MeDJ: Multidimensional Emotion-aware Music Delivery for Adolescent

Xiping Hu[1,2], Kun Bai[3], Jun Cheng[1,2], Jun-qi Deng[4], Yanxiang Guo[1,2], Bin Hu[5], Arun Sai Krishnan[6], Fei Wang[7]

[1] Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China | [2] The Chinese University of Hong Kong, Hong Kong | [3] MIG Tencent Company, China | [4] The University of Hong Kong, Hong Kong | [5] Lanzhou University, China | [6] Carnegie Mellon University, USA | [7] Cornell University, USA

xp.hu@siat.ac.cn

ABSTRACT

Music listening is an integral part of many adolescents' everyday lives, but it is also a time when adolescents are uniquely vulnerable. Emotional-oriented and avoidance through listening to unsuitable music may bring negative emotion to adolescents and increase the level of their depression. We propose MeDJ, a multidimensional emotion-aware music delivery application, which turns adolescents' music listening into a health and pleasure way. MeDJ aims at helping adolescents to improve emotional management and prevent depression. It is built on a cloud-based platform that enables adolescents and their peers collaboratively recommend suitable music to each other through smartphones. Prototype implementation and initial results of MeDJ have demonstrated its practicability for real-world deployment.

Keywords

Cloud, emotion-aware, mobile health application

1. INTRODUCTION

According to the statistics published by the World Health Organization (WHO), depression is becoming the number 1 cause of illness and disability for adolescents [1]. Previous research has demonstrated that music influences important aspects of adolescent development, and not only does listening to suitable music not deepen negative emotion, but it can serve as an important adjunct component in prevention of adolescents' depression [2]. Thus, we propose MeDJ, a novel multidimensional emotion-aware music delivery application for adolescent, to help them improve emotional management and prevent depression during music listening. MeDJ orchestrates multidimensional sources of sensing data from adolescents' smartphones with social contexts to design novel emotional identification mechanisms, and further integrates intelligent matching to form a seamless crowdsensing solution. This solution enables smartphones to collaboratively recommend suitable music to adolescents in real-time according to their emotional states. Currently, a variety of mobile music recommendation solutions have been proposed [3]. Most of them recommend music to users only based on their listening behavior and history, and/or locations and daily activities. However, a smartphone-based music platform specifically designed for adolescents' mental health is not yet available. Different from them, MeDJ recommends music not only based on adolescents' listening behaviors, but also their real-time emotional status and internal attributes of music content.

WWW 2017 Companion, April 3-7, 2017, Perth, Australia.
ACM 978-1-4503-4914-7/17/04.
http://dx.doi.org/10.1145/3041021.3054259

2. SYSTEM ARCHITECTURE DESIGN

The system architecture of MeDJ consists of two tiers: mobile device tier and cloud tier.

Mobile device tier: Based on the mobile SOA platform [4] developed in our former work, the MeDJ application could be deployed on different mobile devices. Furthermore, in order to interpret the emotion-related sensing data from multiple source in real-time, e.g., from microphone, camera, 3D accelerometer, and gravity sensors of smartphones, two services are contemplated:

Behavioral Pattern Analysis Service: We analyze human behavior by smartphones equipped with 3D accelerometers. After obtaining the raw acceleration signal peaks, a fixed-length window was used to cut out part of the acceleration signal centered on a peak. The acceleration was next divided into its horizontal and vertical components to produce a novel two-directional feature, with its vertical and horizontal components accounting for its two rows. A tensor-based feature selection method termed tensor manifold discriminant projections is used to conducting feature selection. Finally a SVM classifier is trained to recognize behavior.

Facial & Tone Recognition Service: A learning based approach is designed to recognize the tone. After extracting Mel frequency cepstral coefficients from waveform, a modest AdaBoost classifier is trained. Also, we extract local binary patterns from facial image. Then we adopt a subspace selection scheme to reduce feature dimension and a SVM classifier to determine emotion.

Cloud tier: The cloud tier works in parallel with the mobile device tier. The cloud tier could be built based on the Vita cloud platform [5] introduced in our previous work. The cloud tier works as a central coordinating platform to: i) aggregate the emotion-related sensing data of adolescents, and Internet services (e.g., healthcare dataset, social activities) from multiple sources; ii) analyze and store the multidimensional attributes of music; iii) big data analytics to interpret the data from different sources, perform matching and deliver suitable music to adolescents according to their emotions dynamically.

