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Application of an Intelligent Graphical Interface to Electronic Patient Records

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Abstract

Physicians are under a lot of pressure to perform. The power of the computer can be used to reduce the cognitive stresses. The use of an intelligent graphical interface can tailor the information that is presented to the physician. The user can be assured that all the information is presented and that important facts are brought to the users attention. The screen displays can be made to be self organizing. This saves the user the effort of moving and resizing windows. The technology to do this has been developed and has been applied to a web browser interface. This paper describes the advantages of applying this technology to medical records databases.

Keywords:

intelligent graphical interface, electronic patient record, human computer interface, human factors, medical informatics, cognitive load

Introduction

Current interfaces generally offer a keyhole view of data that is in computer systems. The state of the art in currently available electronic health records programs does not take advantage of more advanced interfaces that are possible. The domain of clinical medicine is very complex and clinical users have to work under severe time constraints. They are expected to not make mistakes. Mistakes are being made and a large number of patients are not getting treatments that are generally recommended. Simple preventive measures are not carried out. These problems would all be reduced if the clinical practionner had some assistance that computers can provide. Time constraints do not allow for a leisurely perusal of the data. On the other hand the physician is concerned about neglecting important data. Advanced interfaces are capable of displaying large amounts of data on a single screen. 10,000 lines of code can be displayed on one screen. The lines would only be one pixel high but could be colour coded to instantiate some meaning into that line. When areas of interest are identified the size of the line can be expanded to the point that it is readable.

The initial issue that can be considered is the problem of the volume of data that can accumulate on a patient. Some patients may have only a few pages that record their medical encounters going back several years. Other patients may have records that span several volumes in the primary care physician's office and also have voluminous records in multiple other locations. Patients may have problems related to only one system or multiple problems that involve several specialty areas. Patients may visit the doctor for a single routine problem or have one visit that touches on multiple problems. The physician will rely primarily on memory or what ever records are available at the time of the visit. If the doctor cannot find lab results quickly there is a tendency to just order some more tests [1]. A considerable portion of the encounter time is spent grazing through the paper chart. If the electronic record is not designed properly can be even more difficult to scan than the paper chart [2]. Physicians would like to base their decisions on as much information as they can. This information needs to be organized in such a way that it can be assessed quickly with the physician having the confidence that all the relevant information has been seen. As the volume of information grows the need for indexing and flagging certain information becomes more and more important. It is also important to keep the user oriented and to display the context of the information [3].

The intelligent interface should be able to notify the physician that new critical lab results are in the database and they have not be reviewed. If treatment guidelines change or if there is a newly identified problem with a medication the physician should be notified. These functions would deal with the overall practice. At the individual patient level there should be a single screen that displays the current status of the patient. This would include current medications, current problems, recent lab results, dates locations and reasons for recent encounters. There should be some indication as to the content of the various components of the electronic record.

The intelligent graphical interface or IGI, was developed about 5 years ago [4, 5]. This technology is capable of providing the functionality described above. This system was initially developed to allow a single operator to monitor a large province wide system with 130,000 monitoring points. The novel idea in this proposal is to apply this

computer tool to monitoring a database. This concept was discussed with some of the developers of the IGI. They felt that it should be possible to monitor data in a database just as easily as monitoring a live online system.

The IGI has the ability to have embedded rules that would look at the content or the data and then affect the screen display. This could provide warnings to the user or draw attention to areas that should be noticed. Clinical guidelines and protocols are widely available that cover many topics. A very exciting product in the Untied Kingdom is Prodigy [6]. This source of reference material has been integrated with several of the software products available to physicians in the UK. These can be used to create the rules that the IGI can use to control the screen displays. Some of the rules would be designed to trigger when a given user logs on. Other rules may trigger when a specific patient is selected. Some rules may be designed to trigger as new data is entered. An example would be if a new medication order is entered the rules would check the allergy list and the problem list.

Work will have to be done on how to organize the data entry screens and the screens used to display information. The IGI interface will make it possible to provide the user with a general overview on a patient and then the ability to drill down to specific data in areas that attract the users attention. The intelligent zoom function of the IGI would manage the overall screen display.

Some of the features of the IGI have been used by Thoughtshare a company that developed a web browser interface [7]. This product demonstrates the automatic zooming and icon repositioning features of the IGI.

As it is possible to have very complex systems it is increasingly important that attention is paid to how human attention, location indexing and supervisory control are allowed to function. Current technology makes it possible to have adaptive and intelligent interfaces which provide high bandwidth interactive communication between the user and a complex system [5].

The main issue in human-machine interaction is to obtain a "collaboration situation" between a human user and a computer system [8].

The following techniques can be employed in intelligent interfaces:

- **User Adaptivity**: Techniques that allow the user - system interaction to be adapted to different users and different usage situations.
- **User Modelling**: Techniques that allow a system to maintain knowledge about a user.
- **Natural Language Technology**: Techniques that allow a system to interpret or generate natural language utterances, in text or in speech,
- **Dialogue Modelling**: Techniques that allow a system to maintain a natural language dialogue with a user, possible in combination with other interaction means (multimodal dialogue),
- **Explanation Generation**: Techniques that allow a system to explain its results to a user [8].

