Study on Clinical Application of Intelligent Control Technology

Na Wang¹, Gaoqi Yu¹, Zilong Zhong² and Qun Li³*,

¹ Department of Anesthesiology, First Hospital of Jilin University, 71 Xinmini St., Chaoyang District, Changchun 130021, Jilin, P. R. China.
² The First Operating Room, First Hospital of Jilin University, 71 Xinmini St., Chaoyang District, Changchun 130021, Jilin, P. R. China.
³ Department of Thyroid Surgery, First Hospital of Jilin University, 71 Xinmini St., Chaoyang District, Changchun 130021, Jilin, P. R. China.
*Email: lilyly12345@163.com, Corresponding author: Qun Li

Abstract. The main research direction of intelligent control technology is analyzed and discussed in detail, including fuzzy model and basic control algorithm, fuzzy predictive control, stability analysis of fuzzy control system. The status and function of intelligent control are discussed, and the application and development of intelligent control in medicine are summarized and prospected in this paper.

1. Introduction

With the development of social economy and the progress of science and technology, intelligent auxiliary system has been widely used in all aspects of life [1]. The high development of science and technology makes the control system more and more complicated. When the traditional automatic control theory is faced with the dilemma brought by complexity, it tries to break through the old mode to adapt to the new requirements of society on the automation subject. As one of the advanced subjects of automatic control theory, intelligent control reflects the efforts made in the field of control theory to meet the challenge of objective complexity [2, 3].

2. Rehabilitation and Intelligent Assistance

Our country is facing increasingly serious aging problem and the large number of disabled people. The development and application of rehabilitation robot and intelligent auxiliary system are expected to solve this problem by providing technical means and support [4]. Rehabilitation robot and intelligent auxiliary system involve multiple disciplines, and its research and development also face many challenges and difficulties. Existing medical resource of rehabilitation is scarce in China, the rehabilitation treatment methods used by domestic general staff is costly and long-period, but limited effect. Rehabilitation robot and intelligent auxiliary system of research and application are expected to effectively alleviate the contradiction between supply and demand of rehabilitation medical resources, improve the quality of life in patients with disability and aging populations, drive the development of related industries, increase employment and promote social harmony, so it has important social significance [5, 6].

Rehabilitation robot is in response to the lack of traditional rehabilitation training method, and it is the advanced robotics and clinical rehabilitation medicine with the combination of a rehabilitation training of automation equipment. The advantage of robots is performing repetitive heavy labor, being able to realize accurate, automated, intelligent rehabilitation training, so rehabilitation robot enhances
the level of rehabilitation medicine, increases the chances of patients receiving rehabilitation treatment, improves patient's quality of life, and promotes social harmony [7].

Research institutions worldwide have made many achievements in the technical research of rehabilitation intelligence, which has been applied in clinical practice [8]. However, the existing rehabilitation robot still has problems, such as high production cost, limited popularity benefited and limited rehabilitation effect, so there are still many problems to be further studied.

On the base of the perception physiological electrical signals, the rehabilitation robot obtains the corresponding physiological electrical signals from the patient, judges the motion intention of the patient through the recognition of the signals, and commands a controller based on the motion intention to drive the patient's limbs for rehabilitation training [9].

3. Intelligent Technology in Ventilator

The development of ventilator in developed countries has a history of nearly 100 years, and has accumulated rich theoretical knowledge and engineering experience. It has great advantages in quality, reliability, function and performance, while our country started relatively late in the production and development of ventilator, which is relatively backward in technology. Because of this reason, China is committed to developing a new type of ventilator to change the backward state of domestic ventilator [10].

The fuzzy control algorithm of PSV, the key technology of high performance ventilator, is studied theoretically and technically. In the past, only controlled the ventilation mode and the conventional algorithm were used, and satisfactory results were obtained. However, for the advanced breathing mode in the high-performance ventilator, the conventional mode was powerless. Because the main control object of the ventilator is human lung, which is a typical nonlinear time-varying object with distributed parameters, it is difficult to establish accurate mathematical model. The effect of conventional control is not good, while intelligent control shows excellent performance when it is difficult to establish the control object model [11]. Considering all kinds of situations in the clinical practice, the conventional algorithm and the intelligent control algorithm are compared. The simulation and clinical trial are conducted, and the advanced control theory and technology will be used to do further research on other advanced breathing mode, intelligent ventilation mode and so on.

