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A CHROMA-BASED TEMPO-INSENSITIVE DISTANCE MEASURE FOR COVER SONG IDENTIFICATION USING THE 2D AUTOCORRELATION FUNCTION

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ABSTRACT

In the following, we describe the refined version of our 2007 cover song identification algorithm [3] submitted for the 2008 MIREX cover song identification task. The refined algorithm is faster and has higher recognition performance than the original version.

1 INTRODUCTION

The MIREX cover song identification task was introduced in 2006 and has since been quite popular. In 2007, we introduced a cover song detection algorithm using features that were insensitive to changes in instrumentation, tempo and time shifts. If it had attended the 2006 cover song detection contest, it would have performed on par with the winner, despite being much faster. However, in 2007 standards had increased tremendously, leaving our algorithm on a fourth place of eight contenders. Our 2008 algorithm uses the same principles as our 2007 algorithm but is even faster and performs slightly better on the covers80 data set [1]. The source code of the algorithm is available as part of the Intelligent Sound Processing toolbox [1] .

2 FEATURE EXTRACTION

It is assumed that a song and its cover versions share the same melody, but might differ with respect to instrumentation, time shifts, tempo and transpositions. The extracted feature is therefore designed to be insensitive to time shifts and changes in instrumentation and tempo. Feature extraction comprises the following steps:

1. Compute the chromagram, $c_s^{(1)}(n)$, $s \in \{0, \cdots, 11\}$ and $n \in 0, \cdots, N$, from the sampled song using the code from [2]. The value $c_s^{(1)}(n)$ is the power of semitone s at time n. As the chromagram primarily captures melodic information, it is somewhat insensitive to differences in instrumentation.

2. To reduce the influence of peaks, compute $c_s^{(2)}(n) = |c_s^{(1)}(n)|^{0.7}$.

3. To remove any DC offset, filter all $c_s^{(2)}(n)$ by the high-pass filter $h(n)$:
$$c_s^{(3)}(n) = c_s^{(2)}(n) * h(n) \tag{1}$$

4. In order to obtain a representation insensitive to temporal alignment and key, we compute the 2D autocorrelation function $R^{(4)}(m, k)$:
$$R^{(4)}(m,k) = \sum_{s=0}^{11} \sum_{n=0}^{N} c_s^{(3)}(n) c_{s+m \bmod 12}^{(3)}(n+k). \tag{2}$$
This step is different from last year's submission. Back then we computed the power spectrum of each individual $c_s^{(3)}(n)$ to avoid alignment problems.

5. By summing the values of the autocorrelation in 16 exponentially distributed bands, B_l, we obtain a representation that is insensitive to different tempi (see [3]):
$$R^{(5)}(m,l) = \sum_{k=0}^{N} R^{(4)}(m,k) B_l(k), \quad l \in \{0, \ldots, 15\} \tag{3}$$

6. Finally, we normalize $R^{(5)}(m, l)$:
$$R^{(6)}(m,l) = \frac{R^{(5)}(m,k)}{\sqrt{\sum_{m'=0}^{11} \sum_{l=0}^{16} R^{(5)}(m',l)^2}} \tag{4}$$

We end up with a 2-D function $R^{(6)}(m, l)$ where $m \in \{0, \ldots, 11\}$ and $l \in \{0, \ldots, 16\}$, i.e., with $12 \cdot 17 = 204$ different values.

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[1] http://isound.es.aau.dk/

Participant	Num. correct	Time (sec.)
CL1	1056	281487
CL2	1073	281352
EL1	1762	136469
EL2	1781	435240
EL3	1778	434712
JCJ	**763**	**3648**
SGH1	2422	373370
SGH2	2116	373371

Table 1. Results for the MIREX 2008 Audio Cover Song Identification. The maximum possible number of identified cover songs is 3300. Our algorithm is denoted JCJ. The CL1 and CL2 algorithms ran on different computers than the other algorithms, so execution times should be taken with a grain of salt.

3 DISTANCE COMPUTATION

The similarity between two songs, s_{ij}, where the songs are represented by the features $R_i^{(6)}(m,l)$ and $R_j^{(6)}(m,l)$, respectively, is given by

$$s_{ij} = \max_{d\in -1,0,1} \sum_{m=0}^{11} \sum_{l} (R_i^{(6)}(m,l+d) - R_i^{(6)}(m,l))^2. \quad (5)$$

The corresponding distance measure, d_{ij}, is given by $d_{ij} = 2 - s_{ij}$. It obeys the triangle inequality.

4 EVALUATIONS

The covers80 dataset [1] consists of 80 titles each in two different versions, i.e., a total of 160 songs. With this set, a song's nearest neighbor was the cover version in 36% of the cases for our 2007 submission. For the 2008 edition, accuracy has increased to 48%. However, as parameters have been tweaked using this dataset, some degree of overtraining is inevitable. On a 1.86 GHz Intel Core 2 CPU using only a single core, feature extraction on average took less than 2 seconds per songs for the covers80 data set.

The MIREX 2008 Audio Cover Song Identification results are shown in Table 1, where it is quite obvious that our algorithm by far has the lowest performance and by far is the fastest.

5 REFERENCES

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