GEOLOCATION-ADAPTIVE MUSIC PLAYER

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ABSTRACT

We present an adaptive music player that combines music information retrieval (MIR) and audio processing technologies with the interaction capabilities offered by GPS-equipped mobile devices. The application plays back a list of music tracks, which are linked to geographic paths in a map. The music player provides two main enhanced features, adaptable length of the song and automatic transitions, which adapt to the geo-location of the user.

1. INTRODUCTION

This work presents a platform-independent web-based prototype that combines Music Information Retrieval methods to extract semantic music features (Section 2) and audio processing algorithms able to process sounds in real-time (Section 3) while exploiting the new sensing and processing capabilities of mobile platforms, more specifically, GPS based geo-location. The prototype plays back a predefined playlist of music tracks, which are linked to geographic paths in a map. The music player has two main enhanced features that adapt to the geographic position of the user, namely, adaptable length of the song and automatic transitions. The modification of the length of a track is based on building a beat-similarity graph for the track, which allows the player to jump to similar beat locations [1] and the automatic transitions are based on algorithms for automatic beat-matching, time-stretching and cross-fading [5].

The application was built on Web standards (Web Audio API, HTML5 and Javascript) and cross-platform frameworks (Ionic [2] based on Cordova [3] and AngularJS [4]).

[1] infinitejuke.com/
[2] http://ionicframework.com
[3] http://cordova.apache.org
[4] https://angularjs.org

2. AUDIO ANALYSIS

Spectral domain audio signal analysis is used to extract musically meaningful features related to rhythm (i.e. onsets, beat position, beat duration, metrical position), pitch (Chroma features [3]), timbre (MFCC coefficients [1]) and loudness (beat maximum and average energy). Rhythmic analysis [2] is used to segment the tracks into beats and features are averaged across each beat interval. Beat synchronous features are then used to measure similarity among the beats. Similarity is estimated by computing a self-similarity matrix (SSM) [4] for each feature and combining all of the matrices into a general one by performing a weighted sum. Finally, the general SSM is transformed into a similarity graph, where the nodes represent the beats and the connections indicate the degree of similarity. The graph is pruned in order to keep only the strongest connections (i.e most similar beats). Dimension reduction, needed to compute the SSM of n-dimensional features (as is the case of MFCC and Chroma), is carried out by computing the Euclidean distance.

3. AUDIO RENDERING

The application plays back a list of music tracks, which are linked to geographic paths in a map. It is meant to be used with a GPS-equipped mobile device as it reacts to the geo-location of the user. The player implements two main enhanced features, adaptable length of the song to the pace of the user and automatic transitioning between songs. Representation of musical tracks as beat similarity graphs allows for advanced playback capabilities, in contrast to the traditional sequential playback, such as jumping to different parts of the song through the similarity connections, and therefore adaptable song duration from the smallest loop in the graph to infinite. The music player implements a beat scheduler, selecting the following beats to render and can adapt to the position of the listener based on standard graph algorithms (Dijkstra). During beat concatenation, cross-fading may be applied, although it is not necessary as beats are already cut at psycho-acoustically strategic positions and transitions are generally artifact-free and smooth. Regarding the effect of jumping to other parts of the songs, this changes can be unnoticeable through careful selection of the parameters of the scheduler (e.g. jumping frequency, minimum distance, metrical position restrictions, minimum length of consecutive fragments).

When the listener walks into the geographic path of a

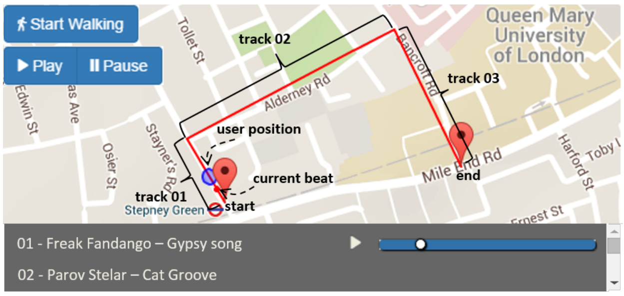

Figure 1. Screen-shot of the geo-location adaptive player. A playlist with three tracks has been prepared and assigned to three segments in a geographic path. The position of the user is represented by the blue circle and the current playing-beat corresponds to the red dot in the path. The application plays back beats by navigating the track-graph and adapting to the position of the user.

new track, a transition between tracks is triggered. Automatic beat-matching, cross-fading and time-stretching is carried out until the transition is finished and then the player turns to the previous state of track length adaptation. An screen-shot of the geo-location adaptive player is shown in Figure 3.

4. ACKNOWLEDGMENTS

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5. REFERENCES

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