

# Two Different Interfaces to Visualize Patient Histories on a PDA

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## ABSTRACT

PHiP (Patient History in Pocket) is a tool designed for a mobile device that displays patient histories and permits to visually query patient data stored in the hospital database. It exploits Information Visualization techniques and it is able to accommodate on the screen a good amount of information that physicians require in their analysis of clinical cases. Two different user interfaces for PHiP have been implemented and informal user testing has been performed to compare their impact on users.

## Categories & Subject Descriptors

H.5.2 [User Interfaces]: User-centered design, Screen design; J.3 [Life and medical sciences]: Health, Medical information systems.

## General Terms

Design, Performance.

## Keywords

Mobile Devices, Information Visualization, Overview+detail interface, Zoomable interface, Healthcare.

## 1. INTRODUCTION

This paper describes two different users interfaces for a mobile device tool that displays patient histories and permits to visually query patient data stored in the hospital database. The work is motivated by specific requests of physicians of a pediatric hospital treating children with neurological diseases. The challenge is to display as much as possible information about the patient history on a limited display space, providing overview data as well as details. The two interfaces differ on the strategies used to visualize the patient histories. The first one is an overview+detail interface [10], the second one is a zoomable interface [9].

Both interfaces have been inspired by LifeLines, a technique for visualizing summaries of personal histories [11]. By displaying on a single screen of a personal computer the overview of multiple facets of records, this technique provides users with a better sense of type and volume of available data. Other systems have been proposed to support medical personnel in their work, but often

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MobileHCI '06, September 12-15, 2006, Helsinki, Finland.  
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they are sophisticated or they need large system resources [2], [3]. To our knowledge, our application is the first one adapting LifeLines on a PDA, thus visualizing on a small screen as much as possible patient data useful to the physicians in their analysis of the clinical cases.

Since the overview+detail interface has been presented in [1], in this paper after comparing the two different strategies exploited by the implemented interfaces, we mainly describe the zoomable interface. It has been developed in order to experiment and verify with users if a zoomable interface is indeed more usable, as assumed by some studies in the literature [8].

## 2. OVERVIEW+DETAIL VS ZOOMABLE INTERFACES

Overview+detail and zoomable user interfaces have been extensively discussed in the literature on information visualization. Overview+detail interfaces show the details of an information space together with an overview of the entire information space [10]. Overview+detail interfaces have several benefits. In fact, navigation is more efficient because users may navigate using the overview window rather than using the detail window [4]. The overview window aids users in keeping track of their current position in the information space [10]. Moreover, the overview window itself might give users task-relevant information and a feeling of control [12]. The dimensions of the two windows in an overview+detail interface is the main factor that the designers of an application for small devices must consider. A large overview permits to display more information and to easily navigate in it; however, it is more difficult for users to access information in the smaller detail area.

Zoomable user interfaces organize information in space and scale [9]. The information space is directly visible and manipulable through panning and zooming, which are the main interaction techniques of these interfaces. Panning changes the area of the information space that is visible, zooming changes the scale at which the information space is viewed so that the user can look to more detailed information. The appearance of information objects is based on the scale at which they are shown. Most common is *geometric zoom*, i.e., the scale linearly determines the apparent size of the object. Objects may also have a more complex relation between appearance and scale, as in so-called *semantic zooming* [7], [9]. A zoomable interface can provide a solution to overcome the problem of limited screen on small device, because it allows the user to view much more information than can normally fit on a single screen [5].

Hornbæk et al. [8] have performed a study to compare overview+detail and zoomable interfaces to understand the navigation patterns and usability of these interfaces. The users

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Ardito C., Buono P., Costabile M., Lanzilotti R. (2006). Two Different Interfaces to Visualize Patient Histories on a PDA. In Proc. of MobileHCI '06, Espoo, Finland. September 12-15, 2006. (pp. 37-40). New York: ACM Press (United States). ISBN/ISSN: 1-59593-390-5.

preferred the overview+detail interface, though they were faster using the zoomable interface. Common expectations about difficulties with zoomable interfaces were not confirmed in that study. Conversely, authors found that zoomable interfaces offered certain benefits compared to overview+detail interfaces.

