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Optimal Architecture Design of Convolutional Neural Network for Automatic Detection of Premature Ventricular Contraction (PVC)

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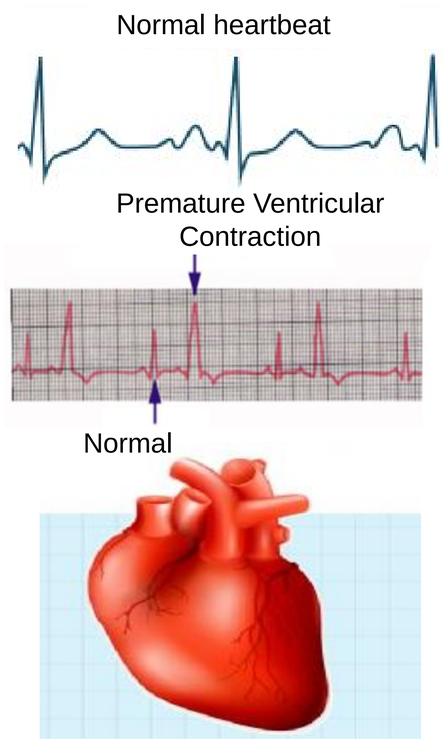
ABSTRACT

In this study, we designed and evaluated an optimal architecture of convolutional neural network (CNN) for automatic detection of premature ventricular contraction (PVC). For this purpose, we used MIT-BIH Arrhythmia Dataset without data pre-processing. The optimal CNN structure we have found is a four-layer structure with 120, 90, 60, 30 hidden nodes respectively. This structure consists of several layers including convolution layer, activation layer, max-pooling, and dropout (0.1). The results shown as accuracy of 99.0%, recall of 99.0%, and F1-score of 99.0%.

INTRODUCTION



Risk factors :
- Cardiovascular disease
- Health problems
- Life-threatening
- Ventricular tachycardia
- Ventricular fibrillation.

Diagnosis :
- Machine learning methods
- Deep learning methods.

Drawbacks :
- Low detection rate
- High computational cost

The optimal structure of convolution neural network for automatic detection of PVC is designed and evaluated.

MATERIALS & METHOD

2.1 Data processing and Dataset

- MIT-BIH Arrhythmia Database (17 subjects with PVC, 6 non-PVC)
- Segmented every 5 seconds (Fs = 360Hz), 6.308 segments
- Training set (5,042 segments), test set (1,261 segments)

2.2 CNN model

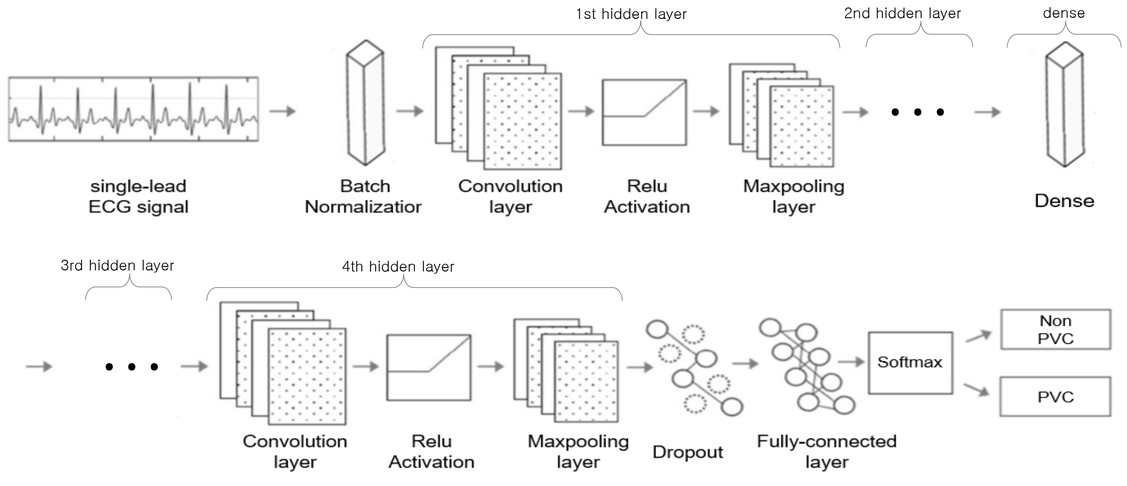


Figure 1. The proposed optimal CNN model.

2.3 Selection of optimal CNN structure

Table 1. Comparison of accuracy with structure of filters.

Structure	2 layer	3 layer	4 layer	5 layer
Arithmetic	94%	96%	99%	93%
Geometric	93%	97%	98%	98%

Table 2. Comparison of accuracy with absence or presence of dense.

Fitting	2 layer	3 layer	4 layer	5 layer
With Dense	94%	96%	99%	94%
Without Dense	93%	98%	99%	98%

2.4 Implementation and Training

- Software - Keras library with TensorFlow background
- Hardware - GeForce GTX 1080 TI, Win 10

RESULTS

The selected optimal CNN structure showed robust performances as below.

Table 3. The results of the CNN model.

Dataset	Accuracy	Recall	F1-score
Training set	100%	100%	100%
Test set	99%	99%	99%

DISCUSSION

Table 4. Comparison with previous. studies

Study	Sensitivity	Accuracy
Tae Joon Kim et al,	96.08%	99.41%
Our study	98.00%	99.04%

Pros & Cons

- Without feature extraction and preprocessing
- Excellent performances
- Small dataset

In further study

- To increase the diverse dataset
- To detect various cardiac abnormal events

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