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Haptic E-learning in Surgical Education

Motor Skill Transfer via Telehaptics

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GENERAL OVERVIEW

The advent of new information technologies is considered a revolution in surgical education as well as in planning and executing surgical movements and gestures. As we know that traditional surgery lessons have been guided by the professor throughout beginning training classes, which consist of learning movements, gestures, developing a dissection plan, and making the choice for type of therapy. With the wide availability of gesture interfaces, simulation technologies and new robust telecommunication technologies, constructing e-learning platforms through which surgeons professors can transmit their experience to a remote students became feasible. In this kind of platform the expert and the student share a distributed virtual surgical environment and each of them equipped with haptic or gesture instruments that enable the expert to transfer his/her motor skill to the student. These instruments or interfaces give the student the sensation of the physical environment experienced and also enable the expert to accompany the gesture of the student and guide him.c

The question which arise here is: How can we ensure such remote transfer of motor skills in robust and flexible manner (i.e. we must provide the QoS requirements needed), knowing that such transfer is occurring through an IP network which is a subject for traffic issues and consequently, affects the learning process and quality?

The aim of this study is to propose a generic and adaptive method which detect network traffic changes and apply compensation techniques to assure robust and effective haptic guidance and surgical motor skill transfer, and this method was integrated in our proposed platform for remote surgical guidance (surgical teleguidance).

This teleguidance platform consists of haptic interfaces, a telecommunications infrastructure, surgical simulator, and especially guidance protocol. And this platform ensures a long-distance collaboration between the student and the expert who take the hand of the student (through the haptic interface) and guide him, if necessary, to perform distance suturing. And for effective collaboration between the users it is essential to provide a real time global synchronization.

The goal of this system, in addition that it provides a virtual surgical environment, is giving the possibility to learn complex surgical gestures remotely with expert assistance.

Our main research problem is to define a method for managing a surgical e-learning session adaptive to network characteristics and quality in order to ensure a flexible and robust collaboration between the expert and the student. We solved this problem by relying primarily on the state of the art (i.e. the researches done in learning via telehaptics), secondly on our studies on The effect of network characteristics on Telehaptics applications (al-chama et al.2008) in which we tested two different architectures of distributed virtual surgical environment.

Finally, after several iterative users tests and results analyzing, we have modelled the effects of network parameters on the quality of motor skill e-learning.

This model was incorporated in our haptic e-learning platform making it adaptive to network status (i.e. our method detect the network traffic changes and apply compensation techniques) and ensuring a robust and stable e-learning environment.

THIS PAPERS WILL BE ORGANIZED AS FOLLOWS.

I. INTRODUCTION AND RELATED RESEARCH:

In this section we will give an overview about:

A. Haptic media, and telehaptics.

B. Presentation of several techniques proposed by related studies for network lag compensation in telehaptics applications.

C. Haptic Surgical simulation techniques.

D. Teleguidance, motor skill transfer in medical fields , motor skill evaluation.

II. PLATFORM FOR TELE-GUIDANCE APPLIED IN SUTURE SIMULATION (SURGICAL HAPTIC E-LEARNING PLATFORM)

In this section we will present our adopted approach for constructing a haptic e-learning platform immersed in a virtual surgical environment.

The choice of simulator was made from our study of several projects in the surgical field from which we built a platform for surgical simulation, as a basis of our haptic e-learning system.

In the following figures (Figure 1,2) we can see our proposed architectures for haptic surgical e-learning system.

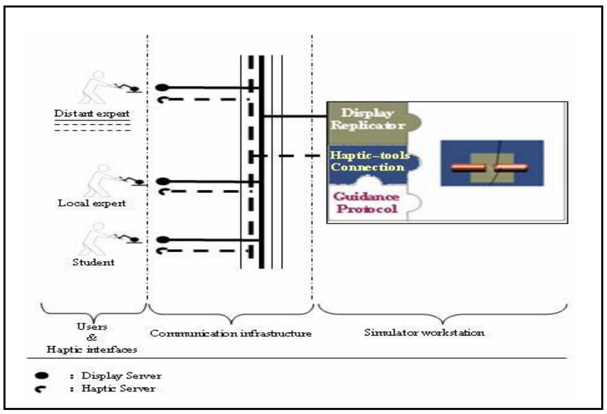

Figure 1. Architecture for haptic surgical e-learning system based on TCP protocol.

