Retraction

Retraction: Research on Informatics System and Practice Prospects Based on Artificial Intelligence Mathematical Algorithm (J. Phys.: Conf. Ser. 1865 042076)

Published 9 September 2022

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Retraction published: 9 September 2022
Research on Informatics System and Practice Prospects Based on Artificial Intelligence Mathematical Algorithm

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Abstract. Based on the background of artificial intelligence, this paper uses the 8~13Hz synchronization/desynchronization principle of C3 and C4 channels related to mathematical model algorithm events to design a set of virtual information control model system based on LabVIEW mathematical algorithm platform. In the mathematical information operation model, the EEG signal is filtered and feature extracted by using a digital band-pass filter and power spectrum estimation to control the direction of signal transmission. Experiments show that this mathematical algorithm can achieve the control accuracy of signal transmission, laying a foundation for building a completer and more complex signal system on the LabVIEW platform.

Keywords. Mathematical algorithms, artificial intelligence, LabVIEW platform, information control system.

1. Introduction
On October 2, 2014, the State Council issued the "Guo Fa [2014] No. 46" document entitled "Several Opinions of the State Council on Accelerating the Development of the Sports Industry and Promoting Sports Consumption". The document clearly stated that "strongly support the development of fitness running, walking, cycling, water sports, mountain climbing, shooting and archery, equestrianism, aviation, extreme sports, and other popular and promising projects that have room for development." Among them, horsemanship is impressive. In recent years, domestic equestrian sports have been developing vigorously. Domestic equestrian events are increasing with the rapid development of equestrian sports. Since the 2008 Olympic equestrian events were held in the Hong Kong Equestrian Arena, my country has hosted many large-scale national and international equestrian events. Just as the 2011 International Equestrian Masters Tournament was held in Beijing Bird's Nest. In 2012 alone, there have been more than 20 major domestic equestrian competitions. At present, the National Equestrian Jumping Championship, Youth Championship, Dressage, Triathlon, Speed Race, Endurance Race, Westwood Grand Prix, Barrel Race, Snow Polo World Cup and other domestic equestrian competitions can be described as a slight prosperity. However, the dramatic increase in workload has made the work of the organizer and the organizer more and more trivial and complicated. From competition promotion and athlete registration to rider condition review and performance record; from competition planning to sponsor’s inventory and registration summary; each step retains a large amount of data. Experiments have shown that this kind of ERD/ERS phenomenon can be generated when a person’s limbs move or just imagine the movement of the limbs [1]. This article uses this feature to design a brain-computer...
interface system based on motor imagination, and uses Butterworth band-pass filter to filter out irrelevant Signal; use power spectrum estimation to extract features, convert left- and right-hand motion imagination EEG signals into control commands; use LabVIEW to build a system to realize the left and right movement control of horse racing.

2. Motor imaging EEG signals

2.1. Characteristics and acquisition methods of EEG signals

2.1.1 Characteristics of EEG signals. The basic purpose of medical signal processing is to extract physiological and pathological information useful for disease diagnosis from medical signals with severe background interference. Before processing and transforming the signal, it is necessary to understand the characteristics of the signal to be processed so that a suitable method can be found for processing. The electrophysiological activity of the cerebral cortex recorded by placing detection electrodes on the scalp is the so-called EEG signal. When selecting feature algorithms and classification algorithms, full consideration should be given to the fact that the EEG signal is a non-stationary random signal with no ergodicity, and has the characteristics of strong noise, non-stationarity, and randomness [2]. In the process of processing, a specific rhythm should be selected. The frequency band is the processing object, so that the signal after data reprocessing cannot only well describe the characteristics of the original signal, but also appropriately reduce the feature dimension, and improve the accuracy and speed of the subsequent algorithm.

2.1.2 The acquisition method of EEG signals. EEG signals are the distribution of potentials on the scalp produced by brain neuron activity. EEG signals are usually obtained by using an EEG device. An electroencephalogram is a device specially used to measure and record electroencephalograms. The electrical signals from the brain are transmitted to the signal collector through electrodes placed on the scalp. After pre-analysis, they are then sent to the computer for processing. Related analysis and processing.

According to the different electrode placement positions, EEG is divided into scalp EEG, cortical EEG and deep EEG. Cortical EEG and deep EEG are traumatic and sometimes require surgery to complete, which is technically difficult. The routine EEG examination uses scalp EEG. The scalp EEG is the electric field generated by the brain's nerve activity through the volume conductor (consisting of the cortex, skull, meninges and scalp) and the potential distribution on the scalp. The method of scalp EEG is simple, but because the electrodes are located on the surface of the scalp, there is artifact interference, and the measured signal amplitude is weak and needs to be amplified. Figure 1 shows the EEG signal collection process.

