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MENTAL HEALTH SUPPORT APPLICATION BASED ON ARITIFICIAL INTELLIGENCE

Abstract: the current state of human mental health is considered and its content is defined. It describes a program that you install on your gadget to stabilize your mental health. A review and comparison of existing analogues of the mental state support application was carried out, a description of the system and algorithms used to create the mental state support application: speech recognition, dynamic time transformation, artificial neural networks, hidden Markov models, the final speech recognition algorithm. Analysis of affordability is also important, because it affects the possibility of using applications by a wide range of users. a description of the system and algorithms used to create an application for mental state support is presented. The proposed technologies are intertwined with a deep understanding of the human psyche in the context of creating an application for mental stabilization. For further development, you can improve the quality of the theory presented in the application, the speed and efficiency of artificial intelligence, and also constantly add new functions to the application.

Key words: artificial intelligence; mental state support application; psychological health; chatbot; speech recognition; dynamic time warping; artificial neural networks; hidden Markov models; comprehensive speech recognition algorithm; methods for combating stress and negative emotions.

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ДОДАТОК ДЛЯ ПІДТРИМКИ ПСИХІЧНОГО ЗДОРОВ'Я НА ОСНОВІ ШТУЧНОГО ІНТЕЛЕКТУ

Анотація: розглянуто сучасний стан ментального здоровя людини та визначено його зміст. Описано програму, яку ви встановлюєте на свій гаджет для стабілізації ментального здоровя. Здійснено огляд та порівняння існуючих аналогів застосунку для підтримки ментального стану, опис системи та алгоритмів використаних для створення застосунку для підтримки ментального стану: розпізнавання мови, динамічне трансформування часу, штучні нейронні мережі, приховані Марковські моделі, підсумковий алгоритм розпізнавання мови. Також важливим є аналіз цінової доступності, адже вона впливає на можливість використання застосунків широким колом користувачів. представлено опис системи та алгоритмів використаних для створення застосунку для підтримки ментального стану. Запропоновані технології переплітаються з глибоким розумінням людської психіки в контексті створення

застосунку для ментальної стабілізації. Для подальшого розвитку можна покращувати якість теорії, представленої в додатку, швидкість та ефективність роботи штучного інтелекту, а також постійно додавати нові функції у додаток.

Ключові слова: штучний інтелект; застосунок українською мовою програма, яку ви встановлюєте на свій гаджет; називається застосунок (від анг. application) для підтримки ментального стану; психологічне здоров'я; чат-бот; розпізнавання мови; динамічне трансформування часу; штучні нейронні мережі; приховані Марковські моделі; підсумковий алгоритм розпізнавання мови; методи боротьби зі стресом та негативними емоціями .

Олександр Єловець, Микола Арзубов, Віктор Челак, Ніна Підбуцка, Юрій Панфілов

Розширена анотація для ознайомлення з цією темою:
"Додаток для підтримки психічного здоров'я на основі штучного інтелекту"

Постановка проблеми в загальному вигляді *та її зв'язок із важливими науковими чи практичними завданнями. Психологічний стан людини має великий та недооцінений вплив на її фізичне здоров'я. Враховуючи сучасний стан суспільства, де люди мало не щодня стикаються зі стресовими ситуаціями та особливо у часи глобальних криз, додаток на основі штучного інтелекту для підтримки ментального стану стане важливим інструментом у протидії психоемоційному вигоранню, внутрішнім конфліктам, соціальному відчуженню та й усім їхнім наслідкам.*

Аналіз останніх досліджень і публікацій, *у яких започатковано розв'язання цієї проблеми і на які спирається автор. Визначення "штучний інтелект" вигадав доцент математики Датрмутського коледжу Джон Маккарті у 1955 році. Він хотів відмежувати цю сферу досліджень від уже добре відомої кібернетики. Джон Маккарті заклав базу технології розпізнавання голосу за допомогою комп'ютерної мови високого рівня. Сьогодні LISP, хоч і не в оригінальній формі, але використовується в робототехніці, різних наукових додатках, безлічі онлайн-сервісів, включаючи виявлення шахрайства з кредитними картками та розклад авіарейсів. Роботу в цьому напрямку проводив Дж. Робінсон, який у 1965 році запропонував метод резолюцій; Дж. Вейценбаум – у 1966 році розробив першого чат-бота ELIZA, котрий міг імітувати діалог із психотерапевтом. Наприкінці 1980-х рр. Дж. Ланьє запропонував і популяризував термін "віртуальна реальність" як відчуття реальних образів, які генеруються комп'ютерною технікою. Суттєвий вклад в створення штучного інтелекту зробив Дж. Хінтон, котрий у 2006 році разомі з колегами запропонував підхід побудови глибших нейронних мереж, а також спосіб уникнути зникнення градієнта під час навчанн, У дослідженні (Khan & Lulwani, 2023) вивчено підходи до використання штучного інтелекту у віртуальних класах, а також їхні переваги для покращення розуміння слухачами курсу. У дослідженні (Alhumaid et al., 2023) оцінюються гіпотези, як студенти сприймають використання програм штучного інтелекту в освіті, а також як заклади освіти підготовлені до цього та як суспільство загалом відреагує на широке впровадження штучного інтелекту в освіту. Було показано (Chaka, 2023), що в переважній більшості в якості засобів штучного інтелекту в освіті переважають чат-боти. Штучний інтелект має перспективу у використанні для персоналізованого, масштабованого та доступного навчання. Результати*

(García-Martínez et al., 2023) підтверджують позитивний вплив штучного інтелекту на успішність студентів, було виявлено підвищення мотивації до навчання, особливо в сфері STEM. Вітчизняні дослідники також продемонстрували позитивний ефект діалогового штучного інтелекту для зниження рівню тривожності та депресії у користувачів [19].

***Виділення не вирішених раніше частин загальної проблеми**, котрим присвячується дана стаття. Підвищення якості теоретичного підґрунтя застосунку, його швидкості та ефективності, додавання нових функцій, що дозволило охопити всі типи психологічних і психічних.*

***Формулювання цілей статті** (постановка завдання)**.** Зробити огляд існуючих аналогів додатку для підтримки ментального стану; дати опис системи та алгоритмів використаних для створення додатку для підтримки ментального стану та показати реалізацію ідей для створення додатку для підтримки ментального стану*

***Виклад основного матеріалу дослідження** з повним обґрунтуванням отриманих наукових результатів. Розроблена програма є застосунком для стабілізації ментального здоров'я, що є не лише інноваційний проект, але й дуже корисний помічник для людини у повсякденному житті, якому зараз приділяється досить мало уваги. Цей проект не обмежується одним завданням чи функцією, а надає цілу низку опцій та послуг.*

Його унікальність полягає у здатності надавати миттєву підтримку особистості та можливості ведення діалогу з користувачем, заснованого на досягненнях психології та штучного інтелекту. Ця програма пропонує користувачам різні методи боротьби зі стресом та негативними емоціями через сукупність таких речей як:

• психологічний помічник на основі ШІ;

• заспокійливі мелодії для сну чи роботи;

• релаксації та медитації.