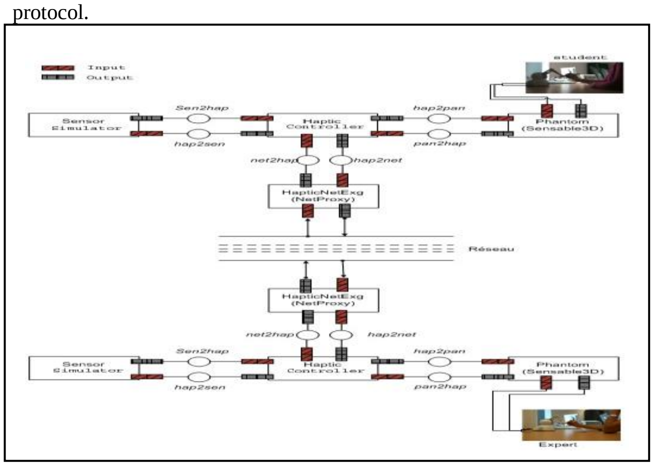

Figure 2. Architecture for haptic surgical e-learning system based on UDP/RTP.

III. THE EFFECT OF NETWORK CHARACTERISTICS ON TELEHAPTICS APPLICATIONS :

This section will describe our investigation to clarify the impact of the network parameters on our surgical haptic e-learning platforms, using a suture learning application. We have identified the operational ranges for real time tele-guidance in suture simulation and have found values for some important operational thresholds.

IV. MODELLING THE EFFECT OF NETWORK LAG (PACKET LOSS) ON THE MOTOR SKILL TELE-TRANSFER QUALITY

In this section we will discuss and analyse our results of the users tests (subjective experiments) that aimed to identify the relationship between the quality of motor skill transfer on one side, and the network status and teleguidance stiffness (guidance protocol) of another. Form these experimental measurements we made some assumptions describing the logic of the results. We then validated these assumptions qualitatively, and with a frequency analysis of the haptic e-learning process to corroborate our results.

Finally, we built a mathematical 3D model that describes this experimental relationship (Figure 3) (i.e. relationship between the haptic e-learning quality (LQ), network status (PP), and guidance stiffness (K)). This model has been integrated into our platform of virtual surgical haptic telementoring and make it real-time adaptive to network status (Figure 4), which optimize the performance of haptic e-leaning (telementoring) session.

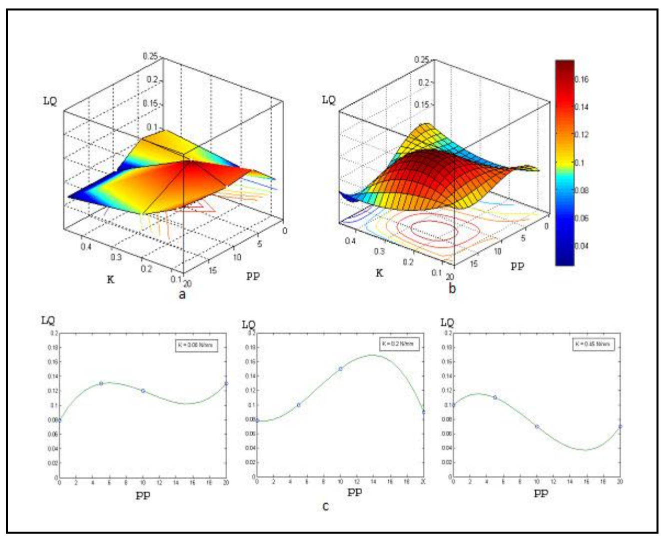

Figure 3. 3D Representation of the function between the Learning Quality (LQ) the guidance stiffness (K) and the network status (Packet Loss PP)

V. CONCLUSION AND FUTURE WORK

Finally, we will conclude this chapter and outline our future work.