

A SIMPLE AND COUNTABLE METHOD FOR THE ASSESSMENT OF PERCEIVED WELL-BEING AMONG ELDERLY PEOPLE

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Abstract- This report illustrates the technical design for the monitoring system of well-being and demonstrates its feasibility in elderly people. The Con-Dis device consists of three buttons with a happy, neutral or unhappy face, each describing the mood of the patient. The functionality of the device was tested on 5 test persons who were asked to demonstrate their state of well-being by pressing one of the three buttons representing present condition three times per day for a time period of one week (5 working days). The device is based on Atmel's 8-bit AVR microcontroller, ATMEGA 128, placed on an AVR-MT-128 development board. The software used by the ATMEGA microcontroller was developed using the C language in the AVRStudio development environment. On the basis of the collected results, the Con-Dis - device functioned reliably in monitoring the perceived well-being and mood of the test persons.

Index terms: perceived well-being, monitoring system, microcontroller

I. INTRODUCTION

The population in developed countries is suffering increasingly from obesity, high blood pressure, and elevated cholesterol levels in serum [1]. These conditions tend to lead to the development of serious symptoms such as heart disease or cardiac arrest [1]. Perceived well-being has been found to be an early warning sign of the onset of a serious disease [2, 3, 4].

A number of patient well-being questionnaire methods that are accepted worldwide already exist [5]. Most methods are based on a multiple-choice questionnaire to be filled in using a computer or paper. Some of them are commonly used in Finland, such as RAI (Resident Assessment Instrument) [6, 7] and RAVA [8,9].

RAI is a very comprehensive questionnaire consisting of over 300 questions dealing with the comprehensiveness and quality of patient care and costs at both individual and facility levels.

Applications of RAI exist for home healthcare, services, for the acute care of the elderly, and for the hospital care of mental patients. It is considered a suitable tool for the physician to examine the patient's health, because of the accuracy of the 15 RAI parameters obtained.

RAVA is an older, simpler questionnaire that comprises 12 questions. It is faster to complete, but does not provide parameters as comprehensive as those obtained with RAI. It supplies an overall index ("RAVA index") of the patient's health.

There are also other assessment methods, such as the VAS (visual analogue scale) [10, 11, 12], which are used in assessing the intensity of pain in different parts of the body.

Perceived well-being can give important information about elderly or handicapped persons or those who are impaired in other ways from expressing their problems explicitly. It can be used to assess care quality, medication, and the follow-up of recovery from surgery or other treatment [10].

To reveal the increasing risk of serious disease, perceived well-being should be measured on a daily basis. However, current methods are complex and time-consuming and need professional supervision. Answering all the required questions in RAI takes up to an hour and it is seen as being too laborious for the monitoring of daily well-being [13]. There is a need for a simple, non-disturbing, daily test method which could be used to assist social workers and health professionals.

Our work aims to develop a simple but countable method and an electronic device to gain reliable information on elderly patients' perceived well-being. This study aims to illustrate the technical design for the monitoring system and demonstrate its feasibility.

II. METHODS

A. System requirements

The system should be able to collect information on a patient's perceived well-being at regular time intervals. The collection should be more efficient and consistent than the existing well-being questionnaires (e.g. RAI or RAVA). The collected measurements should be capable of being stored and transferred by reliable and convenient means. The stored data should be processed to produce clear parameters and trend figures, which could be used to assist in care assessment and diagnosis.

The requirements also include faster usage than the existing well-being questionnaires (e.g. RAI and RAVA). Additionally, it is expected to be highly countable so as to provide solid evidence of patient's well-being condition. The assumption is that if patients' state of well-being is beginning to deteriorate, it can be predicted by the answers patients have given about their perceived well-being. The frequency of these answers is seen as a key element in predicting the patient's future welfare. More frequent answers give healthcare staff a better perception of the patient's medical condition. Therefore the monitoring device should be designed to be a system that attracts elderly patients to carry on using the system and thus gives the health care staff continuous and reliable information on their well-being.

