

Identifying technology interaction opportunities within a gastroenterology exam room

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Abstract. Gastric cancer is a serious disease that most people usually do not know they have until they start to get symptoms. Gastroenterology imaging is an essential tool for this battle, since an early diagnosis typically leads to a good prognosis. However, this is a rapidly evolving technological area with novel imaging devices such as capsule, narrow-band imaging or high-definition endoscopy. Adapting to these technologies has a high time-price cost, even for experienced clinicians, motivating the appearance of interactive environments that can accelerate these training processes. The GEMINI (Gastroenterology Made Interactive) project aims to create an interactive clinical decision support system (CDSS) that can be used to help with the diagnosis within a gastroenterology room during real endoscopic examinations. We used human computer interaction (HCI) support methodologies in order to identify interaction opportunities. As a final conclusion, the most promising avenue for interactions with CDSS is probably using mobile devices such as tablets, controlled by a nurse at the physician's request. As future work, we will prototype and evaluate such a system in a real hospital environment.

Keywords. Gastroenterology, Cancer, Evaluation Studies, Computer-Assisted Decision Making, User Computer Interfaces

Introduction

Cancer is a leading cause of death worldwide. According to the World Health Organization data, cancer accounted for 8.2 million deaths in 2012, with gastric cancer being the third most lethal type after lung and liver cancer, causing around 750.000 deaths per year [1]. Gastroenterology imaging is an essential tool for this battle, since an early diagnosis typically leads to a good prognosis. However, this is a rapidly evolving technological area with novel imaging devices such as capsule, narrow-band imaging or high-definition endoscopy. Adapting to these technologies has a high time-price cost, even for experienced clinicians, motivating the appearance of interactive environments that can accelerate these training processes.

Developments in computer assisted decision systems for gastroenterology have already been reported on various sets of studies that began spurring interest about a decade ago,

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being bleeding, polyp and tumor detection and classification considered to be the most mature fields [2]. Decision support systems can sometimes be directed to classification (polyps, lesions, cancer), using previously trained classifiers or feature detectors to support their decisions [3], or focused on content based image retrieval (CBIR), for example. They usually are differentiated into passive, active or cooperative systems [4]. Our main goal is to create an interactive clinical decision support system (CDSS) that can be used to help with the diagnosis within a gastroenterology room during real endoscopic examinations. In this paper we present results obtained from contextual studies at IPO-Porto (the largest cancer Hospital in the north region of Portugal) in order to identify and model all relevant participants (doctor, nurse, patient), with the objective of obtaining accurate descriptions of the user (needs, ability to use technology), as well as modeling the scenario and its restrictions in terms of space and equipment, seeking ways of adding to/modifying the available technology. Also, action models of relevant medical procedures were created to better understand the staff routine. This gives us the necessary information to identify promising interaction opportunities.

1. Methods

1.1 Users

The users of our system are the Doctors, responsible for performing the endoscopy and associated procedures, providing a diagnosis and producing a report of the exam, and the Nurses, responsible for patient care and support, as well as assisting the doctor on all procedures. In order to study them we have used a combination of contextual inquiries and structured interviews.

1.2 Study Protocol

This study was conducted in the Gastroenterology department of the Instituto Português de Oncologia (IPO) Porto, comprising 6 physicians (2 of which were interns), 6 nurses and 8 operating technicians. We conducted our observational study of routine non-sedated endoscopy procedures, which make up for the vast majority of the hospital's total. They are done by utilizing two distinct analysis systems, according to availability and case nature: Olympus Evis Exera II (CV-180), and Olympus Evis Exera III (CV-190).

On the first visit we observed 8 endoscopies, 5 having been conducted by the intern and 3 by the attending physician. We wrote down the exams' protocol, as well as the tasks of every worker involved in them. These observations familiarized us with the methodology and praxis of gastroenterology exams, and we further complemented and consolidated our data by conducting semi-structured, informal interviews with 4 physicians (one of them an intern) and 3 nurses, all from the department. We also posed a small questionnaire to every potential user in the department with a view to determine their aptitude for IT, along with their age group and years of practice. The resulting information guided us in conceiving our system with a focus on simplification, potentially making use of mobile devices.

2. Results

2.1 Scenario Modelling

Although we did all scenario modeling in one of the two available exam rooms, we found that the other room layout is similar enough for results to be valid for it too. In addition to the pictures we took, the environment analysis during endoscopy observation resulted in the following diagrams:

