Framework for a Telemedicine Multilevel Diagnose System

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Abstract: We have designed a system that provides support for physicians, regardless to their specializations. The main objective of the system is to ensure an accurate diagnosis to local unclassified patients. Our computerized support system takes as input clinical data collected and stored in an electronic patient record. It generates, as output, recommendation for therapeutic interventions and laboratory testing, based on a four-level diagnosis process. The process starts with the diagnosis made by the local physician, which will be subject to a double verification by local and remote expert systems, and finally approved by an appropriate remote specialist. We have constructed a telemedicine based system called SOS Specialist (SOSS) to achieve our objective. The SOSS will provide quality care to rural areas and also in the big cities where in some hospitals and other government organizations are still suffering from the lack of specialists in some very specific domains. A very attractive characteristic of the SOSS is that it has the capability to promote itself, and that by adding the diagnosis of the appropriate specialist about the new cases to its local patient database, furthermore, it helps the physicians to update their knowledge outside their specializations.

1. Introduction

The lack of the experts in the small town and the big city hospitals around all the world, increase the risk of inaccurate diagnosis and mistakes. For example, in United Arab Emirates, there are only four chest specialists for at least 15 hospitals [1]. The prestigious institute of Medicine, a division of the American National Academy of Sciences, published a decisive report [2], in which it conclusively stated 98,000 Americans die each year from “medical mistakes”. That is more than die annually from breast cancer, highway accidents and AIDS.

A practical solution to optimize the medical mistakes in the light of the experts shortage, is to fill the gap between physicians and enable them to communicate and to help each other. The help should be as it is needed and based on a detailed medical patient record. For this purpose, we propose in this paper a telemedicine based system called SOS Specialist (SOSS) to insure an accurate diagnosis wherever there is a lack of experts.

In a trial to overcome the above mentioned problems we find in the literature some automated support for protocol-based care [3]. All participants in the health-care system now recognize the importance of appropriate use of protocols to provide optimum patient management and to ensure a high quality of care. The text of many protocols and guidelines also is becoming available via the world wide web and other electronic information sources [3]. However, in many cases it may be appropriate for a provider not to follow guidelines, particularly if those guidelines are not based on empirical evidence, often guidelines are ignored merely because they never reach the practitioners consciousness[4]. Our SOSS system comes to give more confidence in physician diagnosis, and to strengthen the positive changes in clinician behavior when computer systems can offer advice that is tailored to the particular clinical situation, due to the use of the Medical Information System [3, 4], the HELP System [6], and also due to a remote appropriate specialist final diagnosis based on an individual patient record. In section 2 we give the requirements and considerations of the system, section 3 presents the system architecture, in section 4 we describe the rationale for the need of the SOSS system, and we give our comments and conclusions in section 5.

2. Requirements and considerations

The system we have designed (SOSS) is able to provide, to a non expert practitioner (Physician), the appropriate help of a distant expert. SOSS is influenced by the following set of constraints and considerations :

1) Before asking for a help of a distant expert, the system should be able to proceed a multilevel automatic diagnose in order to refine, classify, and to document the case.
2) The non expert site of our system should be able to learn from previous experiences and the diagnosed cases by specialists.

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Abstract

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3) The responses should not exceed a limit of time specified by the requestor on the basis of the case emergency.
4) The expert can refuse or not be able to respond to a query.
5) In order to facilitate and accelerate the expert diagnosis, the information related to a query and sent to the experts should be as complete as possible.
6) For security purposes, the system should ensure the authentication of both the requestor and the advisor, and also the integrity and confidentiality of the interchanged data.
7) The system should be easy to extend and to maintain.

Taking into account these requirements, we can imagine how the system should work. First of all, the SOSS is composed of a set of medical sites, each of them has a server connected to a telemedicine network. This later can be either a private network or the Internet. In each medical site we have at least one physician able to collect patient symptoms. When a patient goes for a consultation, we cannot be sure that in his local medical site there is the appropriate expert for his disease. In case of lack of expert, the Physician collects the symptoms through a guided computerized user interface, and a multilevel diagnose process starts as shown in Figure 1. In the following, we explain the four-level diagnosis process which is composed of two human diagnosis (levels 1 and 4) and two computerized automatic diagnosis (levels 2 and 3).

