

A Comprehensive Survey of Personalized Music Identifier System



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Abstract: Music occupies a very important space in the heart and life of common people and it is rather subjective and universal nature indeed. Music Identifier System is obviously concerned with providing a very meaningful and personalized recommendation of items i.e. songs, music, playlist according to the mood, emotion, interest and preference of the users or listeners. With the advancement of technologies, rapid development of internet, it has become very common to use the streaming services to listen and enjoy music or songs in more convenient ways. In this paper, an attempt has been made to perform a comparative analysis, systematic research, empirical thorough review on various approaches or strategies proposed and applied by different researchers in the task of designing an effective system for music identification or recommendation. The basic theme of the paper includes music identifier system, its components, and different features along with emphasize on the methods, metrics, general framework and state-of-art strategies proposed during the last two decades or so, have been empirically reviewed. The existing studies were found lacking with systematic research work on the behaviour, requirements and preferences of the users plus poor level of extraction of features and limitations in the area of evaluation of performance of the music identifier systems. Although, the study reveals that systems based on effective, social information, emotional-traits, content, context and knowledge have been widely applied and improved the quality of identification or recommendation of music to a large extend but still it is not enough. In future, more in-depth studies or research work need to be conducted based on enlarging the scope of further development of personalized contextual awareness based music identifier system and generating a continuous and automatic top playlist of music and songs with added tracks matching with profile, mood, emotional traits, and behaviour of the user in a mobile environment.

Keywords : About four key words or phrases in alphabetical order, separated by commas.

I. INTRODUCTION

Music Identifier System (MIS) has its own growing importance in helping the users to find or recommend

interesting items without any problem of overloading of information. This system basically comprises of key factors or components like users, items and user-item matching algorithms. From ancient times, Music has always been taken as an important factor for expressing the mood and emotions of an individual and also helps in changing the mood too. Displaying appropriate songs matching the mood of an individual can play a great role in altering mood, making the mind calm and have an overall pleasing effect on the mind of users. In fact today, two very popular forms of entertainment in our daily life are: listening to singing music online. As such, lot of companies are providing the service of music on demand as well as online singing of music. They are engaged to provide the users personalized music or songs according to the interests of the users. So, for the music service providers, this system (MIS) has really become essential one. Moreover, keeping pace with rapid development of mobile networks and digital multimedia technologies, digital music has become popular and so to say the main stream of content and choice of consumers-especially the young people or young generation. During last few decades with the explosion and expansion of network system, Internet has actually become a major source for retrieving information from multimedia like videos, books and music etc. Music has been considered as an important aspect of public life and listening music has taken the place of a very crucial and frequent activity of common people. Practically, the system of recommendation of music has become an important topic and area of search. In recent years, the technology of music recommendation has attracted very close attention of both foreign and domestic scholars and so series of research work in this field. In fact, consideration of music recommendation as a research objects and personalized music recommendation system as a special field of research has obtained great research value and huge practical significance. Music being a powerful communication and self-expression area, attracted as well appealed the researchers. The present time or days can be termed as an era of information and the system of music recommendation may be taken as a system that is performing filtering of various information as per the liking, choice and interest of the users in the form of movies, music, books, news, web-pages, images etc. The basic aim is to remove the unwanted and redundant information and provide more information about items and help the users to get maximum or desired satisfaction or content.

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II. CATEGORIES OF MUSIC IDENTIFIER SYSTEM

The system MIS has been studied widely over last few years and it is observed that the entire system can be divided into certain categories.

On the basis of use of those approaches, the MIS can function or operate. The basic categories are Collaborative Filtering based system, Content based system, Context based system and Knowledge based system.

