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Motion rehabilitation detection system based on artificial fish swarm intelligent algorithm

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Abstract. The motion rehabilitation system based on artificial fish swarm intelligence algorithm has a positive impact on the recovery of motor function in patients with disabilities. In order to better apply this detection system to the clinical treatment of disabled patients in our country, in this paper, the motion rehabilitation detection system based on artificial fish swarm intelligent algorithm was constructed. Then, the running performance was tested. It is found that the vortex signal frequency obtained by the system is 118.60 Hz, which can effectively collect the weak signals of the sensor, and the control ability of the limbs is improved after the disabled patients use the system. Therefore, the motion rehabilitation detection system is beneficial to the recovery of motor function in patients with disabilities. The purpose of this study is to provide a theoretical basis for the improvement of motion rehabilitation detection system.

Key words. Artificial fish swarm intelligent algorithm, motion rehabilitation, detection system.

1. Introduction

Since the beginning of the new century, medical care has become one of the most important issues affecting social development in the current situation. Diseases such as bone diseases and brain tissue injuries are the main diseases that affect the normal life of the people because of their high incidence and disability in the population. With the rapid development of the society, the improvement of medical level has provided some positive effects on the diagnosis and treatment of some diseases, and has reduced the mortality of patients effectively. However, due to a variety of complications and sequelae, many patients have disabling symptoms in different degree, thus weakening the ability of the self-help movement, and directly or indirectly affecting the normal life and work of patients. The rehabilitation of the damaged nervous system is one of the key links in the later diagnosis and treatment

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of the disabled. The development of rehabilitation medicine has prompted some techniques for rehabilitation training to be developed and gradually applied to the recovery of neurological deficits in patients with disabilities. However, there are still some problems in the movement rehabilitation training, such as the movement of the therapist and the inaccuracy of the exercise, so that the rehabilitation testing system needs further improvement and development. In view of this situation, the motion rehabilitation detection system based on artificial fish swarm intelligent algorithm was studied in this paper, so as to provide theoretical basis and support for the improvement of motion rehabilitation training mode and theory in China.

2. State of the art

In the process of rapid development of the times, the medical level of the world has also been greatly improved. Although studies have suggested that improvements in medical standards provide technical support for the reduction in mortality from diseases, many patients still suffer from some damage to the nervous system, which weakens their motor function, and then affects their psychological and life [1]. In the 80 s of last century, researchers put forward that the motion rehabilitation testing can be applied in the diagnosis and treatment of some diseases, and can be further developed into an auxiliary means of clinical medical treatment [2]. In 1991, the Massachusetts Institute of Technology designed and developed the world's first rehabilitation equipment for human upper limb rehabilitation exercises, which can collect information about the movements of the upper limbs of the patient and provide visual feedback for the therapist [3]. With the continuous development of science and technology, motion rehabilitation testing system with better algorithms and more sensors has been constantly researched and developed, thus promoting the rehabilitation of patients and increasing the effectiveness of rehabilitation training [4]. However, with the development of motion rehabilitation testing system, many researchers gradually realized that the detection of the weak feedback signals from sensors can have a positive impact on the improvement of the motion rehabilitation system. Under this demand, due to the strong adaptability, artificial fish swarm intelligent algorithm is gradually combined with the traditional motion rehabilitation system, and has achieved great development [5].

3. Methodology

3.1. Motion rehabilitation detection system

Under the development of our national economy, unhealthy lifestyles affect people's normal production and life directly or indirectly, thus causing damage to the nerve center of the body movement and causing frequent diseases [6]. Although the medical level of our country has improved in the development of the times, and the cure rate of the national disease has also improved, the related diseases and complications may cause the rise of our national physical disability rate [7]. China's motion

rehabilitation field has made great progress and development. However, compared with the developed countries in the west, China's relative theories and techniques are still relatively backward, and most of the studies are only in the initial stage, and thus are in lack of mature practical application of theory and products. Nowadays, many colleges and universities in China have developed a multifunctional rehabilitation system for motion rehabilitation to interact with a variety of secondary modes. These related systems can detect the state of the user in real time, and improve the structure of the system, so that it can be more effective in practical clinical applications. In addition, it provides some technical support for some patients to recover their normal body through the auxiliary training of motion rehabilitation system in a more efficient manner (Fig. 1).