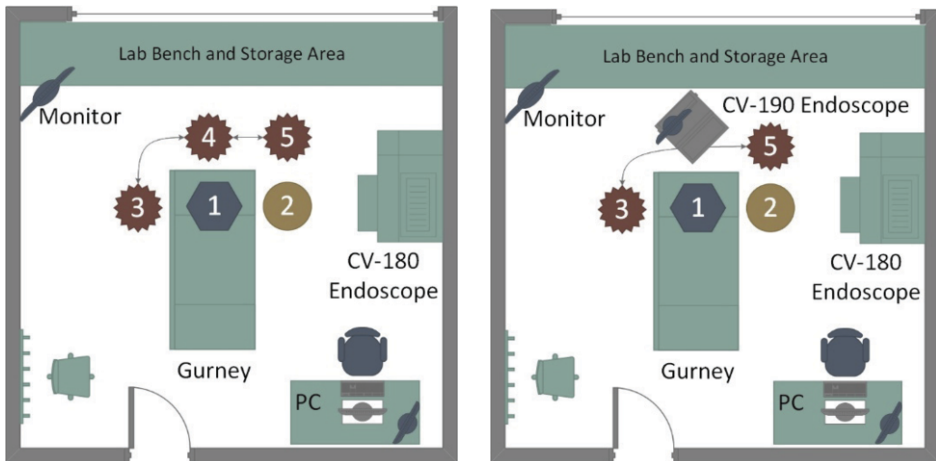


Figure 1. Diagram of the configuration of an exam room and actor placements. Left: when using the CV-180 system, Right: when using the CV-190 system.

Patients take position 1, lying on their side on the gurney, facing the attending physician or the intern conducting the procedure, which in turn occupy position 2. A nurse takes up positions 3, 4 or 5, determined by personal taste, the endoscope in use (the CV-190 takes up position 4), and specific assistance to the physician, such as biopsy collection and handling, which mandates position 5. ;

As the exam progresses, the doctor observes and analyses the image feed on the monitor positioned at the top left of the diagram (part of the CV-180 system) or on the one included in the CV-190 cart. Both use proprietary RGB cables to output the feed, also with the option to choose from DVI, *S-video* or *firewire* formats. We can directly intercept the feed that comes out of each one of the processors to an additional computer, where our system will run. Its output would be on an additional monitor placed just beside the one that is already there. A small tower placed near a high speed internet connection would provide us with the necessary resources for high resolution image and video processing. Regarding system control, having for example the option of using a *tablet* via *bluetooth* or *wireless*, it would be possible to have it on the counter, ready to be used whenever necessary.

2.2 User Modelling

Besides observing the users in their natural habitat, the questionnaire we posed to 10 health professionals working in the department (4 gastroenterologists, 6 nurses), along with the interviews, helped us understand the type of users we were dealing with. From

the questionnaire, we learned that: 70% of the users have had IT-related training; 100% had computers at home and used the internet frequently; 90% had smartphones and 100% had a tablet; 100% admitted that most of their work is done electronically. In an age range between 28 and 48 and years of experience between 3 and 18, we believe it is safe to say that we have a fairly tech savvy group.

2.3 Action Modelling

Before the exam, the physician and the intern consult the request for the next procedure, as well as various patient data: demographics, clinical history, risk factors, comorbidities, current medication, etc. The average number of endoscopies performed by each doctor at IPO, per week, is 13. Once the patient enters the room, the nurse's jobs are to put the patient at ease and explain the whole procedure (especially to first timers), administrate Simethicone orally (an anti-foaming agent that reduces bloating and pain), spray Lidocaine on the patient's throat to numb it, and put him a mouthpiece that allows the safe passage of the endoscope tube. The lights are dimmed, the patient lies on his left side on the gurney and the examination begins with the insertion of the endoscope tube, and subsequent visualization of all stomach regions and duodenum. As it progresses, the professional can take multiple pictures, regular and NBI (Narrow Band Imaging), plus saving the video on demand to help with the diagnosis. The use of both hands is extensive, with the left one guiding the tube and the right one on the controller. This controller has several buttons, depending on the model, to which are pre-assigned functions at the doctor's will, such as freeze frame, image save, switch to NBI (when available), among others. The nurse will divide her actions between patient care (stability, comfort, tolerance to the exam) and physician assistance. Should it be the intern to perform the examination, the physician will validate his decisions and give suggestions. The endoscope is withdrawn and the endoscopy comes to an end, having an average of 5 to 7 minutes, depending on patient tolerance, need for biopsies, or case severity. The lights are switched on and a casual conversation takes place as an appointment for a follow-up consultation is scheduled. The patient is discharged and the physician or the intern check the exam on the computer. They usually prepare the report shortly after, depending on the ease of diagnosis (need of a second opinion) or available time. Some doctors exchange impressions with nurses regarding the elapsed exam, consulting their ruling on a possible diagnosis. This practice appeals to nurses, who feel more valued. Figure 2 depicts an action model of an endoscopy procedure.

Discussion

Regarding system interaction, our studies hint that this interaction with a CDSS cannot easily be done with hands-free approaches such as face, voice, and gesture controls. Facial recognition seems inadequate since, among other motives, the exam is performed at very low light, which makes the process difficult. We pondered voice control, but as the IPO-Porto percentage of exams in which the patient is not sedated is high, some discussed issues and the commands dictated to the system could be uncomfortable and unsuitable (even in ethical terms) to have in front of a patient. This option may still be interesting to endoscopic modalities that use sedation most of the time. Gesture control, albeit with considerable potential in other areas such as surgery,

