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Designing Surgical Telementoring Systems to Support Learning

Conception de systèmes de telementoring chirurgical pour faciliter l'apprentissage

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ABSTRACT

Surgeons practising outside experts centers have difficulty accessing mentors to operate with them in order to update their skills. Telementoring can increase the reach of mentors by supporting mentoring at a distance but despite their potential, current systems remain rarely institutionalized. The goal of this PhD is to explore how the design of surgical telementoring systems could support learning. We present the results of a field study on mentoring needs as well as discuss implications for telementoring systems and future works.

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in HCI; Collaborative interaction.**

KEYWORDS

Surgery, Mentoring, Learning

RÉSUMÉ

Les chirurgiens qui exercent en dehors des centres d'experts ont des difficultés à accéder à des mentors pour opérer avec eux afin d'améliorer leurs compétences. Le télémentoring peut augmenter l'accessibilité des mentors en permettant de mentorer à distance. Cependant, malgré leur potentiel, les systèmes actuels

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restent rarement institutionnalisés. L'objectif de cette thèse est d'explorer comment la conception de systèmes de télémentoring chirurgical pourrait soutenir l'apprentissage. Nous présentons les résultats d'une étude de terrain sur les besoins lors du mentoring et discutons des implications pour les systèmes de télémentorat ainsi que de nos futurs travaux.

MOTS CLÉS

Chirurgie, Compagnonage, Apprentissage

DOCTORAL RESEARCH OVERVIEW

Surgeons acquire much of their knowledge through situated learning in what is known as *mentoring*: young surgeons assume the role of mentees, acquiring and perfecting skills by observing surgical interventions and progressively participating more and more under control of expert surgeons—their mentors. Despite the benefits for learning, surgeon practicing outside experts centers, have difficulty accessing experts to update their skills [2]. Additionally, when those mentoring sessions are implemented, the logistical constraints may limit the frequency of mentoring sessions and the scarce time of experts is wasted in travels. In this context, surgical telementoring offers promising avenues to overcome those difficulties. Surgical telementoring is defined as a relationship facilitated by telecommunication technology in which an expert surgeon (mentor) provides guidance to a less experienced learner (mentee) from a remote location [11]. Telementoring systems typically consist in videoconferencing systems, transmitting audio and video with added possibility to point and draw on the surgical view [3]. Despite their potential, telementoring is still rarely institutionalized, partly due to safety, legal, infrastructural, financial and organizational obstacles [2, 8]. In this PhD work, we explore the technological limitations that may hinder telementoring adoption and how to overcome them. Specifically, we inquire how the design of telementoring systems could support learning in surgery. To answer this research question, we follow a user-centered approach. That is, we start by investigating the needs in surgical mentoring. We then conceptualize new interactions mechanisms, prototype them, evaluate formally and informally with surgeons before going into these concepts with more depths. That way, we first aim to contribute empirically to the growing literature on the practice of surgical mentoring [6, 7, 9, 10]. Second, we will contribute conceptually through demonstrating how novel interaction mechanisms could support learning from a remote mentor. In particular, we investigate how new designs of telementoring systems could help meet the functional needs for mentoring in surgery.

UNDERSTANDING MENTORING NEEDS

During this first year of PhD, we focused on understanding mentoring needs and limitations of current telementoring systems. We did not observe situated use of systems for telementoring, as this

practice has been institutionalized in very rare cases, which makes it difficult to access for research. Instead, we observe onsite mentoring as it takes place today, to gain understanding of this practice and contrast our findings with the design of telementoring tools. Existing works already provide insights on mentoring techniques such as physical demonstrations and verbal feedback [4, 5]. However, concepts such as scaffolding [13] widely used in educational sciences emphasize the importance to not only provide support to mentees, but to diagnose their needs, so that mentors can choose an appropriate strategy given the current context. We therefore focus on mentor's informational needs when diagnosing mentees' learning needs. We also explored mentee's perspective on mentoring, a lens that we have not seen in previous work. Our inquiry of onsite mentoring is guided by two questions. First, what are the cues that mentees exhibit and mentors perceive that inform mentor's action? Second, how do mentees benefit from the mentor's presence?

