Music Recommendation System based on Context and EEG Data

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Abstract: *An effective music recommendation can reduce the effort given by a music listener inchoosing a piece of music to be heard. Music recommendations can not only be obtained bysimilar genre or audio similarity, because the music chosen by the music listeners can bedifferent in different contexts. In this research, a case base for music recommendation systemwas developed based on the music listeners' context in order to make it easier to choosemusic that suits the current situation. The context used in this study is the personal context ofthe music listeners consisting of age, gender, emotional states, favorite activities, and musicalpreferences by genre. An emotional state often called a mood will be detected usingbrainwave sensors. Brainwaves or Electro Encephalogram (EEG) will be classified based onthe emotional state of the listeners and the Case based reasoning (CBR) method used todetermine music recommendations based on the context of the listener and EEG data. Thesystem tested to 20 participants and obtained music recommendation accuracy value of64.5%.*

Keywords: case-based reasoning, context, electro encephalogram, music recommendations

1. Introduction

Today there are several ways to recommend music. People recommend music based on genre, audio similarity, or even by searching related artists. People or system recommend music based on genre such as pop, rock, or classical to ease music listener in searching music with similar style or characteristic. Music recommendation based on audio similarity uses musical features such as tempo, key, or loudness to calculate similarity. The recommendation produced by using audio similarity might consist of various genre.

Music recommendation nowadays is not always being obtained based on genre or audio similarity, because the music listeners' choice of music depends on their personal context [1], and even their mood [2],[3],[4].Personal context can be consisting of age, favorite genre, and hobby which can easily be collected from music listeners. However, music listeners' mood while listening to a specific music is a bit difficult to obtain.

In this research, a music recommendation system based on context and electro encephalogram (EEG) data is developed, in order to recommend music that suitable to the listeners based on their personal context and mood. Personal context data used in this research are age, gender, hobby, genre preferences, and mood. Music listeners' mood is detected by an electro encephalogram sensors and then classified into four moods (stress, excitement, focus, and relaxation. Case-Based Reasoning method is used to determine the music recommendations based on similar previous cases.

Although online music providers such as Spotify and Deezer provide various playlist based on mood, context, or genre, but to this time, there are no music recommendation or playlist that uses combination of those three factors (mood, context, and genre). The uses of electro encephalogram (EEG) data and personal context data in this research is expected to give better music recommendation to the music listeners.

2. System Overview

This music recommendation system is a web based system using Spotify API to get music data. Data used to construct the case base are personal context data (age, gender, favorite genres, and hobbies), music data (artist and title), and mood data (stress, excitement, focus, and relaxation) which obtained from EEG data.

A user has to register or make an account to user the system in order to collect the personal context data. To get the recommendation, registered user only has to choose the desired mood and the playlist consist of 5 music recommendations determined by Case-Based Reasoning will be shown.

3. Research Methods

The research is done with 20 participants consist of 10 male participants and 10 female participants. This section explains how the data is collected, the case-based reasoning method, and system evaluation method.

3.1 Personal Context Data Collection

Data collection process begins with personal context data collection process which consist of age, gender, favorite music genres, and hobbies. Data collection is done online by each participant by registering on the research website and entering personal data through a registration form.

3.2 Music Data Collection

Music data is collected by participants who have signed up on the system (already filled in personal context data). There are 160 music (international music and music from Indonesia) music data consist of artist, music title, and an emotional label (excitement, focus, stress, or relaxation) that is subjectively determined by the participants. There are 40 music in each emotional label. The subjective emotional label of the participant later be used as a comparison of the

emotional results recorded by the EEG sensor.

3.3 Electro Encephalogram Data Collection

EEG data is collected by recording the average emotional value which is recorded by EEG sensors when participants were listening to music. EEG sensors in the form of headsets used by participants while listening to music, at the same time,a software from EEG sensors will record the emotional values of excitement, focus, stress, and relaxation every second. EEG data obtained in the form of numbers with 1-100range, where the greater the value of data, the higher the emotional level. The emotional data used is the highest average value of the four emotions shown.

3.4 Case-Based Reasoning

Case-Based Reasoning is an approach intended to solve a new problem by using a previously completed experiences or old cases[5]. CBR cycle is shown in Figure 1. Knowledge representation in the case base is made in the form of cases. Each case contains problems and solutions, so the case is more similar to a certain pattern[6]. In a simple way, CBR shares the experience or case in two parts, the problem part and the solution part. The problem part consists of a description of the problem in the case, while the solution section consists of solution, diagnosis, or problem solving steps for the case.
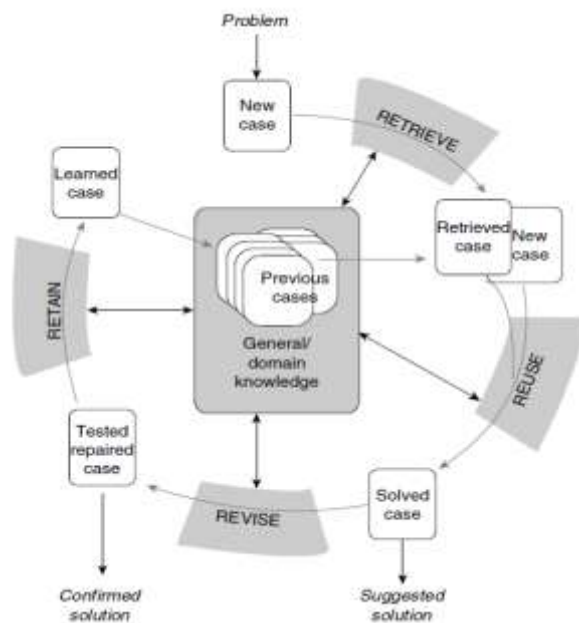

