Strategies to reduce interruptions from mobile communication systems in surgical wards

Terje Solvoll and Jeremiah Scholl

Norwegian Centre for Telemedicine, University Hospital of North Norway, Tromsø, Norway

Summary

We conducted interviews with two surgeons from the department of gastrointestinal surgery at the University Hospital of North Norway. The results confirmed that interruptions from mobile devices were a problem, especially in surgical theatres, outpatient wards, emergency wards and inpatient rooms. Users in hospitals, especially surgeons and physicians, need a better communication system. Our proposed system would intercept the signals from the existing communication system before they are sent out to the mobile devices. The signals would then be routed through a context-aware system, paired with context information and available rules defined by the doctor, which will decide what to do with the call/page. A single device which integrates both the pager and the phone system, and makes use of context information to control interruptions automatically yet allow the caller to decide whether to interrupt, would be highly appreciated by the users.

Introduction

Mobile communication systems are a method for improving communication in hospitals.[1] Doctors often need information quickly, and any delay between the decision made and the action taken could cause medical errors.[2] A mobile communication device can facilitate communication between colleagues, and one approach is to provide doctors with wireless phones. Studies have shown benefits by the use of wireless phones in hospital settings.[3–5]

Pagers are the most common mobile communication device in hospitals. Most doctors only use pagers, and often carry several pagers for both personal and role-based communication,[6] instead of carrying a wireless phone. However, pagers suffer from limitations due to their simplicity and often cause delays. When a page is placed, the recipient has to stop what he or she is doing, find a telephone and call the number on the pager. By the time this has been done, the caller may not be available any more.[5]

Wireless phones also have limitations. One problem is that they can be more interruptive than a pager. When the phone rings, the person carrying it may feel obliged to answer and explain that they will call back, if they are busy. In contrast, a page may be returned when the person is ready.[6] Some pagers contain displays that allow users to see who is paging just by looking down at the pager in their coat pocket, which is more convenient than having to pick up the phone to find out who is calling. Some doctors carry a wireless phone, using it for outgoing calls and use the pager for incoming calls, while others leave the wireless phone in their office.[6] It is also quite common to have a wireless phone for incoming emergency calls to the ward, i.e. this acts as a role-based phone and is carried by the doctor who is on call.[6] This means that a doctor may carry several pagers or phones, depending on which roles they are fulfilling.

The fact that hospital workers prefer interruptive communication methods before non-interruptive methods,[1,7,8] amplifies the risk of overloading people when phones are widely deployed. A key challenge when deploying them is thus how to handle the balance between increased availability, and increased interruptions.[6] We are developing a system for managing interruptions from the mobile devices used by doctors. The purpose of this work is to develop a new communication system where each doctor is equipped with a single mobile communication device for both personal and role-based communication. The system will reduce interruptions in a safe and reliable way.

Related work

There have been many suggestions about how to reduce interruptions from mobile devices.

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Correspondence: Terje Solvoll, PO Box 35, N-9038 Tromsø, Norway (*Fax: +47 77 75 40 98*; *Email: terje.solvoll@telemed.no*)

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Context-aware phones

Context-aware phone systems that reduce interruptions can be divided into two categories.[9] The first category includes systems where the phone automatically changes configuration.[10–13] This includes quiet calls where the receiver can negotiate with the caller through text or pre-recorded audio messages.[10] Since the user has to act on the call through pre-recorded voice or text messages, this only reduces the interruptions to the surroundings and not the personal interruptions. In the SenSay system[11] information from several different sensors was combined to sense the user's context, and thereby control the ringer/vibration on the phone. Schmidt *et al.*[12] used wireless application protocols (WAP) to automatically change the phone settings based on the recognized context, and Khalil *et al.*[13] used calendar information with the user's scheduled activity stored, to automatically configure the phone.

