Abstract—Cardiac Arrhythmia is irregular heartbeat caused by irregular rhythms. The heartbeat is either slowed down or increased causing irregular rhythm. Electrocardiogram (ECG) is used to assess the heart arrhythmia. Different types of arrhythmia which are relevant to diagnosis of heart disease are accurately detected using ECG. Automatic assessment of arrhythmia from ECG is widely researched. Features in the form of RR interval extracted from the ECG and used for classifying the arrhythmia. In this paper, a new approach for cardiac arrhythmia classification is proposed. The proposed method incorporates Support Vector Machine (SVM) approach with Polynomial kernel and Radial Basis Function (RBF). First, the features are extracted from the time series ECG data using Discrete Cosine Transform (DCT) and the distance between RR wave computed. Experiments were conducted using MIT-BIH arrhythmia database.

Keywords—Cardiac Arrhythmia, Electrocardiogram (ECG), RR interval, Discrete Cosine Transform (DCT), Support Vector Machine (SVM).

I. INTRODUCTION

The electrocardiogram (ECG) is the bioelectrical activity signal of the heart muscles and electrocardiograph is a graph that records this electrical voltage of the heart. It plays a crucial role in the diagnosis of cardiovascular diseases. ECG represents arterial depolarization and ventricular repolarization of the heartbeat. The ECG signal is obtained through a number of electrodes. P, Q, R, S, and T [1] as shown in Figure 1, are the peaks and other ECG waveforms. Different characteristics, such as PR, QRS, and ST intervals are also used in diagnosis of cardiac arrhythmia [2]. Guidelines for standards are summarized in [3] for categorizations of heart rate variability measures. Summary of measures and models is presented in [4], and the physiological origins and mechanisms of heart rate are examined can be found in [5].

Cardiac Arrhythmia is an irregular heartbeat caused by irregular rhythms [6]. The heartbeat is either slowed down or increased causing irregular rhythm. Arrhythmias are indications of the serious heart problems. Visual inspection for diagnosis of arrhythmia takes time and is a tedious process, thus, automatic classification of heartbeat is beneficial for medical professionals for fast diagnosis of heart beat. Automatic arrhythmia detection and classification performed in real time is critical in clinical cardiology. Pattern classifier techniques are utilized to improve ECG arrhythmia diagnoses. The ECG recordings beats vary from person to person due to noise and the amplitude. Hence, the signals are preprocessed for beat detection and feature extraction.

Automatic assessment of arrhythmia from ECG is widely researched. The problem of automatic detection and classification of cardiac rhythms and arrhythmia is researched. Heart Rate Variability (HRV) analysis measures the variability of heart rate signals, with specific reference to variations per unit of time of the number of heartbeats. This is called as RR interval, as it is the time interval between consecutive R points of QRS complex of the electrocardiogram. The position and magnitudes of PR interval and segment, ST interval, QRS interval [7, 8], and QT interval are popularly used to diagnosis of heart disease. The features are either selected from the time
domain or frequency domain. The wavelet transform methods are widely used for denoising of the ECG signal [9, 10].

In this work, it is proposed to investigate the classification accuracy of Support Vector Machine (SVM) on ECG data. The time series data obtained from MIT-BIH is converted to frequency domain using Discrete Cosine Transform (DCT) for feature extraction. Two types of arrhythmia namely LBB and RBB are considered for classification. Datasets used for evaluation of automated classification of ECG signals incorporate many different features. One of the most popular and widely used databases in the research of arrhythmia detection and classification is the MIT-BIH database. In this paper, the proposed method is evaluated using the MIT-BIH database.

II. RELATED WORK

The most essential bio-signal implemented by cardiologists for diagnostic purposes and for further suitable treatment is provided by a graphical record of the electrical tension of the heart called ECG. The automatic detection of cardiac arrhythmia disorders is necessitated due to the complexities faced in interpretation of ECG signals while investigated by the researchers. Easy interpretation of complex ECG signals is achieved by the data analysis methods using specific computer software for the prediction of the presence/absence of cardiac arrhythmia. This work facilitates real time analysis and also supports timely diagnosis. Bhardwaj et al., [11] applies Support Vector Machine (SVM) technique, using LibSVM3.1 for arrhythmia classification in five categories, for ECG dataset. In the categories presented one category is for normal and the other four categories are for arrhythmic beat. The investigation is performed on a dataset of 3003 arrhythmic beats from which for training 2101 beats (70%) are employed and for the purpose of testing the rest of the 902 beats (30%) are used. About 95.21 % was the total performance accuracy achieved.

The main problem to provide suitable therapy delivery in implantable cardioverter defibrillators (ICDs) is due to the exact classification of Arrhythmia. Milpied et al., [12] proposed a novel algorithm for the purpose of arrhythmia discrimination, spatial projection of tachycardia (SPOT). EGMs which are based on a statistical classification using support vector machines of new 2-D representation of electrograms (EGMs). In a test database the proposed SPOT-based discrimination algorithm achieved 98.8% of sensitivity and 91.3% of specificity. Additionally, the algorithm’s a simplified version is also provided for direct utilization in the ICD. Therefore, the proposed SPOT-based morphological algorithm provides promising results.