A. Collaborative Filtering based system:

This is a technique which is mainly based on the historical data and numerical reviews given by the historical data and numerical review given by the users connected with the system (Su and Khoshgoftaar, 2009; Zhang et al., 2015). This method is applied for prediction of unknown preferences of the people by virtue of using the already available preferences of some or many of the users (Resnick and Varian, 1997). The quantum of available historical data helps in framing the user profile and the available data on items is used for making the item profile. On the basis of two factors like users and items computation is performed. In fact, use of both user profile and item profile are the basis of operation of the system. Collaborative filtering approach has gained importance and become commonly popular in the Netflix completion case (Bennett and Lanning, 2007). This approach has been considered as the most basic as well as easiest method for finding out recommendations and making predictions about sales of a product. The advantages of Collaborative filtering based system have played a vital role in case of developing some new methods or techniques. The main challenges faced in case of collaborative filtering are data sparsity, data scalability and problem of cold start. Basically, three main algorithms i.e. memory based algorithm, model based algorithm, and hybrid collaborative filtering are applied for combining collaborative filtering with other recommendation techniques as well as their strength or ability to deal with the challenges faced (Zhang et al., 2015).

B. Content based system:

This technique takes into account individual user profile, focuses on the basic features of the products and also aims at framing a user profile based on earlier reviews. It also aims at creating item profile on the basis of features provided and reviews received (Titov and McDonald, 2008). It is found that the reviews mainly contain along with opinion of the users in pairs (Lops *et al.*, 2011; Ding *et al.*, 2008). Generally, the users' review contains features of the product along with the views or opinion of the users about the products. It has been stated by Balabonovice and Shoham in 1997 that the basis if this method is the content of users' profile for providing a recommendation works without any evaluation of the users. Further, Basu *et al.*, 1998 pointed out that for collecting information on the interest and choice of the users which relates to the content of the profile of users, machine learning methods are applied. In this system, characterization methods are used and the objects or items are mainly defined by the features and related attributes. According to Buroke, 2007, the content based approach commonly applies Machine learning, Neural Network, Decision Tree methods and by use

of text only, the interest and choice of the users are predicted usually. This system is able to provide recommendation for new items and it can provide recommendation in the very initial stage of system with more ease and without any problem of data sparsity. The limitations of the system are that it cannot function properly unless users' choice and tastes are expressed in characteristics form (Balabonovice and Shoham, 1997). This technique is not considered very suitable for analyzing the media contents like music, video, etc. by use of Machine learning methods and in regard to information on relevant attributes.

C. Context-based System

The contextual information about the users is also considered in the process of designing a recommendation system. Context is defined as an information that may be used for characterizing the situation of any entity such as person, place, time and object which may be taken as valuable and relevant for interaction between user and application. It is considered as an important factor for providing services like music recommendation to the users. Context actually helps in defining the status of the users as it refers to the location, time, environment and area about the users. Contextual information are incorporated in a Music recommendation or identifier system in order to get a clear picture of situation of an individual, place, time and object which is considered very relevant to the system for prediction purpose (Lee and Lee, 2007; Asher Levi *et al.*, 2012). For the purpose of extracting information about any particular person or any community, such inputs have very vital role and importance in case of providing appropriate suggestions to any user thus making the system more efficient too. In fact, various data or information concerning users, location, social status, time, weather are considered as contextual data and used as inputs for the system. Usually, Bayesian Network (BN) is applied to deal with context inference. But, the BN method has the limitation of being not much effective to deal with diverse information and so far overcoming this problem and reflect the context more appropriately; the fuzzy method is also utilized or used.

D. Knowledge based System

In some cases as an inference technology, knowledge-based recommendation is used which is not actually based only on demands of users but also on the preferences of the users. This approach basically uses different types of knowledge acquired from different functions as well as features of the objects for recommendation and prediction (Resnick and Veriom, 1997). Moreover, knowledge about the effectiveness of any function i.e. how much a particular user is satisfied from an item or project is very helpful for the users in case of generating any data that may be supportive for inference of a knowledge structure. Relationship between demands and recommendations can be explained very well by functional knowledge (Burke *et al.*, 1996).

