Healthcare Technology Innovation Centre
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Indian Institute of Technology Madras

Dept. of Biotechnology
Ministry of Science & Technology

RPnet: A Deep Learning approach for robust R Peak detection in noisy ECG

Sricharan Vijayarangan, Vignesh R, Balamurali Murugesan, Preejith SP
Jayaraj Joseph and Mohansankar Sivaprakasam

Motivation

- **R Peak detection**
  - Important precursor - HRV and CVD diagnosis
  - Signal processing - Digital Filters
  - Multiple methods
- **Limitation**
  - Evaluation on clean ECG database
  - Signals with low SNR - Difficult to model
  - HRV Irregulates - Difficult to model
- **Deep Learning**
  - Used widely
  - Ability to model data with high variance
- **Requirement**
  - Detect RPeaks in ECG with noise
  - Have the model generalize to multiple databases

Contribution

- A novel application of the IncRes-Unet to produce a distance map
- Quantitative evaluation of model performance relative to three other baselines
- Quantitative evaluation on 3 different databases to evaluate
- Evaluate model performance at different SNR levels

Problem Formulation

$x^{(i)}$ → **Input**

$y^{(i)}$ **Ground Truth Distance map**

$$z^{(i)} = F_1(x^{(i)}; \theta 1)$$

$$y_{pred}^{(i)} = F_2(z^{(i)}; \theta 2)$$

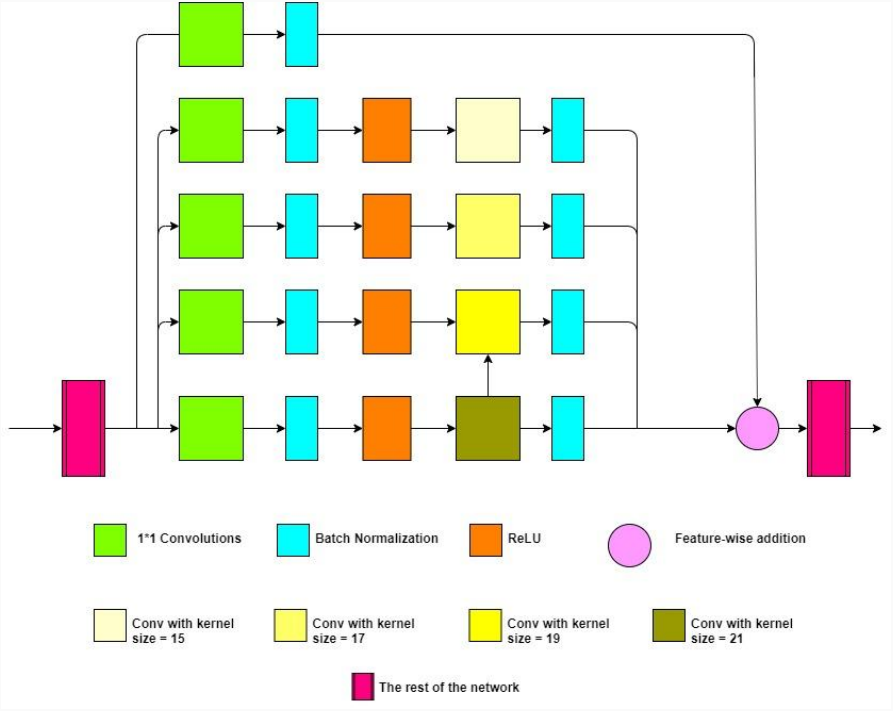
$$y_{diff} = y^{(i)} - y_{pred}^{(i)}$$

$$L(X) = \sum_{i=1}^{m} SmoothL_1(y_{diff})$$ → **Loss to be minimized**

$$SmoothL_1(y_{diff}) = \begin{cases} 0.5(y_{diff}^2), & \text{if } abs(y_{diff}) < 1 \\ abs(y_{diff}) - 0.5, & \text{otherwise,} \end{cases}$$

Architecture Diagram

Inception Module



Dataset Description

Dataset	Total	Train	Test
CPSC	2000	1936	64
MIT-BIH	8640	-	8640
MIT Exercise Stress Test	4842	-	4842
NSTDB	1800	-	1800

Quantitative Results

Algorithm	Precision	Recall	F1-score
Hamilton	0.7756	0.8621	0.8166
Christov	0.7135	0.9085	0.7993
SWT	0.7791	0.8709	0.8224
Ours	**0.9862**	**0.9812**	**0.98375**

