International Journal of the Cardiovascular Academy 2 (2016) 44–48

Contents lists available at ScienceDirect

International Journal of the Cardiovascular Academy

journal homepage: www.elsevier.com/locate/ijcac

Short communication

Hybrid firefly and Particle Swarm Optimization algorithm for the detection of Bundle Branch Block

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ARTICLE INFO

Article history:
Received 11 September 2015
Accepted 6 December 2015
Available online 17 December 2015

Keywords:
Bundle Branch Block
FFA
PSO
FFPSO
LM NN classifier

ABSTRACT

Abnormal Cardiac beat identification is a key process in the detection of heart ailments. This work proposes a technique for the detection of Bundle Branch Block (BBB) using hybrid Firefly and Particle Swarm Optimization (FFPSO) technique in combination with Levenberg Marquardt Neural Network (LMNN) classifier. BBB is developed when there is a block along the electrical impulses travel to make heart to beat. ECG feature extraction is a key process in detecting heart ailments. Our present study comes up with a hybrid method combining the two meta-heuristic optimization methods, Firefly algorithm (FFA) and Particle Swarm Optimization (PSO), for feature optimization of ECG (BBB and normal) patterns. One of the major controlling forces is the light intensity attraction of FFA algorithm that models the optimum solution. The light intensity attraction process of the FFA algorithm depends on random directions for search, this may delay in achieving the global optimization solution. The hybrid technique FFPSO, integrates the concepts from FF algorithm and PSO and creates new individuals. In the FFPSO method the local search is performed through the modified light intensity attraction step with PSO operator. The FFPSO features are compared with the classical FF, PSO features. The FFPSO feature values are given as the input to the Levenberg Marquardt Neural Network (LM NN) classifier. It has been observed that the performance of the classifier is improved with the help of the optimized features.

Introduction

Electro-cardiogram is used to access the electrical activity of a human heart. The diagnosis of the heart ailments by the doctors is done by following a standard changes. In this project our aim is to automate the above procedure so that it leads to correct diagnosis. Early diagnosis and treatment is of great importance because immediate treatment can save the life of the patient. BBB is a type of heart block in which disruption to the flow of impulses through the right or left bundle of His, delays activations of the appropriate ventricle that widens QRS complex and makes changes in QRS morphology. The changes in the morphology can be observed through the changes in the ECG. Good performance depends on the accurate detection of ECG features. ECG changes in Left Bundle Branch Block (LBBB) are:

- Increased QRS complex duration (≥0.12 s)
- Increased Q wave amplitude
- Abnormal T wave

ECG changes in Right Bundle Branch Block (RBBB) are:

- Increased QRS complex duration (≥0.12 s)
- RSR' format
- T wave inversion

Detection of BBB using ECG involves three main steps: preprocessing, feature extraction and classification. The first step in preprocessing mainly concentrates in removing the noise from the signal using filters. The next step in the preprocessing is the 'R' peak detection then these 'R' peaks are used to segment the ECG file into beats. The samples that are extracted from each beat contain non-uniform samples. The non-uniform samples in each beat are converted into uniform samples of size 200 by using a technique called resampling. The resampled ECG beat.

In the feature extraction procedure, a fraction of signal around the R peak is extracted as the time-domain features since the R peak of ECG signals is an important index for cardiac diseases. To ensure the important characteristic points of ECG like P, Q, R, S and T are included, a total of 200 sampling points before and after the R peak are collected as one ECG beat sample.

P, Q, R, S and T waves provides information regarding amplitudes and relative time intervals of ECG. These changes in the ECG are called morphological transitions. The morphological changes (P, QRS complex, T, U waves) of ECG are due to the abnormalities in the heart. BBB is one

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Peer review under responsibility of The Society of Cardiovascular Academy.

http://dx.doi.org/10.1016/j.ijcac.2015.12.001
2405-8181/

such morphological abnormality seen in the heart diseases. In the previous studies morphological features are extracted for clinical observation of heart diseases. The feature extraction using traditional techniques generally yield a large number of features, and many of these might be insignificant. Therefore, the common practice is to extract key features useful in the classification.

This paper presents meta-heuristic FFPSO, is used as a feature extraction method instead of using traditional feature extraction/optimization techniques. A large number of meta-heuristic techniques have been designed to solve feature optimization problem. Some of the methods among all these are Genetic Algorithm (GA),[7] Particle Swarm Optimization (PSO),[6] Bacterial Foraging Optimization(BFO),[4,5,3] Firefly Algorithm (FFA)[13] etc.

Meta-heuristic algorithms are proven to outperform the gradient based algorithms for real world optimization problems. Firefly algorithm[1] is one such newly designed algorithm mimicking flashing mechanism of fireflies. A detailed explanation and formulation of the firefly algorithm is given in Section 4.

Traditional Firefly Algorithm (FFA)[2] has one disadvantage of getting trapped into the local optimum. Sometimes it is unable to come out of that state. The parameters in the firefly algorithm are fixed and do not have any mechanism to remember the previous best situation of each firefly and this makes them move regardless of its previous better solution.

In this paper, a novel hybrid optimization method concurrently combines the FFA with the PSO. Now a days the PSO[10] is a swarm based optimization algorithm and it takes inspiration from a group of birds or a group of fish etc. The proposed hybrid algorithm fulfills local search by using the light intensity operation mechanism of FFA whereas the global search is accomplished by a PSO operator. Using this combination it maintains a balance between 'exploration' and 'exploitation' and enjoying the best of both the algorithms (FFA and PSO).[12] The proposed method, referred to as Firefly Particle Swarm Optimization (FFPSO) has been compared with the normal PSO and FFA. The following comparative measures were used to study the (i) accuracy of the final solution, and (ii) convergence speed. Such comparison shows the superiority of the proposed algorithm. This algorithm outperformed both PSO and FFA over a few ECG benchmarks sets for the classification problem.

