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Emotion Based Information Retrieval System

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***Abstract*—**Music emotion plays an important role in music retrieval, mood detection and other music-related applications. Many issues for music emotion recognition have been addressed by different disciplines such as physiology, psychology, cognitive science and musicology. We present a support vector regression (SVR) based Music Information Retrieval System (Emotion based). We have chosen the "Raga" paradigm of Indian classical music as the basis of our formal model since it is well understood and semi-formal in nature. Also a lot of work has been done on Western Music and Karnataka classical Music Initially in the system features are extracted from music. These features are mapped into emotion categories on the Tellegen-Watson Clark model of mood which is an extension to the Thayer's two-dimensional emotion model. Two regression functions are trained using SVR and then distance and angle values are predicted A categorical Response Graph is generated in this module which shows the variation of emotion .

Keywords-*Mood detection, Classifier learning, Music Information retrieval, Computational features*.

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I. INTRODUCTION

Music information retrieval (MIR) is an emerging research area in multimedia to cope with such necessity. A key problem in MIR is classification, which assigns labels to each song based on genre, mood, artists, etc. Music classification is an interesting topic with many potential applications. It provides important functionalities for music retrieval. This is because most end users may only be interested in certain types of music. Thus, a classification system would enable them to search for the music they are interested in. On the other hand, different music types have different properties. Music listeners require new ways to access their music, such as alternative classification taxonomies and playlist generation tools.

In our approach we have focused only on Hindustani classical music as this is the origin of many other types of music. We are using the Tellegen – Watson and Clark model which is the extention of Thayer's model[14].

Mood classification has various applications such as a DJ choosing music to control the emotional level of people on the dance floor, to a composer for composing sound track for a film, to healing therapy etc.. Each of these situations relies heavily on the emotional content of the music

II. RELATED WORK

Owen Craigie Meyers et al. [1]have used combination of extracted features with the value of song lyrics to map a song onto a psychologically based emotion space. James Bergstraet al.[3] presented an algorithm which predicts musical genre and artist from an audio waveform. They used the ensemble learner AdaBoost to select from a set of audio features extracted from segmented audio and then aggregated. Ruijie Zhang [5]et al. suggested a high-accuracy audio classification algorithm based on SVM-UBM using MFCCs as classification features. Firstly MFCCs are extracted in frame level, then a Universal Background Gaussian Mixture Model (UBM) is employed to integrate these sequences of frame-level MFCCs, finally audio classification is performed using SVM with these clip-level features. Four audio typeswere considered: speech, music, speech over music and environmental sound. Lie Luet al. depicted that features like intensity ,timbre,rhythm are more relevant with an individual's mood response, Dan Liu et al.[8]presented a mood detection approach for classical music from acoustic data. Thayer's model [13] of mood is adopted for mood taxonomy Cyril Laurier et al.[7]presented the study on music mood classification using audio and lyrics information. The mood of a song is expressed by means of musical features but a relevant part also seems to be conveyed by the lyrics. Each factor was reviewed independently and explored the possible combination of Natural Language Processing and Music Information Retrieval techniques. Standard distance-based methods and Latent Semantic Analysis were used to classify the lyrics .ZhouyuFu[2] et al. emphasized that detection of emotion in music is a multilabel classification task, where a piece of music may belong to more than one class. Yi-Hsuan Yang et al.[6] presented the subjective nature of emotion perception and suggested that fuzzy logic is more appropriate mathematical tool for emotion detection. They employed two fuzzy classifiers to measure the strength of an emotion class in association with the song under classification.

With the above information and literature review, we propose our approach to retrieve songs based on emotions. We have considered classical music as our domain and have used Tellegen-Watson and Clark mood model for emotion

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recognition.In next sections we have presented our proposed approach for music emotion recognition. Section III gives brief overview of Raga theory and Mood models. Section IV presents the overview of our approach with system architecture. The detailed mood detection process, with a with architectural diagram is presented.

III. RELATED THEORY

A. Introduction to Indian Classical Music

The basic unit of Indian Classical Music is a Raga. 'Raga' literally means "colour". Each Raga consists of unique set of swara each with a specific pitch and melody,Swara is basically a note in an octave of Indian classical music. There are seven basic swara in Hindustani music shorted as Sa,Re,Ga,Ma,Pa,Dha,NiA raga uses a series of five or more musical notes or swara upon which a melody is constructed. However, the way the swara are approached and rendered in musical phrases and the mood they convey are more important in defining a raga. Ragas are associated with different times of the day, or with seasons Thus a piece of music or raga is supposed to paint different moods and thoughts. Indian Classical music defines ninerasas that relate to the mood evoked by Raga. They are known as Nava Rasa. These nav-rasa are 1) Love (Shringar), 2) Humor (Hasya), 3) Pathos (Karuna), 4) Anger (Rudra), 5) Heroism (Veer), 6) Terror (Bhayanaka), 7) Disgust (Veebhatsa), 8) Wonder (Adbhuta), 9) Calm (Shanta). Each raga is associated with one or more rasa. Raga Desh is famous for its feeling of 'belongingness' while raga Lalit is known to impart a sense of 'beginning'.

