

# VPE-Net: Simultaneous Measurement of Heart Rate, Respiration Rate, and Blood Pressure from PPG

Surita Sarkar\*, Pabitra Das\*, Prateek Agrawal\*, Rashmi Kumari\*, Saurabh Pal<sup>+</sup>, Amit Acharyya\*

\* Indian Institute of Technology Hyderabad, <sup>+</sup> University of Calcutta, Kolkata, India

**Aims:** Unexpected irregularity in heart rate (HR), respiration rate (RR), systolic (SBP), and diastolic blood pressure (DBP) are the primary indicators of physiological instability, including chronic cardiopulmonary diseases. This study aimed to develop a deep learning framework, VPE-Net, to monitor these vital parameters from photoplethysmography (PPG) for long-term continuous monitoring, even in ambulatory and home environments.

**Methods:** The block diagram of the proposed model is shown in Fig. 1(A). The model’s performance was evaluated by calculating the mean absolute error (MAE) with standard deviation(SD) to show the effectiveness of our model with others, as most of the prior work had used this error.

**Results:** The MIMIC dataset used in our work for assessment had a simultaneous recording of RR, PPG, ECG, and BP signals of 38 subjects with a sampling frequency of 125 Hz. The model yielded MAE of 1.20 breath rate per minute (brpm), 1.44 beats per minute (bpm), 0.95 mmHg, and 0.77 mmHg for RR, HR, SBP, and DBP, respectively. The value of actual and predicted parameters are represented through a box-whisker plot, as shown in Fig. 1 (B). A quantitative comparison with some earlier studies is shown in Table 1.

**Conclusion:** The results exhibited that the actual values were significantly

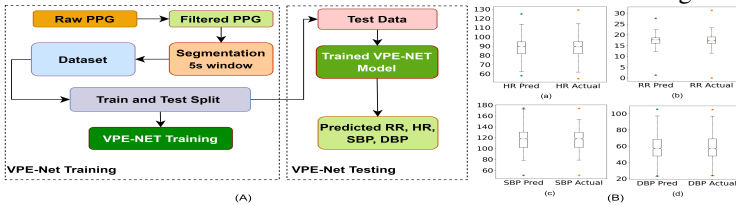


Figure 1: (A) Block diagram of the study, (B) Actual and predicted normalized values of each parameter.

less different from the predicted values, reflecting the proposed framework’s effectiveness for simultaneously measuring all four vital parameters from PPG.

Table 1: Quantitative Comparison of the VPE-Net with previous studies.

Work	Database	Subject	Method used	Performance (MAE±SD)			
				RR (brpm)	HR (bpm)	SBP (mmHg)	DBP (mmHg)
Chowdhury et al.	VORTAL(i), BIDMC (ii)	39 (i), 53(ii)	ConvMixer	1.27(i), 0.77(ii)	–	–	–
Ismail et al.	IEEE signal processing cup	22	Conv-recurrent regressor	–	2.41±2.9	–	–
Yen et al.	Own	100	CNN	–	–	0.17±0.46	0.27±0.52
Lei et al.	MIMIC	90	Comp-ensemble EMD	97.78%	99.95%	–	–
Panwar et al.	MIMIC-II	1557	LRCN	–	2.32±0.095	3.97±0.064	2.30±0.196
<b>Our work</b>	MIMIC-II	38	CNN-GRU-LSTM	<b>1.20</b>	<b>1.44</b>	<b>0.95</b>	<b>0.77</b>