ISSN: 1813-4890

Mind Scavenger: A Comprehensive Mental Illness Rehabilitation System Developed for Diagnosis, Monitoring, and Complementary Therapy

Xinyue Wang

Department of Electrical Engineering & Information Technology, Shandong University of Science and Technology, Jinan 250031, China

* Corresponding author: Xinyue Wang (Email: 201903203122@sdust.edu.cn)

Abstract

This paper proposes a comprehensive mental disease rehabilitation system that consists of three user-specific ports for early diagnosis and treatment, mid-term auxiliary diagnosis, and late adjuvant therapy. The system uses big data analytics to provide accurate prevalence analysis, graded treatment recommendations, online adjuvant treatment, and medication reminders to patients. The system offers auxiliary diagnostic functions to help doctors diagnose, prescribe treatment methods, and deliver personalized treatment recommendations. The patient guardian terminal contains an "Eagle Eye" system that observes patients' emotional expressions, records them, and provides appropriate treatment options and medication reminders. The system uses secure https protocol and multiple protection methods to safeguard sensitive user data. In conclusion, this comprehensive system provides efficient, personalized, and holistic medical treatment throughout all stages of mental illness treatment, ultimately improving the rate and speed of full recovery.

Keywords

Communication Engineering; Mental Illness Rehabilitation; Big Data Analytics; Emotional Expression Observation.

1. Introduction

At present, the rate of seeking medical treatment for social and psychological diseases is low, and the supply of hospital registration places is in short supply. Among the existing psychological service APPs, psychological counseling is the main category, and psychological testing and psychological education coexist. There are many such APPs in foreign countries, and there are also many empirical studies on the intervention effects of such APPs. Generally speaking, such APPs are used for visitors to self-report their emotional state, track and record their symptoms, and provide auxiliary training. For example, an APP called eMoods Bipolar Mood Tracker allows users to record their subjective emotional feelings in a day on an electronic mood recorder. At the same time, the APP also uses some sensors to record the user's sleep status, anxiety level, etc. All can be sent to the user's caregiver or consultant to facilitate the care of the user's psychological state; this type of APP can also help the user to carry out some training independently, such as completing the breathing training taught by the consultant according to the guidance of the APP. Therefore, this type of The APP can also urge the visitor to better complete the homework assigned by the consultant.

Scholars abroad have made statistics on APPs used for clinical treatment. A review in 2011 sorted out 50 widely used APPs, whose functions range from clinical diagnosis, symptom monitoring, psychological education to skill training, etc. The main operating systems are Android, Apple, and Blackberry. In terms of psychological counseling techniques and genres,

ISSN: 1813-4890

due to the strong operability of CBT and DBT, most APPs are designed based on these two types of therapies, or most of the counselors of these two types of therapies will recommend visitors to use APP-assisted counseling . It can be seen that the use of the existing psychological service APP in my country is only the beginning, and the APP is still expected to play an important role in the field of mental health services through continuous improvement.

Through big data analysis, this paper finds that the characteristics and treatment methods of patients with mental illness are similar, so it can be combined with the scores of psychological evaluation scales to pre-diagnose mental illness. And considering the inconvenience of paper medical records, this system adds electronic medical records, where doctors fill in the diagnosis status, and patients fill in their latest changes to facilitate other doctors' follow-up visits. In addition, considering the particularity of mental illness, patients generally have memory loss, and some diseases will have onset periods (depressive period, manic period, etc.), this system has also designed a patient monitoring terminal. When recording your own changes, the records on the guardian side become an important criterion for judging the next time you seek medical treatment.

This system can score and record the current emotion through face recognition and body language recognition in the later stage of auxiliary treatment, as a basis for follow-up diagnosis. Another highlight of this system is that considering that the patient's uncertain thinking may cause harm to his body and threaten his life safety, this system has a wristband peripheral device for radar detection of vital signs to detect the patient's vital signs while observing the effect of medication on the patient's body Influence, in order to facilitate the adjustment of the dosage by the doctor during the follow-up visit.

2. Brief description of project functions

2.1. Early function

2.1.1. Sub-section Headings

This system aims to assist the diagnosis of mental illness in the early stage and assist doctors and patients in the follow-up treatment in the later stage. This product is divided into three ports, which are self-test end (patient end after diagnosis), doctor end and patient guardian end. In order to ensure safety and effectiveness, the three ports are independent of each other and only visible to you.

