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Detection of Myocardial Infarction from 12 Lead ECG Images

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ABSTRACT:

- Twelve lead ECG printouts are used by the physician to diagnose MI.
- The study of large piles of ECG reports is a tedious and error-prone process.
- A lack of expert physicians in developing countries is there.
- This work proposed a method to detect MI from 12 lead ECG images by a deep convolution neural network with the performance of accuracy 87.80%, sensitivity 92.86%, and specificity 78.94%.

1. INTRODUCTION

- Typically, ECG has to be printed on paper for further physical inspection by a medical practitioner. This leads to a large volume of ECG reports, which causes tedious and error-prone examination.
- MI is a leading cause of death worldwide. The expert physicians use 12 lead ECG to diagnose MI.
- Works done to date are mostly on either digitalization of ECG printouts or MI detection from ECG signals.
- MI detection from multi-lead ECG images is not yet largely studied.
- We have used various image processing techniques to retrieve the ECG signal from images and designed a DNN to detect MI.

2. METHOD OVERVIEW

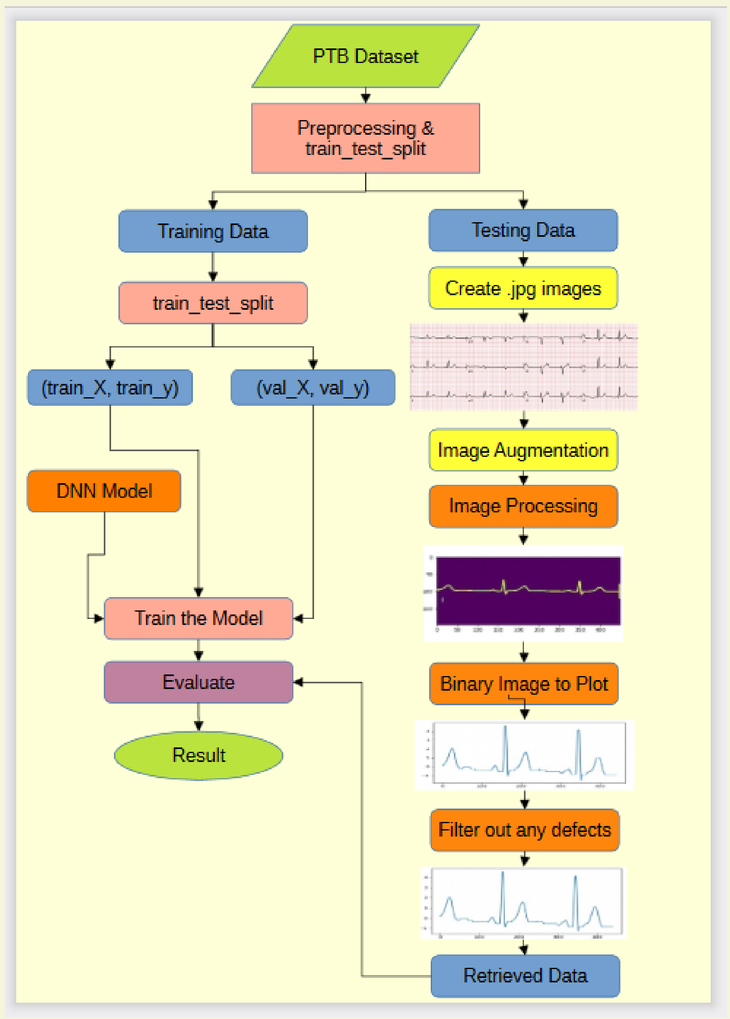

Fig. 1. Block diagram of Detection of MI from ECG Images

Table 1. Architecture of CNN classifier

Layers	Type	Output Shape
0	Input Layer	(625, 12)
1-3	Conv Block 1	(625, 128)
4-6	Conv Block 2	(625, 256)
7-9	Conv Block 3	(625, 128)
10	Global Avg Pool	(128)
11	Dense	(1)

Table 2. Architecture of convolutional block

Type	Filter Size	Kernel/ Pool Size
Convolutional 1D	128/256/128	Same
Batch-norm	-	Same
ReLU Act Layer	-	Same

3. METHOD WORKING

The technique consists of 2 steps:-

- De-skew the image, crop the region-of-interest, remove the background grid, scan vertically to retrieve the ECG signal, and apply filters to remove any noise in the retrieved data. Perform distortion analysis on retrieved data.
- Train the deep CNN on the PTB dataset to detect MI, apply five-fold CV and early stopping techniques to prevent over-fitting. Finally, evaluate the model using retrieved data.