Knowledge based recommendation approach is taken as a model which is able to add more number of functions into the system and having good and desirable compatibility with different other elements of recommendation.

In addition to the above stated approaches, the music identifier or recommendation system has some other important components that play a crucial role for successful performance of this system.

A summarized presentation of those components has been given below: Apart from the hybrid, main and popular MIS approaches,

few other basic meta-data based models have been also applied and proved to be effective for Music recommendation or identifier system.

a) User-Profile Model:

User- profile is generally categorized in three important domains like (i) demographic profile that is related to age, marital status and gender etc. (ii) Geographic profile which is connected with location, city, country etc. (iii) Psychographic profile which relates to interest, lifestyle, personality, mood, attitude, opinions etc. The basic and varied requirements of the users require to be met for a successful MRS. The differences in the user profile concerning region, age and gender of the user, taste or interest in music and mood etc determine the choices of music or preference in music. The choices and preferences differ owing to difference in such factors. User profile is therefore is a key element for modelling and highlighting the differences among users. For designing such a model, lots of studies, efforts are to be made. The process for obtaining user related information is also a laborious and expensive proposition or task (Turnbull *et al.*, 2008; Fiske *et al.*, 1998).

b) Item-Profile Model:

Another important component in music recommendation system is music item which relates to collection of various data/metadata that can be classified in the categories of editorial data, cultural data and acoustic data. Editorial metadata is obtained exclusively by the editors and it relates to information provided on cover name, composer, title etc. Cultural metadata is generally collected from analysis of textual information obtained usually from internet and other public sources. Such information shows emerging patterns, categories and also similarity between music items. Acoustic metadata is desired from analysis of audio signals and it may not have type of information e.g. beat, pitch of the Music recommendation or identifier systems are generally applying acoustic data for discovering music based on content.

c) Query Approach:

As only editorial information like title, name of singer, lyrics etc cannot always serve the purpose of knowing music, an advanced and more flexible music information system that has been popular in recent years is known as "Query by humming/singing system (QBHS) which requires lot of human efforts. It is considered very important and appropriate to apply query mechanism to detect music preferences and listening patterns of the users. It permits the users to select or find out the songs either by singing or humming (Ghias *et al.*, 1995; Shing *et al.*, 2008). Further, music is considered as

subjective, universal and also a self-expression tool which largely conveys the liking, emotion and affection parts of the listeners.

d) Emotion based Model:

It has become important having valuable contents and expressivity (Yi-Hsuan, 2011). In-fact, emotion in music has appealed huge researchers to study and work for discovery and recommendation of music. It has actually become a main trend as conventional approaches are not found sufficient enough. Practically, people do express their emotions and detection of those emotions through facial expressions is rather important as music or so to say preference or choice of songs etc largely depend on the mood, feelings of individuals. Capturing and recognizing the emotional traits of people and display of matching or appropriate songs according to mood of individuals in very vital for making the mind of users calm, cool and overall have a pleasant cum soothing impact. Finally, it becomes pertinent and a valuable task to study the literature for evaluating the outcome of various research works on this particular field of music identifier or recommendation systems.

III. LITERATURE REVIEW

Actually, a thorough study or review of literature on the concerned field for a period of about last two decades reveal that being an interesting field of research, many researchers have proposed very many models or approaches for a successful music recommendation system. A detailed summary of these approaches used for music identifier system have been represented in Table 1.

Way back in the year 2000, Kanade *et al.* proposed a comprehensive database approach for analysing how facial expression can express emotions of individual entity.