On the self-test side (patient side after diagnosis), the tester conducts an online test of the psychological assessment scale. One of the highlights of this project is that through the statistics and analysis of big data in the early stage, the test results will be analyzed in combination with the patient's gender, age, occupation and other related factors. changes, and thus obtain a relatively more accurate prevalence analysis.

In addition, this system has the characteristics of graded treatment recommendations. If the subject is judged to have no medical history, the system will provide corresponding methods to relieve the current emotions; Relief methods; when the teste is judged to have moderate or above symptoms, the system recommends that he must seek medical treatment and receive relevant treatment.

On the doctor side, this system is an auxiliary diagnosis function. The doctor can synchronize the information of the patient to obtain the preliminary diagnosis result, the patient's recent mood swing curve, the score of the evaluation scale and the detailed information of the patient to assist the doctor in diagnosis. After the doctor makes a diagnosis, the system will recommend corresponding treatment methods after learning from big data (only visible to doctors). After the doctor prescribes the prescription, an electronic medical record (including the name of the

ISSN: 1813-4890

drug and the change of the dosage) will be formed for the next consultation (preliminarily forming a closed loop to improve the efficiency of medical treatment).

2.2. Mid-term auxiliary diagnosis

The patient guardian terminal is mainly used to assist patients in treatment and ensure the safety of patients. The guardian can add a peripheral "Eagle Eye" system to observe the patient's emotions (such as eyes, expressions, emotions, dangerous behaviors, etc.), and automatically record the patient's emotions and behaviors by recognizing the patient's expressions and language, and through image and text analysis , to facilitate the next medical treatment. Furthermore, the guardian can manually record the patient's emotional changes during the process of getting along with the patient, and the system will give corresponding suggestions. In addition, the system also has the function of reminding medication and follow-up treatment, and whether the medication is regular is also a major basis for follow-up visits.

Finally, an external smart bracelet can be added to the patient side to record and detect the patient's vital signs (such as heartbeat, etc.) at any time, which is convenient for doctors to adjust the dosage of drugs in the later stage and ensure the safety of patients' lives. After the diagnosis, the patient terminal will automatically set up medication reminders and follow-up reminders, and give positive hints and online adjuvant treatment on the Internet.

2.3. late adjuvant therapy

In the later stage of treatment, patients and guardians can subscribe to psychological rehabilitation courses, which not only include emotional management methods and life improvement suggestions during illness, but also knowledge related to psychological rehabilitation. In addition, patients and guardians can interact with psychologists at any time and receive support and guidance online.

On the doctor's side, the patient's condition during treatment will be recorded and updated in real time, and the statistical analysis of big data will help doctors better understand the patient's condition, treatment effect and monitor medication, so as to provide specific patients with more personalized treatment recommendations and programs.

In order to protect the privacy and security of the system, the three ports use the https protocol for data encryption, and introduce multiple protection methods to prevent the risk of hacker attacks and sensitive data leakage.

Finally, after the psychotherapy is over, the system will provide a self-assessment test to ensure the patient is fully recovered. If the assessment meets the criteria, the patient has successfully recovered, at which point the system stops monitoring and treatment. If the evaluation result does not meet the standard, the system will recommend corresponding materials to help the patient continue psychological treatment and ensure the patient's complete recovery.

To sum up, this system aims to provide a comprehensive mental disease rehabilitation system, which can not only assist in the initial diagnosis and monitoring during treatment, but also provide the knowledge and monitoring of psychological rehabilitation in the later stage, and finally achieve the goal of complete cure.

3. Technical Analysis of Project Application

3.1. Big Data Statistical Analysis and Prediction

The technology focuses on four models based on statistical analysis and predictions developed for that specific disease. These models are respectively: the statistical prediction model of the disease type and the patient's occupation, age, gender and other related factors; the statistical prediction model of the emotional change curve and the disease type; the statistical prediction model of the somatic change and the disease type; and the diagnosis Statistical predictive

ISSN: 1813-4890

models for future related treatments. The establishment of the model is realized through the collection, cleaning, analysis and optimization of relevant data to ensure the accuracy and practicability of the model. These models can provide more accurate predictions and provide doctors with the best treatment recommendations and solutions, thereby providing support and assistance for patients' recovery. We can use the ARIMA model to predict the sentiment change curve, the formula is as follows:

$$\phi_p(L)(1-L)^d X_t = \theta_q(L)\,\varepsilon_t$$

Where $\phi_p(L)$ and $\theta_q(L)$ are p-order autoregressive and q-order moving average polynomials, d is the number of differences in time series, L is a time operator, and X_t is The sequence variable at time t, ε_t is the white noise at time t. This formula can be used to predict the trend of future mood changes and provide guidance to doctors for better treatment and disease management.

