

The Development of Emotional Interaction for Depressive Patients Based on Human-Computer Interaction Technology

Gaocheng Zhang *

School of Physics and Electronic Engineering, Hainan Normal University, China

* Corresponding Author Email: Z2366238292@outlook.com

Abstract. Amid rising mental-health burdens worldwide, timely technological approaches are urgently needed to complement traditional clinical assessment and scalable population-level monitoring. Depression is an emotional disorder that has long plagued various populations. With the development of Human-computer Interaction (HCI) technology, it also provides a new paradigm for the treatment and intervention of depression. Against the background of the onset characteristics of depression and how HCI technology, including brain-computer interaction derived from HCI technology, intervenes in depression through new methods, this study focuses on the intervention and treatment of depression. By introducing methods such as speech signal recognition, relevant baseline models, and wearable eye trackers, this study aims to provide solutions to the emotional interaction problems of depressed patients. The purpose of this study is to provide reference significance for relevant scholars. Future work will integrate longitudinal datasets, multimodal sensors, and ethical frameworks to enhance personalization, safety, and real-world deployment and equity.

Keywords: Human-computer interaction, brain-computer interface, disorder.

1. Introduction

According to the latest report from the World Health Organization (WHO), the number of people worldwide with depressive symptoms has exceeded 350 million during the five-year period from 2020 to 2025, showing a hidden growth trend [1]. Among them, the total number of depression patients in China has exceeded 95 million, with a lifetime prevalence rate of approximately 6.8%. The prevalence rate among women is 1.5 times that among men. The prevalence rate among the youth group aged 18-34 has increased significantly, with an annual growth rate of 2.3%. Statistics show that 75% of depressed patients globally cannot access professional help, which is particularly prominent in resource-poor areas.

With the continuous development of human-computer interaction technology, technological progress has provided a new paradigm for depression intervention. For example, a team from Tianjin Normal University has achieved an accuracy rate of 92.44% in identifying depressive states through voice signal recognition [2]; the Modality-Invariant and Specific Representations for Multimodal Sentiment Analysis (MISA) model has achieved a Concordance Correlation Coefficient (CCC) of 0.438 in depression detection on the Affective Video and Emotion in Context (AVEC) 2019 data set, which is significantly better than the baseline model. Artificial Intelligence (AI) chat bots can accurately identify and intervene in depression through various methods such as simulating emotional support via natural language processing. As human-computer interaction technology continues to advance, various intelligent devices such as wearable devices are increasingly used in the daily lives of depression patients. These devices can monitor emotional changes in real-time, provide personalized intervention plans, effectively improve treatment effects, and enhance quality of life. This also provides valuable reference significance for studying emotional interaction among depression patients in the context of human-computer interaction.

In recent years, significant progress has been made in the research field of Human-computer Interaction (HCI) technology. This technology has provided new therapeutic approaches for the diagnosis, treatment, and intervention of depression. However, it still needs to face various challenges and undergo a long process of exploration and improvement. This article mainly introduces three

aspects: the current situation and characteristics of depression patients; the development research on emotional interaction with depression patients using human-computer interaction technology; and then how brain-computer interaction is applied to depression patients to achieve emotional interaction. This study aims to provide scholars specializing in human-computer interaction technology and depression with thoughts and perspectives from different angles.

2. Current Situation and Characteristics of Depression Patients

Nowadays, depression is a psychological problem that many people suffer from. It is a mental illness mainly characterized by persistent low mood and loss of interest. Depression can be divided into the following major categories according to its severity and different affected groups. In terms of severity, depression can be classified as mild, moderate, and severe. In terms of different affected groups, it can be divided into childhood depression, postpartum depression, geriatric depression, etc. If classified according to symptoms and diseases, it can be subdivided into 8 types: depressive disorder, recurrent depressive disorder, bipolar affective disorder, persistent depressive disorder, seasonal affective disorder, disruptive mood dysregulation disorder, premenstrual dysphoric disorder, and mixed anxiety-depressive disorder [3].

Depressive disorder: This is the most common type of depression. Patients experience obvious depressive mood, feeling hopeless, helpless and down. They may lose interest and sense of pleasure, often feel fatigued, and inferior. Depressive episodes may lead to changes in appetite, sleep disorders, difficulty concentrating, and suicidal thoughts, and are classified as mild, moderate, or severe according to their severity.

Recurrent depressive disorder: Depression is a recurrent disease. When it occurs for the second time or more, it can be considered as recurrent depressive disorder.

Bipolar affective disorder: This is a type of depression with severe mood swings. Patients experience extreme changes in mood, alternating between depressive episodes and manic episodes. During the depressive phase, patients show typical depressive symptoms; during the manic phase, they may be abnormally excited, impulsive and overactive.

Persistent depressive disorder: This type of depression lasts for a long time, generally more than 2 years. Patients will feel low mood, but the symptoms are relatively mild. They may lose interest, and have symptoms such as inferiority, changes in appetite, sleep problems and difficulty concentrating.

