ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 1, January 2017

Automatic Detection of Atrial Fibrillation Using PSO

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ABSTRACT: The project implementation is on the feasibility of the automatic detection of atrial fibrillation (AF) from cardiac vibration signals (ballistocardiograms/BCGs) recorded by unobtrusive bed mounted sensors. The proposed system is intended as a screening and monitoring tool in home-healthcare applications and not as a replacement for ECG-based methods used in clinical environments. Based on the BCG data recorded in a study with ten AF patients, we evaluate and rank popular machine learning algorithms (support vector machines, random forests) for their performance. More interestingly the input ECG data is passed into a optimizer using PSO to enhance the feature selection and finally resulting into more accuracy classification output. Particle Swarm Optimization (PSO) is a biologically inspired computational search and optimization method developed in 1995 by Eberhart and Kennedy based on the social behavior of birds flocking or fish schooling.

KEYWORDS:Atrial fibrillation, Cardiac arrhythmia, Log-energy entropy, Particle Swarm Optimization (PSO), Support vector machine.

I. INTRODUCTION

Atrial fibrillation (AF) is one of the most common cardiacarrhythmias. The prevalence of AF is about 1 % in the general population with an emphasis on the elderly. AF can persist clinical asymptomatic and is liable for increasing the rate of death, hospitalization, stroke and otherthromboembolic events as well as causing severe heart failureand left ventricular dysfunction. Knowing that 70 % ofthe patients affected by AF are at least 65 years old and considering the risk of silent and undetected AF, there is aneed for screening this population.In recent years, the bed has emerged as a promising place for long-term monitoring of cardiopulmonary activityat home. Furthermore, instrumented beds could be applied in the general wards of hospitals to increase the safetyof the patients and improve patient outcome. One promising approach for unobtrusively measuringcardiopulmonary activity is the integration of highly sensitive me chanical sensors into the bed-frame or mattresswhich record the vibrations of the body caused by themechanical activity of the heart. Techniques measuringcardiac-related vibrations of the body are known under avariety of terms such as ballistocardiography [2], seismocardiography[3], apexcardiography [4], mechanocardiography[5], as well as kinetocardiography [6]. New sensormodalities and applications have blurred the lines betweenthe original definitions of these terms. Since we feel that ballistocardiography (BCG) is the most widely used termin recent literature, we will continue to use it to describeour method which records any and all movements of thecardiovascular system as they affect the thorax and can beregistered by a mattress-mounted sensor along its verticalaxis.Modern BCG system have been integrated into objectsof daily life, such as beds or chairs. These systemsshare the common advantage that they are unobtrusive andthat they do not require direct skin contact, such as, forexample, a conventional ECG. Hence, they are very wellsuited for long-term monitoring. It is important to distinguishthis application, where only the BCG signal is available,from the BCG's other major use, where an ECG isrecorded simultaneously and, for example, hemodynamicparameters are derived from the combination of both signals.This work focuses on the automatic detection of cardiacarrhythmias using a single BCG sensor. For this purpose,we obtained BCG recordings of 10 patients withatrial fibrillation (AF). Time-domain and time-frequencydomainfeatures were used to train a support vector machine(SVM) classifier to detect AF episodes in the BCG

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We present a project on the feasibility of the automatic detection of atrial fibrillation (AF) from cardiac vibration signals (ballistocardiograms/BCGs) recorded by unobtrusive bed mounted sensors. ECG Data though it is a hype up-springing many technical challenges that confront both academic research communities and commercial medical deployment, the root sources of ECG Data are founded on data streams and the curse of dimensionality. It is generally known that data which are sourced from data streams accumulate continuously making traditional batch-based model induction algorithms infeasible for real-time data mining. Feature selection has been popularly used to lighten the processing load in inducing a data mining model. However, when it comes to mining over high dimensional data the search space from which an optimal feature subset is derived grows exponentially in size, leading to an intractable demand in computation. In order to tackle this problem which is mainly based on the high-dimensionality and streaming format of data feeds in ECG Data, a novel lightweight feature selection is proposed. The feature selection is designed particularly for mining streaming data on the fly, by using particle swarm optimization (PSO) type of swarm search that achieves enhanced analytical accuracy within reasonable processing time. For each algorithm, feature subsets of a set of statistical time-frequency-domain and time-domain features were selected based on the mutual information between features and class labels as well as the first- and second-order interactions among features.