Fig. 1. Clinical application of motion rehabilitation test system

3.2. Artificial fish swarm intelligent algorithm

The motion rehabilitation testing system has been developed greatly, and has provided a clinical auxiliary role for the recovery of motor function in the disabled population. However, in the process of studying the related system, the collection of the weak signals of the system sensors and the understanding of the causes of the system have become the most important parts in the motion rehabilitation testing system [8]. In the course of mechanical operation, the stochastic resonance among the links may cause noise pollution to the weak signals of sensors [9]. Therefore, in practical applications, only by further improving the relevant algorithm of the system operation can the resonance problem among the mechanical links be effectively controlled, so as to provide scientific support for the accurate operation of the whole motion rehabilitation system. Therefore, in this demand, a large number of algorithm models have been studied and applied to the rehabilitation of clinical patients in our country. As a new and scientific intelligent algorithm theory (Fig. , 2), artificial fish swarm algorithm provides some ideas and methods for solving the

problem of resonance in mechanical operation [10]. In this study, by reading relevant literature, the related theories of artificial fish swarm intelligent algorithm were summarized. The algorithm, derived from the observations of Li Xiaolei and others on the foraging behavior, clustering and pursuit of fish stocks, is the type of algorithm that can obtain the best purpose according to the related behavior. Compared with the traditional genetic algorithm, the artificial fish swarm intelligent algorithm can more easily and quickly optimize the local extremum [11]. Since the artificial fish swarm intelligent algorithm can select the best factor from various factors, its optimization function is usually expressed as follows: the x and y in the function represent the main influencing factors of the project respectively. And its specific algorithm steps are detailed as follows:

(1) The establishment of related parameters of fish stocks includes the scale of fish, the number of iterations, the range of perception, the maximum moving distance of fish stocks and the crowding degree of fish stocks.

(2) In the set of parameters, a certain number of fish are selected randomly and defined as the initial fish group of the algorithm.

(3) The concentration of food consumed by fish stocks is used as the objective function of fish swarm algorithm, and the optimal value is calculated and defined as the announcement value.

(4) The best behavior strategy is select by calculating the rear end collision and swarm behavior of fish stocks. The optimal behavior strategy is defined as the movement strategy of fish, and the foraging behavior of fish is defined as the default behavior. And according to these parameters, the optimal target parameters of each fish are calculated and compared with the announcement value:

$$Maxf(x,y) = \sin\sqrt{(x-10)^2+(y-10)^2}/\sqrt{(\overline{x}-10)^2+(\overline{y}-10)^2}\,. \tag{1}$$

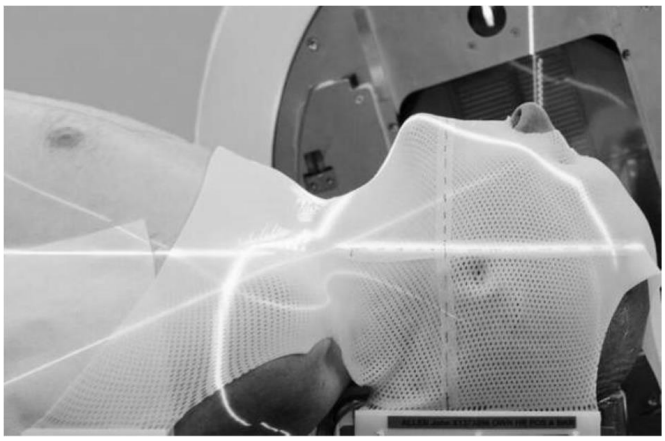

Fig. 2. Application of artificial fish swarm intelligent algorithm in motion rehabilitation detection system

3.3. Development of motion rehabilitation detection system based on artificial fish swarm intelligent algorithm

On the basis of fully understanding the related theories, the motion rehabilitation detection system based on artificial fish swarm intelligent algorithm was developed and constructed. In the process of building the system, the visual programming tool of Lab VIEW was introduced, and the design of the rehabilitation system was carried out, the operation mode of which was mainly accomplished by the mixed programming methods of Lab VIEW and MATLAB. Then, artificial fish swarm intelligent algorithm was embedded into the system, and then a motion rehabilitation detection system suitable for this study was built, providing the research foundation for the subsequent rehabilitation training. Therefore, on the basis of understanding the relevant theories, first of all, the motion rehabilitation testing system involved in this study was constructed. Then, artificial fish swarm intelligent algorithm was introduced into the system, thus providing theoretical support for the rational rehabilitation scheme of the later treatment [12]. Then, in the design of the motion rehabilitation system, the mixed programming mode of Lab, VIEW and MATLAB was mainly used. Only by combining the two programming methods can the optimization process of artificial fish swarm intelligent algorithm mentioned in this study be more efficient [13]. Thus, the whole movement rehabilitation system can be in a relatively stable running state, so as to further promote the whole system to intelligently detect the weak signals emitted by the sensors, and provide certain technical support for the accurate collection of the patient's rehabilitation data [14]. Part of the program diagram of the motion rehabilitation system based on artificial fish swarm intelligent algorithm developed in this research is shown in Fig. 3. The performance parameters of the whole motion rehabilitation system are shown in Table 1. Then, the performance of the system was evaluated and analyzed.

