

A Web-Based Multiuser Interface to Medical Information Systems

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Extended Abstract

A computer-based patient record (CPR) was defined in 1991 by the Institute of Medicine, National Academy of Sciences as "...an electronic patient record that resides in a system specifically designed to support users through availability of complete and accurate data, practitioner reminders and alerts, clinical decision support systems, links to the body of medical knowledge, and other aid ..." [Dick91]. Recent developments in computer networking and telecommunications, however, have expanded this definition to include integration of CPR systems with other systems used in applications such as diagnostics or insurance that are already in use by health-care organizations.

Such integration can even conquer geographic distance, as shown by the emergence of "collaboratories" [Kouzes96], virtual environments that support remote interaction and sharing of data or resources among scientific researchers separated by long distances. Certainly, this approach can apply in the medical community as well: using telecommunications to support remote access to a CPR system would allow a patient's record to be accessed by an authorized user from anywhere. This technology could also be applied to more comprehensive data files, such as a national medical research database.

Unfortunately, the medical community has been slow to adopt these technological advances, even at the most basic level. Despite the obvious benefits of integrated hospital information systems, a recent study [Anderson97] showed that not a single hospital out of 360 surveyed had integrated their separate computer systems into a comprehensive unit. Some work has been done in developing "virtual patient records" that provide access to health data regardless of the user's (or the patient's) location, but even these only provide a single interface to the entire patient record. This clearly affects both the performance and the security of the system.

Current database design theory emphasizes that a database system should grant only as much access to a user as is need for that user to complete his/her task. This makes the issues of performance and security much easier to manage, as any user only sees what is authorized and necessary at that user's level. Where multiple users are involved, therefore, the database should provide multiple views of the data that the database contains for each specific type or "role" of user. Furthermore, the database could even provide a view based on virtual data that is derived from the database but never stored there.

Multiple views of medical information can be provided through the use of relational database management systems. However, the problem in providing remote access to such as system is that most currently available commercial systems, e.g., Oracle, are complex and difficult for the non-specialist to use. In addition, any remote user would likely need a license for the software to interact with the database directly. A preferable approach would be to develop a system with a familiar and widely available interface that could provide access to the database information without relying on the database management system.

Our suggestion is that the World-Wide Web provides exactly this kind of interface. Since the Web relies on TCP/IP protocols for its telecommunication, access can be granted to multiple users simultaneously, on all types of machines. Through the use of the Common Gateway Interface (CGI), an HTTP server on one machine can exchange information with other machines in a programmable but flexible manner. Depending on the client's request, a CGI specification on the server can allow the server to call up different documents, as well as create new documents dynamically based on parameters included in the request.

Furthermore, HTML code supports various tags that allow a Web browser to display an HTML document with embedded graphics, text fonts and colors, etc. Among these is the *form* tag, which lets the user input data in a specified format and send it to a location on the server for processing. This allows a browser form to be developed that can be customized for a particular user role.

Using these features of Web technology, we have implemented a prototype for a multiuser, Web-based interface to electronic patient records. The various roles of users in the system are represented by different interfaces: patients, lab technicians, nurses, and doctors all see different sets of information. Furthermore, the ability of one user to modify information is limited; for example, a doctor cannot change lab results, although he/she can write a comment regarding the results. Since the information is accessible through a Web browser using forms and CGI programs, remote access is simple and straightforward, and requires no access to the database management system itself.

Due to constraints on the available equipment, we chose Perl as the application language for our prototype system. Perl has been described as "a rapid prototyping tool and full-fledged application language" [Kim98]. In addition to its ease of use, Perl provided

object-oriented modules for specific tasks that we needed, such as CGI interfaces and graphics.

The architecture of the prototype is shown in Figure 1 below. The four separate modules represent the four roles of users in the system; a dispatcher decides which module should receive a URL request from the Web interface. Depending on the request, the receiving module accesses the patient database and produces various reports and/or updates to the database using HTTP form data entered by the user.

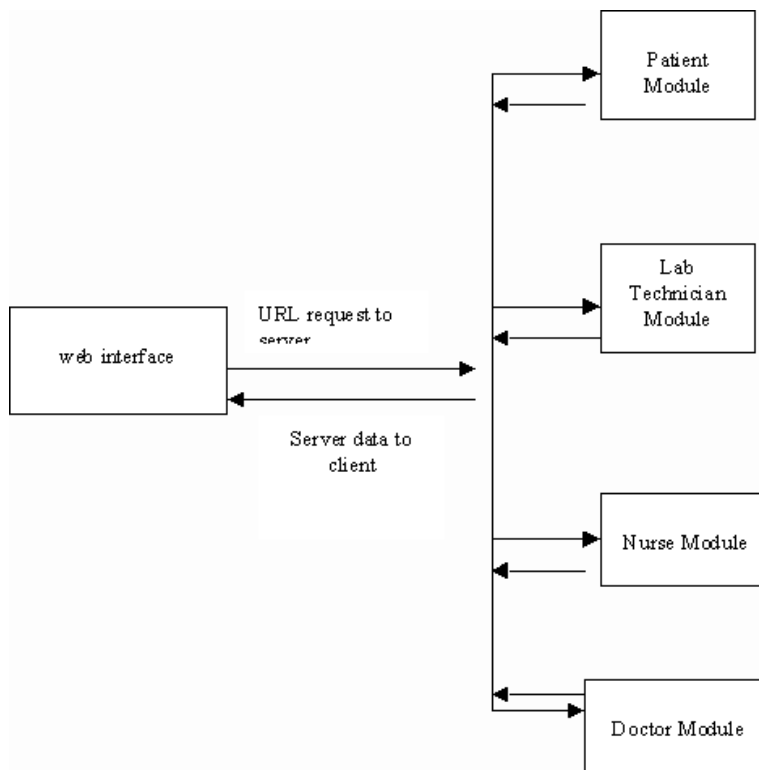


Figure 1. Architecture of the prototype system.

