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Optimal Modeling of College Students' Mental Health Based on Brain-Computer Interface and Imaging Sensing

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***Abstract*— As an important part of Ideological and political work, mental health education is an effective carrier to promote the implementation of the comprehensive reform of "three complete education". Fusion of multi-sensor data to achieve higher target tracking accuracy is the current research hotspot, but the research of dynamic level fusion is still a relatively open problem. In target tracking applications, a single sensor may not be able to provide all the information of tracking target. It is easy to lead to inaccuracy of target position estimation by using one of the measured values of sensors for target tracking. Therefore, the fusion of the measured values of sensors in this paper will reduce the uncertainty of tracking target position and improve the estimation accuracy of target position. At the same time, this paper uses brain computer interface technology to study the optimization model of College Students' mental health. After the design of brain computer interface system based on embedded processor, this paper tests the performance of hardware and software of the whole system. It includes the performance test of EEG amplifier, the test of embedded system and brain computer interface application.**

Keywords*— *Mental Health; Imaging; Sensors; Brain Computer Interface; Brain Wave

I. INTRODUCTION

The educational concept of "three complete education" rose in the 1980s. In 2005, the National Conference on strengthening and improving the ideological and political education of college students clearly put forward the concept of "three complete education". After the nineteen Party's convening, educators have actively pushed Xi Jinping's new socialist thought with China's characteristics into education, and re assigned the connotation of "three all-round education". Education authorities at all levels have also carried out the pilot work of comprehensive reform of "three complete education" to explore the construction of an integrated education system from the macro, meso and micro levels. College Students' mental health education is an effective carrier of "psychological education" in the project of improving the quality of Ideological and political work. It comprehensively coordinates the educational resources and forces in all fields of school running, education and teaching, and personnel training, and comprehensively promotes the comprehensive reform of "three complete education".

Mental health education is an important part of Ideological and political work in colleges and universities. "Three complete education" also has a theoretical navigation position for the development of mental health education of college students in the new era. In addition, there is an internal correlation among the whole staff, the whole process and the whole direction in the concept of "three complete education". The whole staff points to the main body of education, the whole process points to the time and space boundary of education, and the whole direction points to the method path of education. Therefore, the idea of "three complete education" for college students' mental health education method also has theoretical basis and practical basis [6-10].

From the perspective of the overall planning of all staff education elements, there are some problems in the current college students' mental health education, such as insufficient participation and effort of some subjects. For example, the main body of family education is often absent in college students' mental health education. As the first school for children, family is an important place to cast children's good character and personality. The quality of family environment directly affects children's physical and mental health. There is no doubt that the main body of family education plays an important role in students' mental health education. However, for a period of time, due to the influence of exam oriented education, many parents only pay attention to their children's academic performance, and even one sidedly think that as long as they can meet their children's living conditions, they lack attention to their children's emotional and psychological conditions. When college students have psychological problems, parents do not bear the responsibility of guardianship, refuse to communicate, shirk responsibility and other behaviors often occur. Secondly, from the perspective of the organization operation of all staff education, the current college students' mental health education still has the problems of insufficient subject coupling and unbalanced work promotion. For example, the collaborative mechanism of mental health education has not been built around the ultimate goal of students' all-round development between the main body of family education and the main body of school education. Some parents don't know their children well, intervene in time and cooperate actively after their children have psychological problems. The lack of multi frequency, normalized and systematic multi-agent linkage mechanism is a prominent problem in the current college students' mental health education. Therefore, this paper studies the optimization model of college students' mental health based on imaging sensing and brain computer interface technology.

II. The Proposed Methodology

A. Imaging Sensing

SPR sensor is a kind of high precision refractive index sensor, which can characterize the biological bonding process on the surface of the sensor chip coated with gold film in real time, without any labeling of biomolecules. The basic schematic diagram of the SPR sensor is shown below.

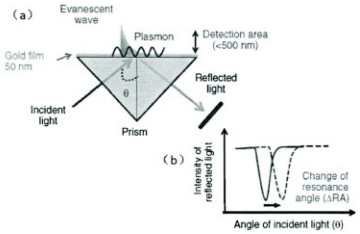

Fig. 1. Basic schematic diagram of SPR sensor

When polarized light incident at the interface between glass and gold film at a specific incident angle (within the range of total reflection Angle), the plasma exciter on the metal surface resonates with the evanescent wave generated by total reflection. At this point, the reflected light will produce a very strong attenuation, and this particular Angle is called the resonance angle (RA).

