of the application and the outcome of the project.

Keywords
Mobile health monitoring; Elderly assistance; Gerontechnology, Wrist phone, Disabilities.

1. INTRODUCTION
Hypertension is an often underestimated risk of fatal long-term consequences. In fact, cardiovascular diseases are one of the most important causes of death. In conjunction with overweight and diabetes it causes the majority of cardiac infarctions and strokes. A successful disease medication therapy often requires the support by lifestyle changes like changing food patterns and doing more physical activity. Establishing awareness for the course of vital parameters will positively influence and motivate people to pay attention to their vicious habits themselves.

The exact diagnosis of hypertension is often complicated by two facts: blood pressure is even for healthy persons dynamic and rapidly varying, and the long-term monitoring tends to result in lower quality of life. In the first case, it results from multiple influences like mental and physical situation (psychological strain, daytime, alertness, stress) or food patterns. In the second case, the fragmentary, uncomfortable, chancy acquisition of vital parameters is incompatible with the normal way of live of in other respect healthy people – in particular incompatible with mobility. It is a challenge to identify increased blood pressure with borderline value in order to initiate a complementary therapy.

Though the risk of hypertension is uniformly distributed on all ages, the biggest single group of patients are people in the age of 50+. In full possession of life, the society remains mobile even in the ripe at old age. It is a challenge to develop applications that specifically meet the requirements of the user group of 50+. In this paper we will illustrate our work of a mobile monitoring application with a specific focus on usability for elderly users. Products for elderly require specific awareness for their specific needs. Therefore we analyzed the usability requirements for elderly that is shown in the next section.

2. Usability Requirements and Ease-of-use for Elderly
Gerontechnology tries to better understand the elderly and to adapt the products to their needs. To improve their quality of life you have to know their main problems. Compared to young people the older are said to have [1-6]:

- less cognitive capacities
  - loss of memory and poor recall
  - few navigation skills or sequencing
- sight loss
  - loss of visual acuity
  - loss of near and/or distance vision
  - reduced field of vision
  - perception of colour, including age-related yellow vision
  - depth perception
  - speed of adaptation to changing light levels
  - sensitivity to light
- hearing loss
- decreased kinaesthetic ability
- less experience with interactive systems and therefore a resulting less confidence in "computer-things"

But this is a generalisation, that doesn't reflect the whole truth: As Rabbit [5, 6] found out, elderly are a group of more variety in their abilities than the younger. That means, some are, even if they are old, still almost as fit as the "youngsters", others have impairments in their abilities that are more or less strong.

Concerning the "average user" [7-9], we can summarize, that the "average user" represents more the figurehead of the younger in population than the one of the elderly [8]. The 50+ generation decayed into a much more varying population related to their task-performance or word-memory-capacities. Heller [8] called this group: "the dynamic diversity". This big variety can explain our putative effort in trying to find the "one User Interface for all". In contrast to the "design-for-all"-philosophy [10] we have not been able to find a "one-for-all"-solution; moreover we realized that a "2 or 3-for-any"-philosophy reflects reality more appropriate.

Based on these characteristics of elderly and based on specifications described in international standards for elderly (ISO 20282 and especially ISO Guide 71, ISO 11581) our claim was to enable simple and safe working interface and to ensure best understanding and handling of the GUI:

- font-sizes up to 48 pt
- only significant words to describe the button functions,
- clear wording with the users (e.g. *emergency call* instead of *SOS*),
- one-level-navigation instead of using menu structures,
- horizontal and vertical grid alignment of all used elements,
- arrangement of the buttons on the bottom of the interface, so the input-hand would not hide the screen,
- headlines displayed on the top of each screen as the major information as well,
- colour-neutral displays for visual impaired users,
- redundant user guidance by colour-coding and blinking boxes,
- slow animation speed, e.g. blinking rate.