В статті здійснено огляд та порівняння існуючих аналогів застосунку для підтримки ментального стану, опис системи та алгоритмів використаних для створення застосунку для підтримки ментального стану: розпізнавання мови, динамічне трансформування часу, штучні нейронні мережі, приховані Марковські моделі, підсумковий алгоритм розпізнавання мови. Також важливим є аналіз цінової доступності, адже вона впливає на можливість використання застосунків широким колом користувачів.

Авторами здійснено врахування переваг та недоліків кожного застосунку, що дозволяє зрозуміти їх практичне застосування та обмеження. Цей аналіз покращує розуміння поточного стану цифрових ресурсів у сфері ментального здоров'я.

Для подальшого розвитку можна покращувати якість теорії, представленої в додатку, швидкість та ефективність роботи штучного інтелекту, а також постійно додавати нові функції у додаток. Такий підхід дозволить повністю охопити всі типи психологічних і ментальних проблем та гарантувати подальший прогрес у цій сфері.

В статті представлено опис системи та алгоритмів використаних для створення застосунку для підтримки ментального стану. Запропоновані технології переплітаються з глибоким розумінням людської психіки в контексті створення застосунку для ментальної стабілізації. Програми мають великий функціонал, що є одним із ключових факторів для майбутнього успіху.

Багато людей мають низку різноманітних проблем, тому й застосунок має різносторонні методи вирішення цих проблем, зокрема виділено 3 основні опції.

По-перше, психологи, на відміну від ШІ, дуже суб'єктивні та мають різні точку зору. Саме тому було використано

та налаштовано розумний ШІ, який використовує різні методи психотерапії, зокрема практикує когнітивно-поведінкову терапію, що допомагає у розумінні емоцій та почуттів людини.

По-друге, застосовано медитації, які використовуються для досягнення розумового балансу та спокою, знижаючи рівень стресу та тривожності. Це впливає на організм, так як це знижує артеріальний тиск, покращує серцево-судинну систему та поліпшує здатність до концентрації уваги людини.

По-третє, релаксації для покращення сну. Внутрішній стан прямопропорційно залежить від сну та його якості, адже сон безпосередньо впливає на нервову систему.

Позитивним є наявність зручного інтерфейсу, який є інтуїтивно зрозумілим, із лаконічним дизайном, що дає змогу користувачам легко використовувати застосунок. Для цього було реалізовано: розпізнавання мови; налагоджену роботу штучного інтелекту; зручний інтерфейс; опції прослуховування мелодій для медитації та релаксації, а також і самі інструкції.

Інтерактивність застосунку забезпечується за допомогою використання чат-боту, який здатен вести діалог, заснований на принципах когнітивно-поведінкової терапії, допомагаючи користувачам осмислювати та працювати над своїми думками та емоціями. Також, програма може пропонувати персоналізовані медитації, дихальні вправи та інші техніки для зниження рівня стресу та підвищення рівня особистісного зростання.

***Висновки з даного дослідження** та перспективи подальших розвідок у даному напрямку. Реалізовано повноцінний додаток для підтримки ментального здоров'я на основі штучного інтелекту. Знайдено переваги та недоліки існуючих аналогів, проаналізовано функціонал і зручність цих додатків та реалізовано свій продукт, що втілює в собі неповторні особливості, а також штучний інтелект. Розроблена програма безкоштовна та має безліч переваг над іншими. Виявлено, що найкращим рішенням для розпізнавання мовлення є гібрид ПММ і ШНМ, оскільки він пом'якшує слабкість одного алгоритму сильними сторонами іншого. Втілено та глибоко налаштовано найкращого існуючого ШІ під психотерапевтичні завдання. Штучний інтелект використовує найефективніші методи боротьби з внутрішніми комплексами та проблемами: КПТ, майндфулнес та інші. Створено зручний інтерфейс, та в своєму додатку поєднані багато практик для боротьби зі стресом: медитації, релаксації для сну тощо. Розроблений застосунок може служити важливим інструментом у боротьбі з психологічними розладами та сприяти підвищенню загального рівня ментального благополуччя в суспільстві.*

Problem setting. Today, artificial intelligence tools can be utilized not only through personal computers but also via smartphones and tablets. Although these tools are predominantly used for entertainment purposes, most of them possess the potential for educational applications.

Artificial intelligence (AI) is a domain of computer science that focuses on developing intelligent computer systems, that is, systems that possess capabilities traditionally associated with human intelligence, such as language comprehension, learning, reasoning, and problem-solving abilities. It allows not just for data processing but also for using the data to analyze situations, health, and individual states, forecasting event developments, and suggesting possible solutions to situations, proposing measures for health improvement and individual well-being. Це авторське визначення?

Artificial intelligence differs from human intelligence in that it is based on algorithms and predefined programming, whereas human intelligence is founded on

cognitive processes, including learning, understanding, problem-solving, and perception. Artificial intelligence lacks the ability to feel emotions, understand the content of texts and images, and be self-aware. For now, artificial intelligence is merely mathematical algorithms, a set of methods for solving specific tasks, albeit very promising ones.

For this reason, we attempted to create the "Mental Health Support Application Based on Artificial Intelligence." This project is a response to the global challenges of the 21st century in the field of mental health. In an era where technological progress accelerates at an unprecedented rate, it's paradoxical that human mental health faces significant challenges. According to the World Health Organization's research, more than 264 million people worldwide suffer from depression, and anxiety disorders affect over 275 million people [14].

The issue of mental disorders occupies one of the leading positions among global health challenges today. This is particularly noticeable among the youth, where an increase in stress factors, such as social pressure, educational load, and the influence of social networks, leads to a rise in cases of mental disorders. The lack of proper attention and access to quality assistance only exacerbates this problem. To some extent, our health reflects our inner state. This is highlighted by the fact that major depressive disorder (MDD) and generalized anxiety disorder (GAD) are the main causes of disability and premature mortality. Globally, over 300 million people suffer from major depressive disorders, equivalent to 4.4 % of the world's population. We can conditionally imagine that each of these individuals could undergo serious consequences following mental disorders. This is a significant problem because most of these people lack the funds and opportunities for regular psychological support.