The interaction between the incident light and surface plasma waves can change the optical properties of the incident light, such as amplitude, phase, Angle and spectral distribution. The change of optical properties is in correspondence with the change of propagation constant of surface plasma wave. Therefore, the change of the refractive index of the sensor head surface can be realized by detecting any change of the optical properties of the incident light. According to different detection methods, SPR sensors can be divided into four sensing types: intensity type, Angle type, wavelength type and phase type [11-16].

Strength type SPR sensor is one of the most basic of SPR sensor, the sensor to a fixed Angle of incidence and excitation wavelength of light, when sensing gold film refractive index changes, on the surface of the sample in a certain linear area, SPR signal changes with the change of the refractive index on the surface of the metal film is one-to-one relationship, by detecting the reflected light of the change of light intensity sensor can be realized. In order to improve the detection flux, multi-channel SPR and SPR imaging sensing are developed.

In theory, the one-to-one correspondence between the sensor surface and the two-dimensional CCD array pixel points can realize large-scale parallel rapid biosensors. However, due to the geometrical distortion of prism and the limited propagation length of surface plasma wave, the spatial resolution along the surface plasma wave direction is very low. The optimal spatial resolution is 1.7um perpendicular to the propagation direction of the surface plasma wave and 2.8um parallel to the propagation direction. Currently, the most direct sensing in combination with 2D arrays is intensity based, and the technology has been widely commercialized by Biacore GE and GWC Technologies for high-throughput detection in immunology, DNA hybridization, protein reactions, and cell analysis. However, in order to simultaneously detect multi-point interactions, it is often impractical to obtain a uniform and optimal response across the entire surface of the analysis in the case of selecting a unique operating point [17-22].

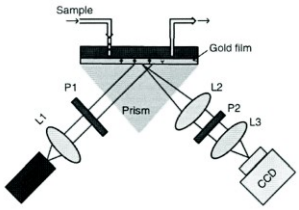

Fig. 2. Intensive-type SPR imaging sensor based on prism coupling

B. The Working Principle of Surface Plasmon Resonance Sensing

Plasma plays an important role in the optical properties of metals and semiconductors. Because the electrons in the material shield the electric field of the light, the light below the plasma frequency will be reflected by the material. Light higher than the plasma frequency is transmitted by the material because the electrons in the material cannot respond fast enough to shield it. In most metals, the frequency of the plasma is ultraviolet, which makes it emit (reflect) light in the visible range.

When the semiconductor is in the form of heavily doped nanoparticles, the plasmon frequency may occur in the mid infrared and near infrared regions. In the free electron model, the energy of plasmon can be estimated as:

$$E_p = h\sqrt{\frac{ne^2}{m\varepsilon_0}} = h\omega_p \tag{1}$$

The surface plasmon is very sensitive to any slight disturbance near the penetration depth. Based on this property, it can be used for sensing the surface of its propagation medium. The wave equation is as follows:

$$E = E_0 \exp\left[\pm i\left(k_x x \pm k_z z - \omega t\right)\right] \tag{2}$$

When the surface plasma wave propagates at the interface of two kinds of media, according to Maxwell equation, the metal layer is set as medium 1 and the ordinary medium is set as medium 2, then the dispersion equation of the surface plasma wave at the interface of the metal and medium is as follows:

$$D_0 = \frac{k_{z1}}{\varepsilon_1} + \frac{k_{z2}}{\varepsilon_2} = 0 \tag{3}$$

The dispersion equation of surface plasma wave is expressed as follows:

$$k_x = \frac{\omega}{c}\left(\frac{\varepsilon_1\varepsilon_2}{\varepsilon_1 + \varepsilon_2}\right)^{\frac{1}{2}} \tag{4}$$

When the wave vector of the surface plasmon is equal to that of the incident light, the surface plasmon polaritons will

be excited to produce surface plasmon resonance, which can be obtained by measuring the reflectivity. When the light with a specific frequency is used to excite the SPR, the condition that the wave vector of the incident light matches the wave vector of the SPR is needed. The wave vector of the incident light can match the wave vector of the surface plasmon by adjusting the incident angle. The excitation occurs at a specific angle where the reflectivity decreases. This method can accurately measure the frequency and wave vector of the surface plasmon. The characteristics of surface plasmon resonance can be simply characterized by the resonance angle. When SPR condition changes with the change of dielectric constant of sensing medium, the change of resonance condition shows the change of resonance angle. Because of the characteristics of SPR angular spectrum, it has been widely used in chemical and biological sensing.

C. Design of Embedded Brain Computer Interface System

According to the different ways of EEG generation, the commonly used signals of brain computer interface system are spontaneous EEG signal and evoked EEG signal.