![Figure 1. Acquisition process of EEG signals](image-url)
In the international 10/20 system, there are 21 electrode positions, the names of the electrodes are: Fp1, Fp2, F3, F4, C3, C4, P3, P4, O1, O2, F7, F8, T3, T4, T5, T6, Fz, Cz, Pz, A1, A2. Table 1 shows the corresponding relationship between the motor code names and parts. The even number in the name indicates that the electrode is located in the right hemisphere, the odd number indicates that the electrode is located in the left hemisphere, and the letter in front of the number represents the area of the cerebral cortex corresponding to the electrode [3]. A represents the ear, C represents the central cortex, Fp represents the frontal lobe, F represents the frontal lobe, P represents the top cortex, O represents the occipital region, and T represents the temporal lobe. Except for the three electrodes FZ, CZ, and PZ in the middle, the placement of the other 16 electrodes in the brain is symmetrical. The electrodes on each side use the same earlobe as the reference electrode (h1, h2).

Table 1. Correspondence between motor code names and parts

| Codename | Location |
|----------|----------|
| Fp       | Forehead |
| F        | Amount   |
| C        | Central  |
| P        | Top      |
| O        | Pillow   |
| T        | Temporal |

2.2. Relevant synchronization and desynchronization of motor imaging EEG signals

The so-called sports imagination, as its literal meaning, refers to the participant's imagination of a certain movement, but in fact no real movement occurs. The origin of motor imagination is inseparable from neurorehabilitation engineering, that is, it is hoped to strengthen the recovery or reconstruction of corresponding neural pathways through motor imagination. A large number of functional brain imaging studies have shown that motor imagery is related to the activation of specific neural circuits in the early stage of motor coding, including areas such as scalp auxiliary motor area (SMA), primary motor scalp (PMC), basal nerve centre, and cerebellum [4]. Motion imagination has been widely used in brain-computer interfaces, mainly because there is a prerequisite between imagined motion and real motion, that is, the nervous system responses caused by them have a certain similarity. Neurophysiological research has known that an important structural feature of the brain is the cross-control of limb movement, that is, the right hemisphere of the brain controls the movement of the left limb, and the left hemisphere of the brain controls the movement of the right limb. When the subjects were performing real or imaginary movements of the left and left foot, the EEG signals from the corresponding scalp area showed large characteristic differences.

3. Basic theory of wavelet packet transforms

Wavelet transform (WT) has multi-resolution (multi-scale); the quality factor, that is, the relative bandwidth (LI between the centre frequency and the bandwidth) is constant; proper selection of the basic wavelet can make the wavelet have a characteristic signal in both the time and frequency domains the ability of local characteristics. When using a smaller scale, the observation range on the time axis is small, and in the frequency domain, it is equivalent to using a higher frequency for analysis with higher resolution, that is, using high-frequency wavelets for detailed observation; when using a larger scale, the on-axis observation range is large, and in the frequency domain, it is equivalent to using low-frequency wavelets for general observation [5]. Therefore, the wavelet transform is known as the "mathematical microscope". The wavelet transforms of signal x(t) is defined as:

\[ Wf(a,b) = \int_{-\infty}^{\infty} f(t)\psi_{a,b}(t)dt \] (1)
Among them, \( \psi(t) \) is called the mother wavelet, \( \psi_{ab}(t) \) is called the wavelet function, \( a > 0 \) is called the scale parameter, and \( b \) is called the translation parameter. Usually used to process EEG signals is the discrete wavelet transform, that is, the discretization of scale parameters and translation parameters. Its advantage is that the amount of calculation is less, but from the perspective of resolution, the discrete wavelet transform is more efficient in decomposing the frequency band than the continuous wavelet transforms.

Wavelet packet transform (WPT) was proposed by Wickerhauser M.V. et al. in the early 1990s, mainly to solve the limitation that wavelet transform cannot further refine the high frequency components. In WPT decomposition, the refinement of the low-frequency and high-frequency components of the signal will be carried out at the same time. Like the low-frequency band, it can realize the frequency subdivision of any high-frequency band, so the resolution of the high-frequency band of the signal will be significantly improved [6]. The wavelet packet transform has good orthogonality and locality, and WPT can be regarded as an extension of the gradual orthogonal division of the function space. The focusing characteristics of WPT in the high and low frequency range at the same time make it have better local time-frequency filtering characteristics, which is suitable for bandwidth refinement before EMD decomposition of EEG signals to obtain a more refined single component model state. Taking the binary wavelet packet transform as an example, the binary tree filter bank for multi-resolution segmentation of the function space is shown in Figure 2.

