Documents

Giraldo-Guzman, J.[a] , Contreras-Ortiz, S.H.[b] , Castells, F.[b] , Kotas, M.[c]

Spatio Temporal Filtering of Multi-lead ECG Signals for Atrial Arrhythmia Classification
(2021) *2021 IEEE 2nd International Congress of Biomedical Engineering and Bioengineering, CI-IB and BI 2021*, .

[a] Universidad Tecnologica de Bolivar, School of Engineering, Cartagena de Indias, Colombia
[b] Universitat Politècnica de València, Instituto ITACA, Valencia, Spain
[c] Silesian University of Technology, Nanotechnology and Data Processing, Department of Cybernetics, Gliwice, Poland

Abstract
Atrial fibrillation (AF) is the most common cardiac arrhythmia and increases the risk of suffering stroke. Some people with AF do not have symptoms, so, its diagnosis can be difficult, especially in early stages of the disease. In this paper, we propose the use of the spatio-Temporal filter (STF) to characterize atrial activity in ECG recordings and distinguish between normal sinus rhythm (NSR) and atrial arrhythmias. This method allows the effective detection of P waves when they are synchronized with QRS complexes. The distances from the QRS complexes to the detected P waves are characterized by seven dispersion metrics that are used as inputs to three clustering algorithms. The results show classification accuracy of up to 98.88% of NSR and atrial arrhythmias. © 2021 IEEE.

Index Keywords
Biomedical signal processing, Clustering algorithms, Electrocardiography, Seismic waves; Atrial arrhythmia, Atrial fibrillation, ECG signal processing, ECG signals, Multi-led ECG, Normal sinus rhythm, P waves, QRS complexes, QRST cancellation, Spatio temporal filtering; Diseases

References
- *Cardiovascular Diseases*,
  W. H. Organization

- JI, R.V.U.
  (1983) *Sage Risk of Recurrent Stroke in Patients with Atrial Fibrillation and Non-valvular Heart Disease Stroke*,

- Cotter, P.E., Martin, P.J., Ring, L., Warburton, E.A., Belham, M., Pugh, P.J.
  Incidence of atrial fibrillation detected by implantable loop recorders in unexplained stroke
  (2013) *Neurology*, 80 (17), pp. 1546-1550.

- Jimenez-Serrano, S., Yagüe-Mayans, J., Simarro-Mondejar, E., Calvo, C.J., Castells, F., Millet, J.
  Atrial fibrillation detection using feedforward neural networks and automatically extracted signal features
  (2017) *2017 Computing in Cardiology (CinC) IEEE*, pp. 1-4.

- Bashar, S.K., Ding, E., Albuquerque, D., Winter, M., Binici, S., Walkey, A.J., McManus, D.D., Chon, K.H.
  Atrial fibrillation detection in icu patients: A pilot study on mimic iii data
  2019 41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC). IEEE, 2019, pp. 298-301.

- Andersen, R.S., Poulsen, E.S., Puthusserypady, S.
  A novel approach for automatic detection of atrial fibrillation based on inter beat intervals and support vector machine
  Engineering in Medicine and Biology Society (EMBC) 2017 39th Annual International Conference of the, 2017, pp. 2039-2042.
  IEEE. IEEE

- Mei, Z., Gu, X., Chen, H., Chen, W.
  Automatic atrial fibrillation detection based on heart rate variability and spectral features
  (2018) *IEEE Access*, 6, pp. 53566-53575.

- Islam, S., Ammour, N., Alajlan, N.
  Atrial fibrillation detection with multiparametric rr interval feature and machine learning technique
  (2017), pp. 1-5.

- Kruger, G.H., Latchamsetty, R., Langhals, N.B., Yokokawa, M., Chugh, A., Morady, F., Oral, H., Berenfeld, O.
  Bimodal classification algorithm for atrial fibrillation detection from m-health ecg recordings
  (2019) *Computers in Biology and Medicine*, 104, pp. 310-318.

- Rodenas, J., Garcia, M., Alcaraz, R., Rieta, J.J.
  Wavelet entropy automatically detects episodes of atrial fibrillation from single-lead electrocardiograms
  (2015) *Entropy*, 17 (9), pp. 6179-6199.

- Garcia Teruel, M., Rieta Ibañez, J.J., Alcaraz Martinez, R., Rodenas Garcia, J.
  Application of the relative wavelet energy to 1 heart rate independent detection of atrial fibrillation
  (2016),

- Ladavich, S., Ghoraani, B.
  Rate-independent detection of atrial fibrillation by statistical modeling of atrial activity
  (2015) *Biomedical Signal Processing and Control*, 18, pp. 274-281.

- He, R., Wang, K., Zhao, N., Liu, Y., Yuan, Y., Li, Q., Zhang, H.
  Automatic detection of atrial fibrillation based on continuous wavelet transform and 2d convolutional neural networks
  (2018) *Frontiers in Physiology*, 9, p. 1206.

- Xia, Y., Wulan, N., Wang, K., Zhang, H.
  Detecting atrial fibrillation by deep convolutional neural networks
  (2018) *Computers in Biology and Medicine*, 93, pp. 84-92.

- Zaidi, S.H., Sheikh, S.-A.A., Akhtar, I., Zaidi, T.
  Differentiation between atrial fibrillation and atrial flutter using 1d poincare maps based on endocardial bipolar intracardiac electrograms extracted from the right atria
  Applied Sciences and Technology (IBCAST) 2016 13th International Bhurban Conference on IEEE, 2016, pp. 77-84.

- Razzaq, N., Sheikh, S.-A.A., Zaidi, T., Akhtar, I., Ahmed, S.H.
  Automated differentiation between normal sinus rhythm, atrial tachycardia, atrial flutter and atrial fibrillation during electrophysiology
  (2017) *2017 IEEE 17th International Conference on Bioinformatics and Bioengineering (BIBE). IEEE*, pp. 266-272.

- Fujita, H., Cimr, D.
  Computer aided detection for fibrillations and flutters using deep convolutional neural network
  (2019) *Information Sciences*, 486, pp. 231-239.

- Kotas, M., Jezewski, J., Horoba, K., Matonia, A.
  Application of spatio-Temporal filtering to fetal electrocardiogram enhancement
  (2011) *Computer Methods and Programs in Biomedicine*, 104 (1), pp. 1-9.

- Giraldo-Guzman, J., Kotas, M., Piela, M., Castells, F., Eski, J., Contreras-Ortiz, S.H.
  Application of spatio-Temporal filtering for atrial activity waveforms enhancement
  (2019) *Proceedings of the 2019 2nd International Conference on Sensors, Signal and Image Processing*, pp. 67-72.

- Jacek, M.K., Leski, M.
  Hierarchical clustering with planar segments as prototypes
  (2015) *Pattern Recognition Letters*, 54 (3), pp. 1-10.