Internet-based telemedicine comprehensive service system

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Abstract-Due to the pandemic which lasted for more than two years, many people cannot get access to the hospital in time. Consequently, tele medicine has gradually entered people's field of version. People can see the doctor at home without going out. Telemedicine refers to the use of computer technology to give full play to the advantages of medical technology and medical equipment in large hospitals or specialized medical centers to diagnose, treat and consult inconvenient people at a distance. In this paper, there are three parts: surgery robot, image processing and 5G transmission. For the first and foremost, medical devices are the premise. Surgical robot is the focus of current research especially the Da Vinci Surgical Robot. Secondly, we discussed image processing and focused on MRI about image analysis, image segmentation and image denoising. Finally, 5G has given "wings" to telemedicine, and built an efficient and all-time-space treatment system. It has not only effectively promoted the sharing and collaborative treatment of emergency information and early treatment of critical diseases, but also brought more sense of gain, happiness and security to people's lives.

1. INTRODUCTION

In an era of rapid medical development, medical equipment and technology are also evolving at a rapid pace. Advances in communications technology and robotic surgery have made the concept of telesurgery a viable option for using technology to obtain better surgical outcomes. The ultimate vision could be what is known as telesurgery, where surgeons can operate on patients from a distance, creating a remote surgical procedure to minimize medical staff turnover while providing access to surgery in remote areas, addressing the impending surgeon shortage and reducing the risk of infection. Today's telesurgery has evolved into an exciting new chapter, with the fusion of augmented reality and machine learning providing a truly digital surgical assistant for the first time. Surgical robots have new concepts and absolute advantages and are gradually replacing traditional manual surgery. The Da Vinci Surgical Robot is a cutting-edge, iconic medical device for minimally invasive surgery. The Da Vinci Surgical Robot was developed by Intuitive Surgical, Inc. and has been successfully introduced to the market. The robot is currently being introduced in major hospitals around the world. In addition, there are countless successful clinical trials.

For MRI image processing methods, it is mainly divided into three parts. They are image parsing, image segmentation and image denoising. The image parsing must first determine the file format and then parse the dicom file. Image segmentation mainly uses three algorithms: KFCM algorithm, WKFC algorithm and watershed algorithm. In February 2022, Wang Yibao from Nanchang University developed his advanced version of the IBA algorithm based on the KFCM algorithm. Image denoising mainly introduces two methods, one is mean filtering, and the other is median filtering. Peng Peng Xie from the National University of Defense Technology used main filtering to improve the filtering technology of vehicle license plate surveillance images.

Telemedicine refers to the two-way transmission of data, voice, images and other information through modern communication technology. The result is long-distance medical services that are not limited by space. Telemedicine is a new type of medical service that closely integrates signal transmission, communication technology, and medical expertise. Through the remote realization of the collection, transmission, processing, storage and query of medical information, remote patients to make treatment, diagnosis, health care, consultation, follow-up diagnosis. The operation of this technology will rely on the development of communication technology, and the quality of communication technology directly determines the implementation of this technology. With the gradual development and popularization of 5G communication

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technology, telemedicine technology is also gradually entering our lives. It is believed that in the future this technology will be applied to medical technology.

2. THE SURGEON'S CONSOLE SYSTEM

2.1. Components

a). The surgeon's console system. The surgeon sits at the surgeon's console outside the sterile area, with his eyes focused on the surgical field of view in the stereoscope and controls the surgical instruments and the 3D endoscope by holding the controller in his hand and pressing the foot pedal, so that the tips of the surgical instruments move in sync with the main controller to simulate the surgeon's hand for surgical purposes.

b). Bedside robotic arm system. The bedside robotic arm system, consisting of a camera arm and two instrument arms, is the operating component of the Da Vinci Surgical Robot. This part is mainly used by the assistant surgeon in the sterile area to change instruments and the endoscope to assist the surgeon in the operation. The arm's wrist is equipped with a new technology that offers seven degrees of freedom, allowing for greater refinement and flexibility and a wider range of motion than is possible manually. In addition, the bedside robotic arm system has a vibration cancellation and motion positioning system that filters out the surgeon's hand tremors and reduces the surgeon's range of motion proportionally (5:1).

