Supplemental Material of ECGLens

I. Details of the CNN Model for Heartbeat Classification

We clarify our description of the CNN model and provide more details about its architecture, the choice of parameters and the evalution of the model.

Architecture We employ the Multi-Scale Convolutional Neural Network (MCNN) to classify the heart beats [1]. As shown in Fig. 1, this model contains three stages: (1) the transformation stage, which transforms the input signal using three transformation branches, (a) an identity mapping transformation that preserves the original signal, (b) a spectral transformation that generates the multi-scale branch in time domain, and (c) a down-sampling transformation that reduce the data noise and enhance the signal features by generating the multi-frequency branch; (2) a connecting stage, in which the transformation results are fed into a local convolution in which 3 layers of convolution are followed by ReLU and max-pooling layers; and (3) finally a full convolution stage, which concatenates the data and sends it through 2 convolutional layers (each followed by a ReLU and maxpooling layer), a fully connected layer, and finally a softmax.

Parameters : The hyper-parameters in our model include filter size, pooling factor, and batch size. We employed grid search and cross validation to tune the hyper-parameters within specific search spaces. The parameters were trained jointly through back propagation and updated through mini-batch SGD with momentum. The training process was completed before the pilot study, which means the CNN model in the pilot system the same as the one used in the final system (R3).

Dataset and model evaluation The model was trained offline using a public dataset, MIT-BIH. The database has 47 records, which come from 25 male subjects aged 32 to 89 years and 22 female subjects aged 23 to 89 years. Each record is slightly over 30 minutes long with a 360Hz sampling frequency. Each input sequence of the model is composed of 171 sampling points before and after R location in one heartbeat, which is 342 data points in total. For each iteration, we selected 22 records as the testing dataset (DS2), then used the remaining records (DS1) and a private dataset named HEDB for training. The private dataset contains 22 ECG records, each of which includes data for 24 hours. More details about the dataset are shown in Table I. The experiment results showed that the average classification accuracy is 91.59%. More details regarding evaluation metrics for the model will be provided in Table II.

TABLE I
SUMMARY OF DATASETS

Name	N	S	V	F	total	# records
DS1	47134	965	3898	420	52417	22
DS2	45363	1890	3303	396	50952	22
HEDB	82846	37647	34855	0	155348	22

TABLE II
CONFUSION MATRIX

	N	S	V	F	Acc(%)
N	42748	623	1933	59	94.24
S	760	1108	20	2	58.62
V	399	24	2809	71	85.04
F	371	0	24	1	0.25
total	45363	1890	3303	396	91.59

References

[1] G. B. Moody and R. G. Mark. The impact of the mit-bih arrhythmia database. *IEEE Engineering in Medicine and Biology Magazine*, 20(3):45–50, 2001.

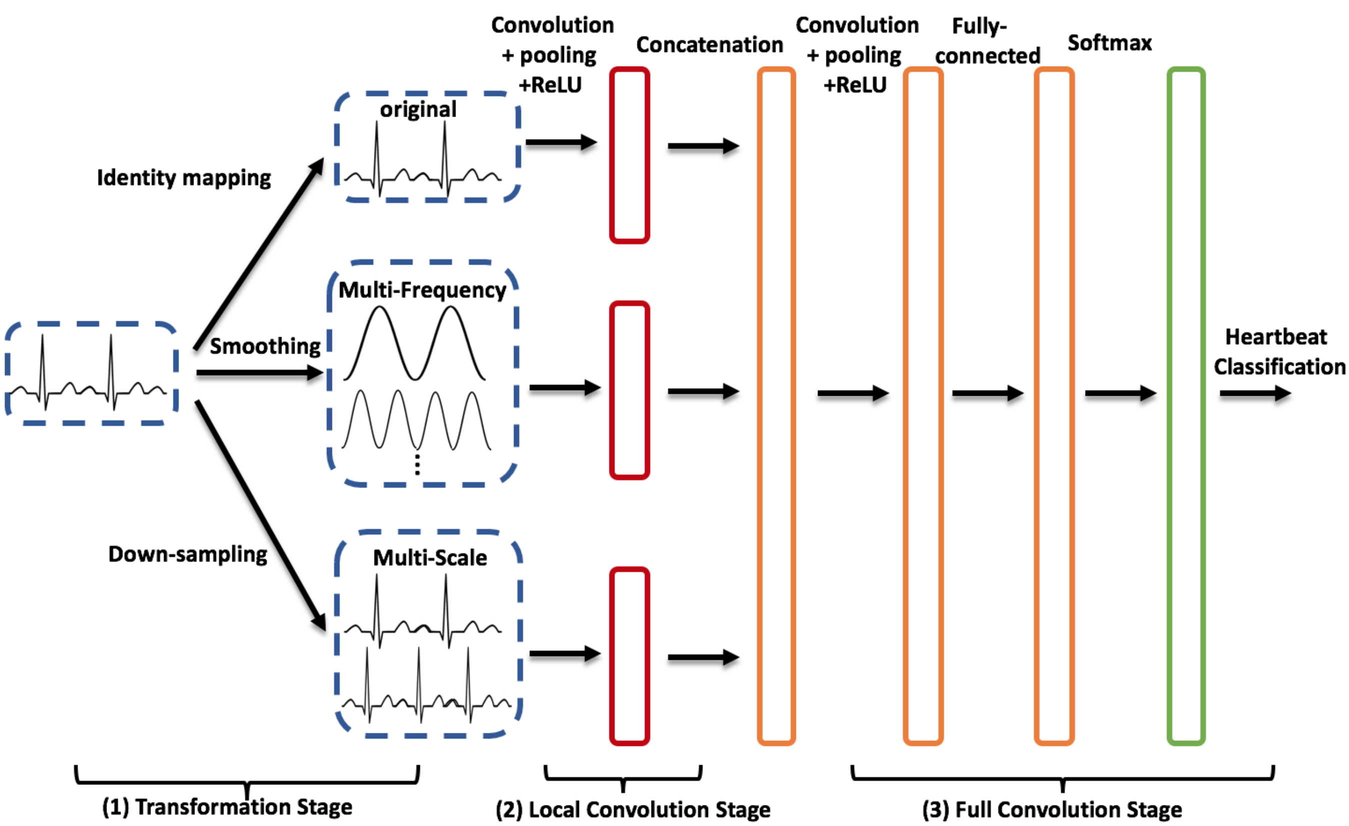

Fig. 1. Overall architecture of MCNN.