Table 1. Summary of the performance parameters of the motion rehabilitation test system designed in this paper

Parameter name	Function	Numerical value
Working space	Translation	Φ160×110 mm
	Rotate	240×140×180 deg
	Grab	25 mm
Freedom	Translation	3
	Rotate	3
	Grab	1
Power	Sustaining power	12.0 N
	Grasping force	±8.0 N
Resolving power	Linear displacement	<0.01 mm
	Angle	0.09 deg
	Grab	0.006 mm
Interface	Standard	USB2.0
	Refresh frequency	Up to 8 kHz

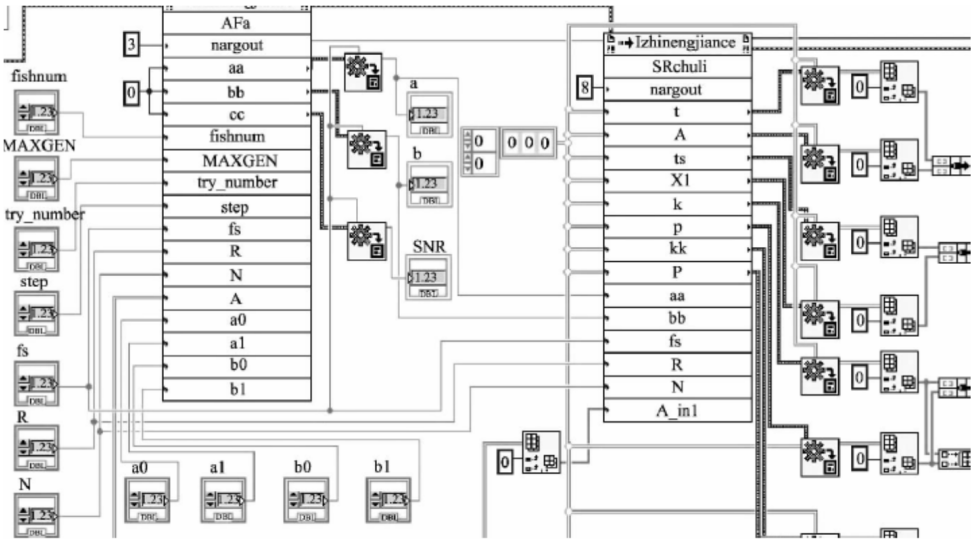

Fig. 3. Part of the program diagram of the motion rehabilitation system based on artificial fish swarm intelligent algorithm

4. Result analysis and discussion

4.1. The test of motion rehabilitation detection system based on artificial fish swarm intelligent algorithm

The motion rehabilitation system based on artificial fish swarm intelligent algorithm is mainly divided into two parts: the test of the system itself and the test of its application effect. All aspects of testing indicators and procedures are described below:

(1) Test of vortex signal Vortex signal is mainly used in the measurement of system running flow. In traditional algorithms, vortex signals in the process of running a motion rehabilitation system may be disturbed due to the irrationality of some links. And the result of the test is low, and even unable to obtain the relevant data, so that the system's detection results can't be timely fed back to the user, thus affecting the normal use of motion rehabilitation detection system [15]. In this study, the related parameters of artificial fish swarm intelligent algorithm were set up, the collection of vortex signals was analyzed, and then the feasibility of this algorithm in rehabilitation system is confirmed.

(2) Application test of motion rehabilitation test system The performance of the motion rehabilitation system based on the artificial fish swarm intelligent algorithm is not only reflected in the operation of the system itself, and it is also necessary to evaluate the effect of motion rehabilitation objectively, and evaluate the effectiveness of the algorithm from the practical point of view. In this study, two patients with upper limb hemiplegia were taken as an example, and relevant data of catching movements at different stages was collected after applying the motion rehabilitation

detection system based on artificial fish swarm intelligent algorithm. And then, the kinematics indexes such as the upper limb rate and the whole motion smoothness were evaluated. Thus, the application effect of the detection system was illustrated. The formulas for calculating the speed and the smoothness of the whole motion are as follows:

$$v = \frac{S}{t}\,, \tag{2}$$

where v represents the rate at which upper limbs move, S represents the trajectory displacement of motion and t stands for the exercise time. Further

$$NJS = \sqrt{\frac{1}{2}\int \left(\left(\frac{\mathrm{d}^3x}{\mathrm{d}t^3}\right)^2 + \left(\frac{\mathrm{d}^3y}{\mathrm{d}t^3}\right)^2 + \left(\frac{\mathrm{d}^3z}{\mathrm{d}t^3}\right)^2\right)\mathrm{d}t\left(\frac{t^3}{S^2}\right)}\,, \tag{3}$$

where NJS represents the overall smoothness of the limbs, x, y, z represent the coordinates of the limb movements obtained by the sensors, S represents the trajectory displacement of motion and t stands for the exercise time.