3. MEDJ MOBILE APPLICATION

Based on the cloud-based system architecture, we develop and deploy a prototype of MeDJ. Figure 1 shows the overall workflow

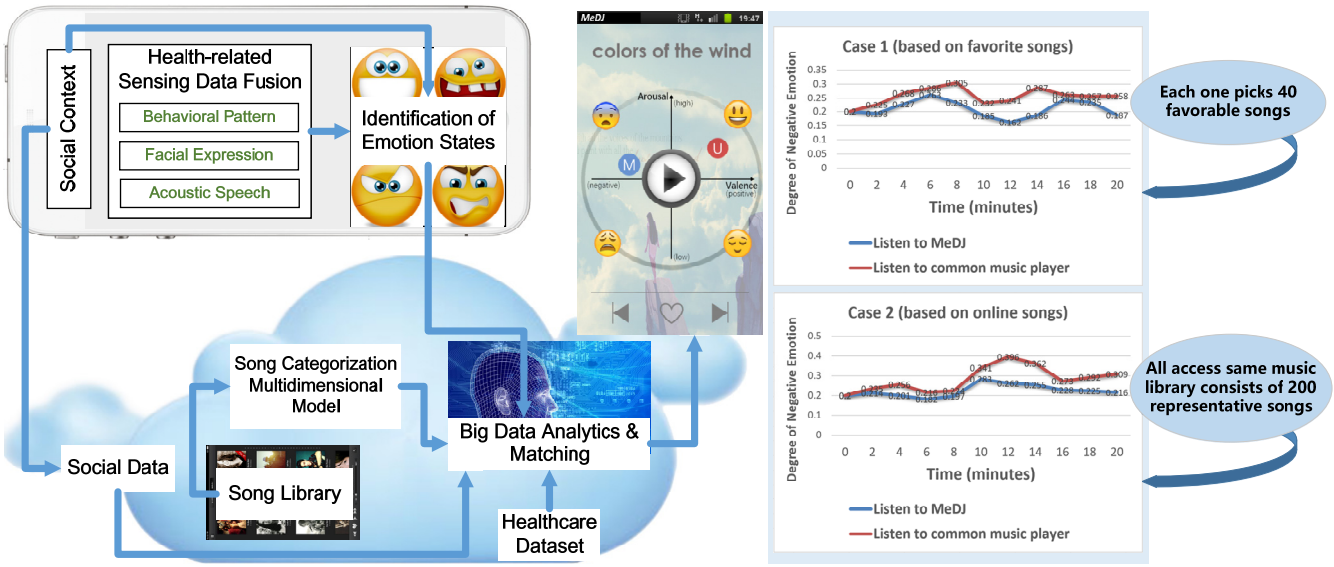

Figure 1. MeDJ mobile application and initial experiments

of MeDJ, and it consists of two major steps. In the first step, MeDJ will collect, contextualize and interpret emotion-related sensing data, as well as analyze the internal attributes of music as mentioned above.

Then, the *Big Data Analytics & Matching* model in the cloud will perform music matching to individual adolescents. This is basically a collaborative filtering problem where we can recommend proper music to proper adolescents at proper time. In order to implement this, we can construct a user-music-time tensor, where the (i,j,k)-th entry indicates the appropriateness of the i-th user listening to the j-th music at the t-th time. Then we can treat the recommendation problem as a relational regression problem. We deployed partial *Polyadic Regression* [6] with temporal smoothness regularizations to achieve this goal. Comparing with conventional matrix/tensor factorization based approaches, our approach can naturally induct the prediction to new users and music. The prediction can also be performed efficiently because our model intrinsically is a multi-linear model.

To evaluate effectiveness of MeDJ, we conducted an initial experiment, in which 20 volunteered adolescents are involved. Each volunteer finished two kinds of tests: (a) Listening music recommended by MeDJ; or (b) Listening music recommended by smartphone's common music player, which plays the songs in random order. We use the Mood-fatigue Detector implemented in our former work [7] to record the negative emotion degree (from 0 to 1) of every volunteer in the tests, and the average result of the 20 volunteers are calculated. The results are summarized in the right side of Figure 1. We can observe that the average negative emotion degree of the adolescents is 17.97% and 20.65% lower when they listening music recommended by MeDJ compared to common music player in these two cases, respectively.

4. CONCLUSIONS

In this paper, we have proposed MeDJ, a novel multidimensional emotion-aware music recommendation application for promoting adolescents' emotional management and preventing depression. It is designed based on a cloud-based system architecture, which supports the deployment of multidimensional sensing models to identify each adolescent's emotion states in multiple aspects. Also, MeDJ integrated crowdsensing-based intelligent music matching, which enables individual adolescents collaboratively recommend suitable health music among their peers together. We have implemented a prototype version of MeDJ and performed initial experiments to verify its practicability in adolescents' daily life. In the future, we shall conduct comprehensive experiments to evaluate MeDJ, so as to explore the qualitative and quantitative relations between depression level, health data, social context, and music preferences.

5. ACKNOWLEDGMENTS

This work is supported in part by the Guangdong Technology Project (2016B010108010, 2016B010125003), and Shenzhen Technology Project (JSGG20160331185256983).

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