### 3. TOOL DESCRIPTION

PHiP is a tool designed to support the neurologists in the treatment of patients with neurological troubles; it is intended to make available on mobile devices some sections of the patients' paper-based records and to implement features and functionalities that neurologists consider relevant to treat neurological diseases. The development of PHiP is carried out in collaboration with physicians of a pediatric hospital. Several important indications emerged from the field study performed during the requirements analysis. First of all, it is very important for the neurologists to analyse the patient history since epilepsy is a disease that may last many years. Neurologists want to have information such as periods during which the patients were hospitalized, types of seizures, different combinations of drugs they took during their disease history. Another indication is that the drugs that really work for the neurological children patients are a small number, less than twelve; some combinations of them are prescribed to the patients during periods of time and the neurologist knows what was prescribed. Another important information is the relation between the prescribed therapy and type, intensity and frequency of the patient's seizures. We therefore realised that neurologists could greatly benefit from having an overview of multi-dimensional, time-oriented data related to all patient hospitalizations, medical controls, therapies, seizures.

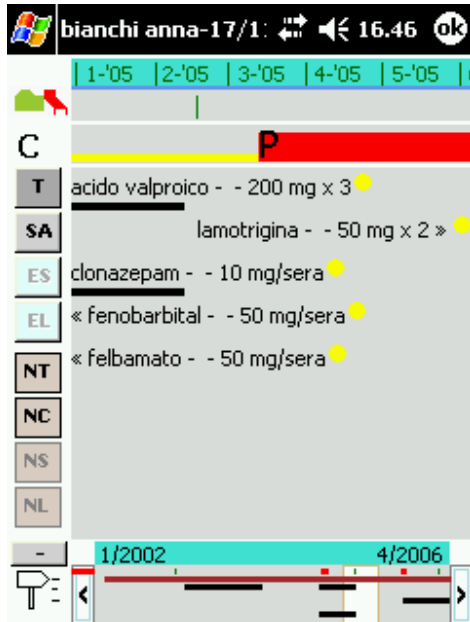


Figure 1. Overview+Detail interface of PHiP

The PHiP overview+detail interface has been presented in [1]; the main screen of this interface is shown in Figure 1. The display is divided in two main areas: the bottom one, below the green bar with 1/2002 and 04/2006 at the sides, is the *overview area* of the patient history; the top larger area is the *focus area* and shows a

zoom in a five months period of time. In the overview area, various information is summarized through colored line segments that we call bars. The bars along a line immediately below the ticker green bar represent hospitalizations or medical controls, in red and green respectively. The bars on the lines below represent the drugs prescribed in the shown time period. The white strip in the overview area represents a lens: it permits to zoom on the information covered by the lens, which spans over five months, and to show it in the focus area. The user can move the lens by either clicking on another point in the overview area or move it gradually by clicking on the single-arrow buttons at the extremes of the overview area. In the focus area, hospitalizations and medical controls are shown along the top line below the month bar using red and green colors. Immediately below there is a bar indicating patient's seizures, with color, bar height and label coding important seizure parameters. In the remaining part of the focus area, details about the prescribed drugs are shown. Each drug is represented by a black bar indicating the time period in which the drug has been prescribed and a textual label explaining the name and the posology. More details on this interface can be found in [1].

The main problem of this interface is the overview area dimension: testing the tool with neurologists, we have observed that bars representing data are too small to communicate useful information or to interact with them. The overview area is mainly used to change the focus area by means of the lens. To overcome these drawbacks, we have developed an alternative version based on a zoomable strategy. It permits to display more information thanks to the absence of the overview window. Furthermore, when zooming out this interface at the highest level, the user gets an overview as large as the whole PDA display.

The main screen of the PHiP zoomable interface is shown in Figure 2. It appears once the user (we suppose a male neurologist) has selected a patient list, whose name and birth are now shown at the very top of the screen. The patient history shown in Figure 2 spans from January 2002 to December 2006 as indicated by the year bar. The user can change the range of the displayed time period by tapping on a year, which is now highlighted in red, and dragging up the slider control on the right side of the screen. The system responds by zooming in the selected time period. The highest zoom level shows a time period lasting one year divided in four trimesters (see Figure 3). The user can pan the screen by dragging down the slider control. If the user wants to visualize a previous (or subsequent) time period, he drags the screen left (or right).

In the example displayed in Figure 3, various information is summarized through colored bars. Hospitalizations and medical controls are shown along the top line below the year bar using red and green colors: they never overlap because a patient might either be hospitalized or go to the outpatient clinic for a medical control. In the period January-December 2005 the patient had a medical control in March, and was hospitalized from end of September to beginning of October. User can require detailed information: tapping on a period in which the patient was hospitalized, or on a medical control, allows the physician to see details related to that event, which appear in a pop-up window.

