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Development of a Personalized Music Recommendation System Using MBTI Personality Types and KNN Algorithm

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Abstract

This study aims to develop a personalized music digital therapeutic based on MBTI personality types and apply it to depression treatment. In the data collection stage, participants' MBTI personality types and music preferences were surveyed to build a database, which was then preprocessed as input data for the KNN model. The KNN model calculates the distance between personality types using Euclidean distance and recommends music suitable for the user's MBTI type based on the nearest K neighbors' data. The developed system was tested with new participants, and the system and algorithm were improved based on user feedback. In the final validation stage, the system's effectiveness in alleviating depression was evaluated. The results showed that the MBTI personality type-based music recommendation system provides a personalized music therapy experience, positively impacting emotional stability and stress reduction. This study suggests the potential of non-pharmacological treatments and demonstrates that a personalized treatment experience can offer more effective and safer methods for treating depression.

Keywords: *MBTI, Personalized Music Recommendation, KNN Model, Depression Treatment, Digital Therapeutics*

1. Introduction

Depression is a significant health problem in modern society, severely affecting individuals' daily lives and social functions. According to the World Health Organization (WHO), depression affects over 264 million people worldwide, causing a substantial economic burden on individuals and society [1]. Traditional depression treatments have primarily focused on medication and psychotherapy, often accompanied by side effects and high costs [2].

Previous studies have shown that music therapy is effective in promoting emotional stability and reducing stress, positively impacting depression relief [3]. For instance, Maratos et al. demonstrated that music therapy significantly reduces depression symptoms [3]. Additionally, Hanser and Thompson reported that listening to music helps reduce stress and anxiety and improve mood [4]. Personalized therapy using the MBTI (Myers-Briggs Type Indicator) offers tailored treatment suitable for each individual's personality type [5]. Myers and McCaulley emphasized that MBTI personality types are crucial tools for understanding personal behavior and preferences [6]. Moreover, Kim and Lee's study investigated the correlation between MBTI personality types and music preferences, suggesting the potential for personalized music recommendations based on each personality type [7]. AI-based therapeutic methods are also gaining attention, with the KNN (k-nearest

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neighbors) model proving useful for providing personalized treatments based on user personality types [8]. For example, Zhang et al. developed a personalized recommendation system using the KNN model based on user preferences, significantly improving user satisfaction with high accuracy [9]. Such studies demonstrate the effective application of the KNN model across various fields.

Digital therapeutics offer a new approach to depression treatment, minimizing side effects and providing safer treatment options [10]. Especially, personalized therapy using MBTI can maximize treatment effectiveness by tailoring treatment to each individual's personality type [11]. Therefore, developing an MBTI-based music digital therapeutic can overcome the limitations of existing treatments and offer a more effective and personalized treatment method.

2. Research Content

This study aims to develop a personalized music recommendation system using the KNN (k-nearest neighbors) model based on MBTI personality types and apply it to depression treatment. The research process consists of the following stages: data collection and preparation, KNN model development, music recommendation system implementation, prototype testing and improvement, and final validation.

In the data collection and preparation stage, MBTI personality type tests are conducted on participants to identify their personality types, and their music preferences are surveyed to build a database [6-7]. The collected MBTI personality types and music preferences data are then preprocessed for use as input data for the KNN model.

In the KNN model development stage, the preprocessed data is used to train the KNN model. Euclidean [1] distance is used to calculate the distance between personality types. The Euclidean distance is calculated using the following formula [9].

$$d(p,q) = \sqrt{\sum_{i=1}^{n}(p_i - q_i)^2} \tag{1}$$

where p and q are data points (vectors representing personality types). The trained model is then validated to evaluate its prediction accuracy, and if necessary, the model is fine-tuned to improve performance. In the music recommendation system implementation stage, a user interface is developed where users can input their MBTI personality types. An algorithm is then implemented using the KNN model to recommend the most suitable music based on the input personality type [8]. The process involves preparing the MBTI personality types and corresponding music preference data, using Euclidean [2] distance to find the K nearest neighbors to the user's MBTI type, and recommending the most frequently chosen music genre among the selected neighbors. This process is expressed using the following formula [9].

$$\hat{y} = \text{argmax}_y \sum_{i=1}^{K} I(y_i = y) \tag{2}$$

where $\hat{y}$ is the predicted music genre, and I is an indicator function that returns 1 if y_i equals y, and 0 otherwise. In the prototype testing and improvement stage, the developed system is tested with new participants, and user feedback is collected. The system and recommendation algorithm are improved based on the collected feedback [10]. In the final validation stage, the improved system is validated to evaluate its effectiveness in relieving depression [11].