For a mobile health service, the user needs a device that stores all information collected from vital events via sensors. We called this device *Wearable Base Station*. Because of a wide spread of mobile/smart phones, even in the group of elderly (in 2005, 73 % of the 55+ age persons in Germany do possess a mobile phone [11]), we primary took this kind of device as the *Wearable Base Station*. There are mobile phones, especially designed for elderly, like Senior Phones with big buttons, but without the health functions, or *Vitaphone 1100* [12] with big buttons, but without understandable wording on it and limited health functions.

Using an ordinary phone as device, the elderly would have problems with systems like the *Vitaphone 2300* [12] because of its small button and screen size. Other systems like the *QBIC* [13], the *MCU* [14] or the *Medi-CliniQ* [15]are, again because of their size, not really portable devices. The third identified problem of existing healthcare devices is the unsatisfactory information representation such as of the *Palmtop Patient Monitor* [16]

We decided to design a combination of a mobile phone with PDA functionality displaying current personal health information and allowing direct interaction by pen or finger of the user. As a secondary device-option, we developed designs for a wrist-healthphone (see 7 future work), because our studies showed, that a wristwatch is a tool of everyday life that all persons almost always carry with them [17].

3. The senSAVE®-prototype

The prototype of senSAVE®, Sensor Assistance for Vital Events, was developed by a consortium of five Fraunhofer Institutes. The objective of senSAVE® was to contribute to the improvement of medical treatment for cardiovascular diseases, thus increasing the quality of life for affected humans. Compared to the present state of the art, senSAVE® enables continuous and non-invasive monitoring of cardiovascular parameters.

With the integration of the know-how of all partner institutes, i.e. the development of new materials enabling long-term ECG-observation, the integration of a mobile ECG-unit into a shirt for daily use and the plethysmography, we were able to detect the blood pressure, pulse and oxygen saturation in daily mobile life. Enabling the target group to handle the device and understand all information was the main focus of our personalized user interface. The prototype is running on any mobile device operated by Windows Mobile 5.

4. Methodology

In order to meet the requirements of the specific user group we decided to employ an approach for User-Centered Design (UCD) combined with the *Ease of Use*-approach. ISO 13407 *Human-centered design processes for interactive systems* and ISO 20282 *Ease of operation of everyday products* give guidance on human-centered design activities throughout the life cycle of computer-based interactive systems and especially on everyday products; ISO Guide 71 extends the characteristics of the users to the group of the elderly. With this approaches we closely interconnected our development with the real users of the intended system.

The core idea of the approach is to have small cycles of specification, simple mock-ups, user feedback and refinements. The result of each single loop is given as input to a subsequent loop for more and more approaching the users' needs. This ensures that all user feedback, also of minorities, will be considered from the very beginning of development to the end of the project.

For the development of the prototype we went through 3 major and some minor cycles. In the first phase, we developed the core ideas and functionalities and evaluated them with eight users from the intended user group with the aid of Flash- and Paper-Mock-ups. In the second phase, we implemented our first user interface and evaluated the design and interaction with another group of nine elderly users. At the end, we integrated all user feedback, finished the implementation of the final prototype which we finally evaluated with 22 users. The results of this final evaluation are explained in Chapter 6. In the next two sub-sections we will show the results of the two preliminary evaluations.

4.1 Basic functionality, design and interaction

Initially, we developed scenarios for a mobile user with cardiovascular disease and a set of use-cases. The main set of use-cases included medical use of the system such as checking current blood pressure, alarming the patient in case of critical values or communication to the doctor. Other use-cases addressed the technical use of the system such as checking battery power left for operation or being informed in case of a lost connection to sensors. The third group of use-cases was about the emergency case.

For all use-cases we developed a set of Paper-Mock-ups with different look-and-feels. In order to test the interaction, we used a Flash-Mock-up that we installed on a mobile device

For prearranging initial text and button size, both determining values for calculating the maximal amount of information and interaction, we interviewed two persons: one with strong sight disabilities and the other one with motor problems. In contrast to study [18], concerning the text size for elderly, the person with the sight problems considered a text size up to 36pt as comfortable. The person with the apraxia, a tremor, liked to have a button size of at least two fingers. These basic, "age-related" parameters helped us in the creation of the shape of the initial mock-ups.