II. Related work

1. Jasper Diesel, Stefan Winter "Automatic Detection of Atrial Fibrillation in Cardiac Vibration Signals"[1] From This Paper we Referred-
Accelerated PSO Swarm Search Feature Selection for Data Stream Mining Big Data Recently a lot of news in the media advocates the hype of Big Data that are manifested in three problematic issues. They are the 3V challenges known as: Velocity problem that gives rise to a huge amount of data to be handled at an escalating high speed; Variety problem that makes data processing and integration difficult because the data come from various sources and they are format-ted differently; and Volume problem that makes storing, processing, and analysis over them both computational and archiving challenging. In views of these 3V challenges, the traditional data mining approaches which are based on the full batch-mode learning may run short in meeting the demand of analytic efficiency. That is simply because the traditional data mining model construction techniques require loading in the full set of data, and then the data are partitioned according to some divide-and-conquer strategy; two classical.Algorithms are Classification And Regression Tree algorithm (CART)for decision tree induction and Rough-set discrimination. Each time when fresh data arrive, which is typical in the data collection process that makes the big data inflate to bigger data, the traditional induction method needs to re-run and the model that was built needs to be built again with the inclusion of new data.

2. Arkady Zaslavsky, Shonali Krishnaswamy, "Mining data streams"[2] From This Paper we Referred-
The recent advances in hardware and software have enabled the capture of different measurements of data in a wide range of fields. These measurements are generated continuously and in a very high fluctuating data rates. Examples include sensor net-works, web logs, and computer network traffic. The storage, querying and mining of such data sets are highly computationally challenging tasks. Mining data streams is concerned with extracting knowledge structures represented in models and patterns in non stopping streams of information. The research in data stream mining has gained a high attraction due to the importance of its applications and the increasing generation of streaming information. Applications of data stream analysis can vary from critical scientific and astronomical applications to important business and financial ones. Algorithms, systems and frameworks that address streaming challenges have been developed over the past three years. In this review paper, we present the state-of-the-art in this growing vital field.

3. The Simon Fong, Suash Deb, Xin-She Yang, Jinyan Li, "Metaheuristic Swarm Search for Feature Selection in Life Science Classification"[3] From This Paper we Referred-
The purpose of classification in medical informatics is to predict the presence or absence of a particular disease as well as disease types from historical data. Medical data often contain irrelevant features and noise, and an appropriate subset of the significant features can improve classification accuracy. Therefore, researchers apply feature se-lection to identify and remove irrelevant and redundant features. The authors propose a versatile feature selection approach called Swarm Search Feature Selection (SS-FS), based on stochastic swarm intelligence. It is designed to overcome NP-hard combinatorial search problems such as the selection of an optimal feature subset from an extremely large array of

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features–which is not uncommon in biomedical data. SS-FS is demonstrated to be a feasible computing tool in achieving high accuracy in classification via testing with two empirical biomedical datasets. This article is part of a special issue on life sciences computing.

4. Users Fong, S., Liang, J., Wong, R., Ghanavati, M., "A novel feature selection by clustering coefficients of variations" [4] From This Paper we Referred-
One of the challenges in inferring a classification model with good prediction accuracy is to select the relevant features that contribute to maximum predictive power. Many feature selection techniques have been proposed and studied in the past, but none so far claimed to be the best. In this paper, a novel and efficient feature selection method called Clustering Coefficients of Variation (CCV) is proposed. CCV is based on a very simple principle of variance-basis which finds an optimal balance between generalization and over fitting. Through a computer simulation experiment, 44 datasets with substantially large number of features are tested by CCV in comparison to four popular feature selection techniques. Results show that CCV outperformed them in all aspects of averaged performances and speed. By the simplicity of design it is anticipated that CCV will be a useful alternative of pre-processing method for classification especially with those datasets that are characterized by many features.

5. Xin-She Yang, Suash Deb, Simon Fong, "Accelerated Particle Swarm Optimization and Support Vector Machine for Business Optimization and Applications"[4] From This Paper we Referred-
Business optimization is becoming increasingly important because all business activities aim to maximize the profit and performance of products and services, under limited resources and appropriate constraints. Recent developments in support vector machine and meta heuristics show many advantages of these techniques. In particular, particle swarm optimization is now widely used in solving tough optimization problems. In this paper, we use a combination of a recently developed Accelerated PSO and a nonlinear support vector machine to form a framework for solving business optimization problems. We first apply the proposed APSO-SVM to production optimization, and then use it for income prediction and project scheduling. We also carry out some parametric studies and discuss the advantages of the proposed meta heuristic SVM.

