International Journal of Advancement in Technology

OPEN ACCESS Freely available online

Perspective

# Recent Breakthroughs and Future Views in Artificial Intelligence-Based Computer Vision in Surgery

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## PERSPECTIVE

Surgery has progressed thanks to technological advancements, particularly Minimally Invasive Surgery (MIS), such as laparoscopic surgery and robotic surgery. As a result, the number of technologies in the operating room has increased. They can offer additional details regarding a surgical process, such as instrumentation and trajectory. The quantity of information collected from a surgical video shot by an endoscope is particularly impressive among various surgery-related technologies. As a result, data analysis automation is critical in surgery to decrease data complexity while enhancing its value to allow new research and development opportunities. Computer Vision (CV) is a branch of research that aims to automate activities that may be accomplished by the human visual system by understanding how computers can perceive digital pictures or movies. Because this discipline encompasses all aspects of real-world data capture by computers, the name "CV" is broad, including anything from image sensor hardware to AI-based picture identification. In recent years, AI-based picture recognition for simple tasks, such as identifying photos, has evolved to the point where it is similar to humans. Although surgical video recognition is a more difficult and difficult challenge, if we can successfully apply it to MIS, it will lead to future surgical improvements like intraoperative decision assistance and image navigation surgery. Automated surgery may become a reality in the future. In this paper, we review current advancements in AI-related surgery research and development, as well as prospects.

There are several reasons why AI can play an important role in ensuring high-quality MIS in every hospital. First, unlike open surgery, MIS relies largely on visual input for both the surgical technique and intraoperative decision-making. As a result, future advancements in AI-based image identification technology may minimize a load of intraoperative decision-making on surgeons. Second, MIS may be used to get a large number of surgical videos. These movies may be used as a training dataset for a Machine Learning (ML) algorithm, which is one of AI's subdomains. Third, fine anatomical features such as arteries and nerves may be seen under enlarged vision during MIS. With a better knowledge of these complex systems, surgery should be conducted more skillfully than ever before. For these needs, AI-based visual navigation would be useful. Human error has grown increasingly prominent in an era where there is a greater emphasis on patient safety. Because human decision-making capacity is naturally restricted, inventing a method to aid surgeons' decision-making processes during surgery would be extremely beneficial. It might pave the way for technology-assisted, real-time intraoperative decision assistance. Many surgical videos might be the basis for developing an AI with collective surgical consciousness, which incorporates the expertise and experience of world-renowned doctors.

Ethical and legal considerations will play a major role in the research field of AI in surgery and should be carefully considered. Acquiring large amounts of surgical video data is paramount to the scalability and sustainability of the use of AI in surgery. Medical records of patients, including diagnosis, operation procedure, and intra/postoperative complication data, must be kept in strict confidence. Furthermore, it is debatable whether the surgical footage should be included in the private information. Failures of AI-based surgical systems must have as little impact on patients as possible. AI-based surgical systems should be thoroughly tested and certified, taking into account all potential dangers. Other than clinical trials, it is now important to consider acceptable approaches for each AI-based surgical system to evaluate its safety and efficacy. The proper use of emerging technologies and the progressive establishment of trust between humans and AI should be considered, for example, the harmful effects of overreliance on AI-based surgical systems on surgical education. It should also be assured that any short or long-term adverse outcomes induced by AI-based surgery are dealt with properly. To address these challenges, surgeons, engineers, policymakers, ethicists, patients, and others are urged to draught and agree on comprehensive protocols governing the collecting, storage, sharing, and use of data.

Although surgeons are trained to detect anatomical structures, AI can do it with great accuracy, and vice versa for challenging targets. The more difficult anatomical features for surgeons to identify, such as small nerves and veins hidden beneath adipose tissue, the more useful AI-based picture navigation becomes. Annotating targets that are difficult for even surgeons to perceive and teaching AI to recognize them is one of the upcoming difficulties. To increase recognition accuracy for tough objects, integration with additional technologies such as Indocyanine Green (ICG) and

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**Received:** December 05, 2021; **Accepted:** December 15, 2021; **Published:** December 24, 2021

**Citation**: Brown R. (2021) Recent Breakthroughs and Future Views in Artificial Intelligence-Based Computer Vision in Surgery. Int J Adv Technol. 12:129

near-infrared light may be required. In tough circumstances, such as individuals with significant obesity, severe adhesions, and anatomical anomalies, AI-based picture navigation might be beneficial. However, based on the statistics, it is believed that the vast majority of the data in the training set consists of standard situations, and AI trained on such datasets will be useless in cases that stray from the norm. The accumulation of instances with anatomical anomalies, in particular, might provide a significant future difficulty.

We covered recent advancements and prospects in AI-related surgical research and development in this paper. Before AI can be smoothly integrated into the future of surgery, various concerns must be solved in terms of technological feasibility, accuracy, safety, cost, and ethical and legal considerations. Future surgical AI and robotics, on the other hand, should be able to see and comprehend complex environments, make real-time decisions, and accomplish desired tasks with enhanced precision, safety, and efficiency. We also feel that this vision will come to fruition in the not-too-distant future.