Next bar below represents patient's seizures. Neurologists classify three types of seizures: P for partial, G for generalized, PG for both. The intensity is represented by colors: red for high, yellow

for medium, green for low. Finally, the bar height indicates the frequency (low, medium, high); in a time period without seizures, the bar is not shown. In the example of Figure 3, the patient had very frequent and severe seizures from March to October, then they were weakened. The bars below represent the drugs prescribed in the shown time period. For each drug the name is shown; a bar starts from the day in which the patient took it and ends when he/she stopped the treatment. The color of a drug bar indicates the side effects of that drug: red for not tolerable, yellow for tolerable and green for no side effects. The drug bar is black if the side effects were not reported. Figure 3 shows that the drug “Felbamato” is taken from April to July 2005 with not tolerable side effects. If a drug was prescribed in a period that is not displayed, the label is shown without the bar and arrows on the left (on the right) indicate that it was taken in a previous (in a following) period. In Figure 3, “Fenobarbital” is a drug that was taken before January 2005. This is important because for neurologists it is important to know if a patient already got a drug at a certain time of his/her life.

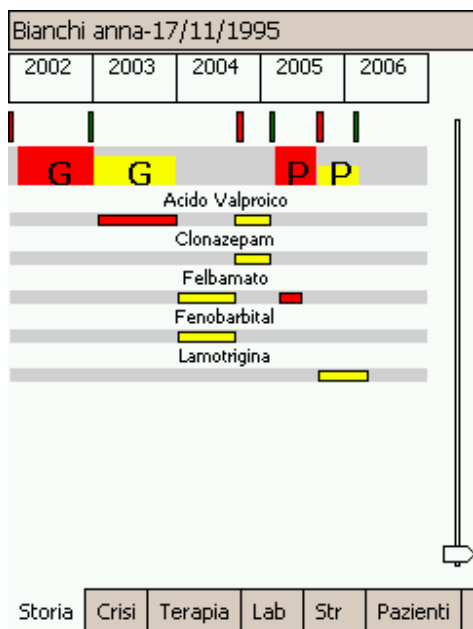


Figure 2. Zoomable interface of PHiP

By tapping on the drug, neurologist can view the time periods when the patient took it together with details about posologies and side effects. The pop-up window in Figure 4 explains that “Acido Valproico” was taken three times a day in two periods: from January 2003 to December 2003 and from September 2004 to February 2005 in a quantity of 150 mg and 200 mg respectively.

The tool allows neurologist to visually perceive the patient’s response to a therapy. In the example of Figure 3, before the patient was hospitalized in September 2005, her/his seizures were partial, very frequent and severe. During the hospitalization, the drug “Lamotrigina” was prescribed and the seizures were weakened.

PHiP permits not only to view the patient history, but also to update some information through the buttons at the screen bottom. The button “Crisi” (button labels and other text are in Italian)

allows the neurologist to display a window where he can insert attributes of new seizures by means of radio buttons. The button “Terapia” is to modify the prescribed therapy, while “Lab” and “Str” permit to insert data on further laboratory and instrumental tests respectively. A new tap on the “Storia” button sets the display back to visualize the patient history. The button “Pazienti” allows neurologist to select another patient from a list.