In terms of the limited screen size of a smart phone/PDA (i.e. max. 640x480px) it was likely that we would have space for 2-3 buttons combined with an information area of about one third of the whole space.

4.1.1 Evaluation results

In the first main evaluation-step we asked 8 persons (6 female and 2 male, in the age of 62-94 years) who are living in an assisted living environment. In general, the users would appreciate to have the system observing their vital parameters. The mobile device, as more than half of the asked persons said, should be as unobtrusive as possible. The shape of a usual watch would be most desirable.

For this user group, the display of blood pressure and pulse are of most interest. The form of numeric values is most appreciated. Most persons knew their personal borders very well and require the opportunity to review the current values themselves. Most desirable, the display should use as less animation as possible. Our study showed that some elderly had problems with auto-scrolling text, representing each health parameter for about 5 seconds. Other parameters, such as oxygen saturation and ECG are not of value for the users.

The system should use an acoustic sound and vibration for alarming the user in case of any distinctive value. For alarming, the user would like to have a clearly noticeable indicator – no matter if casual bystanders would also get aware of it.

The system should support feedback to the doctor in form of phone call. In case of emergency, the patients would appreciate to have automatic emergency call. If implemented, all persons required that the detection of the emergency case is correct in any case. On the one hand, the user would trust on the automatic call in case of emergency; if the system does not recognize the case and the call is not placed, the person will not get any help. On the other hand, if the system raises a causeless call the user could get shocked.

For the evaluation of the interaction we developed a Flash-Mock-Up running on a mobile device. The interface mock-up on the screen consisted of three buttons for *emergency call*, *phone* and *query/acknowledge*. The test persons were surprisingly well able to use the graphical user interface and to understand the features.

4.2 First implemented user interface mock-up

From the results of the first evaluation phase we started to create a first running prototype. The prototype was connected to a (software-) simulator and did not use any hardware sensors.

We used the prototype for a second evaluation with 9 persons (7 female, 2 male, 67-94 years old, 3 with past heart attack(s), 4 with hypertension, only one who owned a personal mobile phone) in the same assisted living institute as we did before. The prototype was running on T-Mobile MDA Pro in the size of 127,7 x 81 x 25 mm, weight of 285g and resolution of 480 x 640 pixel.

We choose this device because of the large touch screen and its technical features. At first, the users disliked the system because of the large and comparatively heavy device. They considered the device to be uncomfortable and complex to use. In order to basically check the input modality, we asked the users to start the calculator and to do some calculations. All users were right from the start able to handle the system with the stick or, more comfortable, with their fingers. On the contrary, all hardware buttons, particularly the scroll-buttons, were too small and to close to each other to be usable.

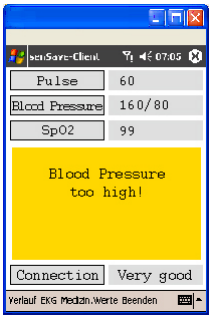

Figure 1: The first prototype of the user interface

The screen design (see Figure 1), placement of elements and colors were accepted by all subjects. The text font was not readable for only two subjects. The health indicator in the center of the screen was understandable for all subjects whereby half of them used the color indicator and half of them used the text. For the colored background we implemented a traffic light metaphor indicating the current personal status, which actually was not realized by most of the subjects. All buttons were good in terms of size, color and wording. The menu on the bottom was neither readable nor applicable for any of the elderly users.

All users were able to read and understand their vital parameters except the oxygen saturation which was not known by 5 persons and seen to be not necessary by two additional users. More detailed information, e.g. the course of specific parameters like blood pressure, was not seen to be helpful. Only one person was able to handle the sequential flow of technical indicators. All the others either had timing problems (too fast) or problems in understanding the wording of *Connection* and *Sensors*.