Tsipouras et al., [13] proposed a new approach to classify arrhythmic beat automatically. The proposed approach is developed on the basis of RR interval signal analysis that is extracted from ECG recordings. Implementing SVM methodology, the classification are performed, for the purpose of formulating a quadratic programming problem subjected to basic limitations that are efficiently resolved by employing the BOXCQP approach. The classification of four types of cardiac rhythms beats is done, they are: 1) the ventricular flutter/fibrillation episodes beats, 2) premature ventricular contractions, 3) normal sinus rhythm and 4) the heart block episodes beats. Using the MIT-BIH arrhythmia database, the proposed approach is evaluated, and the results are illustrated. Therefore, the proposed method using BOXCQP method is able to produce faster solution than the other methods for a particular problem and reveals high-throughput in classifying the cardiac beats efficiently.

The base signal used to observe the functioning of the heart is the HRV. The nature of HRV signals is non-stationary and non-linear. Hence, the higher order spectral (HOS) analysis was employed that’s more appropriate to non-linear systems and is also robust to noise. In healthcare technology, an intelligent system for the identification of cardiac health automatically, is very essential. Chua et al., [14] using HOS extracted seven features from the heart rate signals and for the purpose of classification fed them to a support vector machine (SVM). 330 subjects’ five different kinds of cardiac disease conditions were used to evaluate the performance of the proposed protocol. 90% of sensitivity for the classifier with 87.93% of specificity was illustrated. Therefore, the proposed algorithm can be efficiently applied to large sets of data also.

In patients with structural heart disease, the risk of development of life-threatening ventricular arrhythmias is much greater along with more premature ventricular complex (PVC) occurrence. Due to the complexity of early diagnosis, the detection and classification also becomes very complicated. So the models that can be implemented should provide ensuring robustness and be significantly efficient. In this setting, the existing models show that neural networks (NN) are validated to be efficient but, Ribeiro et al., [15] reveal that superior performance can be obtained using kernel-based learning algorithms. Specifically, the currently used sparse Bayesian approaches like Relevance Vector Machines (RVM) provide a low-costing solution compared to Support Vector Machines (SVM), and also illustrate more accuracy and high-throughput. Hence, RVM is made more appropriate for the real-time applications because the computational complexity is substantially reduced in it.

III. METHODOLOGY

**RR Interval**

The peak amplitude of R signal is measured from k line. The k line is given by:

\[
k = \text{Max}( \theta_i, i = 1, 2, \ldots, 11 ) + c\]

where \( \theta \) is the greatest amplitude, type of heartbeat, and c is a constant.

For training and testing, ECG is taken from MIT-BIH arrhythmia database (mitdb) [16]. LBBB (Left Bundle Branch Block), RBBB (Right Bundle Branch Block) and normal are selected for classification.

**Discrete Cosine Transform (DCT)**

Discrete Cosine Transform (DCT) transforms time series signal into basic frequency components. Forward discrete
cosine transform (FDCT) decomposes an image into a set of cosine basis functions and the process of reconstructing is called inverse discrete cosine transform (IDCT).

The FDCT \[17\] of a list of \( n \) real numbers \( s(x) \), \( x = 0, ..., n-1 \), is the list of length \( n \) given by:

\[
S(u) = \sqrt{2/n} \sum_{x=0}^{n-1} s(x) \cos \left( \frac{2x+1}{2n} \pi u \right)
\]

where \( C(u) = 2^{\frac{u}{2}} \) for \( u=0 \) or otherwise \( C(u) = 1 \).

The constant factors are chosen so that the basis vectors are orthogonal and normalized.

The inverse discrete cosine transform (IDCT):

\[
S(x) = \sqrt{2/n} \sum_{u=0}^{n-1} C(u) s(u) \cos \left( \frac{2x+1}{2n} \pi u \right)
\]

where \( C(u) = 2^{\frac{u}{2}} \) for \( u=0 \) or otherwise \( C(u) = 1 \).

Support Vector Machine (SVM)

Support Vector Machine (SVM) is a supervised learning method based on generalized linear classifiers. SVMs are useful for data classification. SVM separates the data with a hyperplane as shown in Figure 2 and extend the non-linear boundaries using kernel \[18\]. The inputs are mapped into a high dimensional space using nonlinear basis functions in SVM. The input is in the form of vectors of real numbers. So, any categorical attribute used as a feature is represented in numeric data. SVMs is trained and tested for classification tasks using a set of training data instances. The instance contains class value which is the target value and several features. On training the SVM, predicts the class of the test instances on the basis of the features.

![Fig. 2: Representation of Hyper planes.](image)

For a training set consisting of instances \((x_i; y_i), i = 1, ..., i\) where \( x_i \in \mathbb{R}^n \) and \( y_i \in \{1, -1\} \), the support vector machines (SVM) has to solve the following optimization problem \[19\]:

\[
\min_{w, b, \xi} \frac{1}{2} w^T w + C \sum_{i=1}^{i} \xi_i
\]

Subject to

\[
y_i \left( w^T \phi(x_i) + b \right) \geq 1 - \xi_i
\]

Polynomial and Radial Basis function (RBF) are the different kernel functions used in this study.