(1) Spontaneous EEG is a signal from the brain itself, which does not need external stimulation or occupation of sensory pathway. Spontaneous electroencephalogram (EEG) is the most original definition of brain computer interface (BCI). Its application prospect is very broad, and it is the key direction of BCI research in the future. However, spontaneous EEG signals fluctuate greatly and are easily disturbed by subjects' emotions and external stimuli, and the signal characteristics are often not obvious. At present, the popular application of spontaneous EEG is the brain computer interface of motor imagination based on motor sensory rhythm (mi-bci). Before using this kind of brain computer interface system, the subjects need to train for a long time, and the system stability is not high, and the signal recognition rate is low.

(2) Evoked EEG needs a specific external stimulus to induce regular, stable and distinctive EEG signals. Generally, subjects do not need targeted training, so the system has higher stability and recognition rate, and is more practical. Based on the requirements of practicability, stability and high recognition rate, evoked EEG is used as the input signal of the system. At present, P300, SSVEP and MVEP are commonly used in BCI system.

In general, MVEP signal can be stimulated by various motor initial stimuli, but different ways of stimulation induce different MVEP. The commonly used stimulus paradigms are horizontal movement, inward contraction, outward diffusion and central rotation as shown in Figure 3. The difference of MVEP signals stimulated by these four ways is mainly reflected in the amplitude and spatial distribution of N2 components.

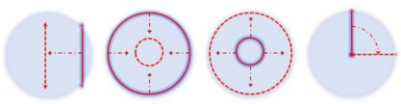

Fig. 3. Common inducing methods of mVEP

III. EXPERIMENT

The off-line training thread designed in this paper will first determine whether all the MVEP signals of the initial motor stimulation have been extracted. If the signal extraction is completed, the training thread will be shut down immediately, otherwise the thread will go to sleep. After the data acquisition thread collects a MVEP signal, it will wake up the offline training thread, and then transmit the collected EEG data to the training thread.

At the end of the offline training thread, we also get the MVEP signal and non target signal generated by all the initial motor stimuli in the training process. Then feature samples are extracted from all the data, as shown in Fig. 4.

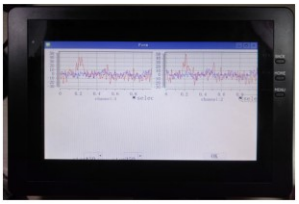

Fig. 4. mVEP Training result chart

The test of EEG amplifier is a test of signal acquisition and signal amplification performance of EEG amplifier. In this test, sinusoidal signals of 1mV and 10Hz were input to the EEG amplifier. The amplification performance of the two channels was tested by oscilloscope, and the test effect was shown in Fig. 5.

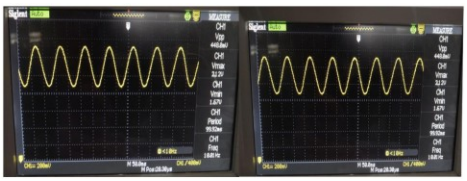

Fig. 5. EEG amplifier performance test

Connect the serial port of Nanopc T2 to the PC, and connect it with Nanopc T2 after parameters such as serial port bort rate and verification mode are set in SecureCRT software. After the Nanopc T2 is powered on and started up, it can be seen that debugging information as shown in Figure 6 will appear on the interface of SecureCRT.

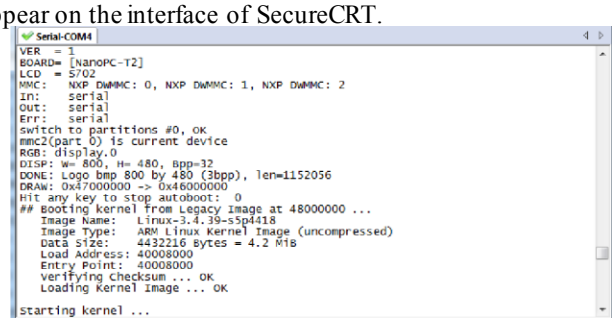

Fig. 6. Embedded system startup debugging information

IV. CONCLUSION

In the construction of college students' mental health education mode, we should not only seek innovation from the practical dimensions such as platform and carrier, but also seek breakthrough from the theoretical aspects such as

discipline and specialty. According to the literature review, the current research on the comprehensive education of mental health education is not enough, and can not meet the practical needs. In view of the problems and shortcomings of the current research, this paper analyzes the imaging sensing technology, and studies the application of brain-computer interface in mental health optimization. Experimental results show the effectiveness of the proposed method.

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