The initial interface to the system consists of forms that provide four separate login screens for the four user roles, as shown in Figure 2. To the user, these login screens appear to be four separate subsystems; in reality, however, they share access to the patient records as well as subroutines for common tasks such as input, output, and database access. Once a user logs in with username and password, the appropriate "subsystem" displays the forms needed to access or update the patient record, depending on the role. The patient, for example, can update personal information such as age, address, etc., while the lab technician can enter lab results for a given patient, who is identified by a unique patient number that is provided as part of the lab request. A nurse can fill in physical data such as temperature, weight, blood pressure, etc.; in our

prototype, different forms are available for a patient depending on factors such as his/her age. The fourth module is used by the doctor, who can view all the patient information in a record and can enter new information regarding diagnosis and recommended treatments.

While this system is not yet a fully functional medical information system, it illustrates the feasibility and utility of a multiuser, Web-based interface to such information. We have demonstrated the prototype to a number of potential users in the medical community and have gotten valuable feedback on the design and interface of the system, which we are using to refine the system. Our goal is to re-implement the system using a more powerful relational database management environment (such as Oracle), which should provide use with better concurrency control, performance, and multimedia data handling. We also intend to add security measures to the system beyond the simple password protection scheme we have used thus far, both within the system itself and for the transmission of medical information over the Internet.

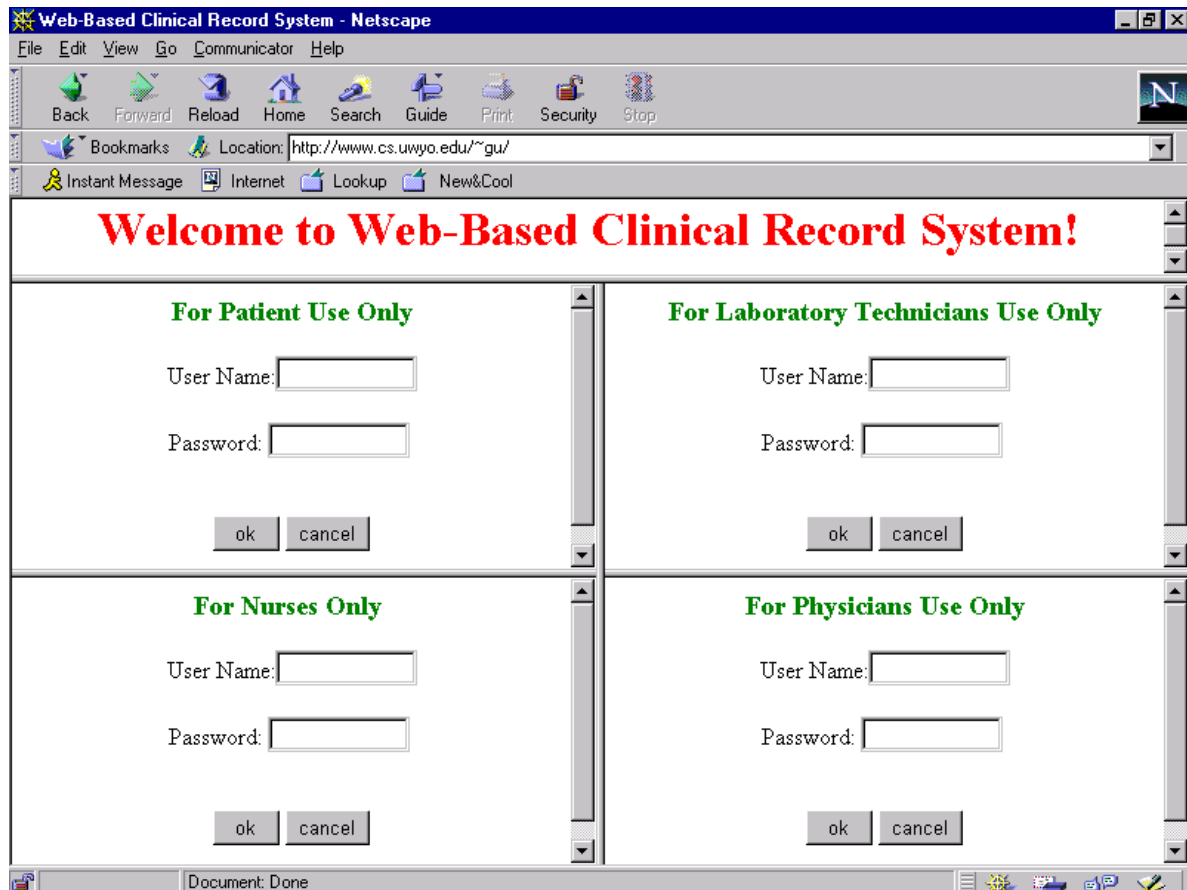


Figure 2. Initial interface of the prototype system.

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