Herlocker *et al.* in 2004 proposed that music recommendation system need to compared and evaluated not only on the commonly used basis of seeking user feedback but also by use of multi-fold testing on the dataset available. They also advocated that not only the parameter of accuracy and coverage of the recommendation system but also the level of usefulness, effectiveness, and user's confidence in the system preference ratings of the active users should be taken into consideration. Hadid *et al.* in 2007 emphasized on learning of personal facial dynamics for recognition of face and facial expression from videos. Zeng *et al.* in 2008 proposed detailed study on audio, visual recordings of displays and computing methods for reviewing spontaneous expressions such as happiness, sadness, fear, anger, surprise etc and various type of advances in human affect recognition. Lucey *et al.* in 2010, worked on extended and complete dataset as a unit of action basically for emotion specified expressions of humans. Luoh *et al.* in year 2010, studied on processing of images in case of recognition of users' emotions. Kim *et al.* in 2010 focused on a hybrid approach based genetic algorithm and music data for an effective MR system.

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The basic aims of this method being very effectively adapt and then respond to the changes in choices or preferences of the users. Londle *et al.* in 2012 proposed analysis of facial expressions based on changes in the curvatures of individuals' face and classification of emotion by using statistical methods like Artificial Neural Network (ANN). Habibzad *et al.* in 2012 proposed use of a new algorithm in order to recognize emotions through facial expressions in different stages of image processing like pre-processing, feature extraction and classification stages.

In-fact, new algorithm and particle swarm optimization methods were used for classification of face emotions through eye and lip features of persons. It was found from the results obtained that extraction of facial features was more effective than other approaches.

Joshi and Kaur in 2013, proposed study of emotions of individuals through speech recognition methods. Xiao *et al.* in 2013 proposed a method based on large scale similarity in music preferences or retrieval in choice of similar type of music by the users or listeners through GPU acceleration.

Durecha in 2014 proposed use of an accurate algorithm for extraction of relevant information from audio signal in lesser computational time and expenses by way of generating a playlist of music according to the emotions of the users. Rani and Garg in 2014 did an advanced research on detection of emotions through facial expression of individuals. Makarand and Sahasrabuddhe in 2014 made a novel approach in searching music by use of contents of music and human perceptions. They made use of electronic systems, signal processing and computation technologies in their proposed research work.

Vaid *et al.* in 2015, proposed application of medical science in the form of Electroencephalography (ECG) that can record the electrical activity from the neurons of human brain cells. On the basis of approximation of the activity recorded, the emotions of persons can be analysed and estimated. This method was not considered much effective, economic and portable. Razuri *et al.* in 2015 focused on speech recognition fools for emotion recognition that may serve the purpose of emotional feedback in case of human-robot interaction. Tambe *et al.* in 2015 proposed automated interactions between users and music players that can read the activities, emotions and preferences of the users and thus result selection of songs accordingly. Kabani *et al.* 2015 proposed connecting music players with the human emotions or users emotions by use of image processing that may be make play a list of songs based on users' emotions. It may very well reduce the efforts of the users for creating and managing a list of songs to be played. Lee *et al.* in 2015 proposed a MR system based on usage users of history and classification of genre in an automatic pattern. They used distance machine learning algorithm and collaborative filtrating method for finding out the most common attributes.

Patel *et al.* in 2016 advocated use of a music player based on mood of the users for an effective music identifier or recommendation system.

Uma and Sheela in 2017-2018 proposed a new method for analysing Brain Computer Interface (BCI) based on personalized GUI exclusively for the differently abled users. Liu *et al.* in 2018 proposed designing a video feedback system

(SSVEP-BCI) for car control and that may be based on an improved type of music system.

Chang *et al.* in the year 2018 proposed personalized music recommendation system based on application of neural network method. Liu *et al.* in 2018 focused on personalized music recommendation systems on the basis of tag information solely.

IV. CHALLENGES FACED

It is an accepted fact that the researchers generally face lots of challenges working in the field of music recommendation systems. For overcoming various problems currently faced by the researchers' lot of studies have been made so far and several approaches have been made advocating application of different measures.

Review of some valuable studies showed that a number approaches and methods have been used and highlighted as suitable, effective means to overcome the challenges or problems commonly faced by the researchers in the field of music identifier systems.