The ECG classification flow diagram is shown in the Fig. 1.

Preprocessing

To prove the performance of proposed technique, the usual MIT BIH arrhythmia database[9] is considered. The data used in this algorithm confines to 11 recordings that consists of 5 normal, 3 LBBB and 3 RBBB for a duration of 60 min at 360 Hz sampling rate. Total number of ECG beats used for classification are 19,039. De-noising of ECG data is a preprocessing step that removes noise and makes ECG file useful for subsequent steps in the algorithm. The Sgolay FIR smoothing filter is used for removing the noise in ECG signals. The next step in the preprocessing is the R peak detection, then segmentation of ECG file into beats (P, QRS Complex), by taking R peaks as the reference points.

Feature extraction

In the feature extraction procedure, a fraction of signal around the R peak is extracted as the time-domain features since the R peaks of ECG signal are an important index for cardiac diseases. To ensure the important characteristic points of ECG like P, Q, R, S and T are included, a total of 200 sampling points before and after the R peak are collected as one ECG beat sample. The samples that are extracted from each beat contain nonuniform samples. The nonuniform samples in each beat are

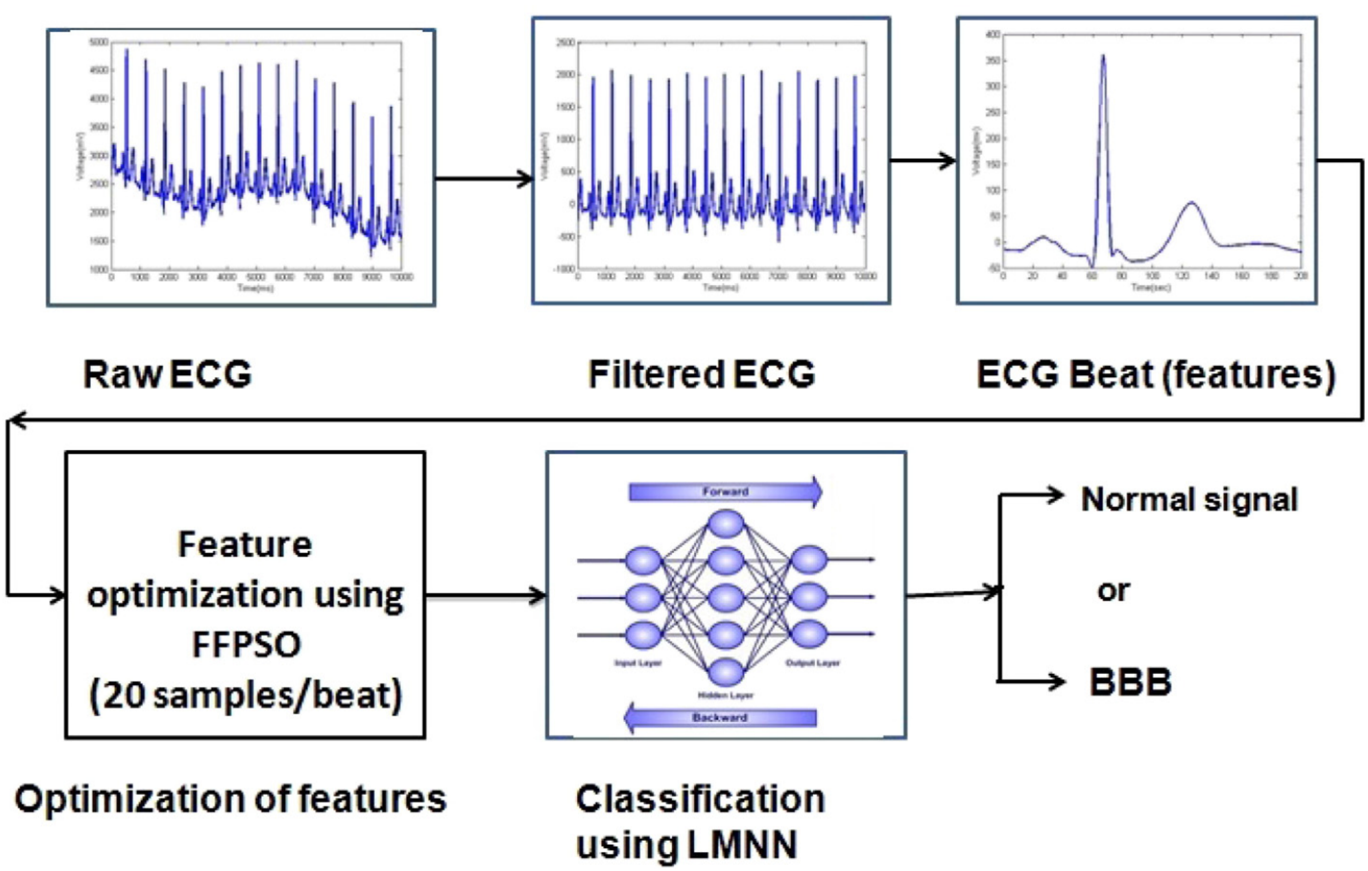

Fig. 1. ECG classification using FFPSO.