1] Polynomial:

\[
k(x, x') = (x \cdot x')^d
\]

2] Gaussian Radial Basis Function: A RBF kernel models non-linear relation of class labels and features. Radial basis functions most commonly with a Gaussian form

\[
k(x, x') = \exp \left( - \frac{\|x - x'\|^2}{2\sigma^2} \right)
\]

IV. RESULTS AND DISCUSSION

A total of 153 images are used for evaluating the SVM. The classification results generated using polynomial and Gaussian RBF is shown in Table 1. Figure 3 shows the classification accuracy of the two kernels.

<table>
<thead>
<tr>
<th>Table 1: Classification Results for Polynomial and Gaussian RBF</th>
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<tbody>
<tr>
<td>SVM – RBF kernel</td>
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<tr>
<td>------------------</td>
</tr>
<tr>
<td>Correctly Classified Instances</td>
</tr>
<tr>
<td>Incorrectly Classified Instances</td>
</tr>
<tr>
<td>Root mean squared error</td>
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<tr>
<td>Relative absolute error</td>
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![Fig. 3: Classification Accuracy for both the kernels](image)
It is seen from Fig. 3, that the Gaussian RBF kernel performs better than the Polynomial kernel. The classification accuracy obtained by RBF kernel is 92.16\%. The precision, recall and f measure for the techniques used is shown in Fig. 4. It is evident that the precision and recall of RBF kernel is much higher than the polynomial kernel.

Fig. 4: Precision, Recall and ‘f’ Measure

V. CONCLUSION

In this paper, it is proposed to classify the ECG data by extracting energy using Discrete Cosine Transform. RR interval was extracted and used as feature. The time series data obtained from MIT-BIH is converted to frequency domain using Discrete Cosine Transform (DCT) for feature extraction. Two types of arrhythmia namely LBB and RBB are considered with normal beats were classified. Experimental results demonstrate the efficiency of the RBF kernel which achieves classification accuracy of 92.16%.

REFERENCES


DYNAMIC SCENARIO TRANSFORMATION IN SOFTWARE SYSTEM DESIGN

G. Manjula, Saleem Malik S, Deepa, Kannani and Jayprakash M

Abstract-- The ability of reconfiguring software architectures in order to adapt them to new requirements or a changing environment has been of growing interest. We propose a uniform algebraic approach that improves on previous formal work in the area due to the following characteristics. First, components are written in a high-level program design language with the usual notion of state. Second, the approach deals with typical problems such as guaranteeing that new components are introduced in the correct state (possibly transferred from the old components they replace) and that the resulting architecture conforms to certain structural constraints. Third, reconfigurations and computations are explicitly related by keeping them separate. This is because the approach provides semantics to a given architecture through the algebraic construction of an equivalent program, whose computations can be mirrored at the architectural level.

Keywords-- Dynamic Scenario, Software, Design.

I. INTRODUCTION

I. Literature Survey on Software Architecture

The goal of software architecture is to capture the persistent parts of the program and to derive the transient versions using architecture refinement. A number of architecture description languages are under development. Common too many of those architecture description languages is the concept of components and connections between them. The work at Northeastern on software architecture is distinguished by using adaptive programming (AP) to capture architecture. This has the advantage that architectural refinements can be automated in many cases. An adaptive program tries to capture the persistent parts of an object-oriented program by using traversals and context objects. Traversals are specified succinctly taking advantage of the structure of object-oriented programs. Work on AP is collected in the adaptive programming book and recent developments are described in Collaborative Behavior Modification.

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AP is programming by hooks which loosely couple the parts together. The program for each part defines hooks into other parts. When all parts are given, the hooks are combined, if necessary, by weaving instructions. (Consider borrow the term "weaving" from AOP; but AOP is more general than AP.) The hooks are used to form the weaving algorithm. In the simplest form of AP, the hooks are classes and edges in the class graph to which refer selectively to express context objects and traversals.

II. APPLICATION ARCHITECTURE:

Software Applications come in all shapes and sizes. Based on their design and architecture enterprise applications can be classified into various categories such as:

- Distributed Applications
- Web Applications
- Web Services
- Smart Client Applications

This reviews some of the architecture Design patterns for Enterprise Applications built using the .NET Platform. Simply put Application architecture is:

- Set of significant decisions about how a software system is organized
- Selection of the elements that the system comprises of
- Interfaces of the elements
- Behavior of these elements
- Interaction of these elements within the system and with other systems

Problem Analysis

Model-View-Controller is a fundamental design pattern for the separation of user interface logic from business logic. Unfortunately, the popularity of the pattern has resulted in a number of faulty descriptions. In particular, the term "controller" has been used to mean different things in different contexts. Fortunately, the advent of Web applications has helped resolve some of the ambiguity because the separation between the view and the controller is so apparent.

The Model-View-Controller (MVC) pattern separates the modeling of the domain, the presentation, and the actions based on user input into three separate classes. Model The model manages the behavior and data of the application domain, responds to requests for information about its state (usually from the view), and responds to instructions to change state (usually from the controller). View The view manages the display of information. Controller The