At the same time, the application of these models is based on a set of key variables or indicators, and through the analysis of these variables or indicators, combined with predictive algorithms, the statistical prediction of the patient's condition and treatment effect can be achieved. Through these models, doctors can better understand and face the performance of a particular disease in different patients, and better prevent and treat diseases.

3.2. Image recognition technology

In this system, this part is mainly used in the "Eagle Eye" system, which captures the patient's facial expressions and behaviors from time to time through an external camera, and records them, as shown in Figure 1. To achieve this functionality, we employ image recognition techniques using the OpenCV library in Python to detect faces and denoise and process the collected data. In general, in the process of processing facial expressions and body movements, we will follow the following process: first, collect data, then denoise or process the data, then extract feature quantities, then train and classify, and finally Realize the recognition of human actions, as shown in Figure 2.

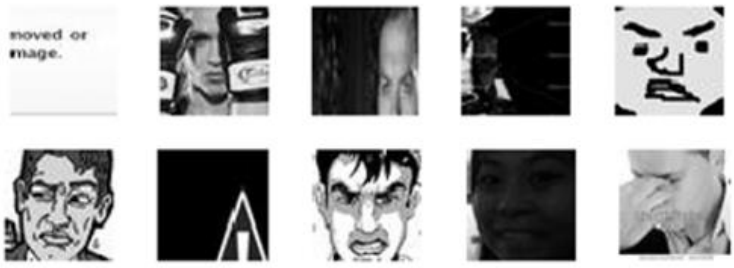

Figure 1. Recognize facial expressions

Figure 2. Filter and classify incorrect annotations

In this system, we use CNN deep learning concepts and classification tasks to obtain feature quantities,as shown in Figure 3. This is a technique widely used in image and audio processing

ISSN: 1813-4890

for training and prediction on data. In our system, we capture the input image by using the camera, and obtain the face image according to the image detection technology. Next, we use CNN technology to extract features that will be used to predict the patient's mood swings and warnings of dangerous behaviors. Through this method, we can identify the expressed emotions, such as happiness, sadness, anger, surprise, etc., and predict them as outputs through classifiers, such as Logistic Regression, SVM, etc.