Through these processes, this study aims to develop a personalized music recommendation system using the KNN model and apply it to depression treatment, presenting an effective non-pharmacological treatment method.

Figure 1 illustrates the major stages and tasks involved in the research using a class diagram. The study includes the following stages: data preparation, KNN model development, user input processing, music recommendation system implementation, and main program execution. First, the MBTI_Music_Preferences

class stores data on MBTI personality types and corresponding music preferences. This class holds information on each user's personality type and their preferred music genres, forming the basis for personalized music recommendations. The Genre_Map class contains dictionaries for converting music genres to integers. This allows the conversion of music genre data into a format that the model can understand. This step is crucial for maintaining data consistency and performing the necessary preprocessing for model training. The data preprocessing is handled by the Data_Preparation class. The prepare_data() method in this class preprocesses the collected data so that it can be used as input for the KNN model. This stage includes tasks such as data normalization and format conversion.

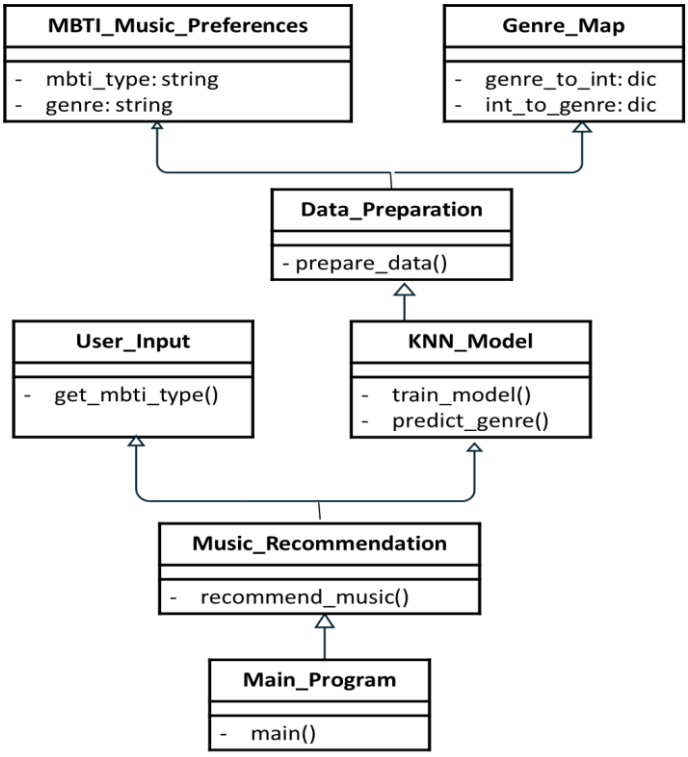

Figure 1. Class diagram for the development process

The KNN_Model class is responsible for training and predicting with the KNN model. This class uses the train_model() method to train the KNN model and the predict_genre() method to predict the most suitable music genre for a given MBTI personality type. The trained model is validated and tuned to improve prediction accuracy. User input processing is performed by the User_Input class. The get_mbti_type() method in this class receives the user's MBTI personality type and passes it to the KNN model. The personality type data entered by the user is used in the music recommendation algorithm. The Music_Recommendation class plays a key role in the music recommendation system implementation stage. The recommend_music() method in this class recommends music genres to the user based on predictions from the KNN model. In this process, the KNN model finds the data points most similar to the user's personality type and selects the most suitable music.

Finally, the Main_Program class handles the overall execution of the program. The main() method integrates and runs the entire process, where the user inputs their MBTI personality type and receives personalized music recommendations. In this stage, the program interacts with the user and provides the final recommendation results.

