A *Spotify*-based system for promoting the wellbeing

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Abstract. Different mobile applications and smart systems are being developed to increase users' wellness and happiness. Unfortunately, some of the most recent technological advances in the field of affective computing, Internet of things or service computing have not yet been included in these solutions. In this paper, we briefly present a smart system that analyses the user's emotions during her/his diary activities and configures mood regulation experiences when she/he comes back at home. These emotion-aware experiences are based on the *Spotify* music services and are personalised for each particular user considering her/his musical tastes and preferences. Besides, the system integrates an emotion recognition system based on wearables and artificial intelligence techniques. The recognised emotions are then used to determine the user's mood and to make decisions on the music interventions to be carried out.

Keywords: Smart systems · mood regulation · mobile applications · music · wellbeing

1 Introduction

Positive Computing is a new technological paradigm whose aim is to promote the development of applications for increasing individuals' wellness and happiness [3]. These applications require to recognise the user's emotions in order to recommend her/him activities or media contents that produce a positive effect on her/his mood. Besides, these recommendations should also take in account the user's context and her/his tastes and preferences with the purpose of providing personalised experiences. These requirements imply to integrate the latest advances in the field of affective computing, Internet of things, ambient intelligence and cloud computing.

Many mobile applications and smart environments for improving the wellbeing have been programmed during the last years. The applications are aimed to encourage the user to make physical activities and to take care her/his mental health [2, 9]. Unfortunately, these application use self-assessment methods or human activity recognition techniques to determine how the user feels, instead of integrating emotion recognition techniques based on wearable technologies. Besides, the interventions proposed for improving the user's wellbeing mostly consist of physical activities and motivating messages. Nevertheless, some example of application that recommends multimedia contents can be exceptionally found [8, 4]. On the other hand, the smart environments are aimed to reduce the user's stress or to regulate her/his mood through experiences that take place in a limited and controlled space, for example, inside a room [5, 10]. These experiences consist of configuring the space conditions for creating a positive atmosphere, for example, through the control of the lighting system, the temperature or the ambient music. These spaces are usually sensorized to monitor the user's behavior and emotions and to execute the regulation interventions.

This paper presents a solution that combines the advantages of mobile applications and smart environments to regulate users' mood through the *Spotify* music. The user wears a wearable that integrates different physiological sensors. The wearable sends sensor data to a mobile application that processes them to deduce the emotions that the user is feeling during her/his daily activities. These emotions are then used to determine the user's mood. Then, when she/he arrives at home, the mobile application connects automatically with a smart system for playing music that regulates her/his mood in order to increase her/his wellbeing. These music interventions are based on the services provided by *Spotify* and considers the user's recent mood and her/his music tastes and preferences. The solution integrates portable wearables, emotion recognition systems based on artificial intelligence techniques, emotion-based music recommendation systems, content personalization tools, and an ecosystem of software services and hardware devices.

The rest of the paper is structured as follows. Section 2 presents the technological architecture of the proposed solution. Section 3 describes some implementation details of the systems integrated into the architecture. And, finally, conclusions and future work are discussed.

2 System architecture

Figure 1 shows the context and the technological elements involved in the solution. It consists of a mobile application and a set of *Spotify*-based services that regulate the user's mood through the music.

The application determines the user's emotions during her/his diary activities and the evolution of these emotions over time. The user wears a wearable device that monitors at real time different physiological parameters of her/his body, in this case an *Empatica E4* wristband [1]. These parameters are periodically sent to the application through a Bluetooth-based streaming connection. Then, the application filters the received data and deduces the emotion that the user is feeling at that moment. When the user arrives at home, the application analyses the diary emotions to determine how the user felt during the day and decides the music interventions to be applied to regulate her/his mood. These decisions are translated to voice commands that determine the type of music to be played.