The user interface of the system should support independent operation. Its use should be convenient and enjoyable, so that the person will not forget to use the device or avoid doing so and the recording can carry on throughout the entire surveillance period.

Most of the functionality of the system is achieved by the program.

A relevant factor for developing the “Con-Dis” is to adequately describe the patient’s perceived welfare and mood. A question arises as to whether the “Con-Dis” should include 3, 5, or 10 buttons to illustrate the patient’s well-being. The minimum system requirement is 3 buttons to separate the main human emotions of well-being: whether a person is in a happy, neutral, or sad state. However, systems with more buttons might enable the patient to describe their state of well-being more specifically. We decided that there is no need for more choices than 3 for illustrating a human state of well-being. Thus the option of using 3 buttons to illustrate the patient’s well-being condition was perceived as the best alternative.

The device design requires a countable measuring device to gather as much reliable data as possible from the users.

B. Test settings

The system is designed for monitoring personal well-being. To test the clinical functionality of the present system for well-being in practice, the monitoring would require extensive, long-term field studies carried out with a large number of participants. However, to test the basic functionality of the system, a laboratory environment test could be used.

The test arrangement should be carried out by assigning a group of volunteers for a certain time period. The time period should be extensive enough to adequately validate the functionality of the test system. In this study, the test persons should report their perceived well-being several times per day to see that the device collects information and stores it properly for further use. The validity and reliability of the data collected by the system (both the measuring device and the system software) is then measured, including the functionality of the buttons.

After the test period the results are gathered on a (laptop) PC and processed with the system software. The test aims to verify whether the device registers the correct event each time one of the buttons is pressed and also whether the device registers the correct date and time for the event concerned.

III. RESULTS

Input device

The developed monitoring system (figure 1) records the patient's evaluations of their well-being and mood and stores it for later access, for example using a laptop computer.



Figure 1. A picture of “Con-Dis” device

The measuring device includes three buttons, each describing the well-being and mood of the patient. According to the preliminary testing the three categories concerning the well-being of the test individuals, the “happy face”, “neutral face”, and “unhappy face”, clearly illustrate the perceived well-being of the test person. Each button is labelled with a smiley face corresponding to the button's function. These three groups can be presented to the test persons without difficulties in interpretation.

The “happy face” button will be pressed at the given time intervals if the test persons assume their well-being to be better than their average. The “happy face” represents a

situation in which the test person feels no abnormal pain, their mental situation does not include depression, and their physical condition is above average at the moment.

The “neutral face” button will be pressed if the test persons assume their well-being is average. The “neutral face” depicts a situation of a stable well-being condition for the patient. Mild but not harmful pain can be accepted and the mental situation and physical condition are seen as average.

The “unhappy face” button will be pressed at the given time intervals if the test persons assume their well-being is worse than average. The “unhappy face” represents a situation in which the test person feels moderate or severe pain. The person is suffering from depression and their physical condition may be notably below average.

When one of the buttons is pressed, the device plays a short sound sample, depending on the button activated. The “happy face” button emits a happy sound, the “neutral face” button emits a neutral sound, and the “sad face” emits a sad sound. This informs the test person that a button has been activated.

The system design also includes a display for the nurses to initially set up the device by entering the current time and date and the name of the test person. The display shows the time, so that at any point the basic functionality of the device can be verified.

The information transfer is performed with a memory card. Thus a memory card reader had to be incorporated into the device. A memory card was inserted for the surveillance period. The well-being results and the well-being information input times were recorded on the memory card. After the measurement results had been gathered, the memory card could be inserted, for example, into a laptop computer. The results were then shown automatically by the computer via an appropriate software program.

User Interface

The user interface of the “Con-Dis” consists of an alpha-numeric liquid crystal display (LCD), an audible output, and three buttons. The user interface design emphasises simplicity and the goal was to create an implementation that requires little

introduction for the target group. A block chart of “Con-Dis” device’s user interface is shown in Figure 2.

