Teledermatology: an experience in Tucumán

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Abstract. Since 2006 projects have been carried out in the Universidad Nacional de Tucumán to introduce Telemedicine in the Provincial System of Health (SIPROSA) in Tucumán, Argentina. These projects aim at improving accessibility to remote populations, providing equity and avoiding costly and unnecessary transfers as well as helping early diagnosis and treatments, timely and appropriate referrals. On the other hand, this consultation has already been set up within the SIPROSA with the application of the system of reference and counter-reference for several years. By applying Telemedicine it is possible to accelerate the times and make this more efficient. This paper presents a prototype Web application for performing consultation in dermatology. These were conducted by professionals in Ranchillos, a small town within the Province, together with specialists from the capital city. After the experience, it can be said that the teledermatological application of the platform has been well received by physicians and dermatologists of rural areas, especially because the interfaces could be adjusted to their requirements. The physicians consider it a useful tool to complete the process of referral and counter-referral.

Introduction

Public health is one of the main challenges for developing countries. Having both material and human resources to solve major health problems of the population is a difficult goal to achieve. In many cases the application of cost-effective technology, easy to use and accessible both to patient and doctor can help. This is the case especially in rural and marginal urban areas. Telemedicine has been used for over 50 years for this purpose. [1]

Already in 1998, the WHO defined it as "The provision of health care services where distance is a critical factor for professionals who appeal to information and communications technology to exchange data for diagnosis, to improve and indicate treatment, for the prevention of diseases and injuries, as well as for the training of health care professionals and for research and evaluation in order to improve the health of people and the communities they live in..."

In Tucumán, Argentina, the Department of Bioengineering of the Faculty of Science and Technology and the Institute of Bioelectronics of the School of Medicine, both from the Universidad Nacional de Tucumán, have undertaken projects to introduce Telemedicine in the Provincial System of Health
(SIPROSA) since 2006. Such projects aim at improving accessibility to remote populations, providing equity and avoiding costly and unnecessary transfers as well as helping early diagnosis and treatment, timely and appropriate referrals.

Among them, a system has been developed that includes information storage, acquisition, distribution, modification and display of images in JPG, PNG, TIFF and BMP formats, performance management, remote communication through a Web page for the exchange of images and security through access control. You can use these elements in conferences between health workers allowing, at the same time, the exchange of experiences and information between them.

Moreover, the consultation has already been set up within the SIPROSA, with the application of the reference and counter-reference system for several years. By applying telemedicine it is possible to accelerate the times and make this more efficient.

In a previous study we described a first prototype used in cardiology. [2]

One of the specialties in which they began using the Web developed prototype is Dermatology. The use of telemedicine in dermatology is based on the fact that its queries are based primarily on thorough medical records and a proper physical inspection, so if the records and the images sent are right, the professionals will be able to issue a diagnostic opinion and a treatment appropriate to the patient's condition. [3]

In the rural areas of Tucuman and other regions of Argentina, it is very common to develop dermatological diseases, but the visit to a specialist’s office is difficult because of inaccessibility and lack of Human Resources. To cover this deficit, a network was organized, where doctors or Health Care Workers in rural centres, when consulted for skin disorders, could use digital photography, chat and standardized default medical records, thus connecting peripheral health facilities with specialized services and the Department of Dermatology using our Web application. [4]

In Tucumán, specialists far from the capital do consultation with those belonging to the Department of Dermatology at the UNT, located at Hospital Avellaneda. Until the implementation of the new system, the consultation was performed by the specialist himself who had, to the extent of his possibilities, to take the photos of the patient and the corresponding medical records and tests to the capital. Though the proceedings are set, they are not available and the course of action is left to the initiative of each professional.

The experience was performed with professionals from Ranchillos. This town has 19,000 inhabitants and is located 25 km. from the capital. This population suffered from common and frequent dermatological disorders. The professionals agreed to use the system and they even suggested some changes. A medical record was included more in agreement with that used in the service.

The aim of this paper is to show aspects of specialization of a Web system already developed as a general telemedical platform to be used in dermatology and to establish a synchronous and asynchronous consultation protocol.

**System Features**

We used the web platform prototype developed and described in a previous paper to record multimedia clinical information, that is, the storage of both text data from entry forms from typical medical records, including multimedia information from electrocardiography, electroencephalography, evoked potentials, ultrasound, photographs, etc. The information can be used through the conference module, where the different actors can communicate via chat. All information generated during the conference is kept in the database, which allows speakers to interact at different times. [5] [6]
From a functional point of view, Figure 1 shows a diagram of the computer system components. Internet is the central element that allows intercommunication between the different actors from different types of terminals, both fixed and mobile including exchange of text, voice, images, videos, etc. that support complementary diagnostic methods.

Internet, applications and databases servers are necessary for the operation and are the means to carry text, images, etc. into the web. But at least at an experimental stage, where the volume of data and transactions is low, the sizing of these resources does not require too many considerations, contrary to what is planned for a period of extensive use, when the safety aspects, efficiency, etc. should be considered as distributing applications and data on properly sized servers.

For users of the system, PCs, notebooks, PDAs, etc., are elements of access to all functionalities of the system. Typical system actors are, on one side, rural doctors and health workers at the rural hospital, who require a system support service that provides information on the condition of the patient; and on the other, a specialist who, from central hospitals or from any device that can access the web, brings expertise to provide solutions to the original request.

