Personalized Pain Diary on a Handheld Device

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Abstract— **With our ageing society, the group of less-computer literate patients is currently growing. Thus, all treatments involving patient cooperation need to address this type of patient into the procedure, well aware of human short comings in punctuality and reliability. We propose to ameliorate these error sources by making use of computerized time stamps and a sophisticated handheld finger-tip user-interface to support unexperienced patients to maintain a reliable pain and medication diary. The diary is individualized by predefining a set of medications and their proper use by a medical doctor. The pain diary application is running on a state-of-the-art hand-held device featuring touch screen and gesture recognition. The application reminds the patient to judge his/her pain status according to the Visual Analog Scale (VAS) up to several times a day at predefined intervalls. At those given times, the patient inputs his medication intake according to the predefined list or with a free text editor. Other events (like meals or bowel movements) may be manually logged as well. To transfer the data back to the practitioner, the handheld device uploads accumulated data as XML-files by cable connection, or by a secure WLAN connection to a dedicated desktop PC, thus enabling the practitioner to analyze the patient log.**

Keywords— **NRS, VAS, pain diary, iPod, individualized medication, WLAN**

INTRODUCTION

Due to an increased economic strain on the health care system, there is a renewed interest in finding hidden budgetary sinks. One of these sinks may be the waste of improperly used or forgotten medication by elderly patients, which may account for up to 10% of all prescribed medications (Morgan 2001; Department of Health 2004) worth several billion $ per year.

At the same time, the outcome of many prescribed medications for chronic diseases needs to be controlled and properly documented by the patient in between his visits to the practitioner (Department of Health 2004). This is usually done with some type of diary, where the patient (or his caretaker) is asked to log all taken medications, the patients activities and his current situation. Again, human shortcomings and results of old age sometimes lead to unreliable, inconsistent and incomplete documentation, thus impede the follow-up analysis of this data by the practitioner.

To remedy this situation, we propose utilizing an easy to use, senior adjusted electronic device (Forjuoh, Reis et al. 2008; O'Hara, Seagriff-Curtin et al. 2008), featuring both a diary and reminder function. This device should be adjustable to the patient‘s individual medical needs by the responsible medical doctor without compromising ease of use. It should for example feature a diary function to poll at given times the patients pain state according to a Numerical Rating Scale (Schädler, Kool et al. 2006). Additionally, with the next visit to the doctors office, logged data should be transferred to the practitioners own computer system and stored for further analysis with the patient‘s electronic files (see Fig. 1).

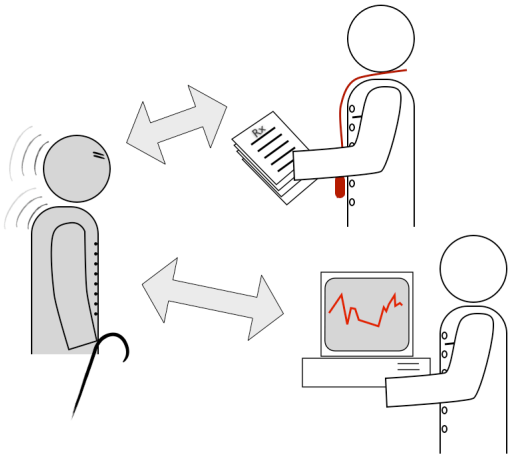

Fig. 1: Sketch of the workflow of individualized use of pain diary.

Fortunately, the ever increasing number of handheld and mobile commodity devices promise a rich feature-set with a wealth of functionality to fill this void. However only some of these devices are suitable to be used by computer-illiterate or elderly patients (King, Ahn et al. 2008). The one we selected is from Apple Inc. (Cupertino, USA) and

feature a unique way of user interface: the *iPod touch* and the *iPhone* are operated by touch only. The user gets a clear human interface which is designed for intuitive use. Most controls are reachable in less than three taps and the buttons can be designed big enough to be recognized without glasses. Both devices fulfill most dialogue principles of the DIN EN ISO 9241-110 for usability engineering e.g. conformity with user expectations and self descriptiveness of the interface controls (ISO 2008). This allows a fast grasp of their handling. The *iPhoneOS* is described (Apple 2008) as a nearly complete *MacOS X,* which is known as high ly stable *Unix* operating systems. This provides a solid basis for the required error tolerance of this standard.