Evaluation on the CPSC dataset

Cont

Dataset	Precision	Recall	F1-score
MIT-BIH	0.9944	0.9975	0.9965
MIT ST Change	0.9972	0.9983	0.9978
NSTDB	0.982	0.9451	0.9632

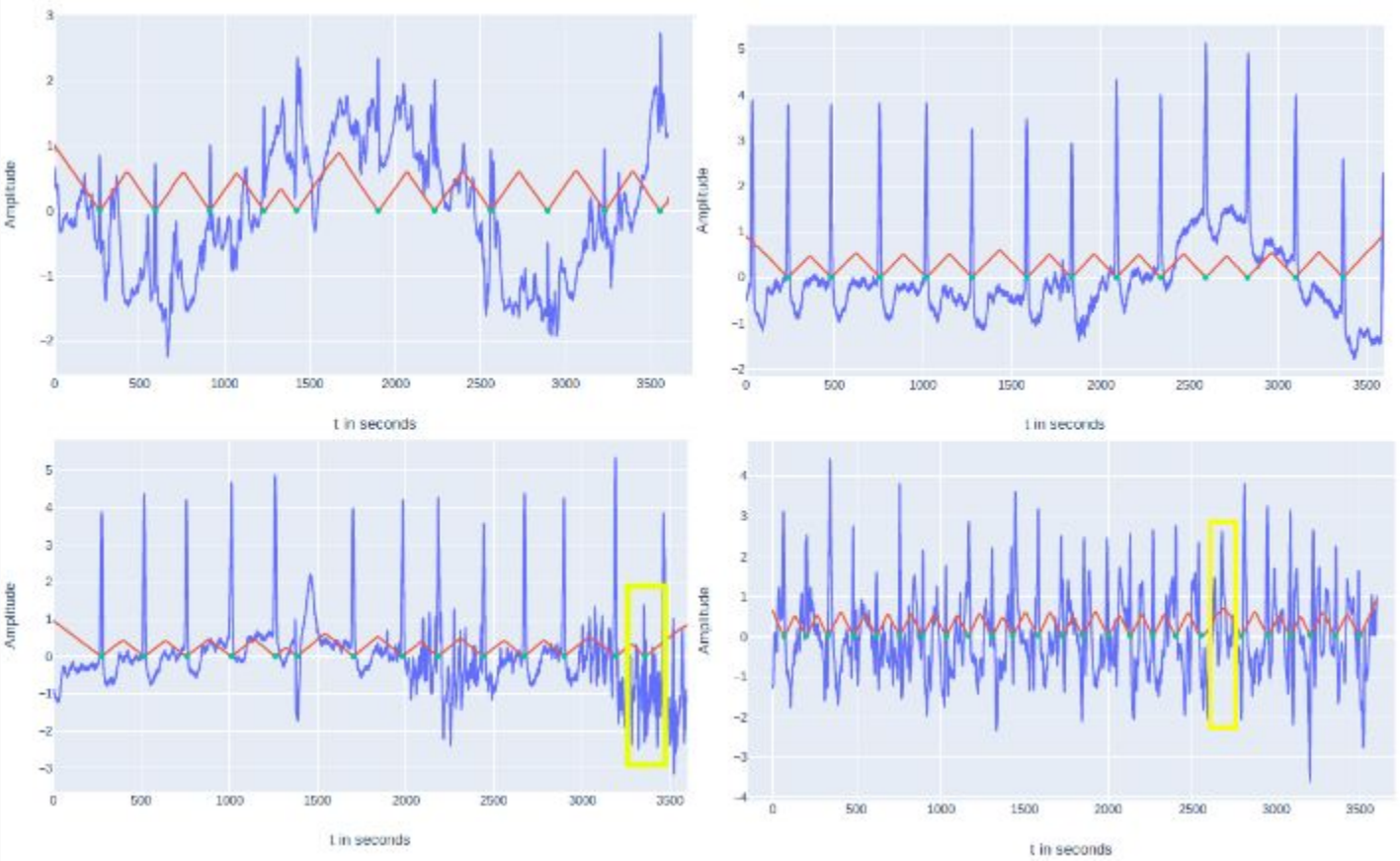
Evaluation on 3 datasets

Cont

SNR (db)	Precision	Recall	F1-Score
24	0.9986	0.9994	0.999
18	0.9979	0.9994	0.9986
12	0.9855	0.9986	0.992
6	0.9361	0.9859	0.9603
0	0.8228	0.9264	0.8715

Evaluation on NSTDB

Qualitative Results



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Thank You

Contact - sricharanv@htic.iitm.ac.in

Github Code - https://github.com/acrarshin/RPNet