The second category[9] are systems that give the caller information about the receiver's context to help the caller to make decisions about when it is appropriate to make the call.[14–16] A recent study revealed that providing the caller with context information about the receiver's situation reduces the mismatch between the caller's decision and the receiver's desires.[17] Milewski *et al.*[14] provided information about the receiver's presence using the phone book and location, like the 'buddy list' in instant messenger services. An interactive web page that gives callers information about the receivers' situation and the available communication channels was used by Pedersen.[15] Marmasse *et al.*[18] formed a kind of member list combined with a prototype of a wristwatch that captures the user's context and shares it with the members of the list, who could use the information to check the availability before calling.

Hospital communications

While people outside hospitals have adopted mobile phones, there has been only limited use within hospitals, due to possible interference with medical equipment. Some earlier studies showed that the benefits from use of mobile phones could outweigh the risk of interference,[19,20] although this has been challenged.[21]

Several studies have been carried out in hospital settings, to improve communication and reduce interruptions.[1,3–5,22,23] Coiera and Tombs[1] recommended a variety of approaches to improve communication, including support and asynchronous communication with acknowledgement. Different kinds of text-messaging systems for hospitals have also been revealed as positive,[3,23] although there were also concerns about character limits, small displays and there being yet another device to carry. Other studies showed positive results when nursing teams were provided with wireless phones,[5] wearable radio transmitters,[4] and wireless hands-free headsets which interfaced with the phone system.[22] The advantages were quicker updates to patient information, easier location of nursing staff, and reduced noise levels, although there were also concerns about making recipients too readily available. Personal Digital Assistants (PDAs) have been used in a contextual message exchange system,[24] and for simple text.[25] PDAs with built in mobile phones, web browsers, electronic textbooks, anatomy atlases, international classification of diseases, guidelines and medical calculators, have been used to enrich communication between health-care workers.[26] PDAs with access to patient data with virtual white boards, have been used to allow health-care workers assigned to the same patient to know about each other's work progress.[27]

Other systems like the AwareMedia and the AwarePhone systems of Bardram *et al.*,[28,29] support context aware communication. In combination, this forms a complete communication system for clinicians in a surgical ward. The tracking system tracks clinicians in selected areas, using Bluetooth tags/devices which are worn by the clinicians. The AwareMedia has large touch screens placed in selected locations around the ward, showing information from the tracking system along with the clinician's schedule. The AwarePhone system is an application running on a mobile phone, which allows clinicians to call or send a message to a person in an operating theatre. Messages sent directly to the room, are shown to all people present in that room through the AwareMedia Screen. However, the problem of privacy is a known drawback of these systems.

In addition, there have also been a number of studies which have focused on context aware systems for hospitals with other problems like accessing clinical data, or on multimedia communication on terminals at fixed locations.[30]

Initial design study

We are using a participatory design process,[31] involving users and field studies in the workplace to design the system. This approach is being used because more than half of medical informatics systems fail because of user resistance.[32]

Previous studies have investigated mobile phone usage in oncology wards.[6] However, those findings may not apply in surgical wards. Oncologists have long-term relationships with patients and few emergencies, whereas surgeons have short-term relationships with many emergencies. We conducted a pilot study at the gastro surgical department of the University Hospital of North Norway (UNN), which confirmed that interruptions are a problem, especially in surgical theatres, outpatient wards, emergency wards and inpatient rooms. The study consisted of extensive non-structured interviews and open ended discussions with one surgeon at the department, a presentation of potential context-aware solutions to the department, followed by a question and answer session, and a discussion with the head of the department.

The study confirmed that surgeons move frequently and do not often remain in the same place for more than a few minutes. Hence, they are in need of a mobile

communication device which allows them to be contacted. Most surgeons only use pagers for this purpose, which involves known communication problems.[5,6]

The surgeon at the gastro surgical department said 'when you are at the most critical stage of an operation, and just a small error could have tremendous consequences, the beeper always goes off'. Moreover, he said that interruptions from the pager were also a problem when they were having serious talks with patients in patient rooms: 'It is not beneficial if the beeper constantly goes off when you are telling a patient that he/she has a serious illness'.