In comparison to another device (T-Mobile MDA Compact, size of 108 x 58 x 18, weight of 150g, resolution of 240 x 320 pixel) about half of the users would prefer this device because of its smaller size and weight. On the other hand we realized that with the smaller display (and therefore smaller interactive elements) the other half of the users did not feel as comfortable in operating the device as they did before. At the end, the software should be designed to run on different devices and not pre-fix graphical element to certain sizes.

5. Aim of the development and its evaluation

The design of the user interface reflects the requirements to be simple and robust. Several alternatives were developed and tested in formative evaluations to find strengths and weaknesses of versions of the design. For the final evaluation 6 variants (see Figure 2) were tested from basic display designs via an *advanced user interface* up to professional versions integrated into a set of standard applications used on the MDA. The evaluation aim was to identify the usefulness of the service and the usability of the user interface including the information presentation, the interaction design, understandability of the medical vocabulary and the alarm announcements in critical situations.

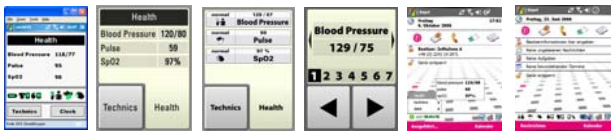

Figure 2: Thumbnails of user interface variants

For the evaluation of the 6 user interfaces a questionnaire was developed. The evaluation session with 22 test persons included the demonstration of the user interfaces and test tasks for the users of how to interpret a given health value (identifiability and understandability) and how to find a specific value not yet displayed on the current interface screen (navigability). The sample of the test users included 8 female and 14 male persons; 18 persons suffered from high blood pressure; 4 had other cardio vascular diseases; because high blood pressure is also relevant for younger patients, the age ranged from 36 to 79 with a median of 60 years; 17 had computer experiences; 17 used mobile phones and 5 used pocket PCs (PDAs).

The 6 interfaces were developed by the following interface concepts: The basic variants have a full screen-mode in common, so the operating system level is hidden, to assure working. One version is reduced to the communication-possibility „This or that“. The second one has additional icons. The third one is a sequential display with the interaction concept of „Forward/Backward“. The advanced user-interface is segmented in 3 parts: The indication of the actual vital parameters. An icon-based state-display and in the bottom there are 2 buttons to navigate through 3 screens. Additionally, there is a password-protected menu for the doctor to set up personal limit values. The professional versions demonstrate the effort to integrate the application into the OS level.

6. Results of the evaluation

6.1 *Advanced user interface*

The *advanced user interface* (Figure 3) is the one with iconographic and textual and numerical display and interaction features. First the evaluation results of the information presentation, the look of the interface, will be described.

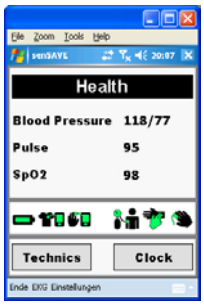

Figure 3: The *advanced user interface*

6.1.1 Look of the interface: information presentation

6.1.1.1 Arrangement and readability of the display and convenience of the colours.

For the look of the user interface a first check of the information presentation in terms of arrangement of elements, the readability of the content and its colour design was analysed.

16 of the subjects found the interface of the “advanced” client very clearly arranged and 6 subjects found it at least rather clearly arranged; nobody found the interface not clearly arranged.

Most of the subjects also found the interface very good readable except 4 who at least found it rather good readable; nobody found the interface not good readable.

Most of the subjects found the colours of the interface very convenient except 6 who at least found it rather convenient; only 2 found the interface colours not convenient.

The big size of the interface elements, the colour contrast and the conservative number of colours were appreciated.

6.1.1.2 Understandability of the health displays

The naming of the medical health values blood pressure and pulse was completely understandable, the naming of the oxygen concentration of the blood was understandable for only 5 out of 22 subjects - oxygen concentration seems not to be a known health indicator.

The subjects were asked about the understandability of the icons showing the normal state of the technical functionality of the system and the current health indicators. All subjects understood the energy status of the battery; most of the subjects also understood the icons of the blood pressure (except 5) and of the pulse (except 7); also the ECG-sensor was recognised by a majority (except 9). Least understandable (by only half of the subjects) were the understandability of the meaning of the oxygen concentration and of its sensor connectivity.

