

Chapter 7

Emerging Technologies Enhancing Haptic Feedback in Medical Applications

Ma. de los Angeles Alamilla Daniel

 <https://orcid.org/0009-0004-5298-9858>

Universidad Politécnica de Pachuca, Mexico

Angel Ricardo Licona Rodríguez

 <https://orcid.org/0000-0002-7629-459X>

Universidad Politécnica de Pachuca, Mexico

ABSTRACT

This chapter delves into the transformative impact of haptic devices systems in the medical field. It highlights how these technologies have revolutionized healthcare delivery by enhancing surgical precision and efficacy. The chapter reviews recent literature that reflects a burgeoning interest in understanding how these tools enhance the capabilities of medical practitioners, particularly in high-stakes environments such as surgery and rehabilitation. Studies have shown that haptic devices significantly improve surgeon dexterity in teleoperated environments, leading to enhanced patient outcomes and reduced surgical complications. Furthermore, the incorporation of tactile feedback in robotic surgery has been shown to enhance the surgeon's situational awareness and precision during procedures.

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INTRODUCTION

The evolution of technology in the medical field has been nothing short of revolutionary, with numerous innovations promising to enhance precision and efficacy in healthcare delivery. Central to this evolution is the integration of haptic devices and teleoperation systems, which have emerged as crucial components in facilitating remote medical interventions. The significance of these technologies is underscored by their potential to bridge geographical gaps, allowing specialized surgical expertise to be accessible in underserved areas. Recent literature reflects a burgeoning interest in understanding how these tools enhance the capabilities of medical practitioners, particularly in high-stakes environments such as surgery and rehabilitation. Studies by Selim et al. (2023) and Lee et al. (2021) illustrate that haptic devices significantly improve surgeon dexterity in teleoperated environments, thus leading to enhanced patient outcomes and reduced surgical complications. Furthermore, the incorporation of tactile feedback in robotic surgery has been shown to enhance the surgeon's situational awareness and precision during procedures, aligning with findings presented by Moreno et al. (2022). Moreover, the potential of these technologies extends beyond surgical applications. Researchers have noted the applicability of haptic feedback systems in physical therapy and patient rehabilitation, as highlighted by the comparative studies conducted by Najdovski et al. (2024). These studies suggest that integrating haptic devices into therapeutic practices not only aids in motor skills recovery but also enhances patient engagement and satisfaction. However, despite these promising findings, critical gaps remain in the literature regarding the long-term efficacy and safety of haptic devices in various medical applications. For instance, while initial studies have focused on short-term outcomes, there is a deficit in longitudinal research that assesses the sustainable impacts of these technologies on patient health outcomes over time, as noted by Giri et al. (2023). Additionally, while much of the current discourse emphasizes the technical aspects of haptic devices, socio-cultural factors influencing their adoption in clinical practice have been comparatively underexplored. Understanding how practitioners perceive these technologies, their willingness to embrace teleoperation in clinical settings, and the potential barrier to adoption remains an essential inquiry that has not been prominently featured in existing literature, (Ahmad & Khan, 2024). As the healthcare landscape continues to evolve in the face of growing patient demands and shifts towards remote care models, investigating these socio-cultural dimensions will be vital for comprehensively assessing the impact of haptic devices and teleoperation in medical applications. In setting the stage for this literature review, it is essential to provide a detailed exploration of the existing studies surrounding haptic technology and teleoperation. This review will outline the key themes of surgical precision, patient engagement, and the socio-cultural implications of these technologies while

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