In addition, the surgeons had an on-call phone at the department. This phone was carried by the surgeon who was on call and thus responsible for answering calls to the department, even though he or she may be in the operating theatre. The surgeon that we talked to really disliked this phone, and thought that it was responsible for a lot of unnecessary interruptions. On the other hand, the head of the department thought that young surgeons learnt how to focus when they were interrupted all the time by this phone.

System architecture

Our proposed system architecture (Figure 1) is based on the existing phone and paging system at the UNN, extended by an Internet Protocol – Digital Enhanced Cordless Telecommunication (IP-DECT) phone system (Ascom Company, Goteborg, Sweden). The latter device has built-in positioning and is especially designed for health care with personal alarm functions, advanced messaging and versatile voice communications. Thus only one device per surgeon/physician is needed, both for personal and role-based communication. The idea is that this is familiar equipment for the surgeons/physicians, and that they could decide to use the existing pager/phone system without any re-configuration of the new system. On the other hand, this could also limit our system due to a possible integration problem with the existing hospital infrastructure.

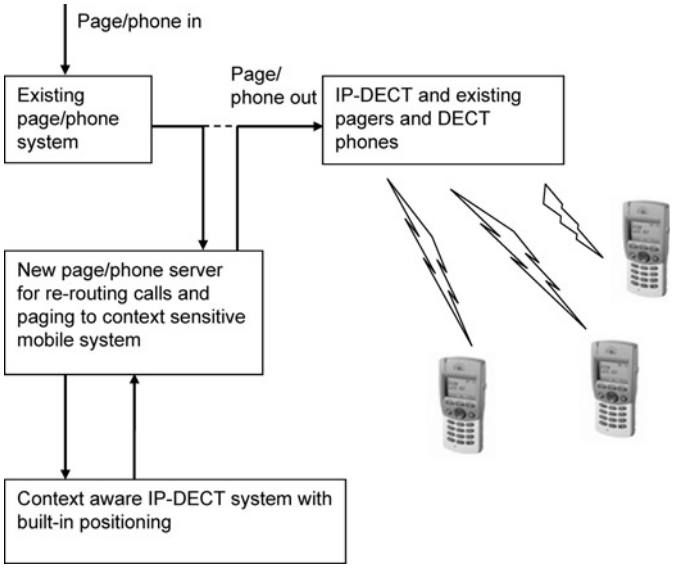

Figure 1 Proposed system architecture

The principle is to intercept the signals from the existing communication system before they are sent out to the devices, leaving the existing system intact. The signals will then be routed through our context aware system, paired with context information and available rules defined by the surgeon/physicians, which will decide what to do with the call/page, e.g. let the call/page go through, automatically reply with text or voice, or configure the device to silence. The system will partly decide automatically what to do with the call/page that was placed, and partly leave it up to the caller. This means that the caller could decide to force the call through when it is an emergency or a very important call. This could be done by giving the caller a message like: 'This surgeon is occupied in surgery and will not be available the next hour. If this is really important or an emergency call, stay on the line for 5 seconds and you will be connected. Otherwise hang up.' Then a countdown: '5, 4, 3…' to give the caller a chance to hang up if it is not important enough. If the call/page is role-based, the system will track down the device that is assigned to the specific role, and then re-route the call/page to that device.

Discussion

Users in hospitals, especially surgeons and physicians, need a better communication system. A single device which integrates both the pager and the phone system, and makes use of context information to control interruptions automatically yet allow the caller to decide whether to interrupt, would be highly appreciated by the users.

In future, further work will be required to investigate surgical wards. This should include observations, interviews, recording how often the staff are interrupted and by whom. Then design studies can be followed by development of the system. Once the system has been brought into service it can be compared with the existing system, in terms of the numbers of interruptions and the quality of communication for physicians and surgeons.

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