But now, the situation is even worse. Due to the tragic events of the last 2 years слід вказати роки, in the form of a full-scale war with daily tragedies and deaths across the country, the level of anxiety and stress among Ukrainians has increased geometrically. About 70 % of Ukrainians feel fear, nervousness, and stress, where the main source of such ailments is Russian aggression towards Ukraine. This is evidenced by the results of the eighth wave of the study "Socio-political moods during the full-scale invasion of the Russian Federation's troops into the territory of Ukraine," conducted by the research company Gradus Research. As Ilyenko noted, among the respondents, two groups feel the most stress: women and the age group 25 – 34 years. Among women, 79 % of respondents feel this way, and among the age group 24 – 34 – 76 % [13]. Therefore, this is a very widespread problem now, and our society needs some solution to this problem. This application could serve as such a solution, as it provides users with the opportunity for unlimited communication with a psychological assistant based on artificial intelligence, as well as offers meditation practices and melodies for relaxation before sleep.

Recent research and publication analysis.The term "artificial intelligence" was coined by John McCarthy, in 1955. He aimed to differentiate this research area from the well-known field of cybernetics. This topic became key during a seminar held in the summer of 1956. McCarthy, along with three colleagues, organized the event. A 17-page document titled "The Dartmouth Proposal," which first used the term artificial intelligence, was presented at the seminar. The document outlined topics that scientists considered fundamental to this field of research: neural networks, theory of computability, creativity, natural language processing. The authors believed that it would suffice to thoroughly describe any feature of human intellect and then transfer this information to a machine created for its imitation.

LISP — the first functional programming language. John McCarthy laid the foundation for voice recognition technology using a high-level computer language. Today, LISP, though not in its original form, is used in robotics, various scientific applications, and a multitude of

online services, including credit card fraud detection and flight scheduling.

In 1965, John McCarthy founded the Stanford Artificial Intelligence Laboratory (SAIL). It became a hub for invention creation. The brightest minds of the time gathered under its roof for intellectual collaboration [2].

Work in this direction was carried out by J. Robinson, who in 1965 proposed the resolution method; [3]

Weizenbaum J. – in 1966, developed the first chatbot, ELIZA, capable of mimicking a dialogue with a psychotherapist [4].

Towards the end of the 1980s, J. Lanier proposed and popularized the term "virtual reality" as the sensation of real images generated by computer technology [5].

The renowned Ukrainian surgeon M. Amosov worked in this direction. He believed that the study of artificial intelligence is based on the sciences of physiology, psychology, engineering, and philosophy [6].

A significant contribution to the creation of artificial intelligence was made by J. Hinton, who in 2006, along with colleagues, proposed a method for constructing deeper neural networks and a way to avoid gradient vanishing during learning [7].

Fukuyama F., studying various aspects of AI, noted that it is one of the characteristics of the information society [8].

Researcher J. Jefferson asserted that artificial intelligence cannot feel and is incapable of self-awareness [1].

Maryenko Maya and Kovalenko Valentyna, employees of the Institute for Digitalization of Education of the NAES of Ukraine, conducted an analysis of artificial intelligence research. They point out that in the study (Aktay, 2022), an attempt was made to determine the possibility of using images generated by artificial intelligence in education, using the DALL·E AI tool developed by OpenAI. The study (Khan & Lulwani, 2023) explored approaches to using artificial intelligence in virtual classes, as well as their benefits for improving course attendees' understanding. The study (Alhumaid et al., 2023) assessed hypotheses on how students perceive the use of artificial intelligence programs in education, how educational institutions are prepared for it, and how society at large will react to the widespread implementation of artificial intelligence in education. It was shown (Chaka, 2023) that chatbots predominantly serve as the means of artificial intelligence in education. Artificial intelligence has potential for use in personalized, scalable, and accessible learning. [10]

The results (García-Martínez et al., 2023) confirm the positive impact of artificial intelligence on student performance, revealing an increase in motivation to learn, especially in the STEM field. [10]

In recent years, many tools have emerged that change the lives of both teachers and students, providing convenience in acquiring knowledge.

Panukhnyk O. provides examples of using artificial intelligence programs. Such as Google Translate allows translating text in over 100 languages;

- Siri and Google Assistant offer people the ability to ask questions and receive quick answers;
- ChatGPT assists in scientific research by summarizing sources or directing to useful publications, as well as providing instant answers to any questions, explanations, and examples;
- Stable Diffusion and Imagen allow entering text to create realistic images;
- Caktus offers personalized recommendations to students regarding their education management;
- Gradescope helps teachers assess student assignments more quickly and effectively, reducing their bias;
- Alta by Knewton adapts to each higher education student's unique learning style;
- Querium simulates a teacher's experience in guiding a student through problem-solving with its unique StepWise technology;
- Educationcopilot offers to save teachers' time and energy through quick

generation of individual templates, and also facilitates collaboration between teachers, etc. [11].

Highlighting the previously unresolved parts of the general problem to which this article is devoted.For further development, you can improve the quality of the theory given in the application, the speed and efficiency of artificial intelligence, and also constantly add new functions to the application. Such an approach will fully cover all types of psychological and mental problems and guarantee further progress in this area.

Paper objective. To review existing analogs of the app for mental state support; to describe the system and algorithms used to create the app for mental state support, and to demonstrate the implementation of ideas for creating an app for mental state support.

Paper main body. However, the creation of an "App for Mental Health Support Based on Artificial Intelligence" is very relevant. This project is aimed at providing effective, accessible, and individualized assistance to users who are struggling with the consequences of some failure or life problem but nevertheless cannot always cope without external help.

The app is based on the principles of artificial intelligence, allowing it to analyze large amounts of data for a more accurate understanding of the user's state. This may include monitoring language patterns, emotional analysis, and behavioral analysis to detect signs of depression, anxiety, and other mental disorders. This information is used to develop individualized intervention strategies, which may include self-help recommendations, relaxation exercises, cognitive-behavioral therapy methods, and, if necessary, referrals to professional psychotherapists.

A key feature of the app is convenience. It is designed so that each user can independently figure out all the details of the program without instructions and help and test the intellectual assistant on themselves. Currently, artificial intelligence is not used by most apps, which is a significant drawback on their part, as artificial intelligence is a substantial resource that can be trained to a human level and beyond. The use of artificial intelligence in this context not only revolutionizes the approach to treating and supporting mental health but also takes a significant step towards progress, as it will undoubtedly be used in other service-related concepts.

Additionally, such an app effectively saves the time that one would spend traveling to a psychologist and waiting for an appointment. Help is always at hand, which is especially important for those who may feel isolated or do not have access to traditional forms of psychotherapy. Moreover, it saves people's money spent on sessions with psychologists and undergoing practices, making it a very advantageous option.

Review of Existing Analogs for Mental State Support Applications

The review of existing mental health application analogs is crucial as it allows for the evaluation of their effectiveness, accessibility, and impact on users. In this context, studying various aspects of the applications, including their functional capabilities and user interaction methods, is key to assessing their potential in addressing the psychological and emotional challenges of modern individuals. An analysis of pricing accessibility is also important, as it influences the usability of applications by a broad spectrum of users. The user interface and its ease of use directly affect the user experience and their willingness to integrate applications into their daily life. Considering the advantages and disadvantages of each application will provide insight into their practical application and limitations. This analysis will enhance understanding of the current state of digital resources in the field of mental health.

