Improved Discrimination Between Healthy and Hypertensive Individuals Combining Photoplethysmography and Electrocardiography

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Background. Cardiovascular disease is one of the leading causes of death, with hypertension (HT) being its main risk factor. Its complications can be avoided with early treatment, but since these patients do not present any symptoms, HT is often detected at very advanced stages. This work presents a model for estimating blood pressure (BP) from electrocardiographic (ECG) and photoplethysmographic (PPG) signals, which can be easily obtained from the patient by means of wearable continuous monitoring devices.

Methods. ECG, PPG and BP recordings from 86 patients were analyzed, with 35 being normotensive, 26 prehypertensive and 25 hypertensive. A total of 34 standard and new features based on previous works were defined, such as pulse arrival times (PAT), and morphological characteristics of PPG signal and its first and second derivatives (VPG and APG), such as pulse width and interval between systolic peaks. 37 classification models, ranging from Logistic Regression, Support Vector Machines (SVM), Nearest Neighbors, Naive Bayes or Coarse Trees were trained to compare discrimination results between the three sets of patients. Classification performance was assessed by Sensitivity (Se), Specificity (Sp) and F1 score aimed at seeking a balance between Precision and Recall.

Results. From all the tested classifiers, the top three providing the highest performance when comparing normotensive patients with prehypertensive and hypertensive patients were quadratic SVM, Naive Bayes and Coarse Tree. Whereas Quadratic SVM provided F1 score of 80.41% (Se of 76.47% and Sp of 80.00%), Naive Bayes reported an F1 score of 84.85% (Se of 82.35% and Sp of 82.86%) and, finally, Coarse Tree provided the highest F1 score of 85.44% (Se of 86.27% and Sp of 77.14%).

Conclusions. The use of PPG and ECG features has successfully discriminated between healthy and hypertensive individuals and, thus, could be used to prevent HT by embedding these techniques in wearable devices.