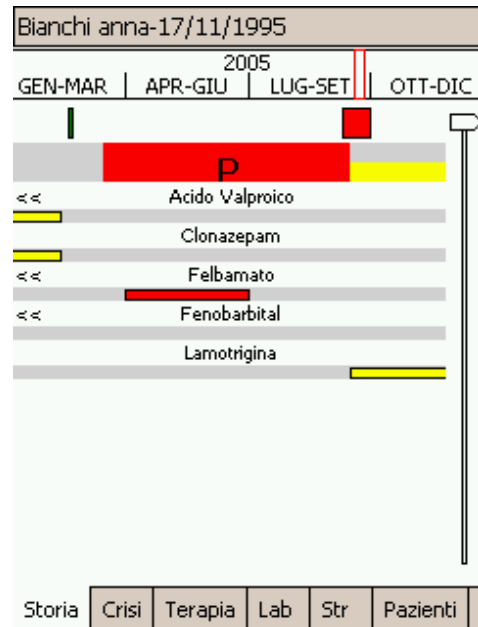


Figure 3. Zooming in a time period lasting one year

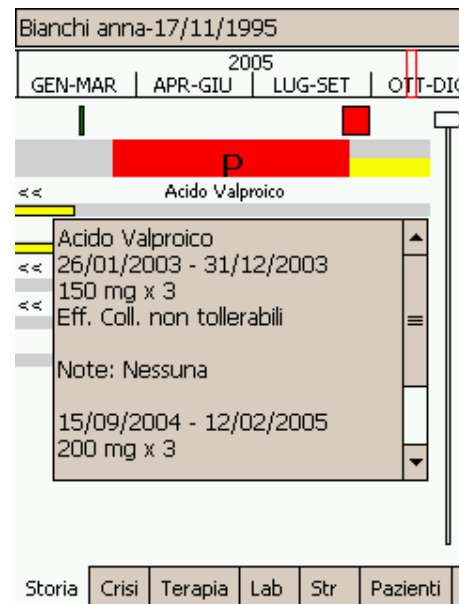


Figure 4. Details for the selected drug

#### 4. TOOL ARCHITECTURE

This section presents the application architecture we have developed. We designed PHiP taking into account the daily work of the neurologists and the different situations in which they need

to access to patient records, such as in a ward round when the patient is hospitalized, during a medical control, on a telephone call for an emergency.

There is a single underlying database that contains all relevant information about patient personal data, medical controls and hospitalizations. Neurologists can still use the previously existing application running on a PC. PHiP allows neurologists to access the same database through the PDA. Specifically, neurologists can load data about patients by connecting the PDA directly to the database by means of the Sync manager before doing their daily ward round, or during a medical control in the outpatient clinic.

In case of a telephone call for an emergency because a patient seizure is occurring, neurologists may not have time to synchronize data and will access them connecting on Internet. The Web architecture includes a request manager that receives the requests from the mobile device, authenticates the user and calls the database manager in order to perform the right query and to retrieve the needed data. The database manager calls the XML manager module that, from the query result, builds the XML file to send to the client. Then, the HTTP server sends the response to the client.

There is also the possibility to connect to the server by using a normal browser from a PC. Since we send XML file to the client, it is possible to associate XSLT and CSS files that permit to present the information to the client in different forms depending on the client. Currently, the database is Microsoft Access because it was already used in the existing application. The PHiP application we have implemented uses Apache 1.3.20 Web server combined with PHP 4.0.6 language for server side scripting. The PHiP client application is developed with C# language and runs on Pocket PC OS and .NET platform. It uses the Piccolo toolkit that support interactive 2D structured graphics applications, and zoomable user interface in particular [6].

## 5. Discussion and Conclusion

PHiP has been developed according to a user-centered approach, thanks to the collaboration of the physicians of the *Giovanni XXIII* pediatric hospital in Bari, Italy. Beside the user studies conducted in the hospital at the requirement phase, we have performed with neurologists evaluations of the different prototypes, up to the final prototypes shown in this paper. From two to five neurologists were involved in each evaluation. Interviews with neurologists confirmed that the developed application is a valid support to their activities. The zoomable interface has been implemented for two main reasons: 1) some papers in the literature indicated that these interfaces are usable; 2) some physicians, especially those with sight problems (typical of more aged people) indicated that the small overview did not provide meaningful information. Since indeed the overview area covers a portion of the already small PDA screen, we decided to implement the zoomable interface.

So far we have not performed a rigorous user study to compare the two interfaces of PHiP. However, a real implementation of PHiP on a PDA is available and has been tested with the physicians collaborating in our project (PHiP can be demonstrated at the conference as well). We have observed them interacting with the mobile device and performing a set of predefined tasks. This preliminary study actually confirms that users prefer zoomable interface. They appreciate the availability of more

screen space that permits to display more data. Zooming and panning are very efficient operations that provide neurologists a more meaningful overview of the patient history, without limiting the possibility of focusing on detailed views. More importantly, changing the displayed time period is faster on the zoomable interface than it was moving the lens on the overview area and getting the corresponding information on the focus area.

Even if the current implementation of PHiP shows histories of patients affected by epilepsy, the neurologists suggested that it can also be used for diseases in which other types of seizures provide significant information, as it occurs in several neurological diseases.

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