Figure 1: Case-Based Reasoning Cycle [7]

One case in the case base of Case-Based Reasoning represents any data obtained during the data collection phase. A case consists of two parts, the problem part and the solution part. Table 1 shows the representation of one case using a flat feature-value list.

Table 1: Case Representation

Case	1
Problem Features	
Gender	Female
Age	21
Hobby	Music
Genre Preferences	Pop

Emotional State	Excited
Solution	
Artist	Ed Sheeran
Title	Shape of You

3.5 System Evaluation Method

System evaluation is done to test how the system works. System evaluation is done by finding the precision of the music recommendations that the system has generated based on user judgment.

The system is evaluated by 20 participants. The first evaluation is to compare subjective moods given by user for a music with the moods from EEG recording. The second evaluation is done by listening to the existing music in the playlist of recommendations for four different emotional states. A precision value is calculated using equation (1) [7]to determine the suitability of recommendation playlist produced.

$$Precision = \frac{tp}{tp+fp} \qquad (1)$$

Where:
tp = true positive, relevant items produced by system
fp = false positife, irrelevant items produced by system

4. Research Result

The first system evaluation is done by 20 participants. After participants listened to music using EEG sensors and their emotional level was calculated, it was found that only 32 subjective labels were the same value as the subjective emotional labels obtained from EEG measurements.

Table 2: Emotional Label Comparison

		EEG Data				
	Emotion	stress	excitement	focus	relaxation	total
Subjective Label	stress	2	11	8	19	40
	excitement	7	13	5	15	40
	focus	3	18	5	14	40
	relaxation	3	19	6	12	40
	total	15	61	24	60	160

Table 2 shows the comparison between subjective label and EEG label. Based on the EEG data of 160 music, there are 15 music produce stress, 61 music produce excitement, 24 music produce focus, and 60 music produce relaxation. The emotion used for case data in the base case is emotional data based on EEG.

The second system evaluation is done by the same participants. Each participant listens to 20 music (5 music for each emotional label). Recommendation precision value based on emotional state is shown in Figure 2. The highest precision value is in the focus emotional state, with a value of 0.78, the second is relaxation with a value of 0.71, followed by excitement with a value of 0.68, and the lowest is stress with an accuracy of 0.41.
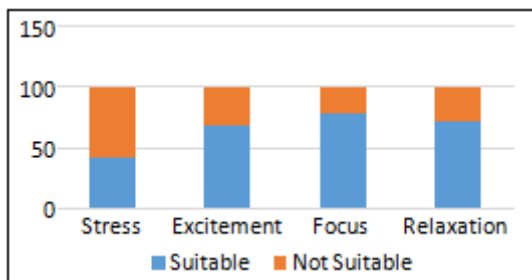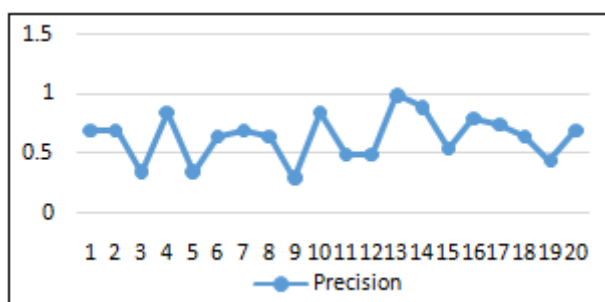
Figure 2: Precision Value Based on Emotional State

Overall, the precision value obtained is 0.645. The highest precision value for each participant is 1, in which a participant accepts and declares all the music recommendations are suitable to the desired emotion. The lowest precision value is 0.35. The precision value obtained for each participant can be seen in Figure 3.

5. Conclusion and Suggestion

The conclusion drawn from this research is a music recommendation system based on context and EEG data has been successfully implemented with a precision value of 0.65. The precision value is not high because many EEG emotional label is not suitable with subjective emotional label created by music listeners. Only 32 subjective emotional labels are the same value as the emotional labels obtained from EEG measurements. Of the 160 music data, there are 15 music produces emotional stress, 61 music excitement, 24 music focus, and 60 music relaxation.

The drawbacks in this study are the absence of expertise in the field of psychology to give the appropriate emotion labels for each music. Besides using EEG data, facial expression data can also be used to determine the emotional state of the user.

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