B. Mood Model

Mood is a comprehensive set of associations among subjective and objective factors,mediated by neural/ hormonal systems, which can give rise to emotional experiencessuch as feelings of excitement, pleasure or displeasure [11]. The two most significantapproaches to emotional modelling are categorical and dimensional. Each type of modelhelps to convey a unique aspect of human emotion and together such models can provideinsight into how emotions are represented and interpreted within the human mind. In categorical approach there are several different classes that form the basis for all otherpossible emotional variations. In dimensional approach we classify emotions alongseveral axes, such as valence, arousal , and strength[11] . Such approaches include James Russells [12]two-dimensional bipolar space, Robert Thayer's energy stress model[13],where contentment is defined as low energy/ low stress, depression as low energy/ highstress, exuberance as high energy/low stress, and anxious/frantic as high energy, highstress and Albert Mehrabians three-dimensional PAD representation (pleasure-arousal) The Tellegen, Watson and Clark Model of mood is applied in our mood detection system. Which is an extension to Thayer's model with a second system of axes, which is rotated by 45 degrees compared to the original axes . The new axes describe (un)pleasantness versus (dis)engagement. The approach used is the PANAS-X test scale which has two dimensional ratings called Positive Affect (PA) and Negative Affect (NA). The dimensional ratings function as entry points to more detailed ratings of discrete emotions under each axis (e.g. Fear under NA). The two PANAS-X dimensions can be mathematically related to Russell's circumplex model[13] . Russell's Arousal is the sum of PA and NA, while Russell's Valence is the difference (PA – NA). Tellegen, Watson and Clark use the Valence dimension (pleasant-unpleasant) as the top-level entry point of a 3-layer model. This unified model offers the benefits of dimensional ratings, plus a theoretical basis that links the entry-point of the hierarchy to the discrete emotion categories at the base (as shown in Figure 1). Thayer's model proposed by Robert Thayer[13] depicts the emotion with two dimensionsStress and Energy, and separates music emotion into four groups according to the fourquadrants in the two-dimensional space: Anxious, Exuberance Contentment, Depression.In this model, contentment is defined as low energy/ low stress, depression as lowenergy/ high stress, exuberance as high energy/low stress, and anxious/frantic as highenergy, high stress.

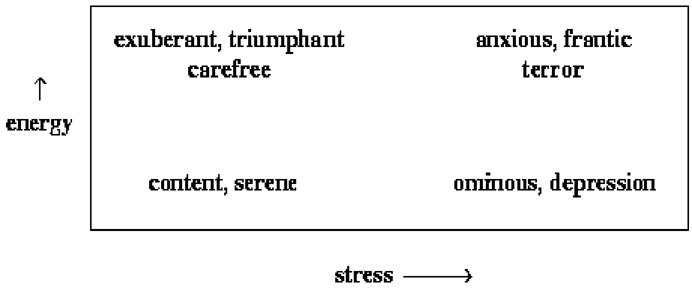

Figure1. Thayer Model

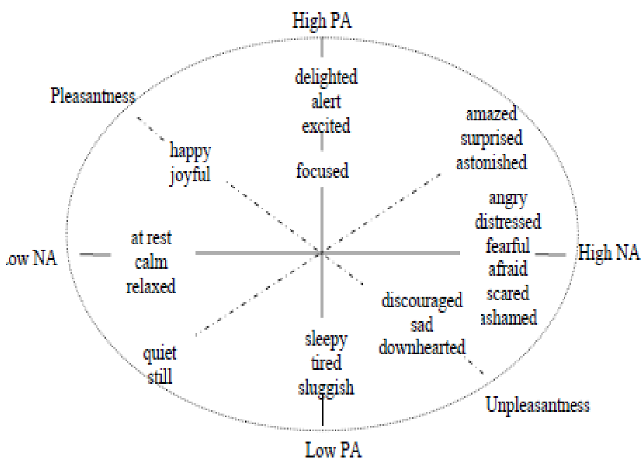

Figure2.Tellegen, Watson and Clark Model of mood

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IV PROPOSED SYSTEM

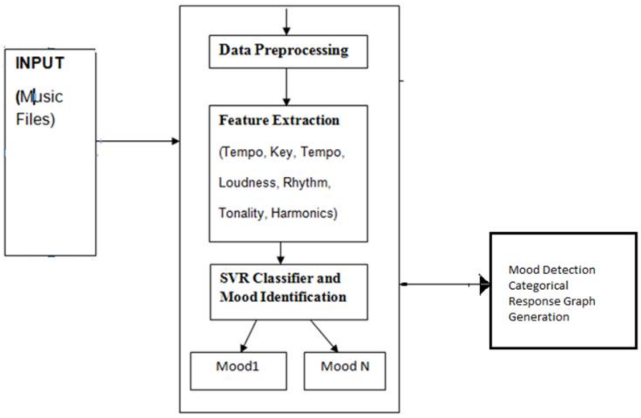

Figure3.System Architecture of proposed system

The overall architecture of the proposed system is given in figure 3. The main processes in the system are Data Preprocessing, Feature Extraction and Classification. Each processes are explained in brief in next sections.

