UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

21P78

Smart Sensing of Blood Pressure Using Photoplethysmography

Aaron Fainman (1386259), Basheq Tarifi (1696842)

SCHOOL OF ELECTRICAL AND INFORMATION ENGINEERING

INTRODUCTION

Photoplethysmography (PPG) uses light to detect changes in blood volume [1]. The aim of this project is to investigate the use of PPG as a means of developing a cuffless, non-invasive blood pressure (BP) monitor.

METHODS

Arterial BP (ABP) waveforms and PPG waveforms were extracted from 4064 patients from the MIMIC-III database [2].

Multiple neural network architectures were investigated. The final models consist of two sets of networks. Diastolic BP (DBP), Systolic BP (SBP) and Mean Arterial Pressure (MAP) are all predicted using separate 3-layered artificial neural networks (ANNs), with 512 nodes per layer.

A 3-layered ANN with 1024 nodes per layer is used to determine the wave shape. This wave shape is then shifted and scaled by the BP values. This process is shown in Figure 1.

RESULTS

The results for DBP, MAP and SBP are shown in Figure 2, with mean errors of 3.50, 3.65 and 5.32 mmHg respectively. The waveform is generated using a Pearson regression loss function to minimise errors in shape, yielding wave correlation of 86%. Examples of predicted and actual ABP waves are presented in Figure 3.

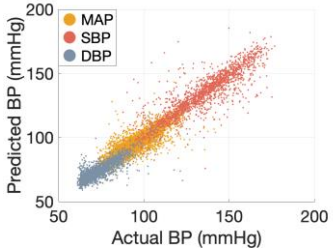

Figure 2: BP Prediction Results

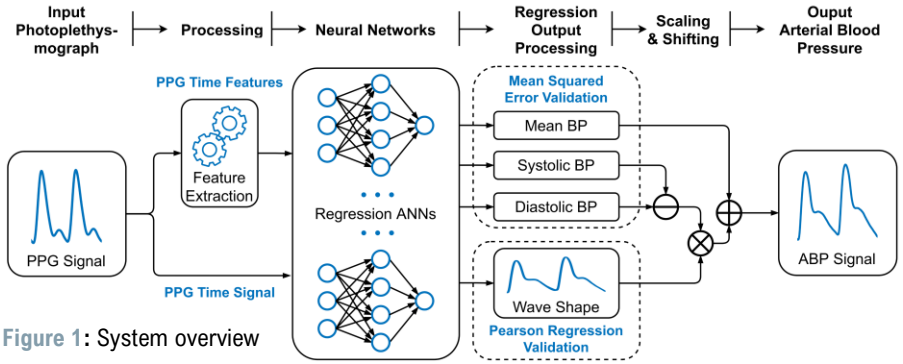

Figure 1: System overview

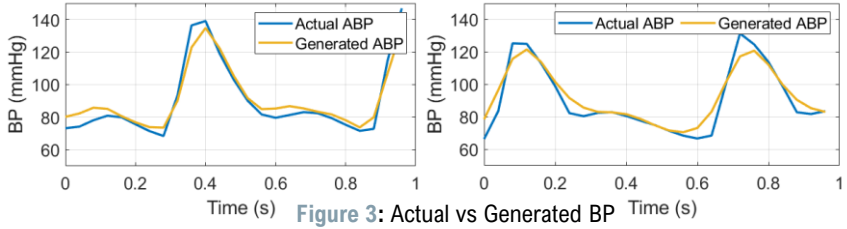

Figure 3: Actual vs Generated BP

HARDWARE IMPLEMENTATION

A basic device using the MAX30102 pulse oximetry IC and an ESP32 MCU was developed, interfaced with a MATLAB application. ABP Waveforms are generated, however the PPG requires calibration to the standard of the training database.

CONCLUSION

The use of PPG can reliably predict blood pressure. Results have 86% correlation and meet standards for blood pressure measurement (<10mmHg error for over 85% of samples). However, accuracy should be improved for hypertensive patients.

REFERENCES

[1] G. Slapničar, N. Mlakar, and M. Luštrek, "Blood pressure estimation from photoplethys-mogram using a spectro-temporal deep neural network," Sensors, vol. 19, no. 15, 2019.

[2] Moody, B., Moody, G., Villarroel, M., Clifford, G., & Silva, I. (2020). MIMIC-III Waveform Database (version 1.0). PhysioNet. https://doi.org/10.13026/c2607m.