c). Imaging system. This system is located outside the sterile area and contains the image processing equipment and core processor of the Da Vinci robot, which can be operated by a visiting nurse. The endoscope magnifies the surgical field of view more than 10 times and is a high-resolution lens that provides high-definition three-dimensional images.[1]

2.2. Application fields

Initially, the Da Vinci robot was used mainly in urology, for example, for the radical treatment of prostate cancer, nephrectomy, cystectomy and vasectomy. In gynaecological surgery, the Da Vinci robot outperforms conventional thoracoscopic surgery in terms of safety and postoperative recovery.

2.3. Advantage [2]

Da Vinci robot uses a seven- degree -of -freedom robot arm. Seven degree-of-freedom robotic arms has better working space than six-degree-of-freedom or lower-degree-freedom robotic arms, and have a good accessibility. As the number of degrees of freedom increases, traditional control system based on the design of the motion of trajectory of space robotic arms and their gripping dynamics simulation, such as forward analysis of control equation modelling and solving process is quite complex, the design cycle is long ,and it is difficult to meet the time-sensitive requirement. This leads to low surgical efficiency.[3]

In addition, during the movement of the arm, it is not only necessary to achieve the desired position and attitude of the end-effector, but also to avoid other equipment and to plan the movement path in order to avoid interference with other equipment during the movement of the arm. The CATIA trajectory planning for the robot arm is divided into the following processes: a. Establishing the CATIA mechanism movement model for the seven degrees of freedom robot arm; b. Setting up the kinematic relationships of the rotating parts; c. Setting up and recording the angles of the robot arm; d. Correcting the set parameters according to the movement results. The third step is the most important and is the driving source for the subsequent robot arm dynamics simulation.[4]

2.4. Recent difficulty

Human hand tremor signals need to be filtered. When the human hand operates the main hand device to maintain the clamping state, although the size of the feedback force can be perceived. The reason for this is that there is involuntary tremor in the natural state of the human hand, and the tremor signal can be used as a signal for the operation.

The reason for this is the presence of involuntary tremor in the natural state of the hand, which is a set of high frequency and low amplitude signals.

The tremor signal is a high-frequency, low-amplitude signal that increases in amplitude when force is applied to the hand and is sent to the actuator of the handpiece along with the control signal. The tremor signal is also sent together with the control signal to the actuator of the handpiece, which directly affects the position and speed of the corresponding motor.

These parameters are used as input to the prediction model and ultimately affect the output of the calculations, making the tremor signal further amplified and finally causing a significant change in the gripping area. The result is a significant jitter in the gripping area, so we need to add a jitter filtering algorithm to the control program to attenuate this jitter.[5]

3. IMAGE PROCESSING

3.1. Analysis of MRI images

In the beginning, we need to parse the dicom file. First, skip the 128-byte preamble and read "DICM" 4 characters to confirm it is a dicom format file. Second, read all tags starting with 0002 and determine the transfer syntax according to the value of 0002, 0010.Determines whether the VR of data Element from 0002 is explicit or implicit. Third, if it is displayed, determine the data type and data length according to VR and Len, and read it directly. Implicit cases can only be read according to the tag dictionary to determine what VR it is.Fourth, read the

grayscale pixel data and adjust the window to display it in GDI.[6]

Thiree-dimensional visualization and segmentation of the MRI was performed using Osirix2.7.5.19 The LA was segmented manually in all patients and verified visually in the original image stack prior to rendering. Initial visualization used a Maximum Intensity Projection (MIP) to assess contrast consistency followed by volume rendering using a ray-cast engine with linear table opacity. A Color Look-Up Table mask was applied in order to better differentiate between enhanced and non-enhanced tissue.[7]