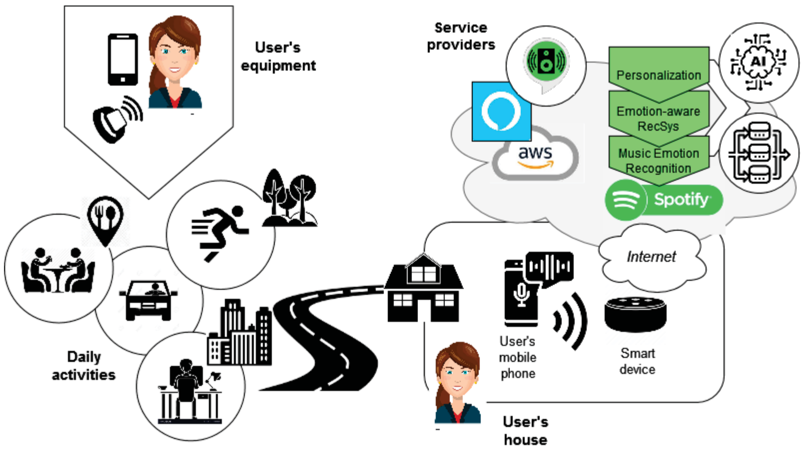

Fig. 1. Technological components involved into the solution

An *Amazon Echo* speaker is responsible for interpreting these commands and playing the most suitable songs though the *Spotify* streaming service.

The mobile application integrates three systems that provide the functionality described above: an emotion recognition system based on artificial intelligence models that deduces the user's emotions from her/his physiological data; a decision-making system based on rules that determines the mood regulation interventions, that is, the emotion to be produced in the user through the music; and, finally, a voice synthesizer that translates those interventions to commands understandable by the speaker, for example, *"Alexa, plays relaxed songs"*.

On the other hand, at the right-hand side of Figure 1 are represented the services programmed for supporting the mood regulation. A new *Alexa skill* has been programmed and installed into the speaker to provide the regulation functionality. When the skill receives a voice command, it interacts with a music recommendation system based on emotions to determine the songs to be played. The recommender selects a set of candidate songs from the *Spotify* music catalogue taking in account the emotion to be produced in the user in order to regulate her/his mood. Then, a personalization system filters and ranks these candidate songs considering the user's music preferences and tastes. Finally, the skill plays the ranked songs until a new regulation command is received.

3 Details on the system implementation

The mobile application integrates an emotion recognition system that is currently based on the analysis of an only physiological parameter, specifically, the electrodermal activity of the user's skin (EDA). Four machine learning models have been combined to determine the user's emotions from the EDA signal sent at real time from her/his wristband. We concluded as part of the research that the application of the same machine learning algorithm to recognise the different emotions was not the best option. Therefore, a multi-model approach based on different algorithms has been applied to improve the accuracy of the recognition. These emotions are represented according to the reference model of affect proposed by Russell [7]. The different emotions felt throughout the day are then processed by an mood-recognition algorithm to create the user's mood map. This map represents the evolution of the mood over a period of time.

The user's mood map is the input of the decision making system included into the application. It integrates a rule engine that determines the type of music to play for regulating the user's mood. Different sets of rules are evaluated according the user profile. These rules have been defined though different experiments with real users (42 rules and more than 200 participants). The result of the rule-based evaluation is the emotion to be produced in the user. This emotion is then translated to a voice command that is played by the synthesizer when she/he arrives at home. A catalog of emotion-aware commands has also been defined to be interpreted by the *Amazon Echo* speaker.

The speaker's functionality requires to know the emotional response that the songs available in *Spotify* produce in the listeners. As part of the work, we have studied the relationship between these responses and the songs' audio features. An emotion recognition system based on audio features was developed to annotate *Spotify* songs from an emotional perspective. This system integrates a set of machine learning models that determine the produced emotion for each particular song and create the corresponding emotional labels. After processing all the *Spotify* catalog of songs, we obtained a database of emotionally labelled songs which is used by the music recommendation system to suggest candidate songs in response to voice commands. A detailed description of the recognition system and the recommender can be found in [6].

