

The Digital Doctor: An Experiment in Wearable Telemedicine

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Abstract

Consultation with various specialists and review of medical literature are key elements in superior, modern medical care. Because this information can be expensive and inconvenient to access, physicians and patients must typically compromise ideal care practices with practical realities. A wearable computer with the ability to transmit and receive text and image data without a direct connection during an examination can remove the need for such compromise, potentially allowing both better care and lower cost. In this paper we report on experiments conducted at the University of Rochester's Strong Hospital in which a wearable computer is used to create patient records and provide remote consultations during dermatological examinations.

1 Introduction

Dermatologic care in the 1990's remains relatively unchanged from the practices of the 19th century. Direct physician to patient interaction still forms the core of dermatologic care. However, advances in the engineering and computer sciences have given the physician the opportunity to provide greater levels of service. A vast amount of information, stored in databases and digital libraries, is available to assist the physician with patient care. Unfortunately, it is difficult for physicians to integrate this huge collection of information because it is widely dispersed and requires significant amounts of time to access.

Another aspect of scientific advancement in medical practice is specialization. Consultation with specialists can significantly enhance patient care; however, due to the need for multiple patient visits, as well as the need for several physicians to independently access and collect information about the case, the process is inefficient and time consuming. Consequently, the consultation process is typically very expensive.

1.1 Current medical systems

Limitations in the current system of medical care prompted us to search for a system which addresses the problems of information collection, retrieval, and processing while also addressing the problems of physician and patient access. Because our clinical practice is in dermatology which relies heavily on visual information, we were particularly interested in solutions that offered flexibility in visual communications.

The current model of dermatological care makes good use of fixed computer systems. Clinic-based computer systems are now providing the physician with a means to collect and store data (both text and images), to network with laboratory and pathology databases and to network with other physicians, primarily through e-mail. It is also now possible to gain access to clinically-related information available on the world wide web such as drug reaction databases.

However, these fixed systems are greatly limited by their stationary nature. They can only be used when the physician is at the terminal. This requires placement of networked systems within each patient examination area, which greatly increases the cost of such access. In addition, the physician-patient interaction is such that it would be difficult to place terminals in all situations where such information would be useful. Thus physicians often can only use this resource during breaks in their clinic schedule, and rarely when the information is most needed — at the bedside. Many times the lack of coordination between the need for information and its availability results in such information never being used at all.

Similarly, we have been impressed by recent advances in the field of teler dermatology, which has attempted to bring dermatologic care to under-served areas through the use of digital imaging acquired at distant sites [1]. Again, however, the use of this technology has been severely limited by the need for specialized rooms, limited numbers of locations, cost and

similar restrictions.

1.2 Digitally enhanced doctors

Consequently, we have begun to develop a freely mobile device, to be worn by the physician, which can communicate digital information in the form of text and images. Worn by the dermatologist in clinical interactions (much as a cardiologist wears a stethoscope), this device will assist the physician at the bedside. It will integrate and synthesize the medical resources that are already available but which are currently time-consuming, difficult or expensive to access. We have named the marriage of doctor and wearable computer, together with supporting infra-structure, the "digital doctor."

Key capabilities of our device will include accessing medical records (text and images) and laboratory/histopathologic results at the bedside, and providing the capability of instant query of the huge volume of medical data that is already on-line [2]. Perhaps most importantly, however, this wearable device provides bedside communication with other physicians for the purpose of consultation. In doing so, the wearable computer can significantly augment the dermatologist's clinical skills in providing patient care.

2 Results

Our experiments have involved volunteer patients examined at the Dermatology Clinic in the Ambulatory care center at Strong Memorial Hospital. In our clinic, the resident physician sees the patient prior to presenting the case to the faculty. As part of our test protocol, patient volunteers who agreed to participate in the experiment were examined by a resident dermatologist who used the prototype 'digital doctor' system, a variation of the Media Lab's Lizzy system [3].

After the initial examination by the resident, a small amount of pertinent clinical information and still image data were transferred by wireless modem to the fixed computer station located in another part of the clinic. The attending dermatologist then reviewed the text and images and attempted to make a diagnosis of the condition depicted.

After each experimental examination, each of the 23 patient volunteers were examined in the traditional manner by the attending physician. Final diagnosis and treatment suggestions were then provided. Of the 23 cases, the diagnosis could be classified as either simple or complex based on the consensus of 3 out of 4 board certified dermatologists. The initial diagnosis made by the senior physician based on the text file and image data in simple cases was correct 72% of the time. In cases classified as difficult, the accuracy fell to 33%.

The major problem in the current system is the quality of the images. The resolution of the captured images is 320 x 240. Larger lesions can be easily recognized, but the fine texture of surface characteristics and detail in smaller lesions is poor. The utility of this degree of resolution is still high enough because supplementary information contained in the text data that accompanies the images helps in making the correct diagnosis. Work by Perednia et al indicates that an accurate diagnosis requires a pixel content of 574x489 [4].

A final problem with the image acquisition process was that the area photographed was difficult to control because of the lag time in capturing image data with the camera. The camera is hand held, and the placement of the lesion in the image may drift during image acquisition. More experiments with larger numbers of patients, better cameras and direct comparison of live versus image-based diagnosis will be necessary to compare the efficacy of the image data as a medium for dermatologic diagnosis.

3 Conclusions

These experiments suggest that wearable computers have the potential to remedy many problems of information access for physicians and improve the quality of care they provide. There are substantial technical hurdles to cross: the speed of the machine and its reliability must be improved. The quality of the images which can be captured must also be better. Based on current work, incremental improvements have been identified that will provide substantial progress in the creation of a fully functional wearable unit within a few years. The advantage to physicians of information availability provides a compelling reason to make these improvements.

References

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