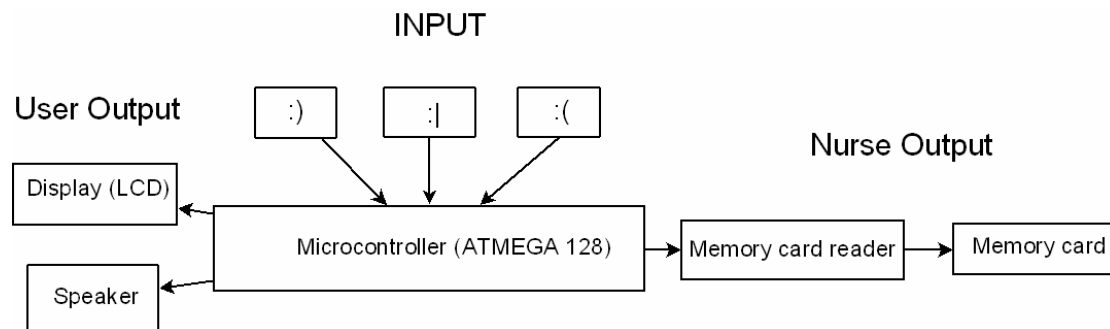


Figure 2. A Block chart of the “Con-Dis” user interface

The figure presents a block chart of the “Con-Dis” user interface. The user input consists of three buttons: Happy, neutral and sad. The user output consists of visual and audible feedback. The nurse receives the recorded information on a memory stick to analyze it – for example – with a laptop PC.

The device user interface for elderly people consists only of the buttons and the resulting audible feedback after the button is activated. The audible feedback varies depending on which of the three buttons has been pressed. In the “Con-Dis” device’s normal operating mode only the time and date are shown on the LCD display. The display is not used for giving feedback to the user and thus does not include any essential information concerning the usage of the device.

The nursing staff’s user interface includes a simple menu shown on the LCD display. The menu is used for entering the digital clock’s date, time, and possible timers for activating the device. After the settings have been defined the device shows the name of the owner or the user. After accepting the name, the device proceeds to its normal operating mode. The menu is shown when the device is turned on for the first time after the power has been turned off. The settings remain in the device’s memory for a while after the power has been turned off.

The reliability and validity of the device were tested by using standardised questionnaires such as the VAS method concerning the feeling of pain in different parts of the body, several questions about mental health (especially depression), and

questions about perceived physical condition. These validated questions acted as gold standards for the present test method, the “Con-Dis”.

In the present test arrangement the measuring device is placed on a table in a workplace. The test group consists of five volunteers (healthy male workers, aged 27-45 years) and the test period is five days. Each volunteer is given instructions to press a button illustrating his/her well-being three times per day.

The time intervals of buttons pressed for the test subjects are shown in Table 1. For instance, subject 1 was asked to press one of the three buttons between 10.10 and 10.30, subject 2 to press one of the three buttons between 10.30 and 10.50 etc. Thus, each subject had 20 minutes to come to press the button. Each subject pressed the button 3 times per day.

Table 1: Time intervals of buttons pressed for the test subjects

	1 Measurement	2 Measurement	3 Measurement
Subject 1	10.10-10.30	11.50-12.10	13.30-13.50
Subject 2	10.30-10.50	12.10-12.30	13.50-14.10
Subject 3	10.50-11.10	12.30-12.50	14.10-14.30
Subject 4	11.10-11.30	12.50-13.10	14.30-14.50
Subject 5	11.30-11.50	13.10-13.30	14.50-15.10

After the results have been collected into the computer, the program which is included in the memory stick displays a statistical figure for the buttons pressed. The percentages reflecting the number of times each button was pressed are shown below each smiley face in Figure 3.

