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Application of Virtual Reality in Colonoscopy

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Abstract

Introduction and Aim: Conventional colonoscopy is a gold standard method to diagnose colorectal internal lesions. However, this method has some problems because of which there is a necessity for substitution method. Virtual colonoscopy as a suggested method provides similar feeling of conventional colonoscopy for the endoscopy specialist through using virtual reality techniques. Therefore, the aim of this study is to inquire the usage of virtual reality in colonoscopy.

Findings: Virtual colonoscopy uses techniques and image processing algorithms and simulation of images obtained of CT modality to create the same feeling as conventional colonoscopy.

Conclusion: Although virtual colonoscopy has solved some of patients' and specialists' problems, it cannot be used as a complete substitution method for conventional colonoscopy because of its limitations. In the future, it is hoped that the development of both artificial intelligent and virtual reality techniques results in creating more effective software that can be used as substitutions in performing conventional colonoscopy.

Keywords

Conventional colonoscopy; CT images; Polyp

Introduction

Colorectal cancer is one of the most important types of cancer that can cause death [1-3]. Commonly, the disease is caused by cancerous colorectal mucosa polyps, which naturally exist in the lower digestive system and at least it takes these polyps about ten years to reach advanced stages of cancer. The notable point is that the early detection of polyps is very important in their treatment [1-4]. The standard method for the detection of internal wall lesions of colorectal, including polyps, is conventional colonoscopy [3, 5-10]. On the other hand, this method is not without problems such as, being invasive, being invisible at some points, high probability of getting cancerous polyps, rupture of colorectal wall, and difficulty in performing the procedure for the patient. Most of these problems are due to colonoscopy entering the patient's anus and its rotational movements during colonoscopy that increases the probability of rupture in the colorectal wall, thus making benign polyps cancerous. Moreover, due to lack of complete flexibility in the tip of the colonoscope and the complexity of the anatomical colorectal structure, some points cannot be seen. On the other hand, there are a lot of risks for patients because they need to observe a specific diet during the 24 hours before colonoscopy, and due to the laxatives they use and the pain and difficulty in performing the procedure. It is notable that the use of painkillers during colonoscopy is very dangerous for diabetic and cardiovascular patients [2,3,8,11,12]. Regarding these problems, the need for an alternative method that can reduce conventional colonoscopy problems is very necessary [13,14]. The alternative method should allow the doctor to treat and monitor the colorectal lesions as well as the conventional method. That is why the application of virtual reality technique is preferred in colonoscopy. Virtual reality is the interface between man and the real world, which creates a sense of immersion in a simulated real-world environment. It has four essential parts: the virtual world; the immersion sense; feedback sensors and interactivity, which will subsequently be dealt with in each section. The virtual world consists of a set of elements that are simulated in a virtual environment and the rules and relationships that govern them. The sense of immersion is the feeling created for the user when interacting with the virtual environment. In addition, feedback sensors are the environment response to user commands and inputs. Finally, interactivity is the ability of the virtual world to respond to the user's actions [15-19]. According to the mentioned earlier, the purpose of this study is to examine the application of virtual reality technique in colonoscopy in order to create an alternative method for conventional colonoscopy.

Background and Finding

Virtual colonoscopy is a diagnostic method for some problems of colorectal mucus. In this method, data from medical imaging devices [PET / CT, MRI, CT] are used to simulate colorectal, as seen in conventional colonoscopy. [2,4,9-11,20-28] Innovative action of David Weining in 1994, which was manifested by screening a patient's intestinal recording based on CT scan data, was a significant introduction to the lead-up of virtual colonoscopy. In addition, this method has progressed a lot since the first paper on virtual colonoscopy was published in 1996.

General stages of the virtual colonoscopy using CT scan data are: Emptying the contents of the intestine and keeping it empty until colonoscopy is done using laxatives and diets, inserting air through the anus into the intestine, performing imaging with CT imaging devices, and using visualization techniques [23]. From the four stated phases, only the final stage [visualization] is a fully software operation that widely uses virtual reality techniques. At this stage, the software processes data of CT scan images using some image processing, navigation and simulation algorithms. The goal of the software is to produce a similar output to the conventional colonoscopy result, and thus, in the visualization process, successful operations of the virtual colonoscopy are performed as follows:

Electronic cleansing

At the beginning of the process, the cleansing of the images from the remaining contents in the intestine begins on the basis of pattern recognition algorithms [29].

Segmentation

In the next step, in order to create an automatic navigation path for moving the virtual camera, the segmentation of the images will be performed [29].

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Calculation of navigation path

At this stage, navigation paths are calculated for the effective detection of colorectal lesions so that rapid and accurate navigation can be performed.

The production of navigation paths requires the calculation of the intestine's central line for moving the virtual camera. The algorithms for producing this path should be executed with minimal operator intervention and with the goal of speeding up.

There should also be a good response time and high accuracy [29].

Simulation of VC and visualization

The final stage in the implementation of virtual colonoscopy is simulation and visualization, in which it makes sense for the physician to move the virtual camera into a simulated intestine. There are certain methods and hardware to improve the quality of this stage [29].

Discussion and Results

By describing virtual colonoscopy and its implementation stages, it can be seen that virtual colonoscopy is essentially a virtual reality of conventional colonoscopy, which seeks to achieve the same goal of virtual reality in creating an intermediate physician and patient with the lowest risk, cost, and various hardships for the patient. By comparing conventional and virtual types, it can be concluded that each method has advantages, disadvantages and limitations.

Despite the mentioned problems by conventional colonoscopy, it should be acknowledged that it is the standard method for diagnosis that is well-known by gastrointestinal experts, and when performing the job, they understand the concept of what they see. On the other hand, virtual colonoscopy is essentially a non-invasive method, or by taking X-ray impairments, it can be categorized into a less invasive approach because, as it was said, during conventional colonoscopy, the probability of cancerous polyps and damage to the intestinal mucosa and rectum is higher, which definitely does not happen in the virtual type. In addition, virtual colonoscopy, in comparison to its conventional type, has no blind spot in terms of full observation of the anatomical structure of the colon and rectum. Furthermore, this method can be used as an alternative or complementary method for conventional colonoscopy in cases where the patient does not, or for other reasons, cannot undergo conventional colonoscopy. Contrary to all the advantages of virtual colonoscopy, this method has the following limitations: First, the detection of polyps depends on their size. The larger the polyps are, the more visible they are in the virtual colonoscopy [14,21]. Second, this technique is used to detect polyps in colorectal and cannot be used if there is a need for sampling.

Virtual colonoscopy, besides the benefits of resolving some patients' and physicians' problems, still has limitations that cannot therefore be used as a completely alternative method for conventional colonoscopy. One could hope that with the growth of artificial intelligence along with the development of virtual reality technology in the future, it would be possible to use more effective software for virtual colonoscopy.

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