Most of the subjects except 5 preferred to get visual signs as icons on the interface. These icons could be helpful to get a short impression of the state of the health (health icons) and of the state of the system (functional icons). The understanding of the icons is subject to training to be sure that the users learn the correct meaning of the icons. Once the users have learned the meaning of the icons, the icon behaviour (blinking) and the icon colour (green of red) helps the user to quickly address the critical states.

6.1.1.3 Neutral displays and blinking icons

The state of the user interface in terms of “no blinking icon”, “green icon colours”, “indicator values inside the critical boundaries” and “no annotations to the values” was understood as an indication of a normal, non-critical health state. Only 3 of the subjects understood that some indicators are not in there expected range or had no clear understanding.Blinking of icons in the status area was understood by more than half of the subjects except 9 as an indication of a critical health situation; some of the rest interpreted blinking as an indication of an ongoing measuring process or of a critical technical situation.

6.1.2 Feel of the interface: interaction design

The interaction design of the *advanced interface* contains three screens with the information display of the health information, the technical components information and a neutral display of date and time – to mask the medical application for the public awareness. Beyond these interactions initiated by the user alarming cues initiated by the system are displayed in case of technical problems with energy resources or bad connectivity or in case of bad health values of the person.

6.1.2.1 *Method to switch to see the date and time*

Almost all of the subjects except 1 had no problem to get the display date and time. 6 subjects expected more services beyond the date and time information after clicking on the respective button.

6.1.2.2 *Understanding of energy displays*

Almost all subjects have no problem to click on the Technics button as the access to the battery power display; only one showed only interest in this feature at the very end of the battery power; four did not have problems to find the information but to understand what the displayed value means, e.g. 3:36h already in operation or still 3:36h left for operation. All subjects understood the icon of an empty battery; two third understood that they should charge the battery soon; 3 only realized the icon of the empty battery but did not realize the indicated time left for operation

6.1.2.3 *Understanding of the alarming*

More than half of the subjects were clear about the meaning of vibration of the device as an alarm that any health indicator value is out of limit. Almost half of the subjects had other associations like measurement is currently active or measurement is currently not in operation. Almost all subjects found the vibration of the device not annoying. Several comments contain suggestions, such that the vibration is too poor, or too neutral, or should be accompanied by acoustic signals or voice.

Half of the subjects prefer a combination of a vibration as an alert followed by an acoustic signal. The vibration can be understood as a discrete signal before the acoustic alarm arouses the attention of the social environment. The comments show that the pattern of the alarm needs adaptation facilities for specific physical, social and individual conditions. Some people are hearing impaired and need stronger/progressive acoustic signals or non-acoustic alternatives, other people face panic when an acoustic alarm rings.

6.1.2.4 *Activate buttons of the display*

Most of the subjects manage to activate the buttons of the display without problems; 3 subjects had problems to identify click sensitive areas of the display – in particular with respect to buttons and visual icon areas with blinking periods during alarm events.

Almost all of the subjects manage to activate the button of the display via pen without problems; only 1 reports problems. Beyond this principal result 3 subjects think that using the pen is too cumbersome.

Almost all of the subjects managed to activate the button of the display via finger without problems; only 1 subject reports problems because the button field is too small for a finger.

6.2 Evaluation of the alternative interfaces

After the evaluation of the main user interface that we call the *advanced interface* with navigation and animation facilities, two *basic interfaces*, one *sequential interface* and two *professional interfaces* were tested in a random order as alternatives to study plain displays with only limited interactions and two versions of interfaces with a high degree of integration into a set of professional applications. To compare the different versions of interfaces three questions about arrangement of the display, readability of the interface elements and the convenience of the colour coding as well as two tasks were explored: trying to retrieve the state of the ECG-Sensor und respond to an alarm announcement.