III. PROPOSED ALGORITHM

A. Particle Swarm Optimization Algorithm

The process of PSO algorithm in finding optimal values follows the work of this animal society. Particle swarm optimization consists of a swarm of particles, where particle represent a potential solution.

The classical PSO algorithm is as follows;

1. Initialize the particles with random velocities and positions in a given Dimension.
2. Compute the fitness of all particles using the desired benchmark function, choose the lowest one as global best and assign the current positions of all particles as their best.
3. Calculate the next velocities and positions using the equations 1 and 2.
4. Calculate the fitness of all particles using the updated velocities and positions. If the new fitness is less than the particles best fitness, the new fitness is considered the best one. In the same way the new position is considered the particle best position.
5. In the same way if the new particle's best fitness is less than the overall global best fitness, it is considered the new best global fitness and its corresponding position is considered new global best position.

Mathematical Model

Datamining Training
Set V:
V= Get Patient ECG Dataset (Bulk)
V1=Extract Data
V2=Apply Low Pass Filter

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V3=Apply High Pass Filter V4=Normalize Data
V5= Apply PSO for Optimization (Feature Selection)
V6=Input Optimized Data for Training SVM/Random Forest V7=Save Trained Samples
V8= Generate Logs
Datamining Classification:
Set P:
V0= Get Patient ECG
V1=Extract Data
V2=Apply Low Pass Filter
V3= Apply High Pass Filter
V4= Normalize Data

P0=Initialize and Select Classifier
P1=Read Trained Samples
P2=Input Test Samples
P3= Input Trained Samples
P4=Classify Class Lable

Representation of Sets and its operation:
Union and Intersection Representation:
Set V = {V0,V1,V2,V3,V4,V5,V6,V7,V8}
Set P= {V0,V1,V2,V3,V4,P0,P1,P2,P3,P4}
Set (V \ P)={V0,V1,V2,V3,V4,V5,V6,V7,V8,V9,V10,P0,P1,P2,P3,P4}
Set (V \ P) ={V0,V1,V2,V3,V4}

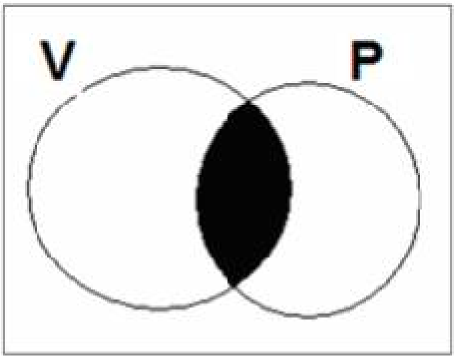

Figure 1: Venn diagrams for intersection representation

IV. SYSTEM ARCHITECTURE

The Input to the system is ECG Dataset downloaded from MIT-BIH Arrhythmia Database. This input set is first given to the Optimizer for data reduction and proper selection of data. Here we apply PSO Feature Selection method. This process input the functioning from PSO framework. After proper optimization of data the optimized data is forwarded to Normalization process.
The Normalization process uses LOW PASS and HIGH PASS FILTERS.The Data collected by the sensor is filtered using High Pass and Low Pass Filter. The process filters the noise and outputs a noise free data which we call as

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Normalized data. The Normalized data is saved in the database. The Normalized data is now forwarded to Training section of the system.

Two well know datamining classifiers are user VM and Random Forest for Training and classification of ECG features dataset.