A. Data pre-processing

Data pre-processing mainly involves two tasks format conversion and clip generation.

- Format Conversion: The song in any format will be converted to .wav format by an audio converteras .Wav format is standard lossless format for audio processing.
- Segmentation: Input Raaga audio files. are divided into 30 seconds segments clips.Reason behind cliplevel analysis is that it is difficult to analyze whole song due to the huge datacontent. Clip for analysis should not be too short to lose any essential contentand not too long to process.Also the mood is usually changeable in a whole piece of classical music, it is not appropriate to detect the mood in the range of the whole song

B. Feature Extraction

In feature extraction every 30 second audio clip is processed by applying various signalprocessing techniques or mathematical signal computations like Fourier transform,logarithms, integral, etc. Values for allfeatures are stored in file. These values can be called as feature vectors.These feature vectors computed in the memory are stored in text file(.txt file). In additionto the features extracted, emotion number is appended to each feature vector. Emotionnumber will be updated manually in case of a training set.Musical features (low-level, mid-level) extractedfrom the Raaga audio files are :

- Entropy – (harmonic tempo) rate at which the chords change (or progress) in a musical composition, in relation to the rate of notes.
- Key - tonic note and chord which gives a subjective sense of arrival and rest.
- Metroid – (rhythm) fluctuation, tempo, attack time
- Mode – (tonality) key clarity, key strength.
- Pitch- (shruti) auditory attribute of sound according to which sounds can be ordered on a scale from low to high.
- RMS – Root mean square energy, dynamics.
- Tempo-(laaya) speed or pace of music

C. Mood Mapping and Mood Detection

Extracted features from feature extraction are mapped into emotion categories on the Tellegen-Watson Clark model of mood which is an extension to the Thayer’s two-dimensional emotion model with a second system of axis which is rotated by 45 degrees compared to the original axis.Two regression functions are trained using SVR and then arousal (PA + NA) and valence (PA-NA) values are predicted. To build classifiers we use Support Vector Regression (SVR) for training.

For training emotion classifier, two distinct SVR functions are required. One is for training and distance value and the second is for anglevalue. The training is performed by the musical features of raga and the emotion of the training data set as input and the fixed values of each music emotion as the desired output. Our test verifies whether or not the outputs (distance and angle values) of trained regression functions are within the range of the proper music emotion intensity rating scale.There are some essential conditions needed for effective emotion recognition. Firstly, the regression function should be trained as perfectly close to ground-truth. If the trained regression function cannot generate proper distance-angle values for a music emotion adjective, the separation policy also cannot act in a proper way. Secondly, a proper music emotion separation policy on the tellegen –Watson and clark mood model plane should be presented. A categorical Response Graph is generated which shows the variation of emotion after every 30 seconds in the audio file and also highlights the overall emotion of the input “Raaga” audio file.

A sample Categorical Response graph generated is given figure 4

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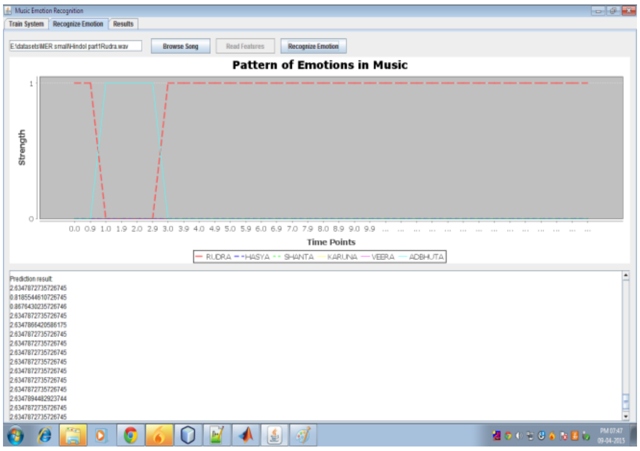

Figure 4.Categorical Response Graph

Input for classifier learner is a training data-set of music features with the emotionattribute (in the form of emotion number) manually updated while training. Classifiersthen evaluate the data-set under concern against the emotion classifier model that hasbeen created. The evaluation results in predicting the emotion for every 30 second musicclip that was provided to the system by the user. Support Vector Regressoris used for classification. The test maps the Predicted_Angle(emotion) obtained from the trained regression function to the Standard_Angle(of each emotion respectively) such that Standard_Angle–Predicted Angle| is minimum. Categorical Response graph is generated which displays the overall mood of the given input Raaga audio file.X axis on the grapg shows raga segments and Y axis depicts the emotion strength. Thus a music information retrieval system is developed which generates the categorical response graph for each Raga.

V. CONCLUSION AND FUTURE SCOPE

In this system, we have developed the system forthe music information retrieval system which generates the categorical response graph for each Raga. The Raga paradigm of Indian classical music is used as the basis of formalmoodmodel.The reliable outcomes can be used in the various applications of Computational Musicology. In future we can try to improve the results using better music feature extraction and incorporating better lyric analysis methods. Research can be done to find the best features for a particular type of music. Combinationof different classifiers and feature set can be tried for enhancement of performance

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