GlucoIR-Net: A Residual Fusion Framework for Glucose Prediction Using IR PPG

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Aim: This study aims to develop a robust and clinically reliable non-invasive blood glucose estimation framework using IR-PPG.

Methods: Data were collected from 99 subjects using an IR-based PPG sensor (MAX30102), with reference glucose values obtained via a standard glucometer. To evaluate generalization, an independent VitalDB dataset was used. PPG signals were preprocessed using bandpass filtering , downsampling, normalization, and segmentation into 5-second windows. Each segment was labeled with corresponding glucose values. A strict subject-wise split was used to prevent data leakage, along with k-fold validation.

The proposed model learns glucose-related features by combining time-domain morphological information and multi-resolution wavelet features, which are fused to predict continuous blood glucose levels via regression.

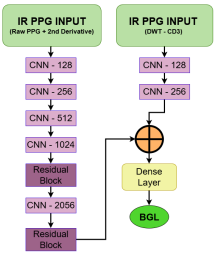

Figure 1: Proposed Model Architecture

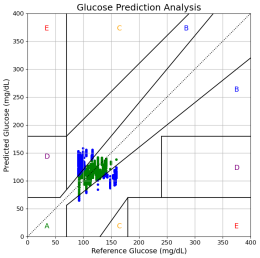

Figure 2: CEG (Vital DB)

Results On unseen subjects from the collected dataset, the model achieved MAE: 8.37 mg/dL and RMSE: 10.28 mg/dL. To assess generalization, evaluation on the independent VitalDB dataset shows consistent performance trends and clinically acceptable predictions, despite differences in acquisition conditions and population distribution. Clarke Error Grid analysis across both datasets shows 100% predictions in Zones A and B, with no clinically unsafe estimates, satisfying ISO 15197:2013 standards.

Conclusion: GlucoIR-Net demonstrates that infrared PPG combined with multi-resolution feature learning enables accurate, clinically reliable, and generalizable non-invasive glucose estimation, supporting its use in real-world and wearable continuous monitoring systems.