Seasonal affective disorder: This type of depression is related to seasonal changes. Patients may experience depressive mood, fatigue, increased appetite and sleep disorders in winter, while symptoms will alleviate or disappear in other seasons.

Disruptive mood dysregulation disorder: This type of depression mainly occurs in children and adolescents. Patients show frequent irritability, anger and emotional outbursts, which seriously interfere with daily life.

Premenstrual dysphoric disorder: Before menstruation, patients show symptoms such as emotional instability, irritability, restlessness and anxiety. These symptoms often appear in the premenstrual period and disappear during or shortly after menstruation.

Mixed anxiety-depressive disorder: Patients with this type of depression have anxiety symptoms, along with depressive mood, as well as tension, restlessness and fear. These groups with depression have different manifestations in terms of depression. These groups with depression have different manifestations. This article will explain and discuss depression according to its severity.

The characteristic of mild depression is that it is mainly featured by significant and persistent low mood. Mild depression is mainly manifested as being depressed and having no interest in things. Most cases recur, and during each episode, in most cases, they can recover on their own. In some cases, mild depression may worsen or turn into chronic depression. According to the statistics data from the World Health Organization in 2012, there are about 350 million people with depressive disorders worldwide. A health survey conducted in 17 countries found that on average, 1 out of every 20 people has had or currently has a depressive disorder.

Moderate depression is an aggravated version of mild depression. It is just like being ill. Its main manifestations include long-term low mood lasting for two weeks, strong sense of self-denial, slow daily movements, and loss of interest in things that were previously interesting, etc. This mental illness is like having a big stone pressing on one's heart, which not only affects mental health for a long time. If not treated in time, it may worsen into severe depression. In China, the number of depression patients may reach about 25 million, which means that 1 out of every 50 Chinese people is troubled by depression. Most of these patients are in a state of moderate depression.

3. HCI Technology-Based Emotional Interaction with Depression Patients

There are mainly two traditional methods for detecting depression: one is based on doctors' evaluations and self-assessment through scales. The method based on doctors' evaluations is time-consuming and labor-intensive, and it also wastes medical resources. As for the self-assessment through scales, although it is more convenient, its credibility is questionable, and it is prone to misjudgment. With the continuous development of human-computer interaction technology, it has provided a new paradigm for the treatment and interaction of depression.

According to a research report on depression by the Chinese Academy of Sciences [4], the repeated transcranial magnetic stimulation (rTMS) technology works on the principle that when a magnetic field passes through the skull, the cerebral cortex generates induced currents, which regulate abnormal neuronal discharge patterns. It can be used to treat diseases such as depression with an effective rate of 70%-80%. In experiments, when subjects wear the device, their hands and legs are the first to receive signals and respond. This is the first time we have applied rTMS to achieve neuromodulation during free walking. At the same time, wearable rTMS also shows its potential in multiple scenarios. For example, patients can receive treatment for mental illnesses in non-hospital environments (such as at home, workplaces, or even during travel). Moreover, this device also provides a new paradigm for studying the dynamically changing brain in new scenarios. According to the China High-Tech Industry Herald [5], brain-computer interface also provides a reference paradigm for the treatment and intervention of depression. Brain-Computer Interface (BCI) refers to a direct communication and control channel established between the human brain and a computer or other electronic devices. Through this channel, users can directly express their thoughts or manipulate devices through brain thinking. Brain-computer interface provides a new way for brain state monitoring, human-computer information interaction and control. On the one hand, it has become a core key technology and an important tool for a comprehensive understanding of the brain; on the other hand, BCI technology will realize a high integration of human and machine intelligence, creating an unprecedented new era of intelligence for mankind. Moreover, it has broad application prospects in multiple fields such as medical treatment, education, games, aerospace and military, and is one of the core fields related to national security and overall development. In terms of treatment methods, ordinary patients can be treated with drugs, but for refractory depression, a combination of drug therapy and current regulation is used.

In the future, brain-computer interface technology can effectively identify the specific electroencephalographic signals of depression in diagnosis. On the one hand, it can avoid misjudgment and subjectivity in questionnaire detection; on the other hand, brain-computer interface technology can assist in the diagnosis of depression. In the treatment of refractory depression, brain-computer interface technology can also provide precise and effective treatment measures. The use of high-throughput brain-computer interfaces can realize synchronous monitoring of multiple brain regions across the entire brain. This method is more effective and advantageous than current treatment methods. Traditional intracranial electrode technology cannot achieve long-term monitoring and regulation of electrical signals. The new generation of improved flexible electrodes not only has good flexible materials, but also has an optimized volume, occupying less space in the skull, making it possible to implant electrodes into the brain for comprehensive detection.