1. The *first level diagnosis*: the physician who collects the symptoms can propose a diagnosis. This diagnosis will be verified by the second level diagnosis.
2. The *second level diagnosis*: the local system analyzes automatically the collected symptoms. If the system detect a disease, it automatically informs the Physician giving him all the information used to reach such diagnosis (used rules and symptoms). This diagnostic may be different from the one given by the physician himself (*first level diagnosis)*. The system then asks the Physician if he wants to confirm this diagnosis by getting the advise of an expert. If yes, a request is sent to an expert (a distant server) chosen automatically by the system. The request contains all the information used in order to get the right diagnosis.
3. The *third level diagnosis*: when the distant server receives the request, it verifies automatically the correctness of the information used in order to produce the *second level diagnosis*. If this information is not correct (not complete or bad rules), the request is returned back to the sender asking for more special information or symptoms about the case.
4. The *fourth level diagnosis*: If the information contained in the request is correct, it is presented to the human expert who will first analyze, give his diagnosis about the case and take the necessary actions.

For the system performance, we suppose that the non expert part learns (self learning) from its previous experience. So, for a given case, the system starts with a minimal of information about the disease, then from the multilevel diagnosis process (specially the third level diagnosis) the system will automatically update its diagnostic rules. As can be seen in the scenario case shown in Figure 1, we can see that the second and the third level diagnosis are repeated twice. For the same case (same disease and for the next time those diagnostics will be performed only once as shown in Figure 2.

3. System Architecture

3.1 Architecture Design

Based on the specifications presented in the previous section, we propose the architecture depicted in Figure 3. This architecture is symmetric so it can be used by either the non expert and the expert sites. The system is composed of the following main components : a user interface, a diagnose manager, a telemedicine kernel and several databases.

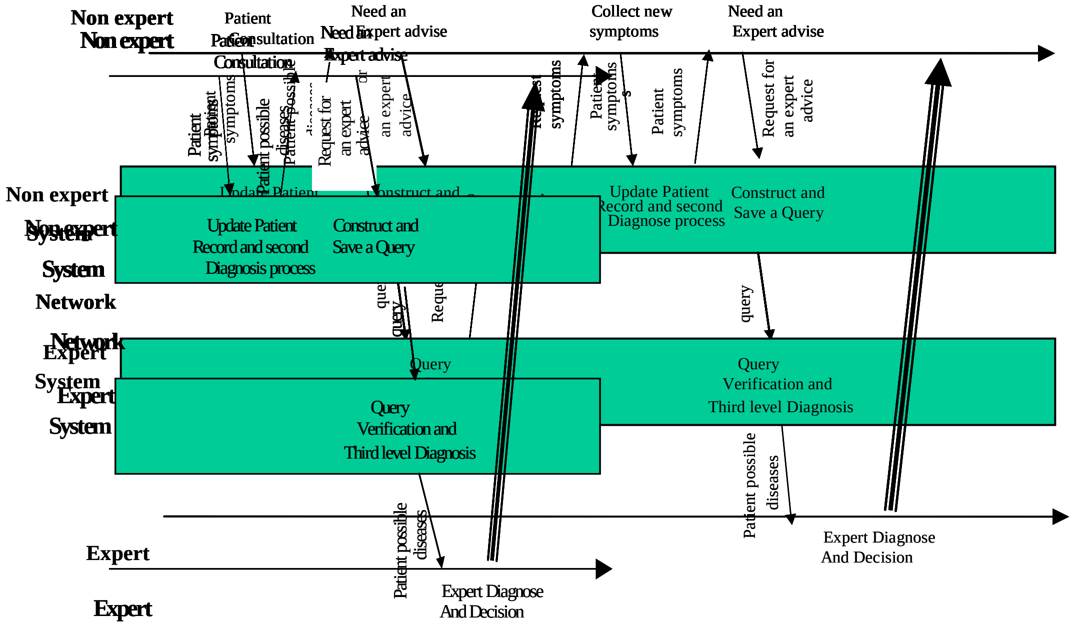

Figure 1 : A complete scenario of the SOSS system at its first dealing with a special disease.

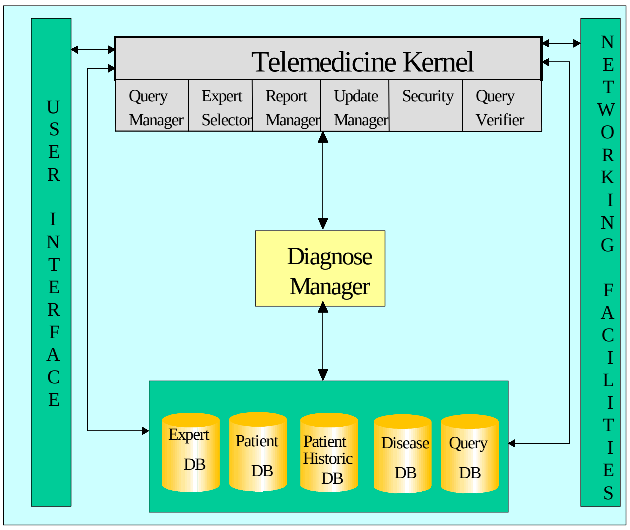

Figure 2. Scenario of the SOSS system after learning about a special disease.	**Figure 3: SOSS System architecture.**

3.2 Design quality

Our design is based on a layered architecture as shown in Figure 4, and is having many important features such as: reduces complexity, standardizes interfaces, facilitates modular engineering, ensures interoperable technology, accelerates evolution.