Through these stages, this study aims to develop a personalized music recommendation system using the KNN model and present an effective non-pharmacological treatment method for depression.

3. Implementation and Result

The development environment for this study is configured as shown in Table 1. The software environment used Python 3.10 and the MMDetection API based on Jupyter notebook. The hardware environment included Windows 10 OS, i9-9900K CPU, 128GB RAM, and NVIDIA RTX 6000 GPU. Detailed configurations are shown in Table.

Table 1. Configuration of development environment.

Division	Specifications
Operating system (OS)	Window 10
Central processing	Intel i9 9900 K
GPU	NVIDIA QUADRO RTX6000
Memory	128 GB
Storage	Samsung M.2 1TB

Figure 2 shows the sequence diagram illustrating the entire process of recommending music based on MBTI personality types using the KNN model. The KNN model predicts music preferences according to each user's MBTI type and recommends personalized music. When the user runs the program, it retrieves the default MBTI type, checks its validity, and if valid, recommends music using the KNN model based on the MBTI type.

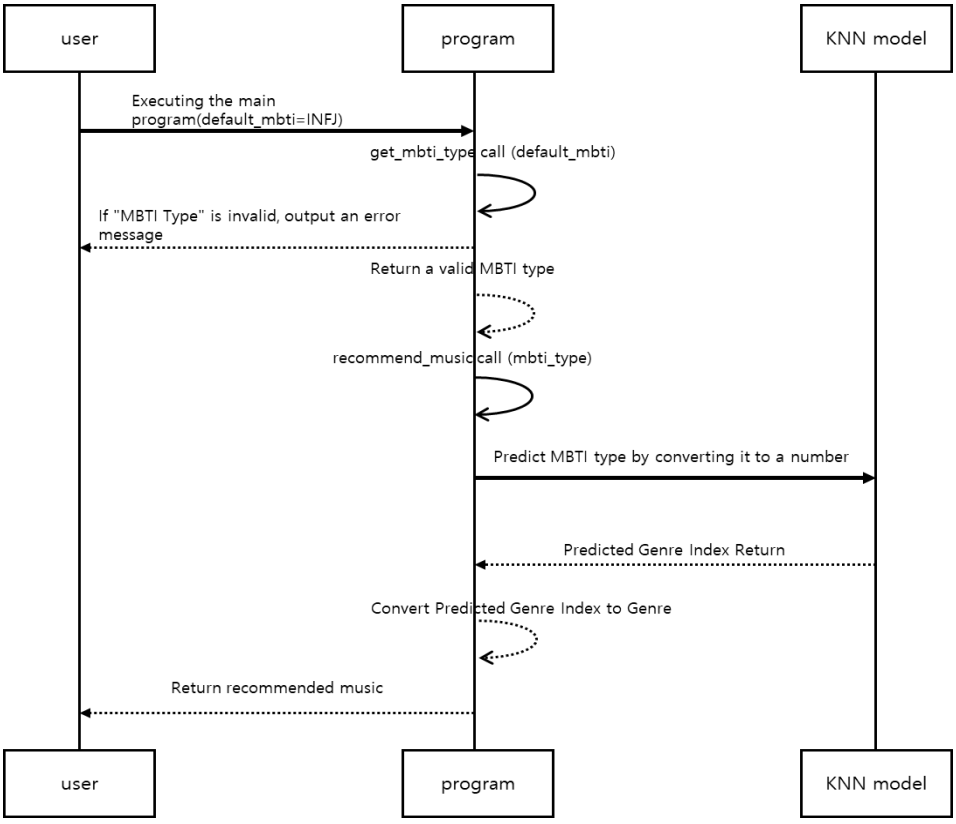

Figure 2. Music recommendation process using KNN model for MBTI

The operation process of this program consists of a series of steps where the user runs the program to receive music recommendations based on their MBTI personality type. When the user runs the main program, it starts by using the default MBTI personality type, 'INFJ'. At this stage, the program informs the user that it has started and specifies that it will proceed based on the default MBTI type. Next, the program calls the get_mbti_type function to retrieve the default MBTI personality type. This function checks the validity of the entered MBTI type. Through the validation process, the program verifies whether the entered MBTI type exists in the database. If an invalid type is entered, it outputs an error message to the user, informing them of the invalid MBTI type and halting the program. Conversely, if the entered MBTI type is valid, the program returns this MBTI type. This allows the program to proceed to the next step and perform subsequent tasks based on the valid MBTI type.