4. Intelligent Technology in Medical Image Processing

Intelligence means that with little or no intervention, the system can perform tasks that normally required the participation of professionally trained personnel [12]. With the help of computer artificial intelligence and expert data system, it has been applied successfully in the diagnosis of some specific organ diseases, such as the diagnosis of lung lump and breast cancer [13]. These applications are primarily targeted at specific organ conditions with well-defined characteristics. The characteristics of these diseases are easy to be ignored or difficult to grasp the standard characteristics. (Figure 1) Therefore, the advantages of intelligent computer diagnosis are highlighted.
4.1. Current Status of Intelligence in Medical Image Processing
The function of the medical image processing system should be to further process the reconstructed images collected by the medical imaging equipment, separate the organs and tissues, highlight the pathological structure, so as to facilitate the observation and diagnosis of the imaging doctor, and improve the doctor's working efficiency and diagnostic accuracy [14].

The existing medical image processing system can process and transform the image, extract or change the dictation part. For example, the image can be strengthened, segmented and separated to display some specific structures and project the object image at different angles [15]. Many commercial systems have been formed, such as three-dimensional multi-plane reconstruction imaging, surface projection imaging, volumetric imaging and so on.

4.2. Problems
The intelligence of image processing system is not high enough. The ideal system itself should have comprehensive anatomical and pathological knowledge and be able to understand and distinguish various organs and tissues. It can extract or remove specific organs and tissues in the image at the command of the user. The difficulty of realizing this function lies in the great variation and dispersion of human body structure. If pathological changes occur, there will be greater changes.

4.3. The Research Direction
There is actually some overlap and fusion between the two systems. There are no clear boundaries. Some image processing systems already have some intelligent capabilities. But the recognition and the diagnosis system also must have the image processing ability. The latter identification and diagnosis system mentioned above contains more machine reasoning thinking abilities such as artificial intelligence. According to these functional requirements, only by enabling the system to understand and recognize the three-dimensional image structure of tissues and organs, and having graphical knowledge of the structure and pathological changes of various normal tissues and organs, that is, by enabling the system to have normal anatomical and pathological knowledge, can various organs and tissues be effectively and accurately separated and displayed in order to make accurate automatic diagnosis.

5. Conclusion
Intelligent control system in the clinical research has just started, and a lot of problems remain to be solved on the science and technology, intelligent control system. The space of foreseeable application is huge. This article aims to introduce the research status and progress of intelligent control system, improve the level of technology in the field of intelligent control system in our country, promote its practical application.
6. References

[1] Graham Prophet. Fuzzy logic and neural nets: still viable after all these years? Though no longer headliners, fuzzy logic and neural networks are options in tackling challenging applications. European Documentary Network, 2004.

[2] S. Shao. Fuzzy Self-Organizing Controller and Its Application for Dynamic Processes. Fuzzy Sets and Systems, 1988.

[3] Tanaka K, Sugeno M. Stability Analysis and Design of Fuzzy Control Systems. Fuzzy Sets and Systems, 1992.

[4] Wang LX, JM Mendel. Fuzzy basis function, universal approximation and orthogonal least squares. IEEE ACM Transactions on Networking, 1992.

[5] Hornik K, M Stinchcombe, H White. Multilayer feed forward networks are universal approximator. Neural Networks, 1989.

[6] Hunt KJ, Sbarbaro D, Zbikowski R, et al. Neural Networks for Control Systems—A Survey. Automatica, 1992.

[7] Nie JH, Linkens DA. Fast self-learning multivariable fuzzy controllers constructed from a modified CPN network. International Journal of Control, 1994.

[8] Saridis GN. Knowledge Implementation: Structure of Intelligent Control Systems. IEEE International Symposium on Intelligent Control, 1987.

[9] Carissa Lynn. A dynamic systems approach to the development and application of new mechanical ventilator technologies. Bellardine, 2006.

[10] Tanaka K. Stability and stabilizability of Fuzzy-Neural-Linear Control systems. IEEE Transactions on Fuzzy Systems, 1995.

[11] Fu KS. Learning Control Systems and Intelligent Control Systems: An Intersection of Artificial Intelligence and Automatic Control. IEEE Transactions on Automatic Control, 1971.

[12] Hao JB. Predictive control of nonlinear systems based on identification by backpropagation networks. International Journal of Neural Systems, 1994.

[13] Hunt KJ, Sbarbaro D. Neural networks for nonlinear internal model control. IEE Proc _D : Control Theory and Application, 1991.

[14] Narendra KS, Parthasarathy K. Identification and control of dynamical systems using neural networks. IEEE Transactions on Neural Networks, 1990.

[15] Young MP, Myeon SC, Kwang Y Lee. An optimal tracking neuro-controller for nonlinear dynamic systems. IEEE ACM Transactions on Networking, 1996.