1.1. Review of Existing Analogs

Below is a rational comparison of the characteristics of other existing analogs. For example, 5 of the best and most popular applications were chosen:

1) Headspace:

- Price and subscriptions: Paid, $12.99 per month, $69.99 annually. There is a free trial option.
- Type of services: Offers a variety of meditations for stress, focus, sleep, and relaxation. Also includes Sleepcasts and audio stories for children.
- Specialization: Stress reduction, sleep improvement, focus enhancement.
- Accessibility and platforms: Available for web, Android, and iOS.
- User experience: Convenient interface, well-organized content.
- Content quality: High, variety of programs.
- Transparency and confidentiality: Serious privacy and data protection policy.

2) Calm:

- Price and subscriptions: Paid, various plans with different features: $14.99 per month, $69.99 annually. There is also a free trial option.
- Type of services: Meditation, relaxation, soundscapes, and masterclasses.
- Specialization: Stress reduction, sleep improvement, concentration enhancement.
- Accessibility and platforms: Available for web, Android, and iOS.
- User experience: Convenient interface, easy to use.
- Content quality: High, variety of content.
- Transparency and confidentiality: Ensures users' data confidentiality.

3) Talkspace:

- Price and subscriptions: Paid, various plans depending on the type of services and frequency of consultations.
- Type of services: Text/video therapy with licensed therapists.
- Specialization: Various specializations, option to choose a therapist.
- Accessibility and platforms: Mainly available on the web, and for Android and iOS.
- User experience: Simple to use, convenient for receiving therapy online.
- Content quality: Focused on therapeutic support but lacks meditations or relaxations.

4) Woebot:

- Price and subscriptions: Some basic features are free, but there are paid options with additional functionalities.
- Type of services: Chat therapy, psychological support through artificial intelligence.
- Specialization: Chat therapy, psychological support through artificial intelligence.
- Accessibility and platforms: Web and iOS.
- User experience: Simple interface, focused on AI communication for psychological support.

5) iBreathe:

- Price and subscriptions: Completely free.
- Type of services: Meditation, stress management, focused on breathing and relaxation.
- Specialization: Meditation, stress management.
- Accessibility and platforms: Available for Android and iOS.
- User experience: Convenient interface, emphasis on breathing and relaxation.
- Content quality: Satisfactory but limited to standard information.

1.2. Comparison of Applications

For a clearer and more specific comparison, the table below presents the main characteristics of existing programs.

Table 1.1

Comparison table of existing analogues

	Headspace	Calm	Talkspace	Woebot	iBreathe

Continued from Table 1.

Cost	$12.99 per month	$14.99 per month	$65 - $100 per week	$0	$0
Services	Meditation, relaxation, breathing exercises	Meditation, relaxation, MK	Text / video therapy	AI-assisted chat therapy	Meditation, breathing exercises
Specialization	Stress reduction, sleep, focus improvement	Stress reduction, sleep, concentration enhancement	Diverse objectives	Chat therapy	Stress management, meditation
Artificial Intelligence	–	–	–	+	–
Platforms	Web, Android, iOS	Web, Android, iOS	Web, Android, iOS	Web, iOS	Android, iOS
Content quality	High	High	–	Satisfactory	Satisfactory
Transparency and privacy	+	+	+	+	+
Reviews and ratings	High rating, positive reviews	High rating, positive reviews	Mixed reviews	Mixed reviews	Mixed reviews

This project is centered on developing an innovative mental health support application that integrates the strongest aspects of existing analogs. The core idea is to amalgamate a wide range of functionalities from meditations and relaxation techniques to therapeutic sessions, ensuring a holistic approach to mental well-being.

The primary innovation of this project is the incorporation of a psychological assistant based on artificial intelligence, capable of providing personalized support to users by analyzing their needs and preferences. The assistant can offer exercises, advice, and techniques best suited to the user's current emotional state.

The project also emphasizes creating an intuitively understandable, user-friendly interface, ensuring high accessibility and ease of use for diverse user groups. This approach includes adjustable settings to cater to the individual preferences and needs of each user.

1. Description of the system and algorithms used for the mental state support application

Technologies intertwine with a deep understanding of human psychology in the context of creating an application for mental stabilization. The extensive functionality of such a program is one of the key factors for future success. Many individuals face a variety of issues, hence the application must have versatile methods for addressing these problems. Three primary options were highlighted for this application:

Firstly, interaction with a psychologist or psychotherapist. However, psychologists, unlike AI, are very subjective and have

differing viewpoints. Therefore, intelligent AI was utilized and configured, employing various psychotherapy methods, including cognitive-behavioral therapy, to aid in understanding human emotions and feelings.

Secondly, meditations. Meditations are used to achieve mental balance and tranquility, in turn, reducing stress and anxiety levels. This impacts the body, as it lowers blood pressure, improves the cardiovascular system, and enhances an individual's concentration ability.

Thirdly, relaxations to improve sleep. The internal state directly correlates with sleep and its quality, as sleep directly influences the nervous system. Additionally, to enhance quality, a convenient and aesthetically pleasing interface was developed, which is intuitively understandable. With a concise design, it will be more enjoyable for users to utilize the application. The application was implemented with:

- speech recognition;
- well-adjusted artificial intelligence operation;
- a user-friendly interface;
- options for listening to melodies for meditation and relaxation, as well as the instructions themselves.

The interactivity of the application is facilitated through the use of a chatbot capable of conducting dialogues based on the principles of cognitive-behavioral therapy, assisting users in reflecting on and working through their thoughts and emotions. Furthermore, the program can offer personalized meditations, breathing exercises, and other techniques for stress reduction and personal growth enhancement.

2.1. Speech Recognition

Speech recognition is the process of taking spoken word as an input signal for a computer program. Sound, in turn, is a superposition (overlay) of sound vibrations (waves) of various frequencies. A wave, as known from physics, is characterized by two attributes - amplitude and frequency. To preserve the sound signal on a digital medium, it needs to be divided into a multitude of intervals and take an approximate average value at each of them.