In the following step, the program calls the recommend_music function to recommend a music genre that matches the valid MBTI type. This function references a predefined database of MBTI personality types and music genres and randomly selects one of the preferred music genres that correspond to the MBTI type. This step is crucial for selecting the music most suitable for the user's MBTI type. The KNN (k-nearest neighbors) model plays an important role in the music recommendation system based on MBTI personality types. The KNN model converts each MBTI personality type into numbers and predicts music genres based on neighboring data with similar characteristics. During the prediction process, the model uses the index of each personality type to find the closest music genre and recommends the music the user is most likely to prefer. The KNN model utilizes a trained database to provide highly accurate recommendation results.

Subsequently, the program recommends the selected music genre to the user. By recommending music genres the user is likely to prefer, the program provides a personalized music therapy experience. Finally, the program returns the recommended music to the user. The user can receive and enjoy the music recommended by the program. At this stage, the program outputs the recommended music to the user or delivers it through other means to ensure easy access. Through this series of steps, the program recommends personalized music to the user, providing a customized music therapy experience. Each step is organically connected, and the program achieves its purpose by recommending the optimal music based on the MBTI personality type entered by the user.

```
# Define MBTI personality types and preferred music genres database
MBTI_Music_Preferences = { 'ISTJ': ['Classical', 'Jazz'], ... }

# Map music genres to integers
Genre_To_Int = { genre: index for index, genre in enumerate(all_genres) }
Int_To_Genre = { index: genre for genre, index in Genre_To_Int.items() }

# Prepare data
Prepare X and y from MBTI_Music_Preferences

# Train K-Nearest Neighbors model
Train KNN_Model with X and y

# Function to get MBTI type from user
Function Get_MBTI_Type(default_mbti):
    Validate MBTI type
```

```
        Return MBTI type or None

    # Function to recommend music (based on KNN)
    Function Recommend_Music(mbti_type):
        Convert MBTI type to numbers
        Predict genre index using KNN_Model
        Return recommended genre

    # Main program
    Function Main(default_mbti):
        Print welcome message
        MBTI_Type = Get_MBTI_Type(default_mbti)
        If valid:
            Return Recommend_Music(MBTI_Type)
        Else:
            Return end message
```

Figure 3. Pseudocode implementing a music recommendation process suitable for MBTI using the KNN model

The pseudocode in Figure 3 simply explains the structure and flow of actual Python code. The main steps consist of defining the MBTI personality type and preferred music genre database, data preparation, K-nearest neighbor (KNN) model training, user input processing, music recommendation function, and main program execution.

Figure 4 shows the result of implementing the program. You can check the result when you actually input the personality type “INFJ.”.

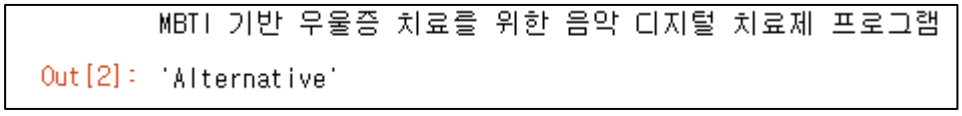

Figure 4. Result of entering personality type

4. Conclusion

In this study, we developed personalized music digital therapy content based on MBTI personality type and presented the process of applying it to the treatment of depression. As a result of the study, it was confirmed that a music recommendation system tailored to MBTI personality type can provide a personalized music therapy experience. The music recommendation algorithm using the KNN (nearest neighbor) model accurately predicted music genres suitable for each personality type, which had a positive effect on users' emotional stability and stress relief. This program analyzed MBTI personality types, developed music content suitable for each type, and then provided a treatment environment in which users could immerse themselves. In addition, through pilot testing, we reflected user feedback and improved the content, ultimately completing the optimal music therapy. This study presented the possibility of non-pharmacological treatment as a new approach to treating depression, and proved that more effective and safer depression treatment can be provided through personalized treatment experience.

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