4. Rationale for using SOSS system

In our system, we consider that telemedicine is not always cost effective but it has other benefits. The question of cost depends more on the investment on specific devices. In the following, we discuss our system benefits. The final diagnostic is obtained through a multilevel diagnosis process that contains two automatic diagnostic processes phases. Those phases have three benefits. First of all, it can support physicians to produce their diagnosis. Second, it acts as a selection filter in order to sort the patients that really need the expert advice. Third, the automatic processes may lower the probability of an erroneous diagnosis.

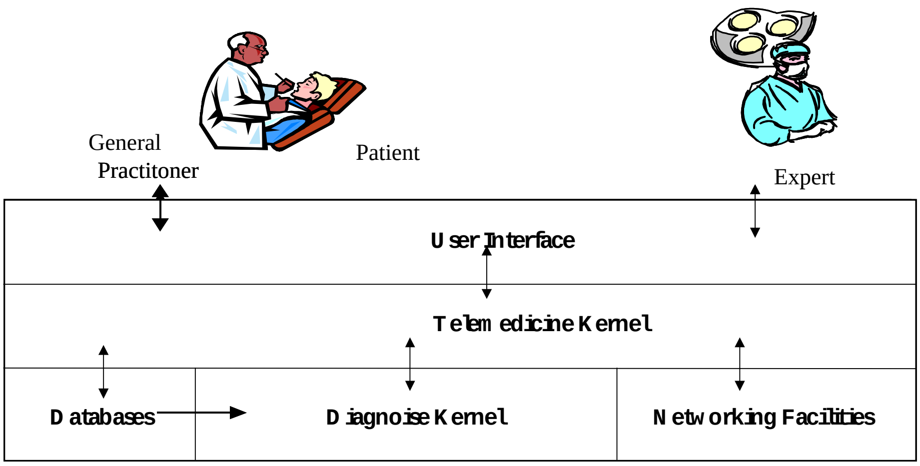

Figure 4. The layered architecture of the SOSS system.

5. Implementation

A prototype of the above described SOSS system is being realized with the collaboration of a group of students of the UAE University. SOSS will be used by different kind of users : physicians and administrative staff. Physicians will use it in order to get an advice from experts or simply to confirm their diagnosis. In the other hand, the administrative staff will use SOSS to produce different kind of reports. Thus, we put a particular emphasis on the system interfaces and we have chosen to use Microsoft Visual Basic as a programming language. The system is based on the specifications presented in the previous sections. It is an application of the United Arab Emirates health care system [1]. Actually, a first version of SOSS is being tested and evaluated.

6. Conclusion

In this paper we have presented a Telemedicine multilevel diagnose system called SOSS, which is a decision support system that can help physician getting the most possible accurate and fast diagnosis for his current patient case. Physician can use SOSS to get an advice from an expert or simply to confirm his own diagnosis. SOSS offers to a requestor two kind of helps: two automatic diagnostic processes and the expert advices. This has two main advantages: remedy to an eventual lack of expert and help physician to avoid erroneous diagnoses and medical mistakes. SOSS is designed to enhance its performance by learning from previous well diagnosed cases.

SOSS is actually being tested and evaluated, if those tests are satisfactory we will try to transform SOSS from a prototype to a real application. For its communication part, we will use a more adequate language as for example Java. We will try to enhance SOSS performance by adding more autonomy and intelligence using mobile agents.

References.

[1] Ministry of Health, UAE, http://www.uae.gov.ae.
[2] Medical Review Foundation, November 29, 1999.
[3] Barnes, M. and Barnett, G.O., “An architecture for a distributed guideline server”, Proceeding of the Nineteenth Annual Symposium on Computer Applications in Medical Care, 1995, pp. 233-237.

[4] Mc Donald, C.J. “Protocol-based Computer Reminders, the Quality of Care and the Non-perfectability of Man” , New England Journal of Medicine. 1989, 321, pp. 1306-1311.
[5] Mc Donald, C. J.Hin, S.L., Smith, D.M., et al. “Reminders to Physicians from an Introspective Computer Medical Record”, Annuals of Internal Medicine, 1984, 100, pp. 130-180.
[6] Evans, R.S. Larsen, R.A., Burke, J.P. et al, “Computer Surveillance of Hospital-Acquired Infections and Antibiotic Use”, Journal of the American Medical Association, 1986, 256, pp. 1007-1011.