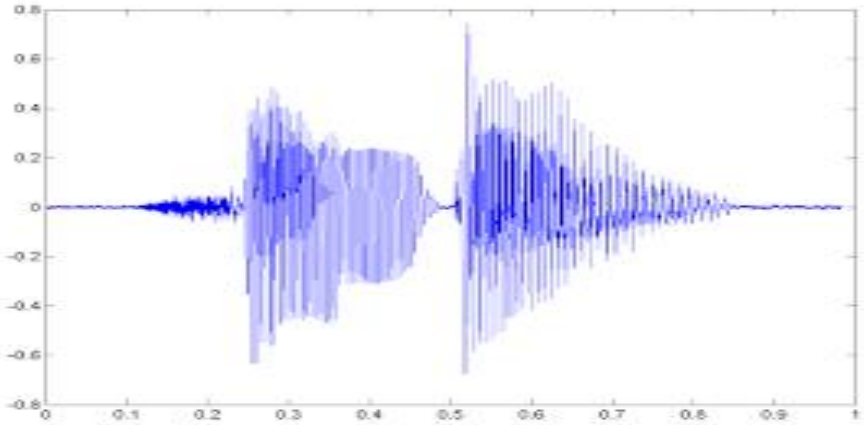

Fig. 2.1. Speech Recognition

Speech recognition is the process of converting spoken words into electrical signals by a computer program, which are then translated into a coding pattern assigned with meaning. The technologies used for speech recognition include:

1. Dynamic Time Warping (DTW);
2. Hidden Markov Models (HMM);
3. Artificial Neural Networks (ANN).

2.1.1. Dynamic Time Warping

The Dynamic Time Warping (DTW) algorithm functions as a method to determine the similarity between two temporal sequences that may vary in time or speed,

utilizing dynamic programming principles. The core idea is to align these sequences by "wrapping" one sequence around another. The alignment process is iterative: the algorithm gradually shifts points in time until the most optimal match between the two sequences is achieved. This means DTW can find correspondences between data series, even if they have some temporal deviations, such as one sequence being slightly faster or slower than the other.

2.1.2. Artificial Neural Networks

Artificial Neural Networks (ANN) belong to the second class of models and are used for the acoustic-phonetic modeling of speech signals. The speech recognition process in ANNs starts with an input layer, where the speech signal is converted into input data that can be represented in numerical values. This data is fed into hidden layers, where each neuron receives signals from all neurons of the previous layer, processes these signals using activation functions, and passes the results to the next layer. Each network neuron (except for those in the input layer) receives an input signal from every neuron of the previous layer, and the output signal of the neuron goes to the input of neurons in the next layer. Eventually, when information reaches the output layer, the ANN produces the final result, which could be, for example, a textual representation of the speech signal.

2.1.3. Hidden Markov Models

Hidden Markov Models (HMM) are mathematical models used to analyze sequences of states where certain random processes are present. These models are based on the concept of Markov processes, where the system at any given time is in one of several states and transitions between these states with certain probabilities. A distinctive feature of HMMs is their consideration of hidden (unobservable) states and observable events. For instance, in speech recognition tasks, hidden states might be individual phonemes, while observable events are sound signals. HMMs determine the transition probabilities between hidden states, as well as the probabilities of observing specific events in each of these states.

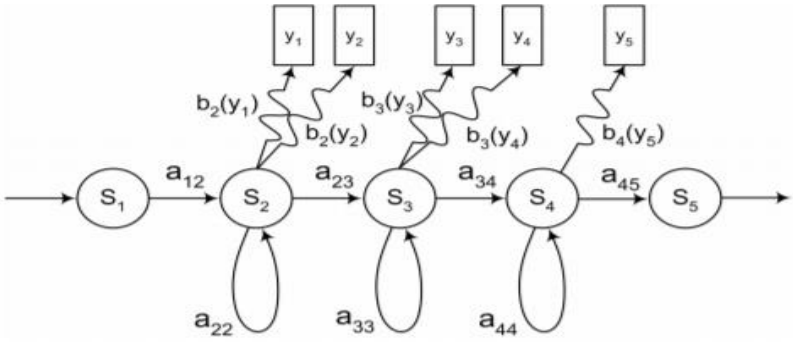

Fig. 2.2 Hidden Markov Model Operation Algorithm

2.1.4. Final Speech Recognition Algorithm

HMM checks all probabilities of the most likely spoken text to appear. This model is well-suited for the sequential nature of speech. However, it lacks flexibility because there is a wide variety of phonemes and their possible combinations, requiring a significant journey before the model can be considered perfect.

Neural networks are flexible and, therefore, can evolve over time, which is a significant advantage. The neural network understands that there is an error and thus begins to adapt to minimize this error. However, for the neural network to continue improving and correcting the error, it requires a large amount of input data. The downside is that ANNs are not well-suited for the

sequential nature of speech, but on the other hand, they are flexible and can capture the diversity of phonemes, uniqueness of accents, emotions, age, gender, etc.

Each method separately has its drawbacks, so the program utilized the idea of combining both approaches, defined as a hybrid HMM/ANN model. As a result, the accuracy of speech recognition was improved, with HMMs providing the ability to model long-term dependencies, and ANNs offering flexibility in recognition and the possibility of continuous learning. This is the algorithm on which the Python programming language library, SpeechRecognition, operates.

Access to the microphone is facilitated using PyAudio. Instead of creating scripts from scratch for microphone access and audio file processing, PyAudio allows you to start working within a few minutes. The SpeechRecognition library acts as a wrapper for several popular speech APIs and, thus, through widespread use and, accordingly, a large amount of data, is extremely flexible. One of the speech APIs, Google Web Speech API, supports a default API key that is hard-coded into the SpeechRecognition library.

2.2. Artificial Intelligence

Artificial intelligence operates based on large neural networks trained on vast amounts of textual data. A neural network is a mathematical model that simulates the way the human brain analyzes and processes information. It consists of a large number of nodes, called artificial neurons, interconnected and capable of transmitting signals.

But how exactly to create a powerful chatbot capable of communicating with a human, considering human language has several features such as sarcasm, metaphors, variability in sentence structure, as well as exceptions to grammar rules and usage. This can be solved by machine learning algorithms for NLP, allowing artificial intelligence models for dialogues to continuously learn from large textual data and recognize various linguistic patterns and nuances. The quality of NLP is incredibly important because the quality of user assistance entirely depends on NLP, i.e., the understanding of human language.

2.2.1. NLP Technology

The tasks of NLP include:

- Word sense disambiguation: In human speech, a word can have several meanings. Eliminating word ambiguity is semantic analysis, choosing the most appropriate meaning for a word based on its context. For example, it helps to determine whether a word functions as a verb or a pronoun.
- Named Entity Recognition (NER): NER identifies words and phrases as specific entities, for example, recognizing “Ivan” as a person's name or “Ukraine” as a country name.
- Sentiment Analysis: Human language often contains moods and undertones. This is particularly important in the context of our application; we must always monitor users' emotional states. Extracting these nuances and hidden emotions, such as attitude, sarcasm, fear, or joy, is one of the most challenging tasks.