3.2. Image Segmentation

a) Now, image segmentation algorithms mainly include boundary-based, threshold-based, fuzzy set theory and region-based methods. The imaging equipment of the MRI image acquires the image with ambiguity. So it is difficult to find the boundaries between different tissues, but the fuzzy clustering method is a good way.The KFCM algorithm is a method of fuzzy clustering of data samples by iterative optimization of the objective function.First, set the number of clusters c and parameter m. Then initialize each cluster center.Last, use the current cluster center to update the membership according to the formula, update each cluster center with the current cluster center and membership until the membership value of each sample is stable.[8]

b) After KFCM, a more accurate algorithm appeared, WKFCM.First,set out the number of selected categories C, the threshold x, the fuzzy index m.Second, select the kernel function and its parameters. Third, initialize cluster centers v and weighting matrix a. Last,update the cluster center to v' and update the dynamic weighting matrix to a'. Use fuzzy clustering to roughly find the boundaries between organizations.The images can then be segmented based on these boundaries.[9]

The watershed algorithm can also be used as a way to segment MRI images. The concept of watershed is based on the three-dimensional visualization of the image.Two of them are coordinates and one is grayscale. Its intuitive concept comes from geography, considering three types of points:1. Belonging to local minimum points. 2. When a drop of water is placed at a certain point, the water must fall to a single minimum point. 3.When the water is at a certain point, the water will flow to more than one such minimum with equal probability. point. For a minimum point in a specific area, the set of points that satisfy condition "2" is called is the "catchment" or "watershed" of this minimum point. The set of points satisfying condition "3" forms the peak line of the terrain surface, which is called the "watershed". The purpose of the segmentation algorithm is to find the watershed.[10]

3.3. Image Denoising

There are two approaches to denoising MRI images.

a) Mean filter

Mean filters using neighborhood averaging are well suited for removing grainy noise from scanned images.Neighborhood averaging method suppresses noise effectively, but also causes blurring due to averaging, and the blurring degree is proportional to the field radius.The smoothness achieved by the geometric mean filter can be compared with that of the arithmetic mean filter, but less image details are lost in the filtering process.

The harmonic mean filter works better for "salt" noise, but not for "pepper" noise. It is good at dealing with other noises like Gaussian noise.The inverse harmonic mean filter is more suitable for dealing with impulse noise, but it has the disadvantage that it is necessary to know whether the noise is dark noise or bright noise, so as to choose the appropriate filter order sign, if the order sign is wrong could have catastrophic consequences.

b) Median filter

It is a commonly used nonlinear smoothing filter. Its basic principle is to replace the value of a point in a digital image or digital sequence with the median value of each point in a field of the point. Its main function is to make the surrounding pixels gray. The pixel with a large difference in degree value is changed to a value close to the surrounding pixel value, so that isolated noise points can be eliminated, so the median filter is very effective for filtering the salt and pepper noise of the image. The median filter can not only remove noise but also protect the edge of the image, so as to obtain a satisfactory restoration effect. Moreover, the statistical characteristics of the image are not required in the actual operation process, which also brings a lot of convenience, but it is not suitable for the image. Some images with many details, especially those with more details of points, lines and spires, should not use the median filter method.[11]

4. THE DEVELOPMENT OF 5G HAS BECOME THE WING OF TELEMEDICINE

4.1. The link between 5G and telemedicine.

The development of medical technology is inseparable from the support of advanced communication technology. The advantages of 5G network high speed, large capacity and low latency have broken through the bottleneck restricting the development of telemedicine to a large extent.

Compared with previous communication technologies, 5G has the following three breakthroughs:

i.Fast. (5G spreads information much faster than before)

ii.Spectral width. (The ability to penetrate and diffrite obstacles is improved, the signal transmission distance is longer, the interference of the climatic environment is reduced, and the antenna gain is higher)

iii.Low latency. （it will reduces physician communication delay. The lower the delay, the closer it is to traditional medicine)

If we say that in the 1G era, we need to rely on voice to see things. Then things in the 2G era have become text. Things in the 3G era are a specific picture. And things in

the 4G era are a picture that can be moved. Then in the 5G era, we see things as things themselves. With the breakthrough of technology telemedicine technology is coming to us. [12]

These big breakthroughs in 5G have enabled telemedicine to be gradually realized.