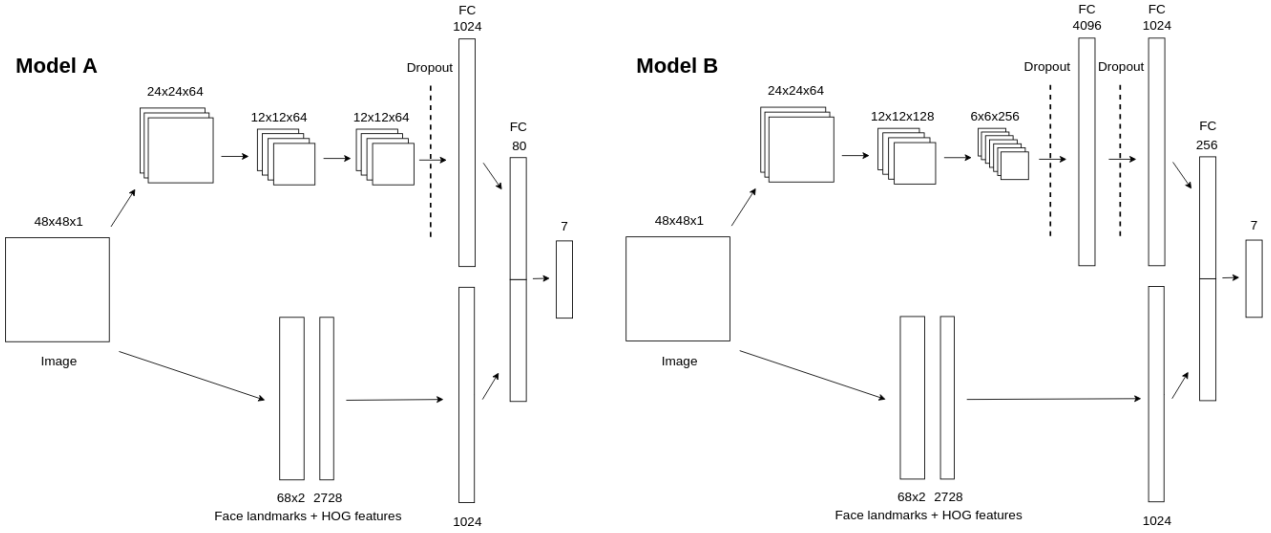

Figure 3. CNN model structure diagram

This method of using CNN technology to detect facial expressions and behaviors and obtain features has been widely used in many fields, such as healthcare, intelligent transportation and security monitoring. In this system, this method can be used to record patients' mood swings and early warning of dangerous behaviors, and provide references for doctors, so as to better treat and manage diseases.

3.3. Text Sentiment Analysis

In the field of sentiment analysis, there are two common sentiment analysis methods: sentiment dictionary-based and machine learning-based.

The first method is based on sentiment lexicon. This method formulates a series of emotional dictionaries and rules, disassembles the text, analyzes the syntax, calculates the emotional value, and finally uses the emotional value as the basis for the emotional orientation of the text. Specifically, a sentiment lexicon is a set of vocabularies that contain sentiment words and their sentiment polarities. In sentiment analysis, the method based on sentiment lexicon can be expressed as the following formula:

$$E = \sum_{i=1}^{n} P_i \times V_i$$

Among them, E represents the emotional value of the text, P_i represents the probability of the \$i\$th word appearing in the text, V_i represents the emotional polarity value of the ith word, and n represents the total number of words. The sentiment polarity value usually takes a value between -1 and 1, with 1 being positive sentiment, -1 being negative sentiment, and 0 being neutral. In the process of text sentiment analysis, the text needs to be analyzed and disassembled first, and then each word in the disassembled text is matched with the sentiment dictionary to obtain the emotional polarity value of each word. Finally, the overall tendency of text sentiment can be obtained by weighted summation of sentiment values of all words in the text.

ISSN: 1813-4890

The second method is based on machine learning. This method mainly converts the problem into a classification problem, divides the target emotion into two categories (such as positive emotion and negative emotion), and then manually labels the training text to realize a supervised machine learning process. Specifically, based on a large number of training sets, the method uses statistical or machine learning methods to train a sentiment classification model with generalization ability, and then applies the model to new texts to predict the emotional polarity of the text. In this approach, typical algorithms include Naive Bayes, Support Vector Machines (SVM), and Decision Trees, among others.

No matter which method is used, sentiment polarity analysis is an important part of sentiment analysis, and its working principle and technical methods have important application significance. It has important applications in the fields of cultural communication and production of emotional products.

3.4. Technology for detecting vital signs

Radar vital sign detection is also called non-contact vital sign detection. FMCW radar is widely used. For example, it can be used for vital sign monitoring. These vital signs include common breathing and heartbeat. This kind of vital sign monitoring of breathing and heartbeat mainly uses the phase change of the receiving signal of the target. The wavelength corresponding to the 77GHz frequency is about 4mm, which makes the phase of the object reflected in the receiving signal very small even if there is a small change. big.

After receiving the ADC data of the chirp sequence, the radar first performs FFT on the data to obtain the distance information of the target, that is, Range FFT processing. The next step is to perform Peak processing. The so-called Peak processing is to find the peak position in the Range FFT result that may be the target of interest, and record the phase at the peak position.

Usually, the chest movement caused by human breathing is about 12mm, which is several times the wavelength of radar (the wavelength of 77GHz radar is about 4mm), so it is necessary to unwarp the acquired phase information and correct it.

Then, filter processing will be performed on the acquired phase information to extract the information we are interested in. Generally, the human breathing frequency is about 0.1-0.5Hz, and the heartbeat frequency is about 0.8-2Hz. Spectral analysis is performed on the output after the filter to confirm the frequency of breathing and heartbeat. The flowchart of this process is shown in Figure 4.