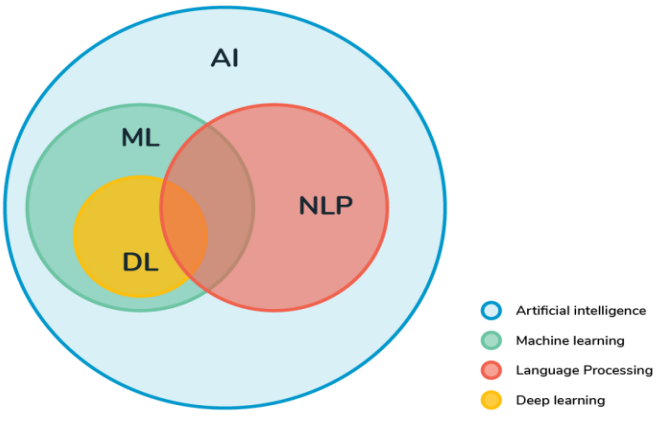

Figure 2.3 Image of AI components and the role of NLP

This project addresses the challenge of chaotic speech by confronting several key obstacles that need to be understood in order to continue refining these chatbots. To comprehend these obstacles or problems, it is necessary to understand how NLP transforms human speech into something an algorithm or AI can understand. Here is a list of obstacles a chatbot faces when users try to interact with it:

- Synonyms, homonyms, slang;
- Spelling errors;
- Abbreviations;
- Complex punctuation rules.

2.2.2. Machine Learning

NLP is closely associated with machine learning. Machine learning is the foundation of modern NLP technologies and plays a crucial role in developing and improving methods for understanding, generating, and translating natural language.

Within NLP, machine learning is used to solve various tasks, such as:

- Sentiment analysis of text: Determining whether a text is positive, negative, or neutral. This function is very significant for monitoring mental states.
- Text classification: Determining the category or theme of the text, for example, classifying news articles.
- Named entity recognition: Identifying and classifying names, organizations, geographic names, etc., in the text.
- Text generation: Creating coherent and understandable text based on given conditions or data.

The machine learning algorithm receives data from the computer and uses statistical methods to help it "learn" to gradually improve the task, without necessarily being programmed for this specific task. Instead, ML algorithms use historical data as input to predict new output values. For this purpose, ML consists of supervised learning (where the expected output for input data is known thanks to labeled data sets) and unsupervised learning (where expected outcomes are unknown due to the use of unlabeled data sets).

Following training on a database, the fine-tuning stage begins, where the artificial intelligence adapts to specific tasks such as dialogue, text creation, answering questions, and others. This stage is important for fine-tuning the model to meet the specific needs of users. AIs like ChatGPT receive vast amounts of information during training, playing a key role in determining their quality and effectiveness. This process begins with collecting diverse textual data, which may include books, articles, dialogues, web content, and many other sources. Such diversity provides a broad overview of language, its use in different contexts, and styles.

The volume of information received is measured in billions of words and sentences, allowing artificial intelligence to deeply understand linguistic structures, nuances, idioms, and contextual relationships. Unfortunately, powerful artificial intelligence is only available to corporations like Google, OpenAI, and others, as the quality of AI is entirely dependent on its training and the data available to it. Therefore, the most advanced artificial intelligence, GPT4, was chosen and later configured as the base for the psychological assistant. GPT4 is the most intelligent AI to date. The intelligence of artificial intelligence directly depends on the volume of machine learning, making it the best option. However, an assistant was created for psychotherapy tasks, using various techniques, such as cognitive-behavioral therapy, psychoanalysis, mindfulness, etc. Python was used as the programming language. The assistant could be created by configuring the AI and giving a clear specification in OpenAI, but in such a case, it would be necessary to pay for each call to artificial intelligence, and the AI would be very limited. Therefore, the G4F library, which fully conveys the properties of GPT4, was applied and implemented in the code. Thus, using the GPT base will not require money, and the application will not depend on the availability of the Internet.

2.3. Application System and Interface

The interface is one of the most crucial parts of the work. The attractiveness of the application directly reflects users' desire to use it. For the full functionality of the mental help application, corresponding pages for the respective functions were made:

- Communication with AI. This page looks like a chat window where users have the opportunity to transmit information to artificial intelligence through speech recognition. In turn, the bot responds in chat or, if available, vocalizes its response to the user, which can be selected in the settings. This is a convenient and understandable chat with functions for recognizing and vocalizing text, a nice feature of the application, as none of the other analogs use the function of recognizing and vocalizing speech.
- Relaxations before sleep. Unlike, for this function, another window of the application was made, which provides the opportunity to listen to sounds, which, for example, can be turned on while working on the computer or before sleep, to calm or distract the user from noises with pleasant and soothing melodies of nature. Each sound has visualization on the activation button in the form of a picture and a small description below.
- Meditation practices. This is the last window, which has instructions for meditations, descriptions of meditations, descriptions of different types of meditations, and essentially represents an important collection of information regarding meditations. Also, there are plans for implementing video players to improve users' understanding.

Moreover, the application contains a separate settings window, which provides the option to change some parameters. A window with basic information about the possibilities and functionality of the program was made. The entire design is built on balanced tones, which were chosen for user enjoyment.

3. Implementation of Ideas for Creating an Application to Support Mental State

To realize the proposed application for mental assistance, the Python programming language was used, which offers numerous advantages, especially in the field of artificial intelligence and machine learning. The following seven libraries were applied for the implementation of the entire program:

- Tkinter + customtkinter: These are the two main libraries for creating the application interface, where the former provides methods for creating widgets and buttons, and the latter enhances the design of each widget, making it more modern overall.
- Pillow: This library was implemented for importing photos from the computer for incorporation into the project.
- G4f: This library grants access to the most advanced AI currently available, without the need for API keys from OpenAI, which require payment, and also allows for the use of the latest technological developments without an internet connection.
- SpeechRecognition: This library was implemented in the project for speech recognition during communication with the bot. It provides useful capabilities to all and saves users' time.
- gTTS: This library is used for speech synthesis, allowing the bot itself to vocalize text. This also represents a useful function that allows listening to the response instead of reading it.
- PyGame: The last library used for importing sounds into the application itself. It is necessary for integrating melodies for relaxation before sleep, for concentration, meditations, etc., into the program.

In developing the application, the efficient “divide and conquer” method was utilized to break the project into several parts and solve each of them separately and independently of the others. As a result, this approach facilitated success in each set task, combined them, and tested the finished product. The project was divided into the following tasks:

- Development and configuration of artificial intelligence for psychotherapeutic purposes.
- Creation of special functions to accelerate and improve processes. In the

application, this included adding speech recognition and vocalization, their analysis, and the use of the most effective libraries.

• Creation of a graphical interface. This is also a significant part because the graphical interface affects users. In creating the interface, concise and pleasant tones were found, and several windows were designed for all necessary functions. The application development began with the implementation of artificial intelligence.