The basic challenge or problem faced relates to cold start problem i.e. when a new user and (or) a new item is added in the system, generally we don't have sufficient data or information about those users/items. In that case, system cannot properly recommend the existing items to new users or the new items to the existing users.

Schein *et al.* in 2002 proposed some methods and use of metrics towards solving this problem. In order to overcome this cold start problem in the domain of music recommendation, several approaches like content-based, hybridization, cross-domain recommendations and active learning have been proposed. These approaches were not found full proof and had limited effectiveness in solving this problem. Slaney and white in 2006, in their study emphasized on sequence prediction as an important factor for ultimate satisfaction of the users. Lee in 2011 conducted a study on qualitative user and creating automatic playlist based on the content-based similarity. Mc Fee and Lanckriet in 2012 proposed a hypergraph model that suggested that in case of playlist continuity, transition effects play a vital role. Bonnin and Jannach in 2015 provided a comprehensive study and survey in this field. Aggarwal in 2016, made efforts to propose various approaches for overcoming the basic challenge. Another major problem relates to the challenge of automatic playlist continuation that basically refers to generating an automatic play list of songs or generating a system of ordering of songs in a playlist in an automated manner by way of adding one or more tracks in the playlist of song in such a manner that actual targets and features of the original playlist remain unchanged. This may benefit the listeners for enjoying continuous listening by extending the length of playlist of songs. Schedl *et al.* in 2017 have highlighted new techniques and new paths in music recommendation system. Studies on this field have recently gained momentum or importance due to growing demand or request of the user's automatic continuation of play list of music/songs.



Vall *et al.*, 2017 emphasized on importance of song context in the playlist of music and was of the opinion that while creating a long playlist with tracks, song order has an importance. Supported by the results of various studies it may be summarized that the matter of creation of a great play list is highly subjective and depends on factors like intention of creators or listeners, coherence or similarity of track, variety, diversity and personal preference of the users and familiarity with the tracks etc. Finally, proper and holistic evaluation of the music recommending systems poses a definite challenge.

The crux of this problem lies in analysing the effectiveness of measures adopted for music recommendation system in terms of factor like accuracy. Actually, apart from accuracy criterion there are some other factors like prediction quality, diversity, novelty and ranking of items that are important and required to be taken into consideration for proper evaluation of performance of measures applied for music recommendation.

Moreover, there is no common method for objective evaluation in Music identifier or recommendation systems and most of the techniques applied are subjective evaluation methods that permit users ranking of systems given in the music playlist basically generated through various common approaches that are expensive and labour intensive in nature.

Vignoli in 2005 focused on the basic similarities in the approaches applied for evaluation of Music recommendation or identifier systems. Another notable point is the difference obtained in results of evaluation done in different regions having different backgrounds, languages and age groups etc. As such it is absolutely essential to have an effective and well recommended technique and criterion for proper evaluation of performances. Luke Barrington *et al.* 2009 made a study on evaluation of MRS done by human and its pros and cons.

V. CONCLUSION

This article or paper basically aimed at studying the quantitative as well as qualitative review of research work conducted in the domain of systems adopted for the task of music identifier or recommendation during the last two decades or so. The context-based, content-based,

knowledge-based systems and their outcome have been studied at length. In this paper, popular music identifier or recommendation strategies or approaches such as context-based, content-based, knowledge-based systems have been analysed and found that although these systems have been proved effective to a certain extend but they are still having their own limitations like biasedness in case of identifying or recommending popular music and minimizing human efforts etc. Further, it has been observed that the effectiveness of hybrid music identifier systems produced better outcome than the single system because it has the capacity of incorporating the advantages of all the above systems. In addition to this, it may be safely stated that due to subjective and universal nature of music, apart from the existing popular approaches, some more human-centred approaches require to be proposed and applied. Although, the study reveals that systems based on effective, social information, emotional-traits, content, context and knowledge have been widely applied and improved the quality of identification or recommendation of music to a large extend but still it is not enough.