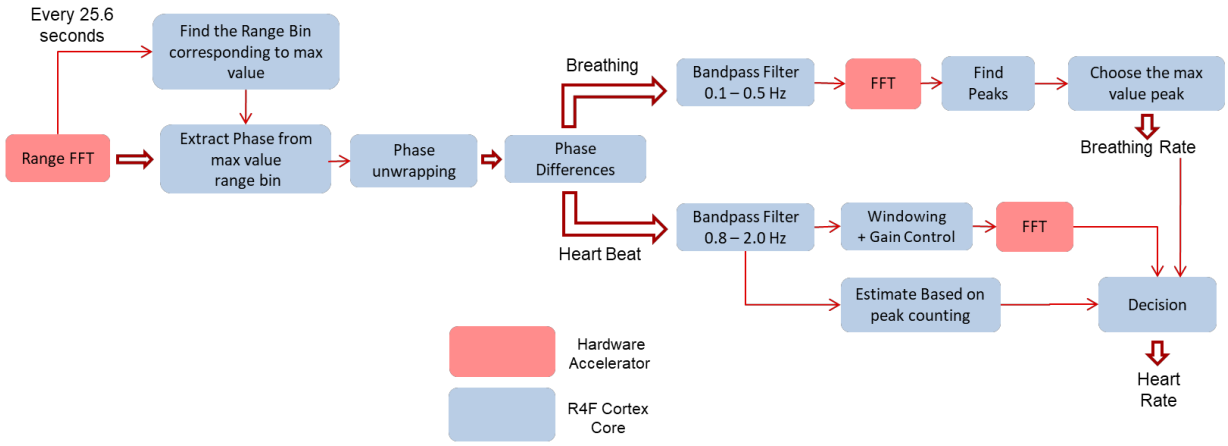

Figure 4. Separation algorithm flow chart of breathing and heartbeat waveforms

4. Conclusion

To sum up, this paper, through case analysis and research on the status quo of mental illness treatment at home and abroad, has concluded that the current low rate of medical treatment

for social mental illness, the shortage of hospital registration places and many other problems. In response to these problems, this article introduces the advanced domestic and foreign APPs for mental illness treatment, and analyzes the functions, characteristics, advantages and disadvantages of these APPs. On this basis, this paper proposes a design scheme for a mental illness treatment system that combines multiple technologies such as psychological assessment scales, face recognition, body language recognition, and wristbands.

The system can not only monitor and record the patient's medical information and changes in real time through the electronic medical record and patient monitoring terminal, but also can monitor the patient's emotion, physical state and medication through technologies such as face recognition, body language recognition and radar detection of vital signs. Comprehensive tracking and analysis of the situation in order to provide more accurate and personalized treatment services.

Overall, this system innovatively adopts a variety of advanced technologies, providing a new way for the diagnosis and treatment of mental diseases. Although the existing psychological service APP has been developed, it still needs continuous improvement and innovation of technology to further improve the accuracy and effect of the APP, to achieve more comprehensive and detailed mental illness treatment services, and to provide more mental illness patients. Good help and support.

Acknowledgments

This study was supported by the Innovation and Entrepreneurship Training Program for College Students, "Mental Cleanliness" (No. 202210424049). We would like to express our sincere thanks for their support.

References

[1] Yang Yuling. Research on radar-based vital signs detection technology [D]. Yanshan University, 2021. DOI: 10.27440/d.cnki.gysdu.2021.001771.

[2] Jin Xianzhi, Lin Fei, Wang Ye. Facial expression recognition algorithm based on CNN [J]. Journal of Qilu University of Technology, 2021,35(03):64-69.DOI:10.16442/j.cnki.qlgydxxb.2021.03. 011.

[3] Zhao Yanyan, Qin Bing, Liu Ting. Text Sentiment Analysis [J]. Journal of Software, 2010,21(08):1834-1848.

[4] Peng Yanan, Xi Juzhe, Zuo Zhihong. The status quo, problems and prospects of psychological service APPs under the background of Internet plus [J]. Chinese Journal of Clinical Psychology, 2017, 25(02): 333-336+309. DOI: 10.16128/j.cnki.1005-3611.2017.02.029.

[5] Liu, T., Xiao, S., Liu, X., Ding, Z., Sun, X., Zheng, J., Qiu, D., Xu, H., Gan, J., Lu, Q., Chan, C. L. W., Tong, X., Wu, M., & Chiu, H. F. K. (2019). Development of a comprehensive mental health service system incorporating digital psychiatry in China: Study protocol for a randomized controlled trial. Trials, 20(1), 185.