3.1. Implementation of Artificial Intelligence

At the beginning of the development, the library for initializing the proposed bot – g4f, based on GPT4, was needed to create AI. Next, a small function was made to generate responses from this artificial intelligence, which takes a list of previous messages as input parameters and configures the bot to respond.

```
def ask_gpt(messages: list) -> str:
    response = g4f.ChatCompletion.create(
        model=g4f.models.gpt_35_turbo,
        messages=messages
    )
    print(response)
    return response
```

Fig. 3.1 Information request function from AI

This function allowed for posing basic questions and receiving answers to them. Following that, a more targeted function was implemented based on the previous one, where full-fledged communication with the bot occurs. It is executed through a loop and by changing the parameters of the list for the bot, messages. The function appears as follows:

```
def startConversation():
    messages = [{"role": "system", "content": "You are a mental t

    while True:
        question = speechrec()
        messages.append({"role": "user", "content": question})

        answer = ask_gpt(messages=get_recent_messages(messages))
        messages.append({"role": "system", "content": answer})

        messages = get_recent_messages(messages)
```

Fig. 3.2 The function of initializing and maintaining dialogue with AI

In the initial line, the bot's settings are enhanced through a more detailed characterization (prompt). This line recreates the assistant, tailored to the given task by providing specific information for AI for a particular task – psychotherapy. It employs well-known and effective methods, such as Cognitive Behavioral Therapy (CBT) and mindfulness. The bot receives a message. In this example, the message is processed through a speech recognition function, but it could also occur through standard text data

reading. Following this, using all the methods described above, the bot sends a response and copies it, adding it to the list to maintain a history of communication.

3.2. Implementation of Speech Recognition and Synthesis

As previously identified, the program also requires the SpeechRecognition and pyttsx3 libraries for speech recognition and speech synthesis, respectively. The first function created was for speech synthesis. This function can be utilized after initializing the speech engine at the beginning of the code:

```
def talk(_text):
    print(_text)
    voice.say(_text)
    voice.runAndWait()
```

Fig. 3.3 Speech synthesis function

Subsequently, a function for speech recognition was developed. To facilitate the use of a microphone, the PyAudio library was downloaded.

```
def speechrec():
    r = sr.Recognizer()

    with sr.Microphone() as source:
        r.pause_threshold = 0.5
        r.adjust_for_ambient_noise(source, duration=1)
        audio = r.listen(source)

    try:
        recognized_text = r.recognize_google(audio, language = 'uk-UA').lower()
        print(recognized_text)

    except sr.UnknownValueError:
        print('Повторіть ще раз, будь ласка')
        recognized_text = speechrec()

    return recognized_text
```

Fig. 3.4 Speech recognition function

The function assigns the class to the variable “r”, after which recognition begins. Initially, a 500ms pause is maintained for smooth initialization. Subsequently, the system adjusts to background noises, echoes, and indistinct sounds over 1 second. Utilizing the algorithms described above, the system then captures the data and converts it to lowercase. The data are displayed in the console, and if a problem or ambiguity arises, the function recursively restarts and provides feedback to the user, indicating the need to repeat the input.

3.3. Implementation of the Interface

For the interface implementation, three well-known libraries were used – tkinter, customtkinter, and pillow. The pillow library was utilized for creating icons and

enhancing the overall interface. A startup menu was created, necessary widgets were added, and specific functions for each button were developed. Additionally, the application was named “Oasis”. This is how the final program appears:

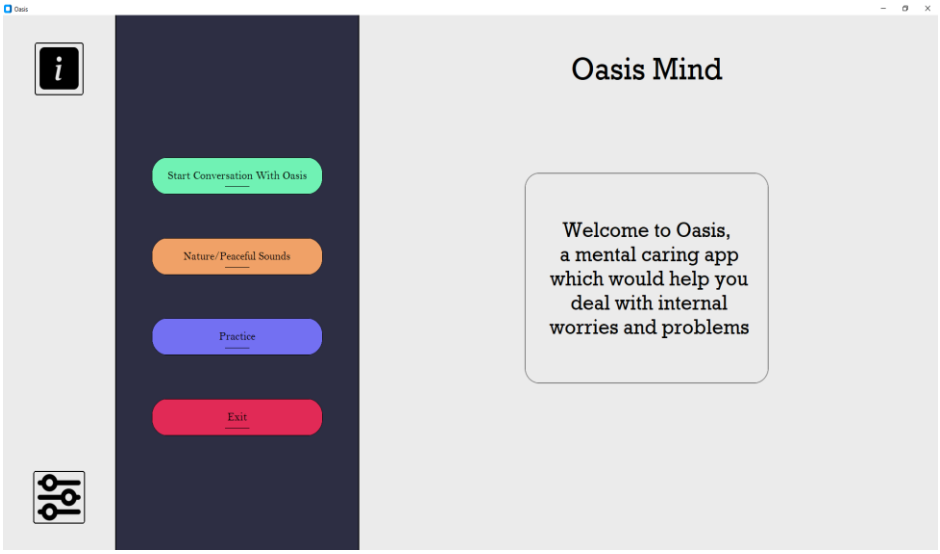

Fig. 3.5 Image of the interface of the developed application

The first main button, “Start Conversation with Oasis”, directs the user to a menu with an open chat for communicating with the bot. The AI window appears as follows:

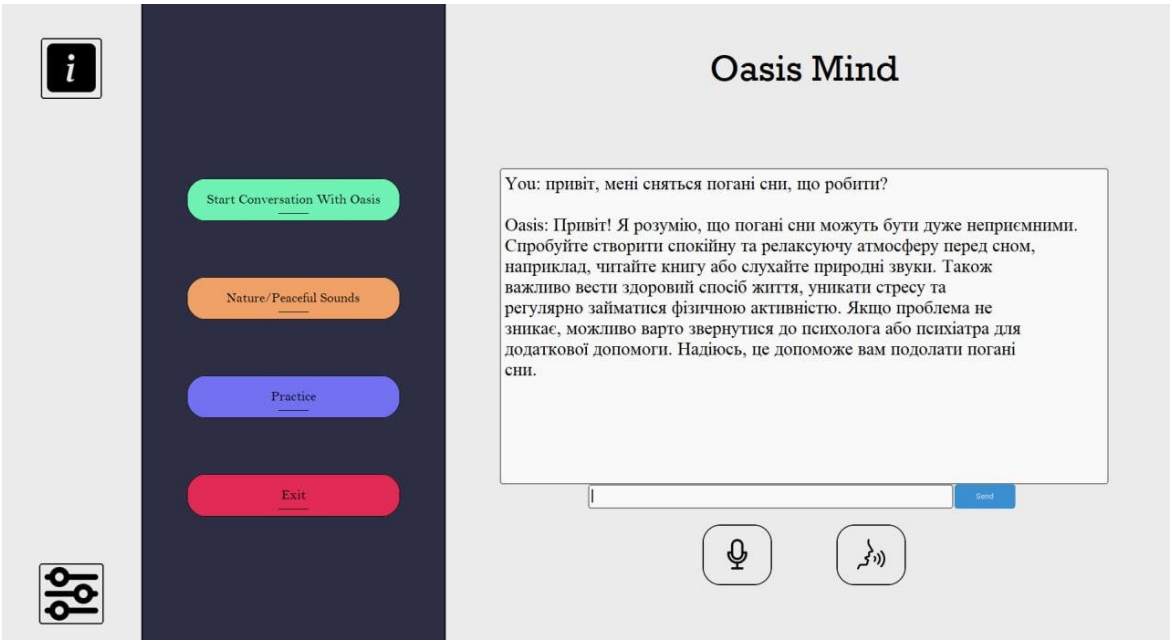

Fig. 3.6 Image of the AI chat window

The next feature is “Nature/Peaceful Sounds”. The menu offers the opportunity to find many sounds for relaxation during focused work or sleep. Additionally, these can be used during meditation sessions and other breathing practices. The sounds were implemented using the PyGame library.

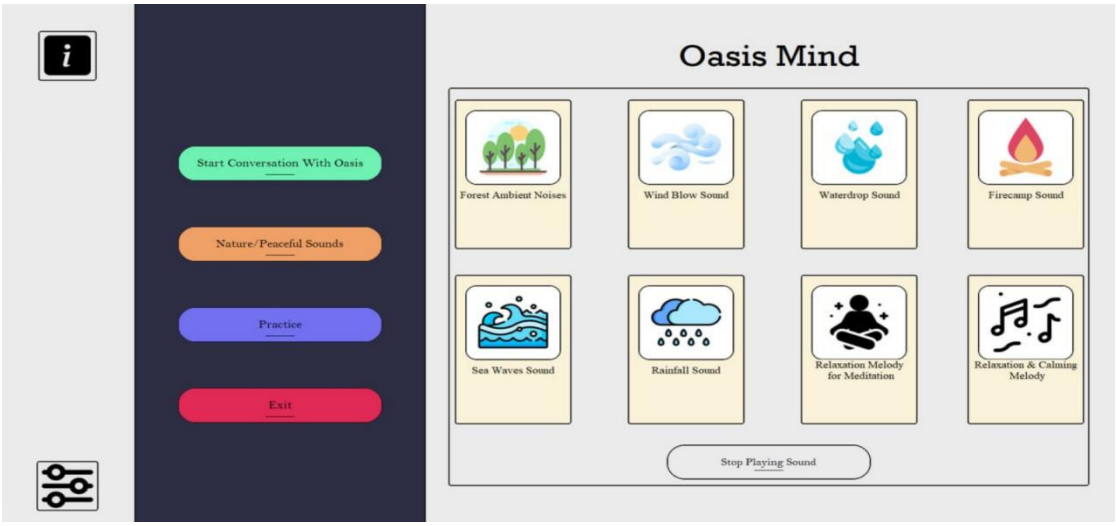

Fig. 3.7 Melodies and sounds menu

The third option is “Practice”. The “Practice” feature is integrated into the application as a means to provide users with access to instructions for meditation, breathing exercises, and other focus techniques aimed at achieving psychological balance and emotional calm. Besides providing instructions, this menu contains a systematic classification of practices, organized according to their type and purpose, allowing users to easily find the appropriate techniques according to their current needs. To enhance the effectiveness of the learning process and engage users, the introduction of interactive video players is considered, which will provide visual and auditory accompaniment to the instructions, thereby increasing the level of material absorption (Fig. 3.8).

The last main option is “Exit”. It simply exits the program, with nothing particularly special about it.

Fig. 3.8 Menu for various practices and theory for them

Additionally, there are two supplementary options - Information and Settings. The Information section contains details about the program itself. In the Settings, certain parameters can be modified, such as: the presence/absence of speech recognition in the program, the presence/absence of speech synthesis, and also the volume level within the program (Fig. 3.9). The settings menu appears as follows:

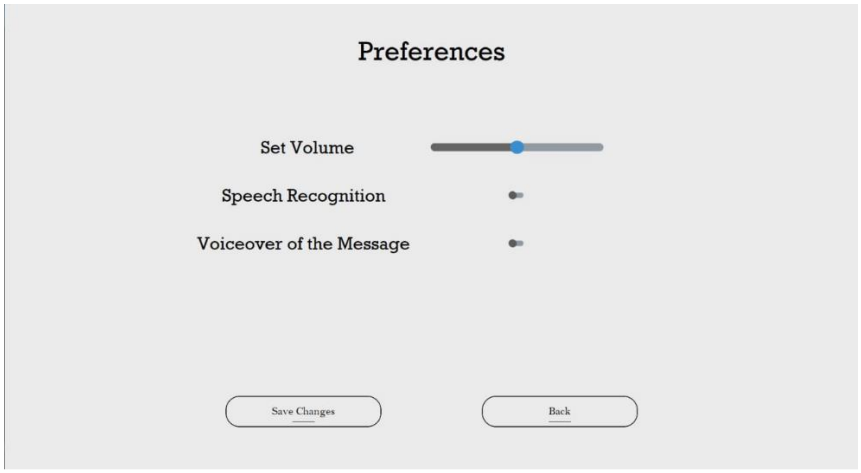

Fig. 3.9 Settings menu

Conclusions of the research. This research is dedicated to addressing the pressing issue related to mental health support using artificial intelligence. The advantages and disadvantages of existing analogs were identified, the functionality and convenience of these applications were analyzed, and a unique product was developed, incorporating distinctive features as well as artificial intelligence. The developed program is free and offers numerous advantages over others. In solving this task, the following results were obtained:

- The best existing AI was implemented and configured for psychotherapeutic tasks. Artificial intelligence uses the most effective methods to combat internal complexes and problems, such as CBT (Cognitive Behavioral Therapy) and mindfulness.
- It was found that the best solution for speech recognition is a hybrid of HMM (Hidden Markov Models) and ANN (Artificial Neural Networks), as this method softens the weakness of one algorithm with the strengths of another. This method was implemented and integrated into the project. An effective text-to-speech function was embedded in the program.
- A user-friendly interface was developed, and the application combines many practices to combat stress: meditations, breathing exercises, and melodies for relaxation/calm.

Additionally, the integration of artificial intelligence in the field of mental health support positively impacts society. This process provides accessibility to psychological help for a wide range of the population, especially for those in remote or less developed regions who do not have the financial means for a professional psychotherapist. The developed application can serve as an important tool in combating psychological disorders and contribute to improving the overall level of mental well-being in society.

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