The stage of research work in this field may be considered as an initial or early stage. Hence, very many areas of research work in this particular topic are still left alone or untouched as for example, the area of recommendation of personalized music identifier system based on profile, regional and emotional traits which is still identified and recognized as complicated subject. It may be concluded with this note that keeping in pace with the rapid development of technologies and considering various changing traits in mood, attitude, preferences of the listeners, the domain of music recommendation has already become an interesting as well as growing field of further research work specially in the area of generating a continuous and automatic top playlist of music and songs with added tracks that can exclusively match the liking, choice of songs and music by the users/listeners depending on their personal profile, mood, emotional traits, state of mind, feelings and other human behaviour in future.

Table- I: A Detailed summary of approaches used in Music Identifier System

Author	Techniques/Datasets used	Findings
Kanade <i>et al.</i> 2000	Image Database of CMU-Pittsburgh AU-Coded Facial Expression	Human-observer based system was proposed for detecting the subtle changes in problem space for facial features or expression analysis.
Hadid <i>et al.</i> 2007	Spatiotemporal based video facial emotion traits detection face recognition based on Local features of Binary Pattern and boosting methods.	The proposed methodology based on Spatiotemporal face recognition extracts both global and local features and showed better results than the existing techniques.
Zeng <i>et al.</i> 2008	Automatic human emotional traits (affect) detection	Performed a critical survey on different techniques or methods used for automatic human emotional traits recognition
Lucey <i>et al.</i> 2010	Extended version of Cohn-Kanade database	A new approach based on support vector machine and Active Appearance Models have been constructed for action unit and facial expressions detection.
Luoh <i>et al.</i> 2010	Gaussian mixture model	A general framework for Facial emotional traits detection method based on Gaussian mixture model has been proposed.
Habibzad <i>et al.</i> 2012	Particle Swarm Optimization	A new algorithm for facial emotional traits or expression recognition has been presented.

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Londhe and Pawar 2012	Scaled based Conjugate Gradient back-propagation, Neural Network	Facial emotional expressions have been recognized using an neural network based scaled gradient back-propagation technique.
Xiao <i>et al.</i> , 2013	Graphics Processing Unit	A music similarity retrieval recommendation system based on GPU method has been presented.
Durecha 2014	Retrieval of Music Information and Recognition of Audio Emotion	Generated music playlist based on a new human facial emotion detection algorithm.
Makarand and Sahasrabuddhe 2014	Retrieval of Music Information	A personalized music similarity framework based on the users' perception and need has been developed.
Kabani <i>et al.</i> 2015	Retrieval of Music Information and Recognition of Audio Emotion	An automated music generated playlist has presented.
Lee <i>et al.</i> , 2015	Mel-frequency cepstral coefficients, Genre Classification	Automatic genre and listener usage history based personalized music recommendation system was proposed.
Razuri <i>et al.</i> 2015	Mel Frequency Cepstral Coefficients	A decision tree based speech emotional feature extraction technique has been proposed.
Vaid <i>et al.</i> 2015	Feature extraction based on Electroencephalogram	Emotions of persons can be analyzed and estimated based on Electroencephalography.
Patel, <i>et al.</i> 2016	Facial landmark Detection system and Histograms of Oriented Gradients	Listener mood based music playlist system has been developed using general techniques like Facial landmark Detection system and Histograms of Oriented Gradients.
Uma and Sheela 2017	Electroencephalography, NeuroSky Mind Wave	Proposed Personalized Music and video Player by analyzing Brain Computer Interface exclusively for the differently abled users
Chang <i>et al.</i> 2018	Convolutional Neural Networks	Convolutional Neural Networks and collaborative filtering were combined to propose a personalized music recommendation approach.
Liu <i>et al.</i> 2018	Steady state visual evoked potential and Brain computer interface	Proposed designing of a video feedback system based on Steady state visual evoked potential combined with brain computer interface for car control.

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