

## Systolic blood pressure estimation using PPG during physical exercise

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### Introduction

- Continuous monitoring of blood pressure not only provides immediate physiological parameters for patient care and monitoring, but also reveals health risks that might eventually lead to hypertension or arteriosclerosis .
- Measurements using brachial cuff can be only obtained intermittently. Measurements using finger cuff is not suitable for long-term use. Measurements using an invasive arterial catheter expose patients to infection risks.
- Photoplethysmography (PPG) has been considered as a method to estimate blood pressure.
- We designed a model using multiple PPG-derived features to estimate systolic blood pressure (SBP) for healthy people during physical exercise.



Fig. 1. Finger photoplethysmography

### Materials and Methods

- N = 19 healthy subjects doing 30-minute cycling exercise
- We initialized the model for each subject at rest.
- We derived 18 features (including 4 proposed features), combined these features using linear regression and quantified their contribution by means of normalized weights
- We evaluated model performance using leave one subject out cross validation (LOSOVC).

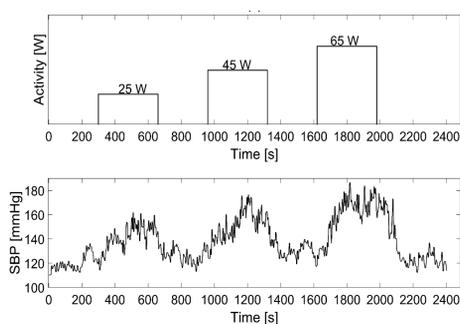


Fig. 2. Study protocol and corresponding SBP changes

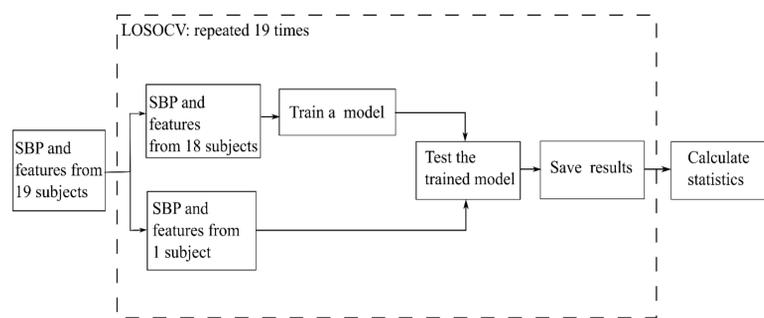


Fig. 4. Block diagram of procedure LOSOCV

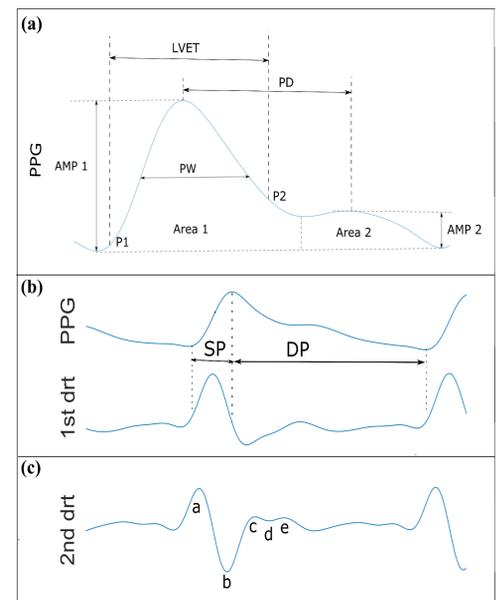


Fig. 3. Derived features. (a) Features derived from the PPG waveform. (b) Features derived from the first derivative of PPG signals. (c) Features derived from the second derivative of PPG signals.

### Results

Table 1 Model performance

Bias	-0.04 mmHg
Standard deviation	14.07 mmHg
Median intra-subject correlation coefficient	0.85

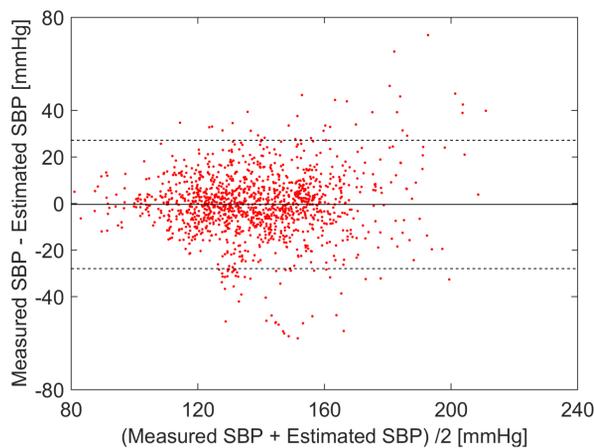


Fig. 5. Bland-Altman plot for estimated and measured SBP

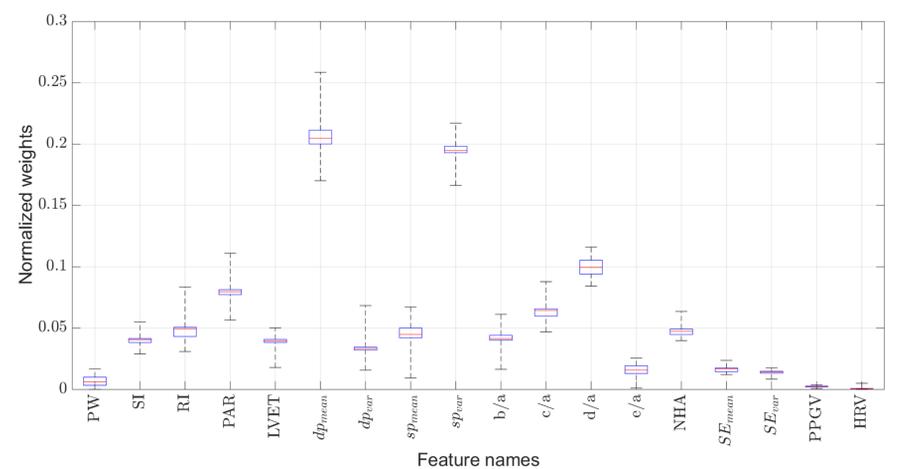


Fig. 6. Normalized weight for each feature from the trained model after all iterations

### Conclusions

- The estimated SBP had high correlations with the measured SBP, while the RMSE still warrants further attention.
- The features we proposed such as  $dp_{mean}$  and  $sp_{var}$  played important roles as indicated by the larger normalized weights