Unobtrusive, Mobile ECG Monitoring and Arrhythmia Detection using Mobile Phones

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Pattern Recognition Lab (CS 5)
World Health Organization

Cardiovascular diseases:
Number one cause of death globally
**Electrocardiogram (ECG)**

= electric activity of the human heart
Use of ECG

Cardiac Conditions

Need for long-term analysis

Detection  Monitoring  Prevention
Measuring of ECG

● Problems:
  ● Specific hardware
  ● Interpretation limited to medical personnel

● Need for:
  ● Automatic, low-cost solution
  ● Portable solution (for home environment)

→ Mobile devices
Our Idea

ECG lead II

shimmer-research.com

Bluetooth

ECG beat classification

<<Abnormal beats detected>>

<<ECG normal>>
Overview – Beat classification

ECG data → QRS detection → Feature extraction → Beat classification
ECG Data

- Platform PhysioNet
  - Free access
  - Large collection of physiological signals
- MIT-BIH Arrhythmia database
  - 48 datasets of half-hour ECG recordings
- MIT-BIH Supraventricular database
  - 78 datasets of half-hour ECG recordings
Overview – Beat classification

ECG data → QRS detection → Feature extraction → Beat classification
QRS Detection

Raw ECG signal (lead II) → Filter operations (Pan & Tompkins) → Threshold-based method
Overview – Beat classification

1. ECG data
2. QRS detection
3. Feature extraction
4. Beat classification
Classification – Decision Tree Classifier

QRSwidth

R-R

Time [s]

Abnormal Classes

Normal Classes
Classification – Decision Tree Classifier

[Diagram showing the process of classification with features like MaxCorr, ArDiff, R-R, and QRSwidth leading to thresholds, resulting in Abnormal Classes and Normal Classes.]
Implementation

- Java
- Android SDK

http://tinyurl.com/lmehearty

(Gradl et al., 2012)
Statistics

- True Positive (TP): correctly classified as normal
- True Negative (TN): correctly classified as abnormal
- False Positive (FP): incorrectly classified as normal
- False Negative (FN): incorrectly classified as abnormal

- Sensitivity = TP / (TP + FN)
- Specificity = TN / (TN + FP)
Results – Decision Tree Classifier

<table>
<thead>
<tr>
<th>MIT-BIH Arrhythmia</th>
<th>MIT-BIH Supraventricular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detected Beats</td>
<td>99.59%</td>
</tr>
<tr>
<td>True Positive</td>
<td>11224</td>
</tr>
<tr>
<td>True Negative</td>
<td>65855</td>
</tr>
<tr>
<td>False Positive</td>
<td>10987</td>
</tr>
<tr>
<td>False Negative</td>
<td>1680</td>
</tr>
</tbody>
</table>

- Sensitivity: 89.5%
- Specificity: 80.6%

(Gradl et al., 2012)
Summary

- Need for mobile, long-term ECG analysis
- Implementation of ECG analysis
- QRS detection in real-time
- Arrhythmia classification
  - Decision Tree Classifier
Outlook – Beat classification

- Best classifier
- Best features

ECST (Embedded Classification Software Toolbox)

ECG data

QRS detection

Calculation of additional features

Feature extraction

Beat classification
Outlook - ECST
Thank you for your attention!