Through remote communication technology and holographic imaging technology, we can provide professional medical technology services, give full play to the advantages of large-scale medical association technology and equipment. Promote regional sharing of high-quality medical resources. And provide medical services for areas with poor medical and health conditions. Remote areas can also experience relatively advanced medical technology. At the same time, it can also reduce the time wasted by the surgeon and improve the work efficiency in another form.

4.2. 5G communication technology is currently encountering problems.

First of all, from the overall point of view, the planning of 5G medical care is not perfect. There are still considerable differences of opinion and disagreement on coordination and cooperation between the different departments responsible for different blocks. The whole did not form a relatively complete long-term plan. This has a huge hidden danger for the final implementation of the project.

Second, from the perspective of implementation application. The combination of 5G technology and telemedicine is just getting started. The relevant technology has not been implemented and supported. Research progress related to the two is still in its infancy.

What's more, from the perspective of operating costs. 5G communications are facing the challenge of high broadband and low cost, which is also the embodiment of customer needs under the development of this era, and the excessive cost is not conducive to the further development of the technology.

Other than that, from the perspective of operation scale. 5G technology should be more deeply rooted in major urban and rural areas. One of the original intentions of telemedicine technology is to deepen the balanced development of medical technology between regions, so that remote areas can also experience the convenience of advanced technology.

One more point. From the perspective of standards and evaluation systems, at present, 5G medical care lacks a unified standard and evaluation system in terms of data, transmission, terminal equipment, and medical devices. Authorities were unable to detect whether the equipment complied with telemedicine standards. There are no standards for forming a unified system and equipment. [13]

4.3. How to resolve the above issues:

a) Accelerate the process of 5G technology research and development. Coordinate 5G top-level technology, focusing on the needs and breakthroughs of 5G technology in medical and health care.

b) The government should strengthen policy guidance. Encourage the realization of telemedicine projects and the advancement of 5G technology.

c)Adhere to 5G technology innovation. Promote the transformation of scientific research results into real technology and provide more reliable technical support for telemedicine.

d)Actively build 5G technology demonstration sites, and gradually let the masses understand telemedicine technology.

e) Share base stations to expand the scope of single base station services. Reduce operating costs while ensuring technical quality.

f) Deepen the popularization of 5G technology in remote areas and expand the scope of 5G technology services.

Ethernet, storage, intellectual property (IP)/multi-protocol label switching (MPLS) and 4G/5G Universal Public Radio Interface (CPRI)/e CPRI services over 100G OTN switched connections have proven to be the most efficient fiber, power and cost-efficient deployment solutions available today on metro and long-haul networks. And to meet the expected bandwidth growth in a highly connected world, network operators are looking to expand their networks with 200G, 400G, and new long-distance network FlexO connections.[14]

5. CONCLUSION

High-quality and efficient medical instruments are a prerequisite for the treatment of diseases. More and more surgical robots are being introduced. Although there are currently limited areas of use for surgical robots, as the technology continues to mature, more and more diseases can be treated by surgical robots and people will be less uncomfortable to treat. After the MRI image is obtained, image processing has become a very important link, which can make the image clearer, reduce the doctor's mistakes in the diagnosis process, greatly improve the efficiency of surgery, and reduce the risk of surgery. The Outbreak of Wuhan pneumonia has brought telemedicine to our attention again. Telemedicine can effectively improve the skewed distribution of hospital medical resources and support medical interaction and consultation to reduce the time and space requirements. The development of 5G systems has greatly shortened the distance between patients and hospitals. With the advent of 5G era, telemedicine will be promoted to a deeper level of development, and mobile health care will also become an indispensable part of the subsequent development trend.

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