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Analysis of Teager-Kaiser Energy Operator Pertinence for R Peak Detection in ECG Recordings on a Smartphone

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Motivation

- Number 1 cause of death globally (31% of all global deaths in 2012)[1]

- Can be prevented by addressing behavioural risk factors (tobacco use, unhealthy diet, obesity, physical inactivity, etc.)
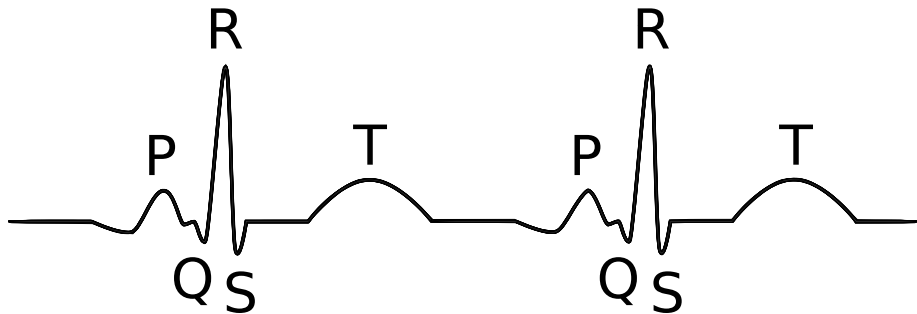
- Need early detection and management

- Contribution of CVDs to mortality in CIS (percents)

Georgia	67
Ukraine	64
Azerbaijan	60
Russia	57
Moldova	56
Belorussia	53
Kazakhstan	50
Armenia	50
Kyrgyzstan	49
Tajikistan	39

[1]Source: WHO

Electrocardiogram morphology

Significance of confident R peak detection

- Normal sinus rhythm

- Sinus tachycardia

- Sinus bradycardia
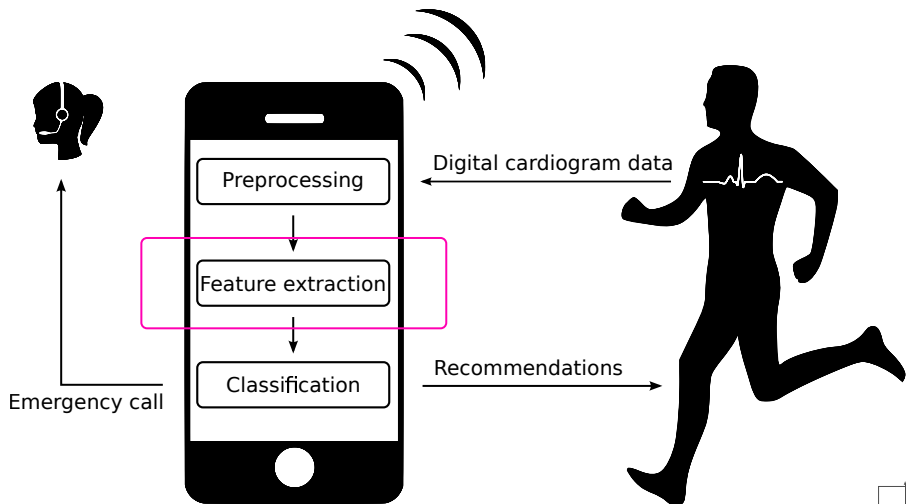

- Sinoatrial block

- Atrial flutter

- Wolff-Parkinson-White syndrome

Source: Medical Training and Simulation LLC
http://www.practicalclinicalskills.com

Rhythm anomalies detection

Teager-Kaiser energy operator based approach

Consider the digital ECG recording represented by discrete signal x_n

1 Estimate the instantaneous energy of a signal

$$\Psi_d[x_n] = x_n^2 - x_{n-1}x_{n+1}$$

2 Emphasize the pulses
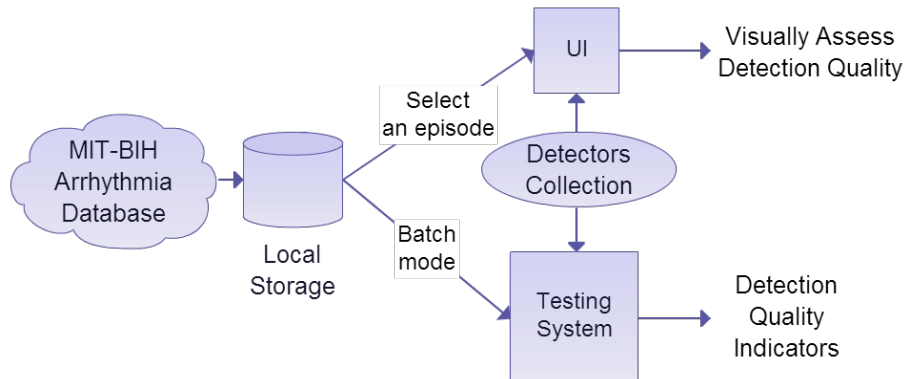
$$y_n = \Psi_d[x_n]^3$$

3 Choosing parameters N, α and β, apply the adaptive threshold

$$z_n = \alpha \frac{1}{N+1} \sum_{k=-N}^{N} y_k + \beta \sigma_y$$

Source: Yamamoto and Yoshida, 2013

Experiments

UI of developed verification system

Results

1. TKEO-based algorithm for R peak detection have been implemented.

2. The system to examine the detectors on the set of recordings have been developed.

3. Experiments show that the approach demonstrates sufficient sensitivity on almost all types of rhythm abnormalities.