Proceedings of CONF-APMM 2025 Symposium: Controlling Robotic Manipulator Using PWM Signals with Microcontrollers
DOI: 10.54254/2753-8818/2025.AD26484

Analysis of Research Hotspots and Trends in the Application of Artificial Intelligence in Gastrointestinal Diseases Field

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Abstract. With the development of artificial intelligence, technological advancements have widely permeated the medical field, exerted a significant influence and played a crucial role in the diagnosis and treatment of gastrointestinal diseases. Artificial intelligence can quickly learn from expert experience, achieve wide-scale replication, work continuously and self-update. It can effectively alleviate the pain caused by gastrointestinal diseases and even help patients recover. This also significantly reduces the pressure on both doctors and patients. Doctors and experts can utilize artificial intelligence and 5G communication technology to remotely control surgeries, and precisely remove tumors, polyps and other issues within patients' bodies. This method can also enable experts to perform surgeries remotely, solving the problems of patients' mobility difficulties and the long distance between the two locations. Moreover, the quality of the surgeries has also been improved through technologies such as artificial intelligence. Based on the research results and the success rate of the surgeries, it has been concluded that through the application of artificial intelligence technology, long-distance surgeries can be conducted, and the results are basically the same as those of traditional surgical methods.

Keywords: Artificial Intelligence, Remote Control, Technological Innovation, Gastrointestinal Diseases, Digestive Tract

1. Introduction

With the development of artificial intelligence, technological advancements have widely permeated the medical field, exerting a significant influence and playing a crucial role in the diagnosis and treatment of gastrointestinal diseases [1, 2]. Artificial intelli- gence can quickly learn from expert experience, achieve wide-scale replication, work continuously and self-update. It can effectively alleviate the pain caused by gastrointestinal diseases and even help patients recover. This also significantly reduces the pressure on both doctors and patients [3].

Remote surgery refers to the procedure where surgeons use wireless networks and robotic technology to perform operations on patients located in distant places. It is a part of remote medical care.Remote surgery not only helps alleviate the shortage of regional surgeons, but also breaks through spatial barriers, enabling timely and effective surgical operations and reducing medical costs

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DOI: 10.54254/2753-8818/2025.AD26484

and patient transfer risks. The development of remote surgery requires the dual assistance of 5G network technology and surgical robot technology.

Conduct a survey on the current status of the digestive endoscopy image and text system to clarify the basic performance of the endoscopy image and text system in our country. Based on this, explore the basic indicators for the functions of the digestive endoscopy image and text system and the anatomical areas that should be covered by upper gastrointestinal endoscopy examinations, and attempt to construct an artificial intelligence quality control model for upper gastrointestinal endoscopy to efficiently, objectively and accurately evaluate the quality of upper gastrointestinal endoscopy diagnosis and treatment [4]. In clinical practice, Song et al. proposed using artificial intelligence to study postoperative inventory of gastrointestinal mucinous adenocarcinoma [5]. Luo and Li introduces the role and potential of AI in the diagnosis and treatment of GT from several aspects, including tumor detection, peritoneal metastasis, precision intelligent diagnosis and treatment, and robotic surgery system [6]. Cui et al. studied the effectiveness of artificial intelligence in predicting short-term complications after gastrointestinal tumor surgery [7].

The thyroid (hernia) surgery team of the General Surgery Department of the Chinese People's Liberation Army General Hospital utilized a dedicated network and 5G wireless network to perform a remote robot-assisted esophageal hiatus hernia repair and gastroesophageal reflux reduction surgery for a 69-year-old female patient who suffered from esophageal hiatus hernia and gastroesophageal reflux. The operation spanned a distance of 2,200 kilometers (from Beijing to Guangzhou).The result was that the surgery was successfully completed without any complications. There was 10 mL of bleeding. The operation lasted for 78 minutes. The average delay of the bidirectional network during the operation was 39 ms. There was no network disconnection or significant frame loss in the surgical robot host network system. The operation was smooth and stable. The patient was able to resume gas release and defecation 23 hours after the surgery, started eating 2 days after the surgery, and was discharged 6 days after the surgery.Conclusion: Remote surgical robot-assisted hiatal hernia and gastric fundoplication procedures are safe and feasible, and can achieve the same results as traditional robotic surgeries [8].