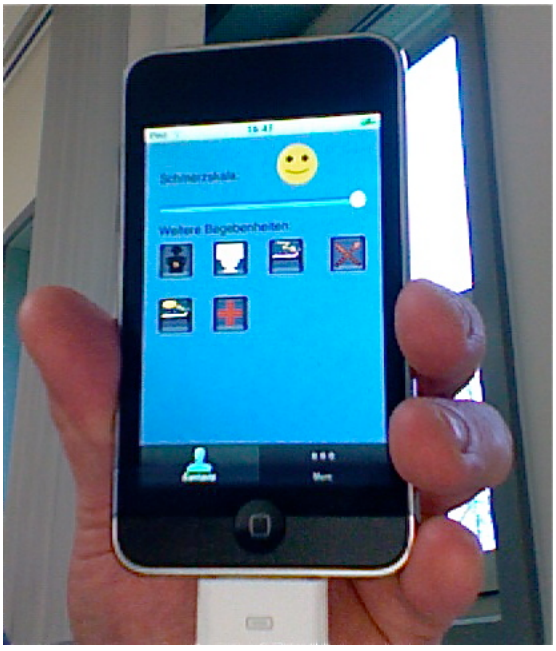

Fig. 2: iPain app running on an iPod touch. The upper trace with the visible „smiley“ is part of the NRS polling interface. Lower icons stand for links to input individual and time-stamped diary entrances.

In the following we present our work on the patient‘s personal health diary called *iPain* running on the *iPod touch*. A description of the practitioner‘s *iPain Suite* to individualize the *iPain* diary with prescribed medicine in the given doses and analyze polled data by WLAN XML-file upload will be described elsewhere.

MATERIALS AND METHODS

I. Programing an iPod

We decided for the given reasons - usability, attractivity, market share, price and programming support - to implement the patient diary *iPain* application on an *iPod touch* (8 GB storage, Apple Inc., Cupertino) running *iPhone OS* 2.2 .

The whole feature set of the iPod‘s User Interface is accessed by the iPhone SDK, running on MacOS computers fitted with XCode programming tools (Apple 2008) . This SDK adopts, without writing any additional code, the predefined and rich feature-sets of Apple‘s software development philosophy, improving usability, cross-application consistency and user expectancy satisfaction. The standard programming language is Objective-C 2.0, a superset of C, with enhancement to object oriented programming. If there is any need to write platform independent code standard C/C++ programming language is permitted. It is even possible to mix C/C++ with Objective C code.

The SDK has e.g. an in-built GUI builder, where the typical *iPhone* controlling interfaces like buttons and sliders are placed on the UI by drag and drop. Involvement of text fields automatically activates orthography checking. Events for the control interfaces are handled by integrated controllers in the Interface Builder. Here, bindings and event evocation are connected with drag and drop as well. Modifications needed for our special requirements were generated and integrated with custom modified controls. Thankfully, Apple provides well structured documentation of their framework and tutorial videos presenting the User Interface (UI) style-guides for the *iPhone*UI on the *iPhone* Developers web site (Apple 2008).

Once the *iPhone SDK* is installed, programming can start in an emulation mode on any MacOS computer. However, transferring the resulting application on an *iPod* requires a special certificate issued by the *iPhone Developers Program* (Apple 2008) to accredited universities for free.

II.The iPain main application

Our clearly marked *iPain* application is started by a finger-touch from the *iPod*‘s main screen or according to the time schedule predefined by the practitioner and evoked by an alarm-clock system with a sound. This event is logged regardless of a patient‘s input.

The application consists primarily of the main screen for polling the VAS pain scale (aka *Numeric Rating Scale-NRS*) by moving a slider with the finger tip to the subjective pain

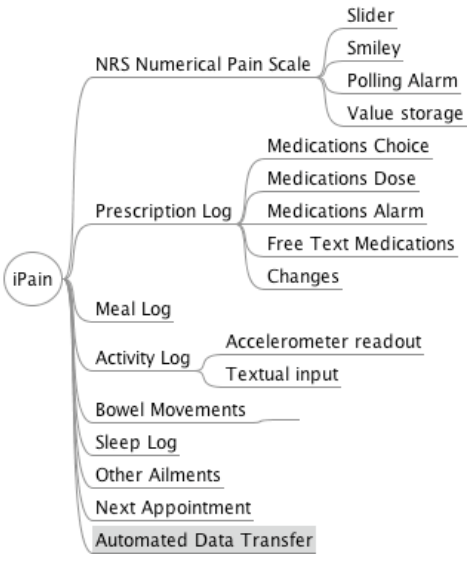

Fig. 3: Overview of *iPain* app

level at this time (see Fig. 4). A „happy smiley“ depicts a painless and sound situation, the worst situation is depicted by an over-exaggerated sad smiley. Due to the big size of the slider-button, this input procedure is an easy task even for untrained fingers. NRS values as well as all other individualized data are saved in an XML-compatible *plist*-file - later to be downloaded to a dedicated desktop computer.