In 2020, Yang et al. team invented a wearable eye tracker called UEYE [6], which can capture eye movement images at an extremely high frequency. This high frame rate enables it to accurately record every tiny movement of the eyes, including rapid eye movements, pupil changes, and fixation shifts. Compared with traditional physiological signal detection devices, which can provide high-precision physiological data but are usually expensive and complicated to operate, eye trackers have significant advantages in terms of cost, portability, and ease of use. Statistics show that the accuracy rate of wearable eye trackers in depression assessment can reach 79%. This is because eye movement data can reflect an individual's attention and emotional state, and depressed patients often show a higher attention bias towards negative information, which can be easily reflected through eye movement data.

4. Future Prospects and Shortcomings

Despite the increasing development and improvement of human-computer interaction technology and brain-computer interaction technology, the continuous improvement of technology has made it possible to treat emotional diseases using emerging technologies. However, there are still many shortcomings in this regard. For example, in human-computer interaction technology, we often use AI to help depressed patients with emotional analysis work and daily psychological counseling activities. But AI's understanding is based on the interpretation of concepts and models, lacking in-depth understanding and judgment of information, resulting in outcomes that are merely reasonable interpretations without touching upon in-depth responses.

In the process of depressed patients interacting with human-computer interaction technology, some advanced devices still use traditional batteries for power supply. Although these devices can achieve certain results, over the long term, the durability of the equipment will decrease significantly and the cost will increase substantially. Perhaps in the near future, the power supply methods of the devices will be greatly improved.

When depressed patients interact with AI, their emotions may suddenly plummet at a certain moment. This change may stem from some bad experiences in the patient's past. When patients interact with AI intelligently, they may experience symptoms such as low mood, and their interactive voice tones are mostly low and sad. However, the AI in human-computer interaction technology mostly interacts based on its own models, which leads to the inability of AI to detect abnormal emotional changes and certain behaviors when patients experience unusual low mood, sadness, and other symptoms.

This exposes the most controversial issue of AI - AI is just a machine algorithm disguised as a human. More often than not, AI understands issues related to emotional diseases through its algorithms and programs, and cannot understand them from the fundamental aspect - emotions. As mentioned earlier, depression is a psychological problem, and the essence of psychological problems is changes in emotions. If psychological problems cannot be solved, it is necessary to figure out how the recovery from depression can be achieved.

But it believes that in the near future, with the increasing improvement of human-computer interaction technology, the above-mentioned problems will be solved one by one. However, this is only the era of the development of human-computer interaction technology. It is believed that in the near future, with the development of human-computer interaction technology, the essential issue of emotional diseases - emotions, will be paid attention to and resolved by AI. For example, the current mainstream solutions mainly include the following two items:

1. Develop a tailored baseline model based on the actual needs and emotional value orientations of patients with depression. This model not only meets the patients' actual needs but also better integrates AI, avoiding the situation where AI cannot empathize with patients with depression due to limitations of its underlying model.

2. Start from the AI model itself to create an algorithm more suitable for patients with depression. This algorithm should cover the entire process from early diagnosis and mid-term treatment to later

rehabilitation, and simulate the intonation of speech and the emotions implied in the text during interactions with patients with depression. In this way, when patients with depression are in a low mood, the device can provide timely feedback and responses, making the patients feel valued and reducing the risk of worsening psychological problems in patients with depression.

5. Conclusion

In this work, this paper surveys to utilize human-computer interaction technology and brain-computer interface technology to survey the identification, diagnosis, improvement and optimization of depression. This avoids the privacy leakage of depression patients, improves the efficiency of treatment and diagnosis, and provides a reference template for the application of human-computer interaction technology in the treatment of depression. Nowadays, with the continuous development of human-computer interaction technology, the diagnosis and treatment of depression are no longer limited to traditional places such as hospitals and psychological counseling rooms. In the near future, with the continuous advancement of technology, human-computer interaction technology may be applied in a wider range of fields, enabling depression patients to receive treatment in multiple scenarios.

References

- [1] Xiaoxiang Morning Post. World Mental Health Day: More than 200 million people worldwide suffer from anxiety and depression—how to understand these “epidemics of the times”? Xiaoxiang Morning Post. 2024 Oct 10.
- [2] Zhao Y, Cao J, Liu J. Depression detection software based on speech prosody. *Computer Programming Skills & Maintenance*. 2019;(5):3.
- [3] Zhang H. In-depth analysis of types of depression. *Healthy Life*. 2024;(8):45–6.
- [4] Qi Z, Liu H, Jin F, Wang Y, Lu X, Liu L, et al. A wearable repetitive transcranial magnetic stimulation device. *Nat Commun*. 2025 Mar 19;16(1):2731.
- [5] Sun L. Brain–computer interfaces bring new breakthroughs in depression treatment. *China High-Tech Industry Herald*. 2025 Jul 21;16: Bio-Pharmaceutical section. Available from: <http://paper.chinahightech.com/pc/attachment/202507/21/08a23d9a-ccb6-4b32-8ae1-93c50f415e3d.pdf>
- [6] Yang M, Ngai EC, Hu X, Hu B, Liu J, Gelenbe E, et al. Digital phenotyping and feature extraction on smartphone data for depression detection. *Proc IEEE*. 2025 Mar 6