

HUMAN PERCEPTION AND COMPUTER EXTRACTION OF MUSICAL BEAT STRENGTH

George Tzanetakis,
Georg Essl, Perry Cook

presented by
Jonathan Mooser
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First Question...

- What is "beat strength" ???
- Answer: we don't know!
- But... we know it when we hear it.

How can we test this?

If a group of people can all agree as to which pieces of music have a *strong beat* or a *weak beat*, then there is such a thing as beat strength.

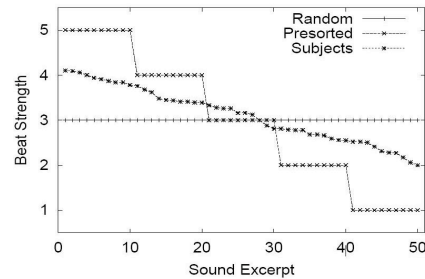
(Even if we have no formal definition)

Research phase I: Human subjects

- 32 participants
- 50 music samples of 15 seconds each
- Rate each on a scale of 1 (weak beat) to 5 (strong beat)

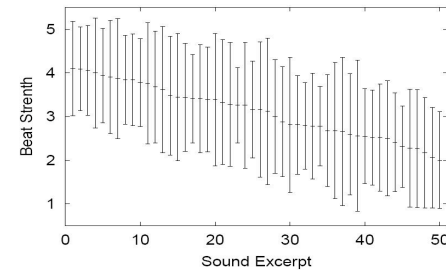
General agreement amongst subjects...

Results show a statistically significant trend.
(Image from Tzanetakis paper)



...But some disparity

For each sample, there are at least a few outliers that disagree
(Image from Tzanetakis paper)



Second Question...

- Humans agree, but can we get a machine to agree too?

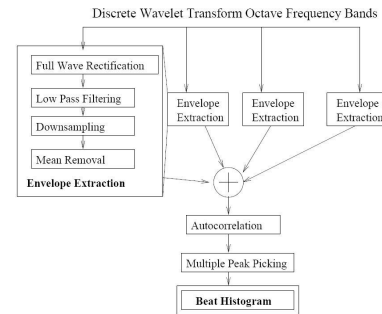
Research phase II: Machine algorithm

- Based on "Beat Histogram" (previously published by Tzanetakis et al.)
- Uses intuitive notions to extract results (still no formal definition of beat strength)

The Beat Histogram

- Based on basic signal processing elements
- Most notably:
 - Wavelet transform
 - Autocorrelation

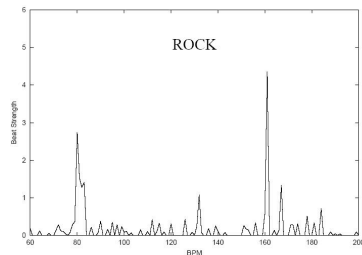
The Beat Histogram (cont.)



(image from Tzanetakis paper)

The Beat Histogram (cont.)

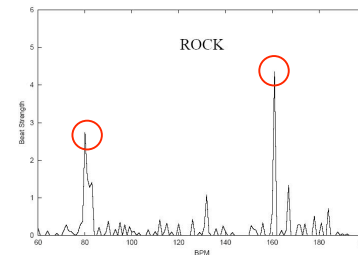
- Resulting histogram plots tempo (BPM) vs. strength.



(image from Tzanetakis paper)

The Beat Histogram (cont.)

- Notice second peak is at exactly twice the tempo of the first.



(image from Tzanetakis paper)

Measuring Beat Strength From Beat Histogram

- Two proposed methods:
 - Simple sum of all histogram values (SUM)
 - Ratio of largest histogram peak to average value (PEAK)

Results

- Algorithm results correlate well with human results
- Two methods (SUM and PEAK) perform about equally well.
- Authors hypothesize that humans use a combination of the two in their own beat strength cognition.

Applications

- Automated classification
- Browsing interfaces for retrieval
- Classification of non-musical sounds - e.g. sound effects