Some of these alternative interfaces could only be tested by a subset of the test users. For elderly persons and persons with low visual abilities some interface elements were too small or the complexity was too high so that they did not answer the questionnaire for the *sequential interface* and the two *professional interfaces*.

As shown in Figure 4 the first two interfaces (on the left of the diagram) are positively evaluated, i.e., the already discussed *advanced interface* and the *basic interface* are very or at least rather clearly arranged, very good or at least rather good readable and very good or at least rather good colour designed. Also the *basic plus interface* has pretty good acceptance values with only one user who evaluated all three aspects of the information presentation negative. For the rest of the user interfaces only a smaller number of test users' evaluation results are shown. These interfaces were not suitable for the majority of the subjects and, therefore, only a minority evaluated these interfaces showing moderate acceptance values.

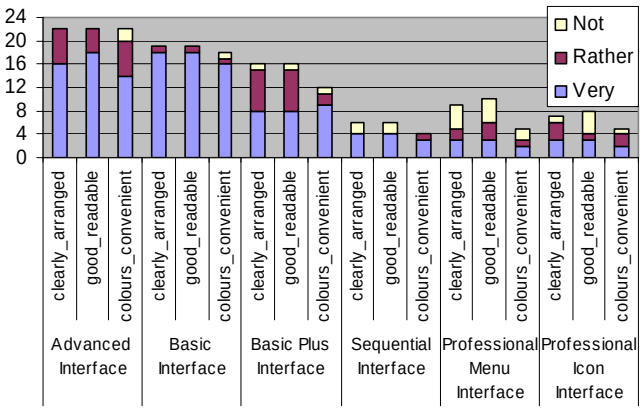

Figure 4: Evaluation of the Information Presentation of the Interfaces

The evaluation of the information presentation is shown in Figure 4 so that in the following paragraphs we only discuss the feel of the interface, the evaluation of the interaction design based on test tasks for the test users.

6.2.1 *The basic interface*

The plain version of the *basic interface* shows a reduced display with bigger health and Technics indicator values and without icons and annotations for normal or critical states (Figure 5). This reduced information presentation goes back to the statement that people affected by high blood pressure are familiar with their threshold values and need no explicit annotations

Almost all subjects identified the *Technics* field as the button to display the ECG-sensor. More than half of the subjects managed to find the information connected in the display.

All subjects understood to click on the blinking *Technics* button and more than half of these subjects successfully found and understood the information *Battery empty*. One subject proposes to display the critical parameter (here the battery) instead of the blinking button Technics what asks the user explicitly to click on

the blinking Technics button before the critical parameter of the battery is visible.

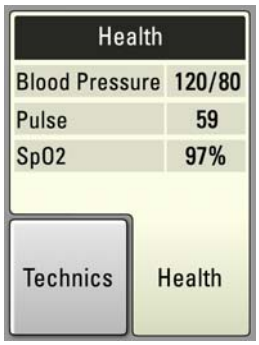

Figure 5: The *basic interface*

6.2.2 The Basic interface plus

This *basic interface plus* includes additional display features for each of the health and Technics indicators in terms of annotations of the numerical values (*normal* or *high*) and in terms of icons, which visualize the indicators and turn green or red according to the indicators to be normal or critical (Figure 6).

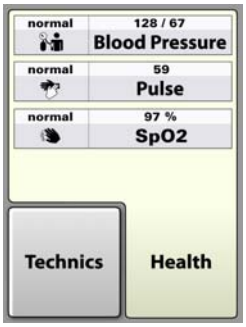

Figure 6: The *basic interface plus*

More than half of the subjects identified the *Technics* field as the button to display the ECG-sensor. Almost half of the subjects managed to find the information *connected* in the display. Some subjects needed more than one trial to find the final result but succeeded at the end.

More than half of the subjects understood to click on the blinking *Technics* button and almost half of these subjects successfully found and understood the information *Battery empty*.

