Automatic detection of atrial fibrillation

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Cardiac fibrillation is one of the leading causes of morbidity and mortality in the Western world, where atrial fibrillation (AF) is the most common sustained arrhythmia. Because cardiac fibrillation and specifically AF can lead to stroke, early detection of these episodes has enormous clinical impact. To date there are no real-time devices that can precisely detect the R peaks in the ECG signal before, during and after cardiac fibrillation. Our main research objectives were to design an algorithm that accurately detects the R peaks from ECG strips during AF and other arrhythmogenic events in the presence of noise or movement, and to use it as the basis for an artificial intelligence algorithm that accurately identifies AF events in short single ECG lead recordings. An algorithm which subtracts motion artifacts, electrical drift and breathing oscillations was developed. The algorithm fixes the signal polarity, filters environmental noise, and deals with electrical spikes and premature beats by heuristic filtering. The algorithm was tested on the MITDB Physionet database. Based on the R peak annotation, the T, P, Q and S peaks were detected and ECG beat morphology was extracted. Machine learning techniques that include a combination of 61 features were used for classification in to four groups. On average, our algorithm precisely detects the R peaks with 0.26% false negative and false positive detection, for a sensitivity of 99.69% and positive prediction of 99.74%. The algorithm performs similarly on AF and non-AF patient data. Our arrhythmia classification algorithm will classify AF ECG data in 89% of the cases (F1). Precise real-time identification of the heart rate on a beat-to-beat basis and classification of ECG strips can serve as a clinical tool to prescreen for cardiac diseases.

Recent Publications

1. Coast D A, Stern R M, Cano G G and Briller S A (1990) An approach to cardiac arrhythmia analysis using hidden Markov models IEEE Transactions on Biomedical Engineering 37:826–36
2. Costa M D, Peng C K and Goldberger A L (2008) Multiscale analysis of heart rate dynamics: Entropy and time irreversibility measures. Cardiovascular Engineering 8:88–93.
3. Kara S and Okandan M (2007) Atrial fibrillation classification with artificial neural networks Pattern Recognition 40:2967–73.
4. Ladavich S and Ghoraani B (2015) Rate-independent detection of atrial fibrillation by statistical modeling of atrial activity. Biomedical Signal Processing and Control 18:274–81.
5. Gliner V and Yaniv Y (2017) Identification of features for machine learning analysis for automatic arrhythmogenic event classification. Computing in Cardiology DOI: 10.22489/CinC.2017.170-101.

Biography

Yael Yaniv has headed the Bioelectrical and Bioenergetic Systems Lab in the Biomedical Engineering Faculty, Technion-IIT, since 2014. She is best known for her work in the pacemaker field, including characterization of pacemaker biochemical and bioenergetic properties. Her recent interest is the contribution of pacemaker cells to heart rate variability under normal and abnormal rhythms. Her lab has recently developed an algorithm to predict AF episodes.