The General Surgery Department of the Chinese People's Liberation Army General Hospital successfully performed the country's first ultra-long-distance robot-assisted radical resection of rectal cancer using a domestically produced surgical robot system between Beijing and Sanya (a distance of approximately 3,000 km). Preliminary evidence indicates that ultra-long-distance robot-assisted rectal cancer surgery supported by 5G communication technology is safe and feasible, and it is worthy of further exploration and implementation [9]. This study, through an analysis of the current status of the graphic system for digestive endoscopy in China and two rounds of Delphi method surveys, initially clarified the basic functional requirements of the graphic system for digestive endoscopy and the anatomical areas that should be covered in standardized upper gastrointestinal endoscopy. Based on these results, an artificial intelligence quality control model for upper gastrointestinal endoscopy was constructed [4].

During the verification process, this model demonstrated excellent accuracy, sensitivity, specificity, positive predictive value and negative predictive value. It showed no significant difference in the accuracy of evaluating the completeness rate of upper gastrointestinal examinations and the application rate of various endoscopic examination methods compared to manual assessment. Moreover, it had a significant advantage in terms of evaluation time and is expected to become an important tool for monitoring the quality of upper gastrointestinal endoscopic examinations in the future. Compared with traditional regression analysis, the complications-related factors identified by artificial intelligence and the constructed nomogram prediction model have

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better prediction accuracy and higher efficacy. Provide examples of the data sources of 5G technology and specific surgical methods. Based on this, apply artificial intelligence technology to compare traditional surgical methods and select the more suitable and effective ones.

This paper analyzes the application and limitations of 5G network technology and computer-aided technology in remote surgeries, summarizes the current situation and progress of the innovative development of remote surgeries, and provides more ideas for the development of remote surgeries.

2. Method

2.1. Data sources

Explore the feasibility and safety of 5G remote surgery robot assistance in liver, gallbladder and pancreas surgeries.Method: A retrospective analysis was conducted on 5 cases of 5G remote robot-assisted liver, gallbladder and pancreatic surgery jointly performed at the Shanghai Huashang Hospital of Zhejiang University School of Medicine and the Aral Hospital in Xinjiang (with a distance of 4600 km between them).The 5G remote surgical robot has shown excellent feasibility and safety in liver, gallbladder and pancreatic surgery, which helps improve the accuracy of the operation, reduces the burden on patients and doctors, provides high-quality medical services in remote areas, and promotes the balanced distribution of medical resources.

From January 2019 to June 2021, the Cancer Hospital of the Chinese Academy of Medical Sciences collected 21,310 images of upper gastrointestinal endoscopy. Among them, 19,191 images were used to build a part recognition model through deep learning, and the remaining 22,119 images were used for verification.Compare the performance differences in identifying 30 locations of the upper digestive tract between two DCCN network construction models. One is the traditional ResNetV2 model constructed by Inception-ResNetV2 (ResNetV2).Another type is the RESENet model constructed by Inception-ResNetV2 and Squeeze-Excitation Networks (RESENet), and the main observed indicators include recognition accuracy, sensitivity, specificity, positive predictive value, and negative predictive value.

2.2. Indicator selection and explanation

During the verification process, this model demonstrated excellent accuracy, sensitivity, specificity, positive predictive value and negative predictive value.

The accuracy of the assessment of the completeness rate of upper gastrointestinal tract examinations and the application rate of various endoscopic examination methods was not significantly different from the manual assessment.Moreover, it has a significant advantage in terms of assessment time and is expected to become an important tool for monitoring the quality of upper gastrointestinal endoscopy in the future.Compared with traditional regression analysis, the complications-related factors identified by artificial intelligence and the constructed nomogram prediction model have better prediction accuracy and higher efficacy.

2.3. Method introduction

2.3.1. Delphi method survey

Based on the relevant technical literature of the American Society for Gastrointestinal Endoscopy, the functional standards of the endoscopic image display system were initially determined. Based on

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the 2020 China Network Survey on Gastrointestinal Endoscopy Diagnosis and Treatment Techniques, an analysis of the current status of endoscopic image display systems in China was conducted.Based on relevant literature and analysis results, the functions of the digestive endoscopy graphic system and the related indicators for standardized upper gastrointestinal endoscopy were initially established. A Delphi method survey was conducted with experts in the relevant domestic fields.