4. RESULTS

Table. 3. PTB Dataset Split

Class	Actual Records	Train Records	Test Records	Train Dataset	Test Dataset
Myocardial Infarction	148	118	30	5318	1372
Healthy Subject	54	42	12	1946	555
Total	202	160	42	7264	1927

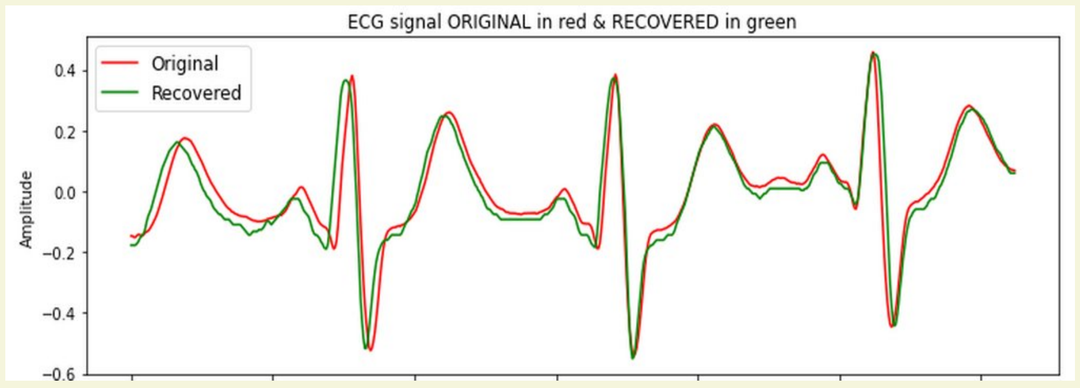

Fig. 2. Original vs Retrieved Data of 'I' lead

Table. 4. WPRD values of each subbands for 12 ECG leads for 6 level wavelet decompositions

Coeff	I	II	III	aVL	aVR	aVF	V1	V2	V3	V4	V5	V6
cA6	0.431	0.216	0.392	0.161	0.423	0.279	0.270	0.376	0.400	0.453	0.204	0.308
cD6	0.235	0.304	0.337	0.306	0.241	0.272	0.371	0.292	0.364	0.488	0.433	0.451
cD5	0.625	0.396	0.588	0.499	0.561	0.435	0.627	0.386	0.567	0.725	0.521	0.513
cD4	0.798	0.605	0.864	0.572	0.786	0.793	0.805	0.593	0.708	0.903	0.657	0.659
cD3	1.170	1.080	0.835	0.793	0.924	1.024	1.206	0.733	1.101	1.257	0.884	0.966
cD2	1.040	1.615	1.296	1.265	1.151	1.319	1.158	0.944	1.353	1.333	0.997	1.115
cD1	0.657	1.428	0.707	0.860	0.580	0.718	0.689	0.508	0.783	2.714	0.910	1.046

- The proposed method is implemented on the PTB dataset.
- The distortion analysis is performed on the retrieved signal, and the result obtained:-
  - Root-Mean-Square-Error(RMSE): 0.0551
  - Mean-Absolute-Error(MAE): 0.0451
  - WPRD values: refer Table 4
- Trained neural network on the dataset, used the retrieved signal to evaluate the model, and compared results with the MEES paper[2] as shown in Table 5.

Table 5. Performance comparisons with existing method

Classifiers	Sensitivity(%)	Specificity(%)	Accuracy(%)
KNN[2]	85	77	81
SVM Linear[2]	90.42	87.69	89
SVM RBF[2]	93	99	96
This Work	**92.86**	**78.94**	**87.80**

5. CONCLUSION

- The proposed model achieved accuracy 87.80%, sensitivity 92.86%, and specificity 78.94%, which shows comparable results with the existing models, which uses ECG signal instead of images for MI detection.
- For future work:
  - Improve the accuracy of the model using a larger dataset and tuning hyper-parameters.
  - Design model to localize the MI using multi-lead ECG images.

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