4.2. Detection results of vortex signals in motion rehabilitation system based on artificial fish swarm intelligent algorithm

On the basis of the design of the system, it is necessary to evaluate and analyze the performance of the system further, so as to determine the feasibility and accuracy of the system. As one of the important parameters in the operation of the whole system, traffic flow effectively reflects the data information collected by the sensors in the whole system and the efficiency of the transmission. And the vortex flowmeter provides technical support for accurate flow measurement. Therefore, in order to better determine the performance of the motion rehabilitation detection system based on artificial fish swarm intelligent algorithm designed in this paper, the vortex signal collected by vortex flow meter is detected during the operation of the system. The parameters of the designed rehabilitation system are as follows: the number of system runs is 100 times, the system detection displacement is 0.1, the system perception of distance Visual is 2.5, and the number of system iterations is 50 times. Then, the system runs, and the vortex signal frequency is 118.60 Hz, which proves that the artificial fish swarm algorithm can effectively achieve the collection of weak signals.

4.3. Test results of motion rehabilitation system based on artificial fish swarm intelligent algorithm

The ultimate goal of the motion rehabilitation detection system of artificial fish swarm intelligent algorithm is to apply it to the actual rehabilitation of patients. Therefore, two disabled patients were included in the study, the catching movements of patients before and after applying the motion rehabilitation detection system were mainly used as evaluation actions, and the moving speed and the smoothness of the

whole movement were tested. The rate of movement of the patient before and after applying the rehabilitation system is shown in Fig. 4. The results show that the motion rehabilitation system based on artificial fish swarm intelligent algorithm has certain influence on patient movement rate. After using the system, the rate of catching movement of the two patients tended to be relatively stable, indicating that the patient's ability to control the body was stronger after the use of the motion rehabilitation test system.

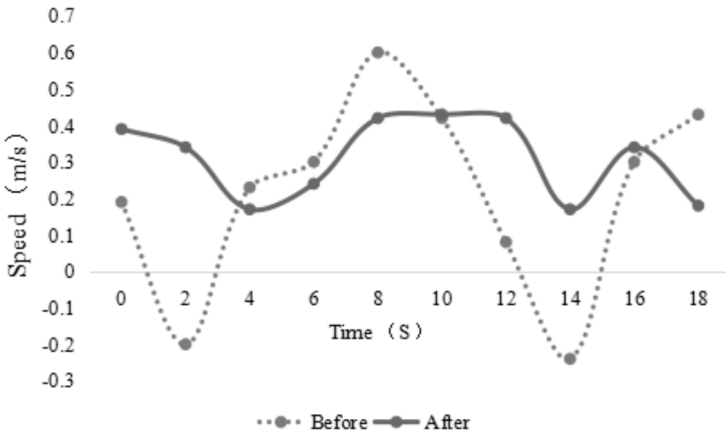

Fig. 4. Changes of catching movement before and after training

Furthermore, the number of catch, the quality and time of the grasping object after the rehabilitation treatment were examined, and the formula (2) was used to calculate the smoothness of the patient's movement. The relevant data is shown in Table 2. The results show that with the increase of training time, the catching movement of patients is increasing, and the weight of what the limbs can take is also increasing. Furthermore, the scores of limb movement smoothness are also increased, which shows that the system has a very important positive effect on limb rehabilitation in patients with disabilities, and has practical value.

Table 2. Analysis of the experimental results before and after applying the motion rehabilitation detection system based on artificial fish swarm intelligent algorithm

Catch quantity				Pinch power		
Time	The sixth day	The thirteenth day	The nineteenth days	Time	The twenty-fourth day	The thirty-first day
Catch number	2	5	8	Object weight	0.15 kg	0.45 kg
NJS (points)	13	22	37	NJS (points)	39	53
Brunnstrom	I	I	II	Brunnstrom	II	III

5. Conclusion

With the development of the times, more diseases have further affected people's normal life and production. However, with the improvement of the medical level, although the cure rate of disease has increased, complications after disease treatment may cause people physical disability, and directly or indirectly affect the development of the whole society. As a supplementary means of limb rehabilitation, the rehabilitation test system has a positive effect on the recovery of the motor function of the disabled patients. Artificial fish swarm intelligent algorithm, as a perfect algorithm of motion rehabilitation system, can select the best parameters from the system and provide some data support for the patient's rehabilitation training. In this study, based on the understanding of the relevant theories, the motion rehabilitation detection system based on artificial fish swarm intelligent algorithm was constructed, and the operation performance and the effect of the patients were analyzed. The results show that the system has a positive effect on the rehabilitation of disabled patients. However, due to the limitations of the theoretical level, there are still some shortcomings in the study, but the study can still provide a reference for follow-up research.

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