6.2.3 The sequential interface

This third version of the *basic interfaces* that we call the *sequential interface* shows a large display of only one element at the time of the health indicator values and the Technics details (Figure 7). The user has to choose between the separate displays by clicking on the respective number of the element or by clicking on the sequential left or right button. This means that the ease of perception is optimised at the expense of the interaction effort. Only 6 of the subjects evaluated this interface.

Half of the subjects identified the arrow button to display the ECG-sensor. Two of the subjects managed to find the information *connected* in the display Half of the subjects understood to click on the blinking number and two of the subjects successfully found and understood the information *Battery empty*.

Figure 7: The *sequential interface*

6.2.4 The professional menu interface

This interface that we call the *professional menu interface* contains a click-sensitive icon “senSAVE” as a menu on the bottom left in the control field of the MDA (Figure 8). It takes only little space and no attention of the user unless any critical state occurs. Once a critical state occurs the ”senSAVE“-button starts blinking. The user can click on the blinking senSAVE-button and gets access to health indicators, technics details and dates for medical appointments.

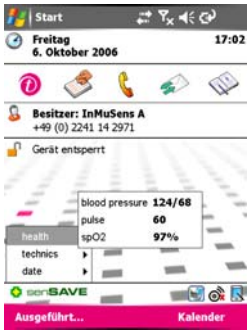

Figure 8: The *professional menu interface*

Almost all subjects identified the *Technics* field as the button to display the ECG-sensor. Half of these subjects found the information *connected* in the display.

Most of the subjects understood to click on the blinking senSAVE icon and almost half of these subjects successfully managed to find and understood the information *ECG sensor not connected*. The blinking does not sufficiently attract the attention.

6.2.5 The professional icon interface

This second interface of the professional version that we call the *professional icon interface* contains several icons of the senSAVE application on the bottom of the control field of the MDA (Figure 9). It takes little space and no attention of the user unless any critical state occurs. Once a critical state occurs the respective icon starts blinking. The user can click on the blinking icon and gets access to the critical health indicator value or the critical technics detail. More than half of the subjects identified the *Technics* field as the button to display the ECG-sensor connection. Almost half of these subjects managed to find the information *connected* in the display. Some subjects needed more than one trial to find the final result but succeeded at the end.

Figure 9: The *professional icon interface*

Most of the subjects understood to click on the blinking icon and almost half of these subjects successfully found and understood the information *pulse 112* as high.

6.3 Overall ranking of the interface variants

We have tested 6 user interface variants of the system. These variants were ranked by the subjects to see the overall preference after some experience of the subjects with the variants and assessments of their detailed presentation and interaction features (see Figure 10).

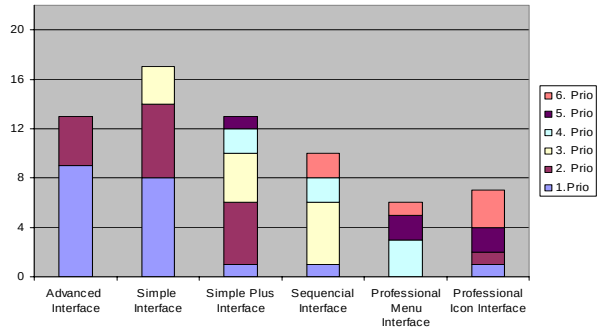

Figure 10: Ranking of the user interfaces

The user interface that we call the *advanced interface* with a full senSAVE® display without intermix with other applications but with several display and interaction features for the user to explore details of the current health condition and features of the technical components of senSAVE® was ranked by half of the subjects as number one. The second priority goes to the *basic interface* with only two buttons for technics and health indicator values and only plain displays of the parameter names and the numeric values of the parameters – without icons and without annotations in case of critical situations. For the rest of the alternative interfaces the number of aficionados is very low: one or even zero. In this context, it is significant, that this person was the only one, that was using the own PDA for business tasks. The *basic interface plus* with additional icons and annotations in case of critical situations shows a secondary attraction to 5 subjects.

This result could mean that there is no clear *one for all* user interface, but two main alternative interfaces for the users (not using a PDA so far):

1. the *advanced interface* for users with interest in details of the application parameters including animations (blinking of icons) and annotations (words interpreting the indicator values) and capable to understand system behaviour as prompts to interact with the user interface.