Finally, the personalization system customises the music experiences and, therefore, it plays a relevant role in the mood regulation process. The system automatically creates a user model that describes the user's musical preferences and tastes. This model is calculated from her/his *Spotify* listening histories and the playlists that she/he has created in the streaming provider. These data are published by *Spotify* through its service platform for developers (we are specially interested in the songs' metadata and audio features and the registered users' playlists and listening histories). Once the model has been calculated, the system applies collaborative filtering techniques to rank the candidate songs suggested by the recommender and to select the most suitable ones to regulate the user's mood.

4 Conclusions and future work

In this paper we have presented a technological architecture to promote music experiences that improve users' wellbeing. A first version of the architecture has been implemented in which the affective dimension is the cornerstone of the solution. Different emotion-aware systems have been integrated to recognise the user's emotions, to deduce her/his mood, to determine the affective response associated to songs and to recommend songs that regulate the listener's mood. These systems are integrated with the services offered by *Spotify* providing a final solution based on its music streaming service.

As future work, we are interested in organising long-term experiments with real users to evaluated the impact of the proposal in the users' wellbeing. These experiments should be focused on certain population segments of interest. Besides, we would also like to enhance the emotion recognition models including new physiological parameters and the regulation rules and the personalization models from the feedback of the experiments.

References

1. Empatica e4 description. https://www.empatica.com/en-eu/research/e4/ (2021), accessed: 2019-11-30
2. Afzal, M., Ali, S.I., Ali, R., Hussain, M., Ali, T., Khan, W.A., Amin, M.B., Kang, B.H., Lee, S.: Personalization of wellness recommendations using contextual interpretation. Expert Systems with Applications **96**, 506–521 (2018). https://doi.org/https://doi.org/10.1016/j.eswa.2017.11.006
3. Calvo, R.A., Peters, D.: Positive computing: technology for well-being and Human Potential. The MIT Press (2014)
4. Chambel, T., Carvalho, P.: Memorable and emotional media moments: Reminding yourself of the good things! In: Chessa, M., Paljic, A., Braz, J. (eds.) Proceedings of the 15th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications, VISIGRAPP 2020, Volume 2: HUCAPP, Valletta, Malta, February 27-29, 2020. pp. 86–98. SCITEPRESS (2020). https://doi.org/10.5220/0009178300860098
5. Duvall, S., Spurlock, S., Duvall, R.: Automatic environment adjustment for emotional disabilities. In: Proceedings of the 19th International ACM SIGACCESS Conference on Computers and Accessibility (ASSETS'17). pp. 363–364 (10 2017). https://doi.org/10.1145/3132525.3134816
6. de Quirós, J.G., Baldassarri, S., Beltrán, J.R., Guiu, A., Álvarez, P.: An automatic emotion recognition system for annotating spotify's songs. In: Panetto, H., Debruyne, C., Hepp, M., Lewis, D., Ardagna, C.A., Meersman, R. (eds.) On the Move to Meaningful Internet Systems: OTM 2019 Conferences. pp. 345–362. Springer, Cham (2019)
7. Russell, J.: A circumplex model of affect. Journal of personality and social psychology **39**(6), 1161–1178 (1980)
8. Timoney, J., O'Leary, S., Czesak, D., Lazzarini, V., Conway, E., Ward, T.E., Villing, R.: The beathealth project: Application to a ubiquitous computing and music framework. Journal of Cases on Information Technology **17**(4), 29–52 (2015)
9. Tolks, D., Sailer, M., Dadaczynski, K., Lampert, C., Huberty, J., Paulus, P., Horstmann, D.: Onya: The wellbeing game: How to use gamification to promote wellbeing **10**(2) (2019). https://doi.org/10.3390/info10020058
10. Yu, B., Hu, J., Funk, M., Feijs, L.: Delight: biofeedback through ambient light for stress intervention and relaxation assistance. Personal and Ubiquitous Computing **22**, 787–805 (08 2018). https://doi.org/10.1007/s00779-018-1141-6