From this main screen (see Fig. 4), several patient-adapted touch buttons open interaction screens like:

- the medication/prescription log
- a meal log
- an activity log
- a bowel movements log
- a sleep log
- an ailment log

Other logs can be easily added, dependent on practitioners definitions.

In addition to the NRS polling, the iPod‘s acceleration sensor data as well as textual input is stored without an UI for later analysis. Clearly, this data set only gives a brief and subjective record in time, but due to the current limitations of the *iPhoneOS*, set by Apple Inc., no continuous and background streaming of acceleration data or GPS positioning data is permitted. This might change in the future and thus will give valuable insights into the patients activity pattern, relevant for medical purposes (Faucheur, Abraham et al. 2008).

III. iPain log screens

One of the most important features of our application is not only to log the subjective pain sensation with help of the NRS scale, but to correlate it e.g. to the ingested medication, the activity pattern, the sleep and meal pattern or bowel movements.

For that purpose, the application provides a dialog screen s for all preset parameters. The prescription screen for example shows a list of preset medications and doses to be chosen from by the user (see Fig. 5). Free text input is possible as well, but has to use the virtual keyboard, which the *iPod* provides.

Fig. 4: Details of iPain app with the NRS scale slider and the predefined sub-menu buttons

Presetting the medications by the practitioner even includes preset timings or intervals for each dose, which automatically activating the reminder feature.

IV. Uploading XML data to the patient file

Each recorded event is stored by its time stamp and the associated inputs in a system-inherent plist-file. These plist-files are XML-conform data sets and are thus easily analysed by an appropriate reader.

In order to get these files on to the practitioners desktop, we are currently using the cable-bound synchronization feature of Apple‘s proprietary *iTunes* software. This requires the user to plug a primed *iPod* into his system and download the *iPain.plist* file for further analysis. With the same procedure, a download of a *plist* containing prescriptions and defining the neccessary log-screens for a particular patient is conducted.

Alternatively, a wireless LAN up- or download is currently under investigation by means of a locally running web server on the *iPod*.

DISCUSSIONS

Preliminary observations with retired, healthy subjects (age > 65yrs.) showed the huge acceptance even enthusiasm when using an *iPod touch*. This is in part owed to the easy

to learn and use touch interface, as well as to the multimedia options provided by this mobile device.

This observation motivated us to consider this commercial mobile system to be utilized for medical purposes. We developed a prototypical pain diary, called *iPain*, to run on the *iPhoneOS*, and such on the stylish *iPhone* or on the more limited *iPod touch* both by Apple Inc. The application acts a reminder to take a given prescription, but polls subjective pain states as well. The core of the application is the

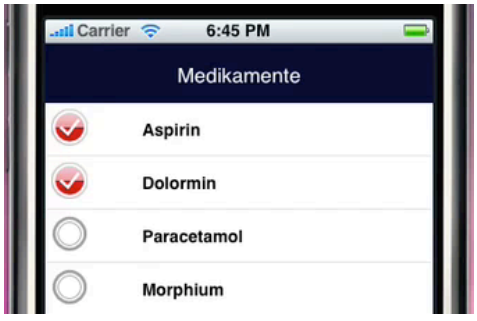

Fig. 5: Details of prescription log with a set of potential medications permitted to be taken. The red ticked ones are actual ingested.

pain scale poll based on the Numerical Rating Scale (NRS or Visual Analog Scale VAS). Several other types of events can be defined and are logged together with the time stamp and the pain data.

Of particular interest is the correlation of medication taken, activity log and NRS values. Medications are chosen out of a preset list and stored with all other data in an XML-type file.

As of this writing, some prototypical *iPod*s with pain diary are in pre-clinical evaluation, in particular to test their interoperatbility with the desktop bound i*PainSuite* to both preset the individual *iPain* diary and analyse collected data.

CONCLUSIONS AND OUTLOOK

The current *iPain* application is clearly still in the prototypical phase of development. However, plans for a small field test study are under way. As soon as Apple permits it, we incorporate GPS and accelerometer logging running in the background. This allows for an improved activity log (Forjuoh, Reis et al. 2008). An improved VAS poll to specify pain locations on the body as well as a simple mental test and WLAN *plist* upload are under construction.

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