We conduct a field study where we observe 11 soft-tissue surgeries, performed through a variety of techniques (open surgery, classic minimally-invasive surgery, and robotic surgery) to grasp mentoring practices in settings that impose different mentor-mentee configurations and needs. We perform semi-structured interviews with self-confrontation, with the mentor and the mentee, exploring mentors' perception of mentees, causes of communicative acts and mentors' taking over, how mentee benefited from the mentor's presence, and what mentees learned during surgery.

Through Thematic Analysis, we shed light on how mentors identify and answer the mentees' needs as well as take distance to let mentees develop autonomy. First, we identify that mentees need: to confront to difficulty, to be spared from part of the workload of the surgery, to be reassured concerning safety. The workload of the surgery refers to the numerous tasks that need to be performed during surgery as well as the necessity to take risks, to overcome difficult situations and to respect the operating room schedule. Second, we observe that mentors understand these needs primarily through their observation of the surgical view, but also through inspecting the mentee's posture and the patient's body. Third, we show that the mentor's presence limits autonomy development which leads mentors to eventually physically take distance.

Implications For Telementoring

From these results, we identified the limitations of current systems, and propose avenues to overcome them. The first limitation of telementoring is the inability for mentors take action on the patient body as it prevent mentor from, understanding surgery, risk and mentees' gesture in complex situations ; from sparing mentees and helping them overcome workload, risk and blockage ; from reassuring the mentee through being available to take over "just in case". Other limitations include the absence of a viewpoint on mentee's posture to identify the cause of struggles and probable weaker implicit validation compared to onsite mentoring.

While telerobotics surgery could solve most of these issues, it would also make telementoring reserved to a few hospitals able to afford such a technology. In our future works, we therefore wish to focus on advances that improve telementoring workflow while keeping it affordable. We highlight the importance to record mentees' posture and tools outside the patient body. We show interest towards technology measuring force applied on the tissues to make texture more visible to an external observer. We emphasize that beyond creating tools to guide the surgery technically, telementoring systems need to support the mentor in increasing safety and reassuring the mentee. For instance, creating feedback to show that the mentor focuses on the surgery could enhance remote implicit validation. Lastly, tools that enable mentors to increase their control through formulating precise instruction, including at a motor level, could help overcome blockage and ensure safety in critical situations.

FUTURE WORKS

One of the core limitations of the adoption of telementoring is the lack of physicality that can prevent mentor-mentee dyads from overcoming struggles during surgery. Creating systems that compensate at least partially, this lack of physicality, may be the most impactful advancement for learning as it will create new learning opportunities through favoring telementoring adoption. We therefore shift our focus from studying learning gain to studying how mentees could overcome blockage or struggle with telementoring.

While improving mentor's instructional means is crucial to compensate for lack of physicality, making mentees' intention more explicit may also be necessary for mentors to adjust efficiently their instructions to mentees' needs. We favor avenues with a lower communication cost for the mentee as their resources is already taken by the surgical work. We identify gaze as a good avenue as it does not require effort of communication on the mentee side, while having the potential to inform mentors on the cognition of mentees. Work outside surgery identify the potential for gaze to predict intention for a driving task [1] as well as to guide attention, guide action, check for misunderstanding during telementoring in an electronic component assembling task [12]. To our knowledge, the mentee's gaze has not been used in surgery to inform mentor instructions.

The main contribution of this future work will be to understand how transmitting mentees' gaze position in real time could inform mentors, and how this could improve efficiency of instructions. We do not intend to explore automatic signal processing to interpret gaze. We plan to conduct a lab experiment on a laparoscopic simulator where participants will create mentor - mentee dyads. Standard telementoring features such as pointing and drawing will be included. The dyads will complete tasks in two conditions : with gaze, or without gaze. We hypothesize that gaze will improve task performance (time, accuracy) as mentor's instructions would be more efficient : mentors may provide additional clarification, ask less verbal confirmation for mentees' understanding, repeat less their instructions as gaze could provide feedback for mentee's understanding.

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