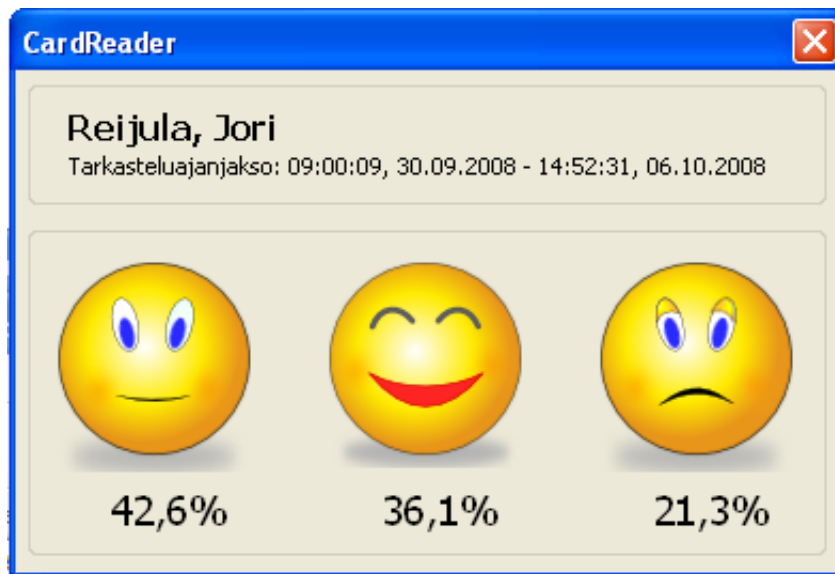


Figure 3. The final result and summary of the test persons during the test period

The view on the PC screen illustrates the final result and summary of a test person (name above) during the time period (between September 30 and October 6, 2008) when the test was performed. Actually the test in question was performed by 5 test persons. The view documents three different face characters (neutral, happy, and sad) and the percentage of 15 responses during five days of each test person during the test period.

Figure 4 displays test subjects' mood as a function of time. The test period covers the days between September 30 and October 6 2008. There are five test days, namely Tuesday, Wednesday, Thursday, Friday, and Monday.

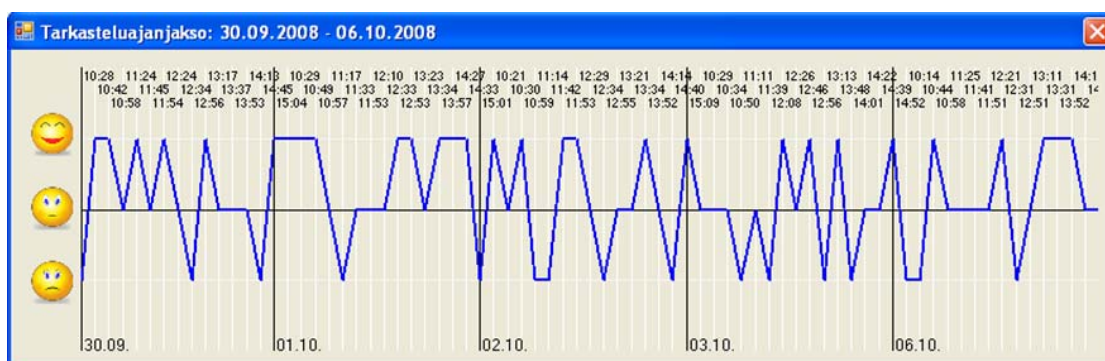


Figure 4 - A summary of the collected data during the test period

The present view on the screen illustrates a summary of the collected data during the five days (between September 30 and October 6 2008) of the experiment after the test persons have pressed the buttons indicating their perceived well-being and mood (happy, neutral, and sad).

The test subjects experienced the “Con-Dis” as easy to use but commented negatively on the grip of the device. The bottom of the “Con-Dis” does not include any surface attachments and thus it slides on a table surface when a button is pressed. Some comments were also made about the positioning of the buttons. The smiley face button was positioned slightly above the other two buttons and thus it was perceived that the smiley button attracted relatively more attention than the other buttons on the device.

During the test period no technical problems were experienced with the “Con-Dis”. The device proved to be countable and stable. There were no power supply failures or system errors either. The moods recorded proved to be 100% correct and the dates and times proved to be 100% correct as well.

Technical information

The “Con-Dis” is based on Atmel’s 8-bit AVR microcontroller, ATMEGA 128, placed on an AVR-MT-128 development board. The development board is stripped of unnecessary components so as to minimise the board’s space requirement inside the device casing. The memory card reader and the buttons on the casing are separately purchased components. The device casing is made of ABS plastic.

