Hypertension Risk Assessment from Photoplethysmographic Recordings Using Deep Learning Classificators

Jesús Cano, Vicente Bertomeu-González, Lorenzo Fácila, Roberto Zangróniz, Raúl Alcaraz, José J Rieta

BioMIT.org, Electronic Engineering Department, Universitat Politecnica de Valencia, Valencia, Spain.

Background. Regular monitoring of blood pressure (BP) is essential to make an early detection of cardiovascular diseases caused by hypertension, a potentially deadly condition that do not present symptoms in its first stages. This study aims to investigate whether deep learning techniques can assess risk levels of BP using only photoplethysmographic (PPG) recordings transformed into images by continuous wavelet transforms (CWT), without the need of electrocardiographic (ECG) recordings, as in many previous studies.

Methods. A total of 508 recordings from 38 different patients were analyzed. Each recording contained simultaneous PPG and arterial blood pressure (ABP) signals. ABP recordings were used to define the category label of patients as normotensive (NT), prehipertensive (PH) or hipertnesive (HT). Each recording lasted 120 seconds and were cut into 5 seconds signal segments, thus providing 12.192 segments for analysis. GoogleNet and ResNet pretrained convolutional neural networks (CNN) were used for classification. PPG signals were converted to RGB images using a scalogram, consisting of a time-frequency representation obtained by CWT that later was used as input images for the CNN.

Results. Classification using GoogleNet and ResNet networks was performed dividing the dataset in 80% for training and 20% for validation. The highest F1 score was achieved by discriminating NT patients from PH and HT, being 92.10% for GoogleNet and 93.91% for ResNet, respectively. Discrimination between NT and PH patients from HT patients achieved F1 scores of 84.16% for GoogleNet and 88.23% for ResNet, respectively. In addition, intra-patient classification using different data segments for training and validation provided an F1 score of 90.28% with GoogleNet and 89.04% with ResNet.

Conclusions. Time frequency transformation of PPG recordings to feed deep learning classifiers has been able to provide outstanding results in hypertension risk assessment. Furthermore, the proposed technique does not need neither ECG recordings nor feature extraction, such as many previous methods.