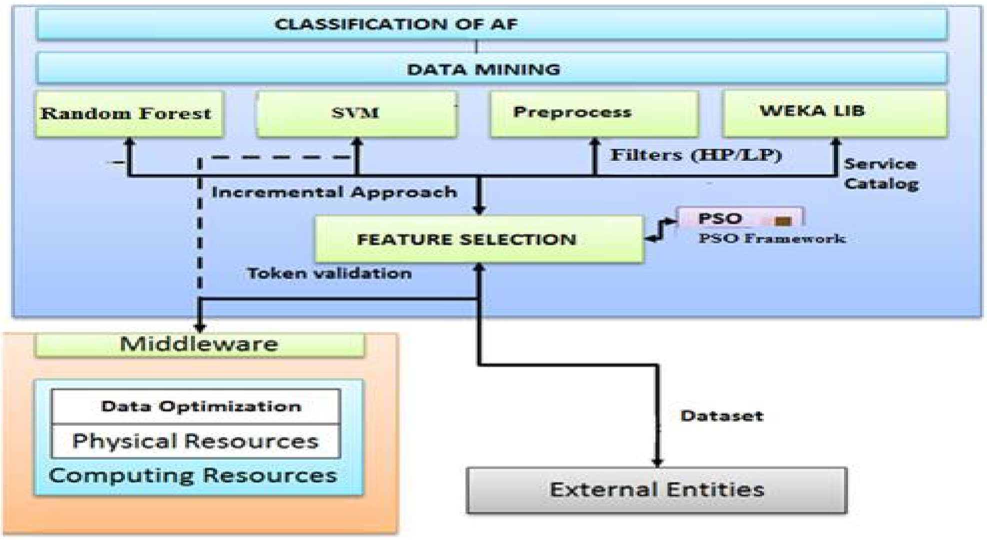

Figure2: System architecture

V. EXPERIMENTAL ANALYSIS

Predictive analytics is the branch of the advanced analytics which is used to make predictions about unknown future events. Predictive analytics uses many techniques from data mining, statistics, modeling, machine learning, and artificial intelligence to analyze current data to make predictions about future. In this project prediction analysis are two mode using default mode (780ms) and using PSO mode (374ms)

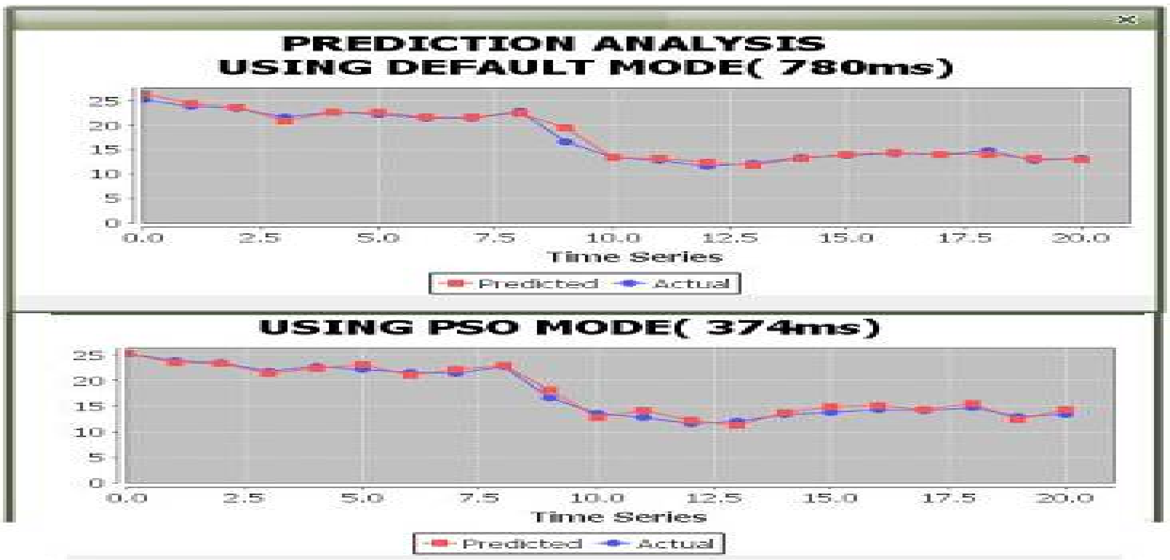

Figure 3: Prediction Analysis

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PSO results is best feature selection of data and thus enhance the Random Forest performance and accuracy

VI. CONCLUSION AND FUTURE WORK

We evaluated and discussed algorithms for the automatic detection of AF epochs from signals recorded using an unobtrusive bed-mounted vibration sensor. Based on the given set of time-frequency-domain and time-domain features and our optimization strategy, RF classifiers seem to be the most suitable algorithms for the task of separating the three classes: normal, arrhythmia, and PVC. The process of PSO algorithm in finding optimal values follows the work of an animal society which has no leader. Particle swarm optimization consists of a swarm of particles, where particle represent a potential solution (better condition). Particle will move through a multidimensional search space to find the best position in that space (the best position may possible to the maximum or minimum values). PSO results is best feature selection of data and thus enhance the Random Forest performance and accuracy.

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