Software development

All the functionality of the “Con-Dis” is implemented by software. The software used by the ATMega microcontroller was developed using the C language in the AVRStudio development environment. The program code for the source language is translated into binary code using GCC (GNU compiler collection), which is included in the WinAVR program package. The source language, translated into binary program code using GCC, is written into the microcontroller’s memory. Software libraries licensed under GPL (General Public License) were used to create the device application. The libraries include Procyon AVRlib and EFSL (Embedded File

System Library). The EFSL library includes a finalised implementation in the File Allocation Table (FAT) file system.

A part of the “Con-Dis” device is a simple utility program created using the Visual Basic programming environment. The utility program reads the information on the memory card and presents it to the user, both in percentages and as simple events along a graphical time-scale. The application is located on the memory card. It is started when the user inserts the memory card into the computer. Thus reading the information does not require programs to be installed on the computer.

Freely distributable development tools were one of the choice criteria for the AVRStudio development environment. AVRLib – included in the AVRStudio development environment – also includes several finalised device-oriented routines that noticeably speed up program development for AVR microcontrollers. Furthermore, the FAT file system implementation included in the EFSL library is necessary because the device records the registered information into a text file on the memory card. Additionally, the card is formatted into the FAT file system so that the information can be read using a normal PC – with or without the supplied utility application.

IV. DISCUSSION

To our knowledge, the present report concerning the “Con-Dis” equipment is the first in which a simple device was developed and used to monitor well-being and mood. A simple, countable device was needed in association with other monitoring systems. The present device provides important information to health care staff caring for elderly people. The “Con-Dis” also presents an easy way for nurses to gather the information onto, for example, a laptop computer using a memory stick and, furthermore, to analyze the data.

Perceived well-being and mood reflects well health developments in the near future [2, 3, 4]. Thus, real-time monitoring of well-being may help the medical staff to react early, before any serious adverse health effects have occurred.

The test period was only five days. It is long enough to see how the device collects the information. Many suggestions on ways to improve the device were collected from the test persons. The smiley faces must be big enough to be clearly distinguished from each other and there should be no differences between their positioning. Thus the test persons won't be tempted to press a certain smiley face because of its misleading positioning and the smiley faces will be pressed solely on the basis of the well-being and mood of the patient. The pressing of the button must be definite. The sound feedback that occurs after each time a button is pressed confirms this aspect of the device. The electric operation of the device must be utterly reliable and electric current flow must not be broken at any time. Furthermore, information must remain securely in the memory card. Additionally, the device should not move at all and thus must stay steady on the test surface at all times. This is especially important for the elderly, because of their weakened coordination skills and lack of strength. If the device slides on the surface, it may drop from the table surface to the floor and become susceptible to breakage.

There were no difficulties in collecting the data. The device was highly functional and showed no technical problems. Thus the system was seen as being ready for the extensive testing of patients' well-being and mood.

The ATMEGA128 microcontroller was chosen because of its simplicity of implementation and its low implementation costs [14]. The relatively low performance of the microcontroller is not a limiting factor, since the task performed by the device does not require complex calculations.

The present device is now going through a process of improvement to get a novel device for our field studies. The device will next be used in care homes for the elderly. In future, the information transfer from the "Con-Dis" to a laptop computer will be made wireless. At the moment, WLAN seems like the strongest solution for wireless information transfer from the "Con-Dis". The option of moving the "Con-Dis" information to a central monitoring station in a hospital environment also has been considered.

V. CONCLUSIONS

The present device – “Con-Dis” - was developed to collect data concerning perceived well-being for instance among elderly people. The laboratory tests showed that the device with three buttons representing three different face characters (happy, neutral and sad) was functioning properly and the data could be collected into the memory card of the device and used for further actions. Health care personnel can respond to the signals which persons send to them by pressing the buttons either in weekly health care check-ups or if the data is sent to the health station in real-time monitoring.

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