2. the *basic interface* for users who simply want to see the values of either the health or the technics indicators without additional interpretation and interaction.

6.4 Final overall assessment of the service

At the end of the evaluation the subjects were asked to assess the acceptability of the system together with the hardware device.

6.4.1 Continuous use of the system

Almost three quarters of the subjects could imagine wearing such a system and using it continuously. Only 3 could not imagine using it. 1 could imagine using the system at least in limited periods of bad feeling. Comments show that the size of the device (MDA Pro) is not convenient enough or obstructive during sport activities; 1 means that continuous monitoring could make the client crazy. Positive comments underline the alarm function supporting the user in critical situations without fixing the continuous attention of the user to the health state.

6.4.2 Acceptable size of the device

Almost half of the subjects preferred the big size with a big display and almost the other half preferred a smaller sized device with a smaller display. Only 2 subjects preferred a wrist watch that was shown as a very rough plastic mock-up. But it is critical to generalize this statement, because the people found “a solution” in the preceding detailed interview, so the wristwatch, as a non-executable prototype did not made so much sense to the users.

6.4.3 Social acceptance of health indication

Almost three quarters of the subjects accept a remarkable device with personal health indicator values, whereas one fifth would not accept showing personal health indicator values. Social tolerance is a limiting factor for one respondent, one person hesitates to accept the sensor shirt and two subjects propose an additional emergency button.

7. CONCLUSIONS AND FUTUTRE WORK

In our project senSAVE® we developed a system for mobile monitoring personal vital parameters. The user interface and the interaction are specifically adapted to the needs of elderly. In this paper we illustrated the development of the project and outcome of our work to ensure the usability of the application.

Almost all people of the test sample suffered from severe high blood pressure or from other cardiovascular diseases so that the evaluation was performed with a sample of people who had experience with health problems and health awareness in real life.

In the tests we studied the presentation of information, the guidance of the dialogue and the alarming function. Out of the evaluated user interfaces two appeared to be the favourites with acceptable usability.

The first of the preferred user interfaces, the *advanced interface*, is characterized by displays of graphical symbols and animations and with a possibility to check parameter values. The interface is more complex than the basic version. Unclear is the statement of some users, that the advanced version is their favourite, even though they had problems to identify the icons.

The second of the preferred interfaces, the *basic interface*, is characterised by a simple navigation over two different screens with an expressive display. It displays critical values by blinking boxes in the background of the type.

We cannot assign one of the two alternatives to a specific group of subjects, i.e., old versus young, computer experienced versus no computer experience. Therefore we assume that either both versions will be conveyed in a next development step by optimizing strengths and weaknesses of both versions or that both versions will be offered to the individuals for selection. Beside the user friendliness of arrangements, wordings, and colour designs as well as beyond the user guidance it was also investigated if the users are willing to use it in their daily life. Three-quarters of the subjects said they would use the service. They would also use this device overtly, not masking that it is a health monitoring system by displaying a neutral application like time and date as a default display.

From the first interviews we knew, that the users would prefer a unobtrusive system. Their most favourable device would have the shape of a wristwatch. Without much doubt, the development of a wristwatch would need to perform a lot of hardware development. For technical reasons we had to limit our software development to an application running on available mobile hardware. In parallel to the application development we conducted studies for getting an idea of a wristwatch that again would fulfil all user requirements in particular respect of usability. In fact, a wristwatch combining the 3 main functions of *emergency*, *phone/service* and *health values* was the most desired proposal. One of our three patented designs is shown in Figure 11. In future development we will realize the user interface in form of such a device.

Figure 11: The senSAVE®-wrist-healthwatch

In general, the basic interface is the solution for the users, that want less information and the most simple interaction. The advanced interface is preferred by people, who like to have additional icons for the system state. A further test has to show, if the younger people, in contrast to the elderly, are more interested in the professional interface version, discreetly integrated in the operating system.

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