The information sent comes mainly from the output of diagnostic equipment, so it has different formats depending on which testing equipment it comes from. The reading of the source files is made using a format analyser that checks the input format with the format the application has previously registered (jpeg, avi, mpeg, etc., additional modules to interpret other formats can be added later). This is integrated with patient’s information (personal and clinical data, etc.) that will constitute the basis of the exchange between actors, that is, the conference.
In Figure 2, we see the two most important aspects of the system: the management of multimedia patients’ clinical data on the left and the conference itself on the right. Both upper cylinders symbolize the database where information is kept. It can be seen, in the top panel of the figure, that the conferences are also kept in the database. In the lower panel accesses to the patients’ clinical records (PCR) are represented, through information management modules and views, both capable of being specialized as revealed by the requirements engineering. It also shows the PCR data view from the conference to which you add a chat room.

In particular, and as a current example, the teledermatology application consists of specialized interfaces tailored to their needs and, speaking in terms of software architecture, a control layer that connects these interfaces to the kernel.

The development evolves from a prototype, as it seeks early interaction with users to achieve intuitive interfaces according to their needs. Furthermore, we use aspects of technologies under the Web 2.0, fundamentally AJAX, which allows a similar behavior to that of a desktop application using asynchronous communication between client and server. Figure 3 shows a diagram of the layers underlying the prototype of the Web application.

![Diagram of layers](image-url)
It should be noted that while in this paper we present a teledermatology application of the platform, the conditions which have led to the current characteristics, in terms of architecture and software design, have been derived from different medical specialties with particular visions of the best approach to the “remote” analysis of patients and their diseases. Thus, the design is based on a common core that manages patients’ information, with interfaces tailored to different needs arising from the requirements set by each group of health workers.

The current state of part of the application interfaces is geared to all the information needed by specialists of the Department of Dermatology of the School of Medicine (Universidad Nacional de Tucumán). These are a set of forms ready for data entry, general history of the patient, current consultation cause, personal and family history of present illness, diagnosis (or diagnostic opinion), etc. Some of these are multimedia forms, that is to say, they allow the entry of text as well as pictures, videos, etc. To sum up, they make up a multimedia record of the patient clinical data, organized hierarchically.

![Figure 4. Tree structure](image)

**Scenario of rural teledermatology**

Below is a case of typical system usage to show the different user interfaces that occur during the sequence of tasks.

Its aim is that a doctor at a central hospital (CHP-Central Hospital Doctor) assists in the diagnostic evaluation and proposes a treatment for the patient, based on information that the rural hospital doctor (RHP- Rural Hospital Doctor) entered in the PCR and what was discussed during the conference.

In particular it is a consultation about a skin disease, which originated in the town of Ranchillos, Tucumán, located 25 km from the capital. The specialists consulted are from the Department of Dermatology of the Medical School of the Universidad Nacional de Tucuman (UNT), which has a specialty service in Hospital Avellaneda in the capital. The consultation is done virtually, through the system.

We present the sample case using a sequence of steps.
Step 1:
The Rural Hospital physician enters data and photographs of injuries from the forms as shown in Figures 5 and 6 which show two different forms, corresponding to the operations of PCR.

![Figure 5. Patient’s Clinical Record](image)

In these forms, the RHP, in contact with the patient, introduces the consultation causes, images of the lesion and the patient's history derived from the interview in the PCR.

![Figure 6. Patient’s Clinical Registration Form](image)

Step 2:
Later, he invites a specialist (or several) which he wants to lecture on the topic (Figure 7). He may invite a doctor from the Central Hospital (CHP) and a chair of the dermatology department. The invitation can be made at any time and there is no limit on the number of speakers. It is not necessary
for the guest speaker to be online at that moment; the invitation can be synchronous or asynchronous. But it is mandatory that the speakers have been admitted to the system previously.

Figure 7. Call for Speakers

Step 3:
When a guest speaker accesses the system through the identification interface, the conferences to which he has been invited are presented as options (in the manner shown in the previous step), as well as those in which he is already involved by previous invitations or generated by the current speaker. Figure 8 is a composition of the screens of both speakers. The log is shown on the right of the system screen once the CHP has been identified. At the bottom is the conference to which he was invited by the RHP. On the left, the screen shows the RHP who is using the conference panel.

Figure 8. Initial Screen of guest lecturer
Step 4:
Figure 9 shows the screens of both the RHP and the CHP conferences. The right side of each screen shows the conference, which is the same in both cases and is updated each time a speaker sends patient’s information from the PCR to the conference. Moreover, as the conference is stored, any guest speaker, entering at any time, accesses the total conference.

![Conference Shared Screen](image)

**Figure 9.** Conference Shared Screen

**Discussion and Conclusion**

In general in rural areas the proposals are intended to extend the uses of the platform to pathologies such as leishmaniasis, refractory epilepsy, some heart disease.

We are working to provide VoIP, as for online communication it is more convenient than chat. While there is quality technology to do it off the shelf, the goal is to manage users, when and from where communications are made.

Another goal is to make the specialist independent from a particular workplace, so we are developing aspects that make the application usable from smartphones.

Finally, the act of “going into production” of the system requires management to solve the security and confidentiality policies.

The short experience we have had using the system indicates that the development of a software architecture that allows the specialization of interfaces according to the user group is strategically vital, as the users seek specific information of their interest and all not going in that direction naturally removes the "virtual meeting" among health workers.

As a conclusion, it can be said that the teledermatological application has been well received by physicians and dermatologists of rural areas, especially because the interfaces could be adjusted to their requirements. Even though there is still a lot to be done in this field, since the requirements evolve as the applications are used, they consider the teledermatological application of the platform a useful tool to complete the process of referral and counter-referral.

**Acknowledgments**

This work was financially supported in part by grants from the UNT Research Council (CIUNT), 26/E422 Research Program, INSIBIO-CONICET and A/027435/09 AECID.
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