Enhancing Optimization and Accuracy in Robotic Surgery through Advanced Geometric Techniques and Deep Learning

Raghav Mukhija and Arnav Tayal

Abstract

Robotic surgery is a promising method to improve surgical outcomes. The field of robotic surgery is poised for remarkable transformations driven by advances in machine learning (ML) and artificial intelligence (AI). This research aims to integrate advanced geometric techniques and deep learning to address the challenges associated with robotic-assisted surgeries. This paper outlines the methodology for optimizing surgical procedures by leveraging metric spaces for accurate anatomical measurements, group theory for optimal robotic motion planning, and data augmentation techniques for improving machine learning models used in surgical planning and intraoperative guidance. The main goal of this research is to enhance the precision and safety of robotic-Assisted Surgery (AAS). The main objective of this study is to improve the surgical outcomes by integrating advanced geometric technique and deep learning. This research will contribute to the development of more reliable and effective robotic systems, paving the way for continued advancements in surgical technology.

1 Introduction

Robotic-assisted surgeries have revolutionized the field of surgery by offering enhanced precision and control. However, optimizing the precision and safety of these procedures remains a significant challenge. This research aims to address this challenge by integrating advanced geometric techniques and deep learning to improve surgical outcomes.

1.1 Background and Motivation

Robotic surgery began with early systems aiding surgeons in complex procedures with enhanced accuracy and precision. The da Vinci Surgical System revolutionized the field by combining robotic manipulators and high-resolution imaging, allowing intricate surgeries with unmatched precision. It features highly flexible and precise robotic manipulators, 3D visualization, and endoscopic cameras for detailed surgical views, thus improving navigation and outcomes. Advances now focus on enhancing precision, dexterity, control mechanisms, and real-time adaptive feedback. Ongoing research aims to improve sensors, actuators, control algorithms, and integrate machine learning for real-time adjustments and safety, prioritizing reliable performance and reduced risks.