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Mobile Consultant: Diagnosis and Consultation on the Go

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The time required for a medical consultant to offer an expert opinion is critical, and minimising it can save lives. In this paper we present a system that allows a medical consultant to be in constant contact with the patients via videoconferencing and high-resolution imaging, while moving within the hospital or even outside. Finally, we demonstrate that such a system further increases the mobility of the medical consultant, thus improving healthcare service quality.

Medical doctors and especially medical consultants usually need to be accessible most of the time. As the latter are assigned to support a group of hospitals, they often cannot physically examine the patient and have thus to move about their hospital or even between hospitals.

Until now, telemedical devices were being used to bridge this gap between the expert and medical personnel requiring an expert opinion. Such devices are usually bulky, require expert installation, have high cost and require a dedicated room to operate. The patient has to be moved to such a videoconferencing room; a time consuming procedure and potentially dangerous to the patient's health [1], [2].

More advanced systems like MedLAN [3] did provide wireless communication capabilities but allowed for mobility only on the patient's side (A&E), whereas the consultants had to be in a fixed location.

Numerous doctors have expressed a demand for a system that would allow consultants to be constantly available for consultation, while moving within the different wards of the hospital. Furthermore, this should be achievable not only inside the hospital, but also while the consultant is roaming outdoors, commuting, etc.

The whole system had to be sufficiently efficient to allow for safe diagnostic evaluation, light so consultants can carry it anywhere, reasonably cheap so the hospital administration can justify its use and simple enough so it can be used with the minimum amount of training [4].

Implementation of such systems seemed impossible only a few years ago [5]. However light handheld systems were recently introduced which practically emulate the abilities of an ordinary computer, while acting as a 3rd generation (3G) mobile phone and supporting videocalling. The current research was based on such a system.

Methology

Research was divided into 3 stages: Selection of the most suitable hardware, development of the videoconferencing and image-viewing software and initial clinical tests so medical consultants could evaluate system performance.

A. Hardware

To cover both the indoor and outdoor environment, a device was required that could operate both as a PDA and as a 3G mobile phone. An excellent candidate was the HTC Universal PDA.

It incorporated numerous desirable characteristics: a 520MHz CPU, up to 4GB flash memory, a high-resolution screen capable of displaying 640x480 pixels, wireless network access, bluetooth support and was running Windows Mobile 2005. Furthermore, the device supported mobile telephony in 4 bands (3 GSM and UMTS) thus allowing for videoconferencing 'on the go'. Its overall weight was just under 290g, making it very easy to be carried anywhere [|Fig. 1].

By default network access could be established\ via IEEE 802.11 and also via a 3G connection, whenever the device could not find an access point [6].

B. Software

Two distinct pieces of software were developed by the authors at the Medical Image lab of TEI Athens.

The VoIP module handles video and audio transfer between the system located in the A&E ward, and the mobile consultant. Apart from video, it also enables the treating side to send uncompressed, high-quality images to the medical

consultant, including x-rays, CT images, MRI, ultrasound scans, etc.

PDAImaging is a tailor-made image viewer for medical applications. It includes operations like pan, zoom in/out, ROI, and most importantly, several filters that assist the doctor in his/her diagnosis. It can also store the received images locally; even in DICOM format. It can run alongside the VoIP module so the images can be transferred while the wireless videoconferencing is taking place.

Fig. 1. Mobile videoconferencing inside a hospital: the medical consultant only has to carry a light PDA.

C. Clinical Testing

A prototype was developed at the beginning of the year and was initially tested at the Central Middlesex Hospital in West London, where a wireless medical project was implemented not so long ago [7]. The three consultants that tested the system were given the device and were asked to use it in two scenarios: videoconference inside the hospital using the internal wireless network, and outdoors connected to a 3G network. Several videos were sent over 14 sessions (more than half were prerecorded to minimize nuisance to the patients) along with a number of medical images (x-ray, CT, MRI, US) [Fig. 2]. Three of these sessions were conducted outside the hospital [8]. Consultants were asked to evaluate both video and still images in terms of: video clarity, frame rate, diagnostic ability, image resolution, image clarity and overall diagnostic ability for the purpose of making a safe distant diagnosis.

Results

Overall results were very encouraging and demonstrated that the system can be used on a larger scale.

Videoconferencing and image transfer were evaluated using the hospital's internal wireless network and also using a 3G network .

The former behaved largely as expected. The PDA was capable of videoconferencing in resolutions ranging between 176x144 and 352x288 pixels.

Sound quality was better than that of a telephone conversation.

High-resolution images of various sizes were sent wirelessly to the mobile unit. The average transmission time for a 500KB image varied from 2-5 seconds.

When the consultants are away from the hospital, they can also connect through the many hot-spots around urban centres. Should this fail, the device can engage in standard videoconferencing through normal video calling. This offers a relatively low frame rate (3-5 fps) and lower resolution in comparison with using the wireless network. However the advantage of having access from anywhere there is UMTS coverage overcomes these limitations [9]. A prepaid "data packet" can also be used allowing largely the same video quality as when using wireless LAN [7].

Another point is the ability of the system to act as a remote/mobile terminal of the hospital network: the mobile PDA can access the network,

check emails and use the Internet as easily as a desktop computer. It can also be used as a beeper sending simple messages and as a cordless phone so any doctor/consultant can be reachable anywhere, anytime and at no cost to the hospital (while within WLAN range).

Discussion

The prototype system behaved satisfactorily in the initial test phase. Apart from some “freeze-up” of the video during videoconferencing, attributed to the access on the wireless network, both video and sound were of good quality.

Doctors who tested the system agreed it would be beneficial to their profession, as it would increase their accessibility while performing other duties. They also agreed that the outputs of the system were of acceptable diagnostic quality (80%) and in most cases allowed for a safe diagnosis and consultation (75%).

The cost of hardware (assuming a WLAN installation exists in the hospital) is about €900 per unit but is likely to decrease with time. Videoconferencing within the hospital is completely free while the airtime for videoconferencing outside the hospital’s WLAN range is approximately €10-20 per 5-minute session.

Although the system has increased interoperability, it is mostly designed as a stand-alone piece.

Overall, the researchers of this system envision that not only medical consultants but all medical personnel in a hospital will gradually replace their beepers, mobile phones and videoconferencing devices, with such an all-in-one system that is light enough to be carried anywhere.

Conclusions

We have presented an integrated system that will, among other services, allow mobile and wireless videoconferencing between a roaming consultant and a base station (usually in a hospital). The system behaves satisfactorily in most conditions, minimising the time required to get expert consultation and thus improving quality of care to the patient.

References are available upon request at english@hospital.be

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