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Design of Human-Computer Interaction Control System Based on Steady-state Visual Evoked Encephalography (SSVEP)

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Abstract: With the continuous development of science and technology, the research of EEG has gradually made great achievements. During this time, a technique called mechanized brain interface was also being used. This technology is based on the computer technology, using the EEG signals generated by the neural activities of the human brain to link with the external devices, so as to form a brain as the signal source, through the signal transmission to the external devices to control the external devices of an emerging technology. The visual system collects information from the outside world, and the EEG signals transmit these signals to the brain. Finally, the brain analyzes and makes judgments so as to give instructions to the mechanical parts, and finally the mechanical parts realize the effect. The experiment found that the system can accurately collect the visual information and the generated EEG signals can be timely display conversion, and finally these signals will be converted into digital signals sent to the calculation of the processing system. In this paper, human-computer interaction control as the entry point, through the analysis and design of the EEG signals of the human brain, and finally designed the ability system that can enable people with physical disabilities to obtain autonomous activities.

Keywords: Steady-State Visual Evoked Eeg; Man-Machine Interaction; Control System

1. Introduction

Since the discovery of EEG signals at the beginning of the last century, people have been trying to use the EEG signals to link the neural activities of the brain with external devices so as to realize certain control of the brain by external devices. If this technology can be realized, it will be a good news for people who are paralyzed or incapacitated due to some special reasons. In modern times, with the continuous development of science and technology, the study of EEG has gradually made great achievements [1]. During this time, a technique called mechanized brain interface was also being used. This technology is based on the computer technology, using the EEG signals generated by the neural activities of the human brain to link with the external devices, so as to form a brain as the signal source, through the signal transmission to the external devices to control the external devices of an emerging technology. Through this technology, people can use their own thoughts to express their actual thoughts and control the external devices, which will be a life-changing technology for people who have lost their physical activity.

2. The principle of the control system

Liking a conventional control system, the system is mainly composed of three parts, the first part is the information collection part, the second part is the brain processing part, and the third part is the mechanical parts operation part [2]. (Figure 1).

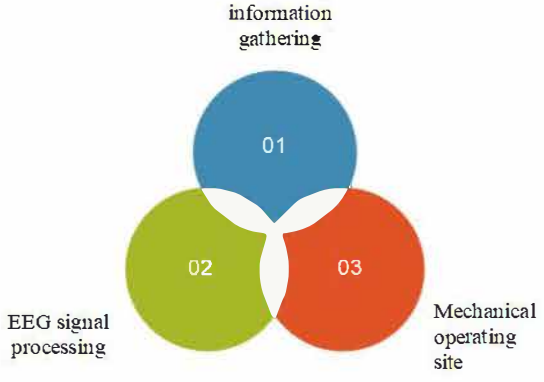

Figure 1. Principle of the control system

2.1 Information collection

The information collection part is mainly to implant the corresponding information collection chip in the human disaster cortex to collect the external information through the human visual and auditory organs, so as to ensure that the external information can be smoothly transmitted to the brain. The basic visual system of the human body is used to receive information from the outside world, and the information is processed and analyzed by means of chips implanted in the cerebral cortex, and finally the information is summarized into the brain.

2.2 EEG signal processing

For a person who has lost the basic ability to move, vision is an important way for these people to obtain information from the outside world. For such groups, their visual system can become more developed due to the disability of the human body. Therefore, visual EEG signal is a very ideal signal transmission choice [3]. When the frequency of visual stimulation is high or the practice of visual stimulation is short, a kind of rhythmic EEG signal is formed. This form of signal is called steady-state visual evoked potential. The advantage of this kind of signal is that the sensing system only needs to perceive a small number of signal transmissions to achieve the desired goal.

2.3 Mechanical operation site

The visual system collects information from the outside world, and the EEG signals transmit these signals to the brain. Finally, the brain analyzes and makes judgments so as to give instructions to the mechanical parts, and finally the mechanical parts realize the effect. This technique, which uses electrical brain signals to control mechanical parts from the brain, could eventually allow groups that have lost the ability to move freely.

3. System design

3.1 Design of the visual collector

The biggest challenge for this technology is to collect information from the outside world through the visual system. In other words, external signals are needed to stimulate the visual system. Therefore, the design of visual stimulator is extremely important. In the existing visual stimulator design methods, there are mainly two mainstream ways, the first is the computer to control the graphics, the point of this method is that the external image information can be timely adjusted by the parameters of the computer to obtain the desired information. The drawback is that image acquisition in this mode is limited to the refresh rate of the computer itself, because the refresh rate of the computer display module can never match that of the human eye [4-5]. The second method is to design a single chip in the system circuit to control the components. The advantage of this method is that the final use effect and the stability of the operation are better, but the disadvantage is also very obvious, because the design of the components in the circuit in advance, so it is impossible to change the parameter information of the components in the later stage. Therefore, combined with these two mainstream methods to carry out a reasonable design, the final design of the computer can control the components in the circuit as a visual stimulator system. This design approach is adopted two mainstream methods of have a little for design, although there is a certain difficulty on technology, the cost of the above and there is difficult, but its advantage is not to be ignored, this is a one-off technology research and development, both to achieve parameter change of computers, and can realize stable long term running effect.