Wavelet packet definition:

\[
\psi_{a,b}(t) = |a|^{-1/2} \psi \left( \frac{t-b}{a} \right)
\]  

\[
\psi_{a,b}(t) = |a|^{-1/2} \psi \left( \frac{t-b}{a} \right)
\]  

The set of this function is the wavelet packet determined by \( u = \phi \). The wavelet packet is a set of related functions including the scale function \( u_n(\phi) \) and the wavelet function \( u_1(\phi) \). If \( n \) is expressed as \( n = \sum \varepsilon_j 2^{-j} \) in binary, \( \varepsilon = 0 \) or 1, then the wavelet packet function:

\[
u_n = \prod_{k=1}^{n} P_k \left( e^{-j\pi/2^k} \right)
\]  

The properties of wavelet packets can be summarized as follows:
Function cluster. \( u_n(t) \) is the wavelet packet generated by the scaling function \( u_0(\phi) \) of the orthonormal wavelet basis, and they also have translational orthogonality:

\[
\langle \mu_n(t-j), \mu_n(t-k) \rangle = \delta_{j,k} \tag{6}
\]

There is orthogonality between \( \mu_{2n} \) and \( \mu_{2n+1} \), that is

\[
\langle \mu_{2n}(t-j), \mu_{2n+1}(t-k) \rangle = \delta_{j,k} \tag{7}
\]

4. System Design

The system consists of three parts: signal acquisition, signal processing and horse racing control. The signal acquisition part includes an EEG amplifier and a silver chloride electrode wire to collect the subject’s EEG signal and transmit it to the computer via USB. The signal processing part is completed by the computer, and the EEG signals are converted into control commands through filtering, feature extraction and classification. The horse racing control part is responsible for the movement control of the horse racing, the recording of the time consumed by the system and the number of moving steps. The entire system is built on the LabVIEW platform, and the interface is shown in Figure 3.

![Figure 3. Front panel](image)

After the system is initialized, the track is 64m long and the horse racing is in the middle position. The subject starts to imagine the left- and right-hand movement to control the horse to move to the left or right. The system calculates the subject’s imagined state every 1s, and the horse moves 1m until it reaches the red flag. After the end position of the mark, the system stops, displaying the elapsed time and the number of moving steps.

5. Experimental verification

The paper selects 3 subjects, all of whom have experience in left- and right-hand movement imagination. After the experimental process is explained and offline training, they are divided into two batches. Each person controls the horse to move to the left and right until the end point, and records the total time and Number of moves. The total time records the total time of generating effective motor imagery EEG signals and invalid signals due to interference and other reasons, reflecting the ability of the subject to generate effective motor imagery EEG signals [7]. The total number of steps recorded the total number of times the subjects imagined limb movements, reflecting the correct rate of the subjects’ left- and right-hand imagination. The summary of the experimental results is shown in Table 1 and Table 2.
Table 2. Statistics of the first experiment results

| Subject | direction | Total time/s | Total steps | Correct rate/% |
|---------|-----------|--------------|-------------|----------------|
| 1       | left      | 41           | 38          | 84.2           |
|         | right     | 38           | 36          | 88.8           |
| 2       | left      | 52           | 43          | 74.4           |
|         | right     | 45           | 38          | 84.2           |
| 3       | left      | 39           | 36          | 88.8           |
|         | right     | 35           | 33          | 96.9           |
| Average value | left | 44           | 38          | 84.2           |
|         | right     | 39           | 35          | 97.4           |

Table 3. Statistics of the second experiment results

| Subject | direction | Total time/s | Total steps | Correct rate/% |
|---------|-----------|--------------|-------------|----------------|
| 1       | left      | 39           | 36          | 88.8           |
|         | right     | 37           | 34          | 94.1           |
| 2       | left      | 49           | 41          | 78             |
|         | right     | 43           | 36          | 88.8           |
| 3       | left      | 38           | 35          | 91.4           |
|         | right     | 34           | 33          | 96.9           |
| Average value | left | 42           | 37          | 86.8           |
|         | right     | 38           | 34          | 94.1           |

It can also be seen from Table 1 and Table 2 that the experimental results of different subjects are not the same, mainly because the subjects have individual differences. Therefore, the design of the system should take into account the self-adaptability, and can adjust the parameters according to the characteristics of the subjects. In addition, through the first experiment, the second experiment is generally better than the first after the subjects have summarized and exchanged their experiences, which shows that the brain-computer interface system based on motor imagination requires the subject to carry out more adequate training. In addition, before the experiment, the subjects must be familiar with the experimental process, understand the generation mechanism of EEG signals, eliminate the sense of strangeness and fear, and eliminate the interference of external factors as much as possible in the experiment, keep the experimental environment relatively quiet, and make the subjects the person is concentrated.

6. Conclusion
The experimental results show that the brain-computer interface system designed in this paper is feasible and reliable, which provides technical support for the further development of a more complete brain-computer interface system on LabVIEW.

Acknowledgements
Ideological and Political Education Demonstration Course 2020 of Wuhan Business University, Project: Equestrian theory and practice.
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