2.3.2. Inception-resnet V2

Based on the research results and actual circumstances, four standards were set:

the anatomical location, the cleanliness of the mucosa, the image quality, and the examination method.Using 21,027 images of upper gastrointestinal endoscopy as the total dataset, an endoscopic identification model for upper gastrointestinal anatomical sites and an image quality model were established using Inception-Resnet V2 as the baseline algorithm.Based on the target detection model, a mucosal cleanliness assessment model was established. Using Mobile Net V3 as the baseline algorithm, an endoscopic examination method identification model was built, and these two were integrated to form the final artificial intelligence upper gastrointestinal endoscopy quality control model.At the same time, this model was applied together with manual assessment to evaluate 4944 images of upper gastrointestinal endoscopy, and the evaluation results were compared.

3. Results and discussion

Based on the surgical results, the 5G remote surgical robot has shown excellent feasibility and safety in liver, gallbladder and pancreatic surgeries. It helps improve the accuracy of the surgery, reduces the burden on patients and doctors, provides high-quality medical services in remote areas, and promotes the balanced distribution of medical resources.

3.1. Medical environment

The investigation ultimately selected 26 out of 4,190 medical institutions and 473 graphic-text systems for analysis. At present, the mainstream endoscopic graphic-text systems used in China are not fully functional. There are significant differences in the functions of endoscopic graphic-text systems used by medical institutions of different levels and in different regions.Overall, only approximately 60% of the image and text systems possess three functions that are of significant importance for endoscope quality control, namely pathological reflux, decontamination traceability, and collection and reporting of endoscope quality control indicators. Moreover, only about 77% of the image and text systems are compatible with the medical and health information transmission protocol, which is a prerequisite [10].

3.2. AI function indicators

In the comparison between AI and manual methods, the assessment time of AI is significantly shorter, and the assessment accuracy of AI for the completeness rate of upper gastrointestinal examinations and the application rate of various endoscopic examination methods is highly consistent with that of manual assessment.The functional indicators for the endoscopic image and text system have been determined as follows: (1) Basic functions: Patient information recording and archive management;The acquisition, storage and export of endoscopic examination images and

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videos; support for simultaneous image and video capture of multiple endoscopic, ERCP and EUS procedures; the generation of endoscopic reports adheres to structured or partially structured requirements; Support ICD10/11 international disease classification standard coding; Compatible with HL7, DICOM and other healthcare information transmission protocols; (2) Auxiliary functions: Re-infusion of pathological results; Workload statistics and analysis; Record tracing of decontamination; (3) Endoscopic quality monitoring function: Autonomous calculation of quality control indicators for digestive endoscopes; Reporting of quality control indicators for digestive endoscopes.

4. Conclusions

Remote surgery refers to the procedure where surgeons use wireless networks and robotic technology to perform operations on patients located in distant places. It is a part of remote medical care. Remote surgery not only helps alleviate the shortage of regional surgeons, but also breaks through spatial barriers, enabling timely and effective surgical operations and reducing medical costs and patient transportation risks. The development of remote surgery requires the dual assistance of 5G network technology and surgical robot technology. This article analyzes the application and limitations of 5G network technology and computer-aided technology in remote surgeries, summarizes the current situation and progress of the innovative development of remote surgeries, and provides more ideas for the development of remote surgeries.

The conclusion is that the artificial intelligence-assisted model for identifying upper gastrointestinal regions, constructed using the hybrid neural network RESENet, has significantly improved performance compared to the traditional ResNetV2 model. This model can be used to monitor the integrity of the examination areas in upper gastrointestinal endoscopy, reduce blind spots during the examination, and is expected to become an important assistant in standardizing upper gastrointestinal endoscopy and improving the quality of the examination. It will also serve as an important tool for quality supervision and control of upper gastrointestinal endoscopy.

After discussion and result analysis, in the future, the 5G technology of artificial intelligence can be widely applied in the medical field to perform surgeries for patients.

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