3.2 Design of EEG signal circuit

In our normal human body, the electrical signals generated by the cerebral cortex are very weak. In a healthy human body, this form of EEG can be used directly by the human brain due to the subtlety of the internal structure of the body. In addition, the resistance of the human body is relatively large, so after comprehensive analysis, a large number of interference signals will inevitably appear when the EEG information is collected and used. These interference signals come from a wide range of sources, and most of them are useless signals in the human body, but even so, they still have a certain impact on the electrical signals of the brain [6-7]. So in order to be able to have targeted to obtain eeg signals, and the extracted conversion become available eeg signals can be analysis by computer processing of digital signals, so during the acquisition of the circuit must be to deal with the original eeg signals to eventually get to make up and transform it to become available can be analysis by computer processing of digital signals. Combined with the mechanism of the human body and the signal requirements of the computer, the design of the EEG signal circuit must have high resistance, low noise and excellent anti-interference circuit. (Figure 2).

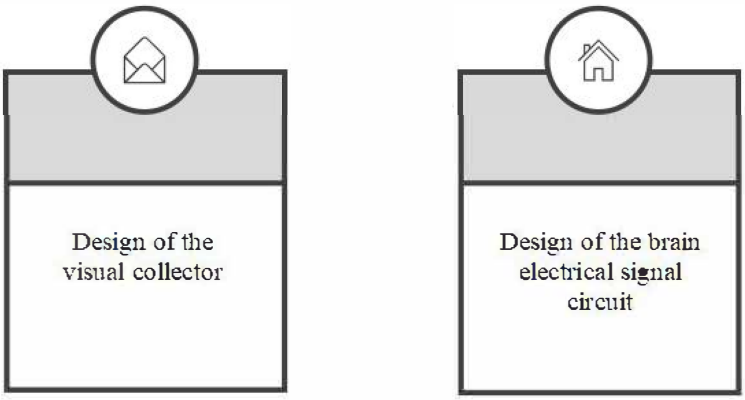

Figure 2. System design

4. The design effect of the system

4.1 The effect of EEG signal input is realized

After the EEG signal circuit design is completed, it is necessary to test the effect of the module of the system. Through the experiment of the test subjects, it is found that under the working frequency set by the system, the EEG signals generated by the test subjects' brain can be displayed in the computer system in time when they observe the pattern on the stimulator [8]. At the same time, the stimulation frequency of SSVEP can also be detected in time. This indicates that the design of the EEG circuit of the system is relatively successful. After receiving the stimulus signals emitted by the stimulus source, the visual system can eliminate the interference signals, accurately transmit the useful signals to the brain in time and analyze and process the EEG signals through the computer equipment in time.

4.2 The effect of the brain controlling the mechanical device

After the EEG signal input test on the test subjects, the experiment found that the system could accurately collect the visual information and timely display and convert the generated EEG signals, and finally convert these signals into digital signals and send them to the computing processing system. Then comes the final, important step, when a computer analyzes and processes the electrical signals in the brain and sends out the correct instructions to manipulate the mechanical device [9-10]. Tester in the test experiment, we use the first visual stimulation is a kind of delicious food, when the stimulation of the optical system of the tester received signal, the brain electrical signals sent to the brain, and transformed into digital signal by computer, and finally the corresponding instructions issued by the computer to test using test equipment after received this letter. The first reaction is to stand up and want to get the delicious food. Therefore, from the point of view of the final effect, the designer is relatively perfect and can better achieve the final goal, and finally convert the signals of the brain into the action signals of the body. (Formula 1).

$$F_N(j) = \frac{1}{N}\sum_{k=1}^{N} X(k)e^{-2\pi(kj/N)} \qquad (1)$$

5. Conclusion

Using EEG signals to control the mechanical devices and finally realize the effect of the mechanical devices can move freely. This technology is based on the human brain's interaction with external devices and takes EEG signals as an important transmission channel. Finally, mechanical devices can replace human limbs to realize the purpose of autonomous activities. This kind of technology is the beginning of a new life for those disabled people who are unable to move. Can let this group of people get rid of the lack of limbs caused by the inconvenience of activity, for this group of people's life is also a great help and improvement. The system is designed to allow people with physical disabilities to use their mechanical limbs to perform some of the activities that normal humans do. Through the continuous improvement of this system, the control of mechanical devices by the brain can be refined, and people with physical disabilities can use their mechanical limbs to do autonomous activities like a normal person, and even complete some subtle tasks that only normal people can do. In this paper, human-computer interaction control as the entry point, through the analysis and design of the EEG signal of the human brain, the final design can enable the disabled people to obtain the ability of autonomous activities, which has a certain help and contribution to the rehabilitation of the disabled.

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