The IGI system can encompass all of these techniques except for the natural language function.

Materials and Methods

Some of the IGI technology was licensed to ThoughtShare Communications. This company has produced a web browser interface that demonstrates some of the features that would be of interest as a front end to a medical records system. The free software was downloaded and installed. The user can connect to the web using widely available browsers. With the ThoughtShare program running in the background web sites can be accessed and the site address can be captured. There is an area where annotations can be made or text copied from the web page can be pasted into the note field. In addition to having web sites displayed on the screen, filenames can be dragged from directory lists and dropped onto this screen. The user can save this map and it can also be edited. The mapping can be attached to email and sent to other users. Figure 1 shows a Thoughtshare screen with some informatics websites displayed.

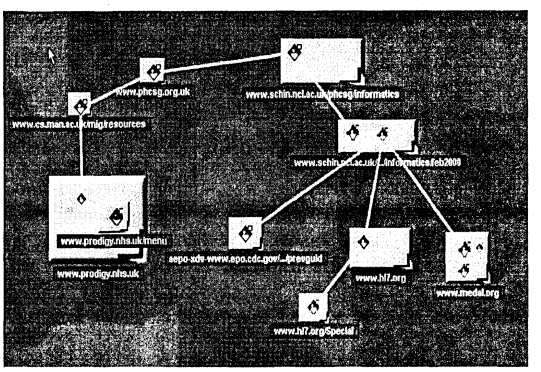

Figure 1

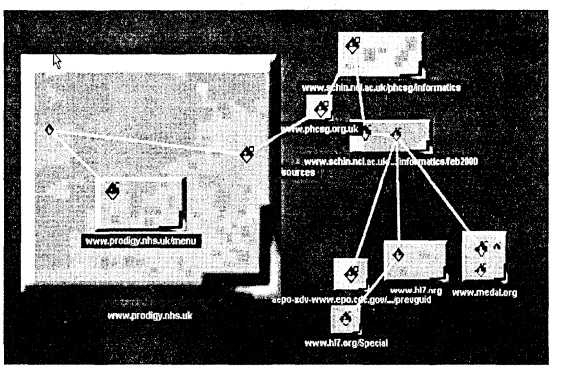

Figure 2

Figure 2 shows the same sites but the larger site at the bottom left corner has be enlarged by clicking and dragging to make it bigger. This figure also shows the other sites on the right side after they automatically shifted to accommodate the site on the left but all of them still remain visible. When this particular feature of the IGI was demonstrated to various users. The usual response was that of amazement, or literally "Oh wow".

These two figures demonstrate only the intelligent zoom aspect of the IGI interface. The full version also allows for the embedding of rules that would alter the display of the icons. The IGI interface allows incoming messages to trigger rules that would change the appearance of the icons to attract the attention of the user.

Figure 3 shows how an electronic patient record could be organized for this type of interface.

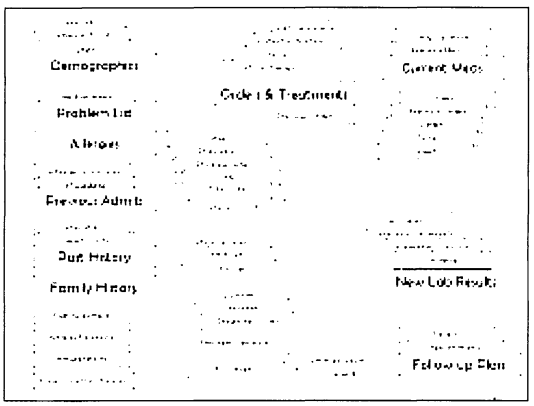

Figure 3

The boxes shown in Figure 3 would provide the basic framework. All of the boxes represent a way of categorizing the various types of information that are commonly encountered in primary care. The boxes with the larger font represent data that could be aggregated into a patient summary. The display attributes of each icon could indicate if there is any data in that area, the age of the data, rules could trigger other attributes that would attract the users attention. Attention should be paid to the semiotics of the display. Green could be used for fresh new information, brown for old faded information. Symbolic representations are hard to get right and personal preferences should be allowed for. A new critical lab result could cause the Lab **New Lab Results** icon to flash or move or even open up and display the specific result. Having all the other boxes visible would help keep the information of interest in context.

Discussion

The office environment for physicians is a time pressured situation where information has to be gathered quickly, historical data reviewed and decisions have to be made. This has to happen with consideration given to the limited human cognitive ability. There are also great concerns about the increasing volume of information on healthcare that is being produced. The number of new medications, protocols and guidelines has reached staggering proportions. Adaptive intelligent interfaces are capable of assisting the physician in the day to day provision of health care by helping to organize and manage the display of this information. Combining the IGI tools with reference systems like Prodigy would make a powerful tool to assist the physician.

Conclusion

It has been demonstrated that the IGI technology can be adapted and provide a useful platform for organizing and browsing information. The next step is to work on adapting this technology to an electronic patient record system.

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