Prototype of a Radio-On-Demand Broadcast Receiver with Real-Time Musical Genre Classification


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Objective

Software Defined Radio applied to broadcast media allows to imagine digitizing an entire broadcast band, decomposing it into its component channels, demodulating these to produce parallel real-time audio streams, and applying indexing or other audio processing algorithms, all in a single programmable device.

Parallel demodulator

• Bandpass sampling @ 87MHz
• Resampling @ 51.2MHz
• 4 WOLA Filter with 128point FFT running @ 51.2MHz
• Cordic

Musical Genre Classification

• MFCC to extract acoustic feature
• Gaussian Mixture Model Classifier
• Training on GTZAN (http://marsyas.info) and French radio datasets
• Decision based on the maximum of the three scores
• 96.3% of accuracy

Confusion matrix

<table>
<thead>
<tr>
<th></th>
<th>Classical</th>
<th>Jazz</th>
<th>Variety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classical</td>
<td>96%</td>
<td>4%</td>
<td>1%</td>
</tr>
<tr>
<td>Jazz</td>
<td>10%</td>
<td>93%</td>
<td>0%</td>
</tr>
<tr>
<td>Variety</td>
<td>4%</td>
<td>5%</td>
<td>99%</td>
</tr>
</tbody>
</table>

Processing time on multi-core

<table>
<thead>
<tr>
<th></th>
<th>Core 2 duo Q9400@ 2.66GHz</th>
<th>Core i7 2600@ 3.4GHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 vector</td>
<td>699ms</td>
<td>457ms</td>
</tr>
<tr>
<td>51 channels</td>
<td>35.67s</td>
<td>23.307s</td>
</tr>
</tbody>
</table>

Features

• Stratix Altera FPGA : EP2S180
  - IP WOLA
  - Resampling
  - Cordic
• Multi-core
  - GMM
  - HMI

Prototype

Radio On Demand

Algorithms

• Parallel demodulator
• MFCC to extract acoustic feature
• Gaussian Mixture Model Classifier
• Training on GTZAN and French radio datasets
• Decision based on the maximum of the three scores
• 96.3% of accuracy